APEC ENERGY OVERVIEW 2015

Prepared by

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FOREWORD

The sustainable development and use of energy resources continues to be at the forefront of energy policy in APEC. Facilitating economic growth and securing adequate energy supply, while also taking into account the global responsibility for reducing greenhouse gas emissions, has resulted in a focus on energy efficiency and carbon emission reduction.

APEC economies continue to develop plans and measures to improve energy efficiency across all sectors of the economy. Most economies have followed-through on previously committed action plans to improve energy efficiency; embarked on efficiency awareness raising campaigns; promoted good energy management practices and facilitated investment in energy efficiency.

In a statement made in November 2011 at the APEC Ministerial Meeting in Honolulu, Hawaii, the APEC Ministers aspired to meet a new APEC-wide regional goal of reducing the energy intensity of the APEC economies by at least 45 percent by 2035, using 2005 as a base year. This came after reviewing data analysed by the APEC Energy Working Group (EWG) which indicated that APEC is on the path to significantly exceed its previous energy intensity goal. The 45% reduction is an aggregate goal, which recognizes that economies' rates of improvement may vary for many reasons.

In addition to this, at the APEC Energy Ministers Meeting in Beijing, China on September 2014, the Ministers reaffirmed the UN 'Sustainable Energy for All' initiative. They instructed the EWG through the Expert Group on New and Renewable Energy Technologies (EGNRET) to develop the road map for the aspirational goal of doubling the share of renewables in the APEC energy mix, including in power generation by 2030. As part of this Ministerial reaffirmation, the Asia Pacific Energy Research Centre (APERC) as well as EGNRET and Expert Group on Energy Data and Analysis (EGEDA) collaborated for facilitating discussions on this issue at EWG. The APEC Renewable Energy Share Doubling Goal will need to address either APEC energy security, reduction of carbon dioxide (CO2) or sustainable development and ensure goal setting is consistent with that of the APEC Energy Intensity Reduction Goal.

Sustainable energy development can be achieved by employing highly effective government policies and by broadening energy cooperation between economies through bilateral, regional and multilateral schemes. In this context, sharing information on common energy challenges is essential. The APEC Energy Overview is an annual publication intended to promote information sharing. It contains energy demand and supply data as well as energy policy information for each of the 21 APEC economies. It also contains information on notable energy developments, including those related to policy updates, upstream development, energy efficiency, low carbon energy, and environmental protection.

We hope that this report helps to deepen mutual understanding among APEC economies on energy issues in the region.

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ABBREVIATIONS AND SYMBOLS

Abbreviation	Term
B/D	barrels per day
Bcf	billion cubic feet
bcm	billion cubic metres
Btu	British thermal units
GW	gigawatt
GWh	gigawatt-hour
kL	kilolitre
km	kilometre
km/L	kilometres per litre
ktoe	kilotonne of oil equivalent
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
Mbbl/D	thousand barrels per day
ML	million litres (megalitre)
Mloe	Million litters of oil equivalent
MMbbl	million barrels
MMbbl/D	million barrels per day
MMBFOE	million barrels of fuel oil equivalent
MMBtu	million British thermal units
MMcf/D	million cubic feet per day
MMscf/D	million standard cubic feet per day
mpg	miles per gallon
Mt	million tonnes
Mtce	million tonnes of coal equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
PJ	petajoules
Tbbl/D	trillion barrels per day
tce	tonnes of coal equivalent
Tcf	trillion cubic feet
toe	tonnes of oil equivalent
tU	tonnes of uranium metal
TWh	terawatt-hours
W	watt

ACRONYMS

APEC	Asia–Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APP	Asia–Pacific Partnership on Clean Development and Climate
ASEAN	Association of Southeast Asian Nations
CBM	coal-bed methane
CCS	carbon capture and storage
CCT	clean coal technology
CDM	clean development mechanism
CFL	compact fluorescent lamp
CME	coconut methyl ester
COP 15	15th Conference of the Parties to the United Nations Framework Convention on Climate Change
CSM	coal-seam methane
DUHF	depleted uranium hexafluoride
EAS	East Asia Summit
EGEDA	Expert Group on Energy Data and Analysis
ESTO	Energy Statistics and Training Office, The Institute of Energy Economics, Japan
EEZ	exclusive economic zone
FEC	final energy consumption
GDP	gross domestic product
GHG	greenhouse gas
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
IPP	independent power producer
JOA	joint operating agreement
JOB	joint operating body
LCD	liquid crystal display
LED	light-emitting diode
LEU	low-enriched uranium
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MDKB	measured depth below kelly
MOPS	Mean of Platts Singapore
NGL	natural gas liquids
NGO	non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PES	primary energy supply

PPP	purchasing power parity
PSA	production sharing agreement
PSC	production sharing contract
PV	photovoltaic
RE	renewable energy
TFEC	total final energy consumption
TPES	total primary energy supply
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VAT	value added tax

CURRENCY CODES

Code	Currency	Economy
AUD	Australian dollar	Australia
BND	Brunei dollar	Brunei Darussalam
CAD	Canadian dollar	Canada
CLP	Chilean peso	Chile
CNY	yuan renminbi	China
TWD	New Taiwan dollar	Chinese Taipei
HKD	Hong Kong dollar	Hong Kong, China
IDR	rupiah	Indonesia
JPY	yen	Japan
KRW	won	Korea
MYR	Malaysian ringgit	Malaysia
MXN	Mexican peso	Mexico
NZD	New Zealand dollar	New Zealand
PGK	kina	Papua New Guinea
PEN	nuevo sol	Peru
PHP	Philippine peso	Philippines
RUB	Russian ruble	Russia
SGD	Singapore dollar	Singapore
THB	baht	Thailand
USD	US dollar	United States
VND	dong	Viet Nam

AUSTRALIA

INTRODUCTION

Australia is the world's largest island economy and the world's sixth largest economy in land area. It lies in the southern hemisphere between the Indian and Pacific oceans. Its total land area of nearly 7.7 million square kilometres (km^2) comprises six states and two territories. The population of just over 23 million lives mostly in major cities or regional centres along the eastern and south-eastern seaboards. The economy has maintained robust economic growth for the last 24 years and has had average annual growth rate (AAGR) of 3.4% from 1960 to 2015 (ABS, 2015). In 2013, gross domestic product (GDP) reached USD 936.9 billion (USD 2010 purchasing power parity [PPP]), a 2.5% increase from 2012 (EGEDA, 2015). Australia has the only developed economy in APEC to have recorded no annual recessions during the last 24 years (ATC, 2014).

Australia has abundant, high-quality energy resources that are likely to last for many decades at current rates of production. The Australian energy industry contributed to 4% (AUD 66.8 billion) of the economy in 2014–15 (OCE, 2016b).

In 2013–14, Australia's primary energy production fell by 4% to 18 715 petajoules (PJ) or 446 979 kilotonnes of oil equivalent (ktoe), compared with a 10% increase in 2012–13 (OCE, 2015a), due to lower uranium oxide and oil production. Australia produces energy for both domestic consumption and export. Energy exports grew by 2% compared with 14% in the previous year and accounted for 84% of domestic energy production in 2013–14 (OCE, 2015a).

Australia produces uranium for export only, while all other energy production supplies both domestic and international markets. Australia's energy production increased at an average annual rate of 2.3% from 2002–03 to 2012–13; however, it fell by 4% in 2013–14 (OCE, 2015a).

In 2013–14, coal accounted for 66% of Australia's primary energy production, in energy content terms, followed by uranium (14%) and gas (13%) (OCE, 2016a). Crude oil and liquefied petroleum gas (LPG) represented a further 4.5% of total energy production in energy content terms, and renewables represented 1.8% (OCE, 2015a). Relative to 2013–14, Australian export earnings from energy and mineral commodities decreased by 12% in 2014–15 to AUD 172 billion (OCE, 2015b).

As of 2013 Australia was the world's eighth-largest energy producer, accounting for around 2.4% of world energy production. It is the second largest exporter of coal (27% of total global coal exports in 2014) and a major exporter of uranium and liquefied natural gas (LNG) (10% of total global LNG exports) (OCE, 2016a). Given Australia's large energy resources and geographical proximity to burgeoning markets in the Asia-Pacific region, it is capable of meeting a significant proportion of the world's growing energy demand as well as its own domestic needs.

Table 1: Key data and economic profile, 2013

Key data [a]		**Energy reserves** [b]	
Area (million km^2)	7.7	Oil (billion barrels)	3.8
Population (million)	23.1	Gas (billion cubic metres)	3 738
GDP (2010 USD billion PPP)	937	Coal (million tonnes)	105 246
GDP (2010 USD PPP per capita)	405 154	Uranium (kilotonnes U)	3 472

Note: Coal reserves are defined as recoverable economically demonstrated resources of black and brown coal.
Sources: a. EGEDA (2015); b. GA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2013–14, Australia's total energy production was 18 715 PJ or 446 979 ktoe (OCE, 2015a). Approximately 66% of production came from coal, 4.5% from crude oil and LPG, 13% from gas, 14% from uranium and the remaining 1.8% from renewables (OCE, 2015a).

Australia accounts for around 9% of the world's black coal production and is the fourth largest producer behind the United States, India and China respectively (OCE, 2016a). Australian coking and steaming coals are high in energy content and are relatively low in sulphur, ash and other contaminants. Coal is Australia's second largest commodity export, earning AUD 38 billion in 2014–15 followed by LNG (AUD 17 billion) and crude oil (AUD 8.7 billion) (OCE, 2015b). Coal is also an important component of domestic energy supply, accounting for approximately 61% of total electricity generation in 2013–14 (OCE, 2015a).

Gas has become increasingly important to the Australian economy, both as a source of export income and as a contributor to domestic energy needs. Almost all of Australia's conventional gas comes from three basins: the offshore Carnarvon Basin, Western Australia; the offshore Gippsland Basin, Victoria; and the onshore Cooper–Eromanga Basin, which straddles the South Australian and Queensland boundary (GA, 2014). Gas production in 2013–14 of 63 billion cubic metres (bcm) was relatively stable, the Macedon gas processing plant began operating in 2013 and offset reductions at some existing fields (OCE, 2015a).

The production of coal seam gas (CSG), which is produced mainly in New South Wales and Queensland, increased 45% from 2013–14 levels to 11.84 bcm (OCE, 2016b). CSG production is projected to grow over the next five years.

Australia is a net importer of oil products, but a net exporter of LPG (OCE, 2016). Australia's crude oil and LPG production declined by 4% in 2013–14 relative to 2012–13 largely due to its mature oil fields scheduling production outages (OCE, 2015a). Australia's oil production is likely to continue to decline due to maturing oil fields and limited plans to develop existing proven and untested reserves (OCE, 2015a).

In 2013–14, 248 297 gigawatt-hours (GWh) of electricity was generated, mostly from coal (61%) (OCE, 2015a). Given its abundance, coal is likely to remain the most commonly used fuel for electricity generation. However, a large number of wind and solar energy projects are planned or underway. They are expected to account for an increasing proportion of total electricity generation over the medium to long term. In 2013–14, the share renewable energy in the electricity generation mix increased to 15% from 8% in 2003–04 and Australia's solar PV generation became the eighth largest in the world.

FINAL ENERGY CONSUMPTION

In 2013–14, Australia's total energy consumption continued its decline that began in 2011–12, and consumption reached approximately 2009–10 levels at 5 831 PJ (or 139 264 ktoe) (OCE, 2015a). In 2013–14, the transport sector marginally overtook the electricity generation sector as the largest energy-consuming sector at 27.3% of Australia's total net energy consumption. The electricity generation sector followed at 27% and then the manufacturing sector at 20% (OCE, 2015a). This was followed by the mining (9.1%), residential (7.7%), commercial (5.4%) and other (3.2%) (OCE, 2015a). By energy source, oil accounted for 38% of consumption in 2013–14, coal 32%, gas 24% and renewables 5.9% (OCE, 2015a). Gas has increased because of greater uptake by the electricity generation sector and growth in mining and industrial use (OCE, 2015a). The share of renewable energy consumption has increased over the past few years, with an increase of 4% between 2012–13 and 2013–14. Between 2012–13 and 2013–14, there has been growth across all types of renewables used in electricity generation including solar, wind, hydro, biomass, biogas and geothermal (OCE, 2015a).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		**Final energy consumption (ktoe)**		**Power generation (GWh)**	
Indigenous production	343 920	Industry sector	24 708	Total power generation	248 961
Net imports and others	–209 704	Transport sector	31 143	Thermal	217 700
Total primary energy supply	129 176	Other sectors	19 689	Hydro	18 171
Coal	45 676	Non-energy	4 738	Nuclear	–
Oil	45 889	Total final energy consumption	80 278	Others	13 090
Gas	29 727	Coal	2 796		
Other	7 885	Oil	41 706		
		Gas	13 469		
		Electricity and others	22 309		

Source: EGEDA (2015).

For full details of the energy balance table, please see www.ieej.or.jp/egeda/database/database-top.html.

ENERGY INTENSITY ANALYSIS

Australia is contributing to APEC's aspirational goal of a 45% energy intensity reduction by 2035 from 2005 levels. Over the last 40 years, Australia's energy intensity has generally improved (OCE, 2015a). In 2013–14, energy intensity declined by 4%. According to Australian Government analysis, changes in energy consumption are broken down into the activity effect, which uses changes in the output or level of activity; the structural effect, which uses changes in the composition of activity; and the efficiency effect, which relies on changes in energy intensity. In 2013, an analysis of APEC Energy Statistics found an improvement in final energy demand of 1.4% from 2012 levels.

Australia's energy intensity improvements are due to developments in energy efficiency. These developments originate from two sources: advances in technology and the movement of industry structures towards less energy-intensive areas such as the commercial and service sectors.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	138.3	137.9	–0.3
Total final energy consumption	87	86	–1.4
Industry	25.8	26.3	2.2
Transportation	34	33	–2.4
Others	22	21	–3.5
Non-energy	5.2	5.1	–3.1

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Australia's system of government has three tiers: federal government; six state governments and two territory governments; and local governments. The federal government or the state/territory governments, rather than private individuals, own Australian energy resources. None of the tiers of government engage in commercial exploration or development. The Australian Federal Government has title and power over energy resources located outside the first three nautical miles of the territorial sea ('offshore').

The state governments and the Northern Territory have jurisdiction over resources on their lands or inside the first three nautical miles of the territorial sea ('onshore'). Each state government oversees the approvals process for unconventional gas exploration for their jurisdiction. However, the Australian Government, in the form of the Australian Department of the Environment, considers aspects of 'national environmental significance' in accordance with the Environment Protection and Biodiversity Conservation Act 1999. In this process, each state/territory assesses applications from organisations that are hoping to explore in its area. Each state/territory then declines or grants access. Similarly, each state/territory carries out the assessment of safety requirements and environmental regulations for the coal industry in its respective jurisdiction.

The Australian Department of Industry, Innovation and Science oversees resources and energy matters at a federal level. This includes energy security, international engagement, energy efficiency programs and energy markets.

The Australian Government has committed to a set of signature economy-wide reforms that respond to rising business and household costs. These are outlined in its 2015 Energy White Paper. The Energy White Paper provides a coherent, integrated and efficient regulatory and policy framework that stimulates sustainable growth, builds community confidence in environmental safeguards and grows investment in the energy sector. See also the section entitled 'Notable Energy Developments'.

In December 2013, the Council of Australian Governments' (COAG) Energy Council replaced the COAG Standing Council on Energy and Resources (SCER). The COAG Energy Council is a Ministerial forum for the Commonwealth, states, territories and New Zealand to work together in the pursuit of national energy reforms. Such action includes developing and implementing an integrated and coherent

energy and mineral resources policy. The COAG Energy Council is responsible for the remits of the former SCER, the Ministerial Council on Energy (MCE) and the former Ministerial Council on Mineral and Petroleum Resources (Industry, 2015a). The Australian Minister for Resources, Energy and Northern Australia chairs the Energy Council.

The Energy Council's work covers the following broad themes:

- Overarching responsibility and policy leadership for Australian gas and electricity markets;
- The promotion of energy efficiency and energy productivity in Australia;
- Australian electricity, gas and petroleum product energy security;
- Cooperation between Commonwealth, state and territory governments; and
- Facilitating the economic and competitive development of Australia's mineral and energy resources.

ENERGY SECURITY

Australia's energy security policy does not equate to energy independence or self-sufficiency in a particular energy source. Instead, energy security is enhanced by diverse commercially driven fuel options and supply and delivery sources, including through the importation of liquid fuels from multiple supply and delivery sources.

The Australian Government assesses Australia's energy security through National Energy Security Assessments (NESAs) that consider the effectiveness and anticipated resilience of Australia's electricity, natural gas and liquid fuel markets and changes in energy security drivers.

The Australian Government broadly defines energy security as the *adequate*, *reliable* and *competitive* supply of energy to support the functioning of the economy and social development. *Adequate* is defined as the provision of sufficient energy to support economic and social activity; *reliable* as the provision of energy with minimal disruptions to supply; and *competitive* as the provision of energy at an affordable price.

In 2009, the Australian Government released the inaugural NESA, which found that Australia's energy sector was adequately meeting Australia's economic and social needs. The second assessment in 2011 found that Australia's energy security situation continued to be robust. Further, Australia's overall energy security should remain adequate and reliable because of the level of new investment going forward and the price of energy. Work has commenced on the development of the next NESA. The updated NESA webpage link is www.industry.gov.au/Energy/EnergySecurity/nesa/Pages/default.aspx.

The Australian Government has committed to present a plan to return to compliance to the International Energy Agency in mid-2016.

UPSTREAM ENERGY DEVELOPMENT

The following basic principles guide the Australian Government's approach to developing the economy's energy resources:

- The efficient commercial development of energy resources should be promoted in order to provide the highest-value return for the community;
- Energy resource development should be safe and sustainable, and consistent with all relevant environmental and health and safety standards and obligations;
- The development of Australia's energy resources should contribute to its on-going domestic energy security;
- The development of Australia's energy resources should enhance its international competitiveness; and
- The energy resource development framework should interface appropriately and effectively with other relevant markets or regulatory frameworks in order to support efficient investment in upstream development and downstream supply capacity.

The Australian Government does not undertake or finance energy resource exploration or development. In the offshore petroleum sector, the Australian Government relies on an annual acreage release of vacant offshore areas in order to create opportunities for investment. The release, distributed worldwide, is a comprehensive package, which includes geological details of the acreage, bidding requirements and investment considerations for each release area on offer. The onshore petroleum sector is managed by the relevant state/territory jurisdictions.

ENERGY MARKETS

MARKET REFORMS

Energy market reform is a priority issue for the COAG Energy Council under the energy market reform program (Industry, 2015a). To date, reforms have included creating the National Electricity Market (NEM), supporting legislation and an Australian Gas Market Development Plan. Details on recent market reforms are available on the COAG Energy Council website: www.scer.gov.au/ (COAG, 2015).

ELECTRICITY AND GAS MARKETS

The NEM was established in 1998 to allow the interjurisdictional flow of electricity between the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria (Tasmania joined the NEM in 2005). The NEM is not connected to Western Australia because of the state's distance from the rest of the market. The NEM comprises a wholesale sector and a competitive retail sector. All electricity dispatched must be traded through the central pool, where output from generators is aggregated and scheduled to meet demand.

The Australian gas market is separated into three distinct regional markets defined by the pipeline transmission infrastructure—the eastern gas market (including the Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania and Victoria), the northern gas market and the western gas market.

Australia's gas markets are projected to undergo major changes in the period to 2030, with the development of new unconventional gas resources causing an expected tripling of domestic gas production in response to strong international and steady domestic demand growth. On 3 January 2014, in response to concerns about the dynamics of the eastern Australian gas market during this transition, the Australian Government released the Eastern Australian Domestic Gas Market Study. The objective of this study was to inform policymakers of the demand-supply situation in the eastern Australian gas market and the barriers to domestic gas supply from 2012–23. The study also discussed canvassing opportunities that could improve market efficiency. In its Energy White Paper, the Australian Government and the COAG Energy Council rejected the need for government interventions such as the establishment of a gas reservation (Industry, 2015b). The study and the White Paper will be complemented by two reviews currently underway. The first is from Australia's Competition and Consumer Commission (ACCC) and the second from the Australian Energy Market Commission (AEMC). Both reports are expected to provide recommendations for market reforms to increase supply, improve transparency of market trading and increase liquidity in the market. The reports are due for public release in May 2016.

A key component of the on-going energy market reforms was the establishment on 1 July 2009 of the Australian Energy Market Operator (AEMO). The AEMO represents the amalgamation of six electricity and gas market bodies: the National Electricity Market Management Company (NEMMCO), the Victorian Energy Networks Corporation (VENCorp), the Electricity Supply Industry Planning Council, the Retail Energy Market Company (REMCO), the Gas Market Company and the Gas Retail Market Operator (AEMO, 2015).

The AEMO's functions include operating the NEM and the retail and wholesale gas markets in eastern and southern Australia; overseeing the system security of the NEM electricity grid and the Victorian gas transmission network; economy-wide transmission planning; and establishing a short-term trading market for gas from 2010 (AEMO, 2015).

The AEMO is also responsible for improving the operation of Australia's energy markets. It prepares and publishes a 20-year National Transmission Network Development Plan, which provides information to market participants and potential investors. In addition, it publishes the Statement of Opportunities regarding electricity, and the new Gas Market Statement of Opportunities, both of which forecast long-term supply and demand. It also maintains Australia's gas market Bulletin Board (AEMO, 2015).

The AEMO oversees Australia's energy market governance in cooperation with the Australian Energy Market Commission (AEMC), which is the rule-making body, and the Australian Energy Regulator (AER), which is the regulating body. The COAG Energy Council, comprising energy and resources ministers from all Australian governmental tiers, is responsible for energy policy and the legislative frameworks under which the AEMO, AEMC and AER operate.

A review of the governance arrangements of these three energy institutions was released in October 2015. It considered the performance of current governance arrangements for energy markets and provided advice to the COAG Energy Council on potential areas of improvement to the institutions and their oversight by the COAG Energy Council. The report is available at www.scer.govspace.gov.au/workstreams/energy-market-reform/review-of-governance-arrangements. The

COAG Energy Council provided its response to the review in December 2015 and mostly agreed with the recommendations.

FISCAL REGIME AND INVESTMENT

FEDERAL CORPORATE INCOME TAX

The corporate taxation treatment of companies operating in the energy sector is generally the same as the treatment of corporations in all other industries. Corporations that earn income in Australia are subject to corporate income tax. This is imposed at a rate of 30%. Project ring fencing does not apply, and the profits and losses of one project can be used to offset those of another project, subject to common ownership criteria.

Certain expenditure incurred by energy companies, such as exploration expenditure and royalty payments, are immediately deductible for corporate income tax purposes. Other indirect taxes, such as payroll tax, fringe benefits tax, fuel excise and land taxes may apply.

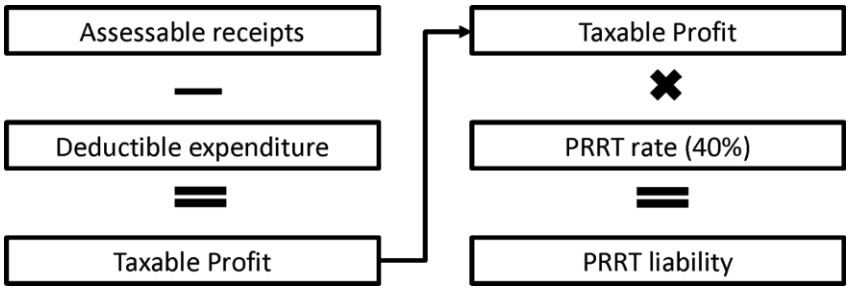
FEDERAL PETROLEUM RESOURCE RENT TAX

The Petroleum Resource Rent Tax (PRRT) is a federal profits-based tax payable on the upstream profits of a petroleum project. The PRRT has been in operation in Australia since 1 July 1986. Previously applied solely to operations in offshore Australia, the PRRT was extended to apply to all onshore and offshore projects operating in Australia from 1 July 2012 (ATO, 2014a).

Unlike royalty and excise regimes, the PRRT applies to the profits derived from a petroleum project and not the volume or value of the petroleum produced. In order to ensure that only the economic rent generated from a petroleum project is captured by the PRRT, deductions are provided for all allowable expenditure (together with indexation of carry-forward losses). Further, when other layers of resource taxes are applicable, such as state and territory royalties and federal crude oil excise, such expenditure is creditable against the liabilities of PRRT projects. This ensures that petroleum projects are not subject to double taxation (ATO, 2014a).

PRRT applies at a rate of 40% to taxable profit derived in a financial year from a petroleum project. Taxable profit is calculated by deducting eligible project expenses from the assessable revenues derived from the project. Because the PRRT is a project-based tax, losses may not generally be offset against other project income. The exception is exploration expenditure, which is transferable to other petroleum projects subject to conditions. PRRT payments are deductible for income tax purposes. Further, PRRT liability is calculated in accordance with Figure 1 below (ATO, 2014a).

Figure 1: Calculating a PRRT liability



Source: ATO (2014a).

ROYALTIES

Royalties are generally levied by the states. They are an alternative mechanism of charging for resource extraction. Royalty rates vary across states and commodities. They are either specific, *ad valorem*, profit based or a hybrid (flat *ad valorem* with a profit component). With regard to petroleum, the state and Northern Territory governments collect royalties for onshore production. The rate is generally from 10% to 12.5% of the net wellhead value of production, depending on whether it is from a primary or secondary production licence or a combination of these.

With regard to offshore production (excluding petroleum), 60% of the royalties are directed to the state or territory government and the remaining 40% to the Australian Government.

FEDERAL CRUDE OIL EXCISE

Excise arrangements apply to eligible crude oil and condensate production from the North West Shelf project area and onshore areas (including coastal waters). Excise is levied on the price of all sales made in a

producing region at rates based on the timing of the discovery and/or the date of development. The first 30 000 barrels of cumulative production from each field are exempt from crude oil excise.

EXPLORATION DEVELOPMENT INCENTIVE (EDI)

With effect from 1 July 2014, the Australian Government introduced the EDI to encourage investment in small exploration companies that undertake 'greenfields' mineral exploration in Australia. The scheme is available to junior mineral exploration companies that incur eligible 'greenfields' exploration expenditure in Australia.

When a mining company does not have sufficient income to utilise exploration deductions, the EDI provides a mechanism for Australian resident shareholders to deduct the expense of mining exploration against their taxable income. The EDI does not apply to exploration for quarry materials, petroleum exploration (including exploration for natural gas from coal seams and shale oil) or geothermal energy resources.

RESEARCH AND DEVELOPMENT TAX INCENTIVE

The research and development tax offset has been in effect since 1 July 2011. The two core components of the package are:

- A 45% refundable tax offset for companies with a turnover of less than AUD 20 million per year; and
- A 40% non-refundable tax offset for aggregate turnover equal to or greater than AUD 20 million per year.

JOINT PETROLEUM DEVELOPMENT AREA

Petroleum produced within the Joint Petroleum Development Area (JPDA) is subject to fiscal terms outlined in a Production Sharing Contract (PSC). PSCs are agreements between the parties to a petroleum extraction facility and the Australian and East Timorese governments regarding the percentage of production each party will receive after the participating parties have recovered a specified amount of costs and expenses. Government revenues from petroleum extracted within the JPDA are shared 90% to Timor-Leste and 10% to Australia.

MINERALS RESOURCE RENT TAX (MRRT)

The MRRT regime previously applied to iron ore and coal mining in Australia from 1 July 2012. However, the Australian Government repealed the MRRT in September 2014. Consequently, from 1 October 2014, MRRT liable entities do not accrue further liabilities (ATO, 2014b).

INVESTMENT

The Australian energy sector faces challenges in attracting investment over the next decade, although Australia's practical investment needs over this period will depend on long-term demand trends. The AEMO 2015 National Transmission Network Development Plan (NTNDP) identified that expenditure in the electricity sector will continue to focus on replacing ageing transmission network infrastructure rather than investing in new network capacity, especially given that electricity demand has been declining in recent years (AEMO, 2015). According to the NTNDP, 'total annual investment in transmission networks across the NEM has decreased, from AUD 1 282 million in 2008–09 to AUD 745 million in 2014–15, whereas replacement expenditure has more than doubled over the same period (AEMO, 2015).

ENERGY EFFICIENCY

In December 2015, the COAG Energy Council released the National Energy Productivity Plan (NEPP). By better coordinating energy efficiency, energy market reform and climate policy, the NEPP brings together new and existing measures from across the COAG Energy Council's work program, as well as from the Commonwealth and industry. The NEPP provides a framework and an economy-wide work plan designed to coordinate efforts and accelerate improvement to deliver a 40% improvement in Australia's energy productivity from 2015 to 2030. Current research suggests that Australia can meet this target by implementing financially attractive end-use energy efficiency initiatives alone. In particular, there are cost-effective opportunities to improve energy productivity in the transport, manufacturing and building sectors. (Please see a more detailed section on NEPP under 'Notable Energy Developments' below).

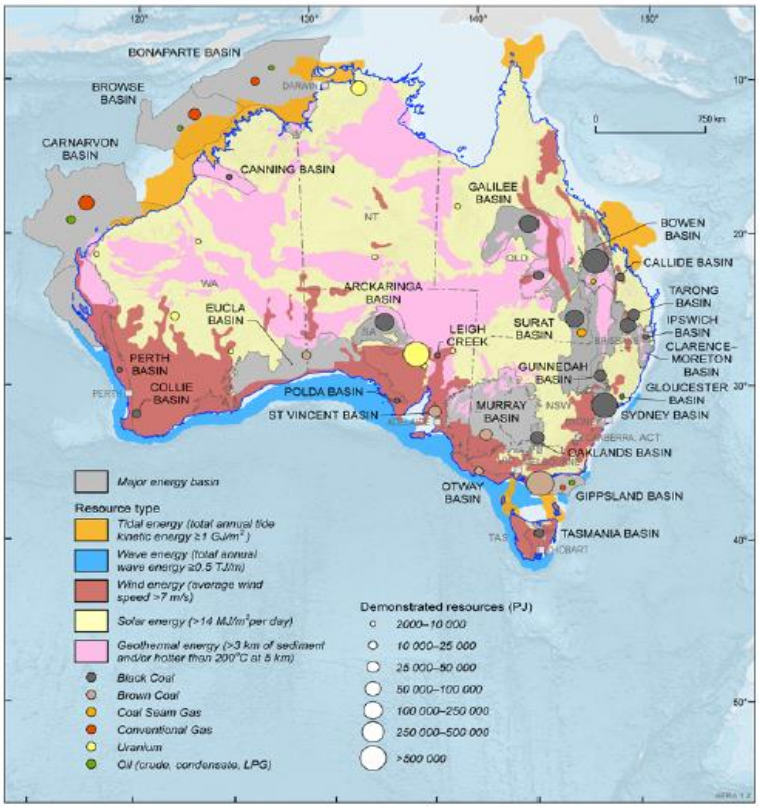
Energy productivity is a measure of the amount of economic output derived from each unit of energy consumed. Over recent years, Australia's energy productivity has improved, growing at around 1.8% per year in the last decade. Despite this, Australia is still lagging behind many economies and countries such as Japan, Germany and the United Kingdom. The NEPP takes action to address this gap. In the past,

improving Australia's energy productivity has been challenging because of either a formal or informal separation between supply-side energy market reform and demand-side energy efficiency actions. The NEPP aims to bring supply and demand side policy closer together in order to fully realise the benefits to both the customer and the broader energy system. By supporting better energy management practices and lowering energy costs, this focus on energy productivity will help Australian businesses compete internationally, growing the economy and creating jobs. The potential for improvement under the NEPP is great. Australian industry has identified potential energy savings of 164.2 PJ per year (more energy than Tasmania uses annually) and potential annual net financial benefits of AUD 1.2 billion.

RENEWABLE ENERGY

Australia has abundant and diverse clean energy resources with significant potential for future development, as shown in Figure 3. Solar PV generation by 27% in 2013–14 from 2012–13 (OCE, 2015a). Wind-powered electricity generation increased by 29% in 2013–14 compared with 2012–13 (OCE, 2015a). Hydro also increased 0.83% in 2013–14 compared with 2012–13 and contributed to just under 50% of total renewable generation, compared with 55% in in 2012–13 (OCE, 2015a).

Figure 3: Map showing the distribution of Australia's energy resources



Source: GA (2014).

The Renewable Energy (Electricity) Amendment Act 2009 and the Renewable Energy (Electricity) (Charge) Amendment Act 2010 were passed in September 2009 and June 2010 respectively. The Renewable Energy (Electricity) Amendment Act 2009 modified the Renewable Energy (Electricity) Act 2000 to enable the Australian Government to replace the Mandatory Renewable Energy Target (MRET) with the expanded Renewable Energy Target (RET) from 1 January 2010 (Environment, 2015a).

In June 2010, the Australian Government passed further legislation to split the expanded RET into two parts. Effective 1 January 2011, the enhanced RET includes the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). This enhanced RET aims for at least 20% (or approximately 60 000 GWh) of electricity generation to be provided from renewable sources by 2020. This includes a target of 45 000 GWh of new renewable electricity generation in addition to the 15 000 GWh of existing renewable electricity generation. The LRET is expected to deliver most of the 2020 target (41 000 GWh). The uncapped SRES provides a subsidy to small-scale technologies, such as residential solar panels and solar hot water systems.

In 2015, the Australian Government undertook a review of the RET and revised the target to 33 000 GWh from large-scale renewable energy by 2020.

The Australian Renewable Energy Agency (ARENA) is an independent agency established by the Australian Government on 1 July 2012. It has AUD 2.5 billion until 2022 to fund renewable energy projects (e.g. solar, bioenergy, marine, geothermal and enabling technologies such as storage). It also supports research and development, commercialisation and early deployment activities, together with activities that capture and share knowledge. The two objectives of ARENA are to improve the competitiveness of renewable energy technologies and to increase the supply of renewable energy in Australia. The Australian Centre for Renewable Energy and the Australian Solar Institute has been incorporated into ARENA. By June 2015, ARENA had committed AUD 1.1 billion in support of more than 200 projects, studies fellowships and scholarships, which have a total value of AUD 2.7 billion (ARENA, 2015).

ARENA's independent decision-making board, also referred to as the 'Board', consists of up to seven members appointed by the Minister for the Environment. The Board also has a CEO appointed by the Minister for the Environment on the recommendation of the members. Membership of the Board reflects the skills required to meet the objectives of ARENA. For more information, see www.arena.gov.au.

There is no Australia-wide feed-in tariff scheme to support small-scale renewable technologies. Most state and territory governments implemented jurisdictional feed-in tariff arrangements for small-scale renewable technologies; however, some of these schemes have now been amended or closed.

In 2015, approximately 15% of Australian households had solar PV installed. Consequently, total solar PV generation reached 4.9 GW of installed solar, a 27% increase from 2012–13 (OCE, 2015a). Most of this capacity is small-scale rooftop systems. In 2015, wind grew by 29% and now accounts for 31% of South Australia's total fuel mix, an increase of 25% from 2013–14.

Over the long term, renewables consumption is expected to increase by approximately an AAGR of 0.9% to 2049–50 and renewables in electricity generation will grow by an AAGR of 1.5% to 2049–50 (BREE, 2014). Renewables generation is expected to grow to 20% of the percentage share of electricity generation by 2049–50, with 10% coming from wind energy (BREE, 2014).

ENERGY TECHNOLOGY AND RESEARCH AND DEVELOPMENT

In the Australian science system, the bulk of basic research is conducted in the university sector. Funding delivery occurs through organisations such as the Australian Research Council, which has established a range of competitive grant schemes. Further, the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Energy Flagships program provides a focus for energy research and development in Australia, and ARENA supports research and development into renewable energy through funding and knowledge sharing.

NUCLEAR

Australia does not have any commercial nuclear reactors.

CLIMATE CHANGE

The Australian Government is committed to reducing Australia's greenhouse gas emissions by 5% below 2000 levels by 2020. The Emissions Reduction Fund (ERF) is the government's program to meet this target. Legislation for the ERF passed parliament on 31 October 2014 (Environment, 2015b).

The fund has three main components: crediting emissions reductions, purchasing emissions reductions and safeguarding emissions reductions (CER, 2015). The emissions reduction fund enables the Australian Government to 'purchase lowest cost abatement (in the form of Australian carbon credit units) from a wide range of sources' (CER, 2015). The Clean Energy Regulator (CER) administers the fund. The fund operates as a reverse auction where the government purchases emissions reductions on eligible carbon reduction projects. The total amount of money in the fund is AUD 2 550 million (USD 2 300 million). In the two fund auctions so far, the Government has contracted to purchase over 92 million tonnes of emission reductions from 275 projects at an average price of AUD 13.12 per tonne of abatement (CER, 2015).

The carbon tax was repealed by Parliament with effect from 1 July 2014 (Environment, 2015c).

Australia's Intended Nationally Determined Contribution (INDC), submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, is set as 26–28% below 2005 levels by 2030.

NOTABLE ENERGY DEVELOPMENTS

ENERGY WHITE PAPER 2015

On April 2015, the Australian Government released the Energy White Paper. This sets out Australia's plan to increase competition, keep prices down, increase 'energy productivity'[1] by 40% from 2015 to 2030 through the introduction of a national energy productivity plan, and increase energy resource development in order to encourage innovation and investor confidence.

Under the 2015 Energy White Paper, the Australian Government aims to achieve its 40% 'energy productivity' target by addressing energy efficiency in buildings, appliances and equipment, and vehicles. It will also coordinate more effectively data among energy-use related government departments and agencies in order to assist decision-makers with planning and forecasting. The government plans to implement market reforms in order to improve consumer choice and lower energy costs through information and voluntary action programs, and market and regulatory measures. Buildings are particularly important. The government is extending the existing Commercial Building Disclosure (CBD) program, which requires the mandatory disclosure of energy ratings for commercial building sales where the area is larger than 2 000 square metres, to cover buildings of 1 000 square metres as well.

There are several programs that are designed to encourage innovation and investor confidence. For example, the AUD 5 billion (USD 4.5 billion) Asset Recycling Initiative encourages states and territories to privatise state-owned electricity assets in order to release capital for investment in new infrastructure. The money from the sales is for new roads, ports and rail projects that are related to energy market competiveness. The AUD 188.5 million (USD 170 m) Industry Growth Centres improve competitiveness and productivity by focusing on areas of competitive strength. The sectors involved include oil, gas and energy resources, and mining equipment, technology and services. The AUD 476 million (USD 429 m) Industry Skills Fund helps to develop the highly skilled workforce that is needed to adapt to new business growth opportunities, rapid technological change and market-driven structural adjustment. It will focus on training for the oil, gas and energy resources sector and the mining equipment, technology and services sector with regard to small to medium enterprises. For more information, see www.ewp.industry.gov.au.

NATIONAL ENERGY PRODUCTIVITY PLAN

The Australian Government is strongly committed to a National Energy Productivity Target of a 40% improvement between 2015 and 2030. To meet this commitment, the Australian Government, along with states and territories, developed the NEPP, which, as mentioned above, was released by the COAG Energy Council in December 2015. The NEPP is expected to contribute more than a quarter of the savings required to meet Australia's 2030 greenhouse gas emissions reduction target and will complement existing policies such as the Emissions Reduction Fund while aiming to avoid placing additional burdens on business.

The NEPP covers all energy use, including electricity, gas and transport fuels, and incorporates:

- Energy market reforms to promote consumer choice and increase competition and innovation in the energy market; and
- Energy efficiency measures that support better energy use in buildings, equipment and vehicles.

The NEPP includes both existing and new initiatives that support:

- More productive consumer choices when selecting energy services through, for example, cost-reflective prices, smart meters and access to information, and labels; and
- More productive energy services through innovation and competition, such as the reduction of barriers to entry in the market for new technologies and service options, and through more efficient minimum standards for equipment, appliances and buildings.

In order to meet Australia's proposed 40% improvement in accordance with the 2030 energy productivity target, Australia must increase its annual productivity improvement from 1.5 to 2.3% per year. This target has been designed to be large enough to promote real change while still being achievable.

[1] An Australian Government term that encompasses energy efficiency, reducing energy intensity and energy costs while promoting economic growth and competitiveness. The government defines it as 'the economic value created for every unit of energy consumed'.

VEHICLE EMISSIONS REFORMS

On 2 November 2015, the Australian Government announced that it is taking a 'whole of government' approach to address vehicle emissions with a Ministerial Forum to examine vehicle emissions standards in Australia and vehicle testing arrangements. The Ministerial Forum is supported by a working group that is examining issues that include implementation of Euro 6, fuel quality standards, fuel efficiency measures (CO_2) for light vehicles and emission testing arrangements.

Australia already has in place a mandatory consumer information program that mandates fuel efficiency labelling on new cars, as well as a voluntary program through the Green Vehicle Guide that aims to assist consumers to make informed purchasing decisions.

The Government will examine further measures such as incentives and standards to encourage the purchase of more fuel-efficient vehicles.

G20–INTERNATIONAL ENERGY FORUM GAS MARKETS DIALOGUE

In November 2014, Australia and Mexico co-chaired the G20–International Energy Forum (IEF) Gas Markets Dialogue. It was the first G20IEF and aimed to bring together gas industry experts from business, government and international and regional organisations in order to enhance collaboration and identify practical ways to improve the ways in which gas markets function. The dialogue centred around three themes: increasing market transparency, encouraging investment in gas infrastructure and exchanging information about regional approaches to increasing gas market resilience and security.

G20 ENERGY EFFICIENCY ACTION PLAN

As president of the G20 in 2014, Australia led the development of the G20 Energy Efficiency Action Plan. This was endorsed by G20 leaders at the November G20 summit and provides a significant step towards the global improvement of energy efficiency through international cooperation.

The G20 Energy Efficiency Action Plan documents six work streams whereby G20 members and guests work together in order to improve energy efficiency. Each G20 member and guest chose the work streams in which they intended to participate. These work streams were progressed through the International Partnership for Energy Efficiency Cooperation (IPEEC) and other international organisations such as the IEA throughout 2015. The G20 also tasked the IPEEC to report on the development of these activities to the G20 at the end of 2015. The plan is available for download here: www.g20.org/sites/default/files/g20_resources/library/g20_energy_efficiency_action_plan.pdf.

OFFSHORE PETROLEUM RESOURCES MANAGEMENT REVIEW

The Australian Government Department of Industry, Innovation and Science is finalising a high-level strategic review of the offshore petroleum frameworks that govern oil and gas resource management in Commonwealth waters. The Offshore Petroleum Resources Management Review aims to refine the regulatory and administrative frameworks that support timely and efficient commercial investment, exploration and development. It will outline actions to improve the effectiveness of how resources are managed and operated; provide greater flexibility and better alignment with technical and operational realities; improve transparency; and reduce costs, including through improved administrative efficiency. A final report is scheduled for release in 2016.

The terms of reference is available for download at: www.industry.gov.au/resource/UpstreamPetroleum/Pages/Offshore-Petroleum-Resources-Management-Review.aspx.

NEW ENERGY PROJECTS

Australia's production and infrastructure capacity will be expanded in the future through the completion of new projects. The Australian Government's *Electricity Generation Major Projects* provides a list of major electricity generation facilities under development, including renewable and non-renewable sources. It is available at www.industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Electricity-generation-major-projects.aspx.

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USEFUL LINKS

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Australian Energy Market Commission—www.aemc.gov.au

Australian Energy Market Operator—www.aemo.com.au

Australian Energy Regulator—www.aer.gov.au

Australian Government—www.australia.gov.au

Australian Government Department of Industry and Science—www.industry.gov.au

Office of the Chief Economist—www.industry.gov.au/industry/Office-of-the-Chief-Economist/Pages/default.aspx

Clean Energy Regulator—www.cleanenergyregulator.gov.au

Commonwealth Law—www.comlaw.gov.au

Energy White Paper—www.ewp.industry.gov.au

BRUNEI DARUSSALAM

INTRODUCTION

Brunei Darussalam, which means 'Brunei the Abode of Peace', is a monarchy state in South-East Asia. Located between the Malaysian states of Sabah and Sarawak on the north-west coast of the island of Borneo, it covers a total land area of around 5 765 square kilometres (km^2) and has a 161-kilometre coastline along the South China Sea. Brunei Darussalam has four districts, namely Brunei Muara, Tutong, Belait and Temburong. In 2013, the economy had a small population of about 406 200. More than half of the population lives in the Brunei Muara district where the economy's capital city, Bandar Seri Begawan, is located. This district is also the hub of government and business activities. Seria, a town in the Belait district, is the site of the first commercial discovery of an onshore oilfield and remains at the heart of the oil and gas industry in Brunei Darussalam.

In 2013, Brunei Darussalam had a gross domestic product (GDP) of USD 28 billion (2010 USD purchasing power parity [PPP]). The economy's GDP per capita is the one of the highest in the APEC region at USD 70 010 (2010 USD PPP). Revenues from the oil and gas sector constitute more than 60% of the economy's GDP. This has enabled the citizens of Brunei Darussalam to enjoy a high standard of living, with free health and education among other services. The government has made economic diversification its main economic priority in order to decrease its strong reliance on the oil and gas industry. This strategy includes diversification within the oil and gas industry; hence, the government is actively strengthening oil and gas upstream and downstream activities as well as energy services.

Table 1: Key data and economic profile, 2013

Key data[a, b]		Energy reserves[c]	
Area (km^2)	5 765	Oil (billion barrels)	1.1
Population (thousand)	406.2	Gas (billion cubic metres)	300
GDP (2010 USD billion PPP)	28	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	70 010	Uranium (kilotonnes U)	–

Sources: a. DEPD (2015); b. EGEDA (2015); c. BP (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The main energy resources in Brunei Darussalam are oil and gas. The oil that is produced is mostly exported as term and spot cargoes with a small percentage refined at the Brunei Shell Refinery. About 90% of gas that is produced is exported as liquefied natural gas (LNG). The remaining gas is used domestically to generate electricity and town gas. The economy's largest LNG export partners are Japan and the Republic of Korea. Both countries have long-term contracts with Brunei Darussalam. Another long-term supply agreement was made in 2013 with a buyer in Malaysia. Further, a growing spot trade was recorded from Chinese Taipei, China and India during the same period.

In 2013, the total primary energy supply of Brunei Darussalam was 2 847 kilotonnes of oil equivalent (ktoe), of which 79% was represented by natural gas and 21% by oil. Natural gas production was around 33.5 million cubic metres a day and oil production was 135 160 barrels per day (bbl/d). The main export destinations for Brunei Darussalam's crude oil and condensate in 2013 were the Republic of Korea (18%), India (16%), Australia (15%), Vietnam (11%), Indonesia (11%) and New Zealand (10%). Meanwhile, other export destinations were Thailand (8%), Japan (6%), China (3%), the Philippines (1%) and Singapore (1%).

Brunei Darussalam's total installed electricity generation capacity of public utilities and auto producers reached 917 megawatts (MW) in 2013. In the same year, total electricity generated was 4 404 gigawatt-hours (GWh). Almost all of the electricity was generated by natural gas (EGEDA, 2015).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	18 349	Industrial sector	156	Total power generation	4 404
Net imports and others	–15 417	Transport sector	447	Thermal	4 402
Total primary energy supply	2 847	Other sectors	313	Hydro	–
Coal	–	Non-energy	200	Nuclear	–
Oil	594	Total final energy consumption	1 116	Geothermal	–
Gas	2 252	Coal	–	Others	1.7
Others	–	Oil	634		
		Gas	211		
		Electricity and others	271		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

Brunei Darussalam's total final energy consumption in 2013 reached 1 116 ktoe. The transport sector led the economy's total energy demand with 447 ktoe, or 40%, of the overall amount. The other sectors (residential, commercial and agriculture sectors combined) followed with 313 ktoe, or 28%, of the economy's energy demand. The remaining amount was for non-energy use (18%) and for the industrial sector (14%). In terms of energy source, oil accounted for 57% of final consumption, followed by electricity and other (24%), and gas (19%). Natural gas accounted for 99% of the fuel type used to generate electricity, while 0.95% was generated by diesel fuel and 0.05% from PV solar power system (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

Brunei Darussalam is committed to reduce 45% of its energy intensity by 2035 from the 2005 level. This is in accordance with APEC's overall target. In 2013, the economy showed significant improvements for both primary intensity and final energy intensity. Primary intensity declined in 2013 by 15% to 100 tonnes of oil equivalent per million USD (toe/million USD). Similarly, the economy's final energy intensity decreased from 56 toe/million USD in 2012 to 39 toe/million in 2013. This was largely due to the reduction of non-energy use and in the industrial sector by 69% and 22% respectively (Table 3).

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	117	100	–15
Total final energy consumption	56	39	–30
Industry	7.0	5.5	–22
Transportation	15.6	15.7	0.9
Other sectors	10	11	6.2
Non-energy	23	7.0	–69

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Brunei Darussalam is heavily dependent on the oil and gas industry as the key driver for economic growth. The economy's energy policy is centred on its oil and gas industry. Following the oil production peak at 254 000 bbl/d in 1979, the Oil Conservation Policy was introduced in the early 1980s. This was intended to extend the lifespan of the economy's oil reserves. Oil production consequently dropped to 150 000 bbl/d

in 1989. However, the policy was revised in November 1990 when the government removed the limit on the production ceiling. This resulted in increased production (APERC, 2009). In 2013, the economy's crude oil and condensate average production was about 135 160 bbl/d (EIDPMO, Peer Review, 15 April 2016).

In order to satisfy gas export obligations, the Brunei Natural Gas Policy (Production and Utilisation) was introduced in 2000. The policy aimed to maintain gas production at year 2000 levels, to open new areas for exploration and development, and to encourage increased exploration by new and existing operators. Under the Policy, priority is always given to domestic gas use, especially for electricity power generation.

ENERGY SECTOR STRUCTURE

The Energy and Industry Department, Prime Minister's Office (EIDPMO), formerly known as the Energy Department, Prime Minister's Office (EDPMO), acts as a regulator for the oil and gas industry in Brunei Darussalam. It oversees all activities carried out by oil and gas companies that hold concession areas in Brunei Darussalam.

PetroleumBRUNEI, Brunei Darussalam's national oil company, was ratified in January 2002 by the Brunei National Petroleum Company Order. It is a private limited company owned solely by the government. PetroleumBRUNEI is given designated areas for which the company has the right to negotiate, conclude and administer petroleum-sharing agreements.

On 24 May 2005, the Energy Division at the Prime Minister's Office was established as the body responsible for the formulation and implementation of Brunei Darussalam's energy policies and other energy-related matters. The Petroleum Unit, which oversees the development of the economy's oil and gas sector, and the Department of Electrical Services, which is tasked with managing and developing the economy's electricity sector, come under the purview of the Minister of Energy at the Prime Minister's Office. In 2011, the Energy Division and the Petroleum Unit merged to become Energy Department, Prime Minister's Office (EDPMO).

Brunei Darussalam has implemented a series of five-year economic development plans known as National Development Plans. Currently, the tenth National Development Plan (RKN 2012–17) is in force. This is the second five-year plan under the long-term development plan, Wawasan Brunei 2035 (Vision Brunei 2035), which states that the economy's major goals for the next two decades are:

- The accomplishments of its well-educated and highly skilled people as measured by the highest international standards;
- To achieve quality of life that is among the top 10 countries in the world; and
- To build a dynamic and sustainable economy with an income per capita among the world's top 10.

In March 2014, the economy launched its first Brunei Darussalam Energy White Paper (EWP). This describes a framework for strategic actions, which ensures sustainable energy for Brunei Darussalam's prosperity.

ENERGY SECURITY

Brunei Darussalam recognises the need to enhance energy security and sustainability, improve energy efficiency and accelerate the deployment of renewable energy and a clean energy supply. Consequently, the economy works to strengthen the partnership arrangements among all its stakeholders.

Brunei Darussalam is an active member of the Association of South-East Asian Nations (ASEAN). It likewise supports the implementation of strategies that relate to energy security, the diversification of supply, energy efficiency and conservation among the regions. The economy is working actively with ASEAN towards the achievement of the targets set under the ASEAN Plan of Action on Energy Cooperation 2010–15 (the Action Plan). This includes, among others, the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline (TAGP) projects.

The energy sector of Brunei Darussalam plays a vital role in the realisation of Wawasan Brunei 2035. Energy sector will continue to serve as the major catalyst for the economy's investment, education and infrastructure development. Brunei Darussalam Energy White Paper indicated three strategic goals that address the growth of the energy sector, namely:

- Strengthen and grow oil and gas upstream and downstream activities;
- Ensure safe, secure, reliable and efficient supply and use of energy; and
- Maximise economic spin-off from the energy industry, boost local content and secure high participation by the local workforce.

In order to assure the achievement of these strategic goals, 10 Key Performance Indicators (KPIs) have been developed. These KPIs will help address needs across the different segments and parts of the value chain in the energy sector in order to achieve the targets set under each strategic goal.

UPSTREAM ENERGY DEVELOPMENT

Brunei Darussalam has numbers of major oil and gas companies that currently operate in the concession and production sharing areas: the Brunei Shell Petroleum Company Sdn Bhd (BSP), Total E&P Deep Offshore Borneo B.V. (Total), PETRONAS and Shell Deepwater Borneo. The economy's existing and potential oil and gas reserves lie within its northern landmass and extend offshore to the outer limits of its Exclusive Economic Zone (EEZ). Most of the existing oil and gas production is located in scattered sites around 70 kilometres offshore. Although the economy's oil and gas reserves are expected to last for at least several decades, a few areas onshore and offshore have been opened up for exploration.

A target has been set to reach a production rate of 430 000 barrels of oil equivalent per day (BOE/d) by 2017 and 650 000 BOE/d by 2035. This is in accordance with the Brunei Darussalam Energy White Paper. In order to meet its upstream production target, Brunei Darussalam is committed to maintaining its oil and gas Reserve Replacement Ratio (RRR) of more than one. Specifically, Brunei Darussalam will undertake several initiatives to stimulate production, such as rejuvenating existing fields, maximising economic recovery from matured and newly discovered fields and reviewing potential solutions for the development of uneconomic, small and unconnected fields.

The economy is also aiming to achieve around 100 000 BOE/d from upstream international ventures investment by 2035. On 19 November 2013, PetroleumBRUNEI was awarded Block EP-1, the onshore Kyaukkyi-Mindon area located 250 kilometres north of Yangon, Myanmar. This covers an area of 1 135 square kilometres. PetroleumBRUNEI will carry out all petroleum activities in Myanmar under the production sharing agreement. Other upstream projects for PetroleumBRUNEI abroad include offshore fields in Sarawak, Malaysia, and a shale gas project in Canada, thereby increasing international investments (PB, 2013).

DOWNSTREAM ENERGY DEVELOPMENT

Brunei Darussalam is aiming to increase the revenue from domestic downstream industries to BND 5 billion in 2035 in accordance with Brunei Darussalam Energy White Paper. The biggest contributor to the existing downstream industry in Brunei Darussalam comes from methanol produced from the economy's natural gas resources as feedstock. This industry aims to contribute about BND 300 million to the economy annually, which means increasing the economic output from downstream processing in order to satisfy the growing demand, especially for the supply of emerging markets. In order to accommodate these growing needs, the Brunei Economic Development Board (BEDB) initiated the development of specialised industrial parks, such as the Sungai Liang Industrial Park (SPARK) and Pulau Muara Besar (PMB) for petrochemicals and other downstream oil and gas activities.

The government will provide appropriate support and incentives in order to encourage more investors to venture into developing and diversifying additional downstream opportunities such as gas-based petrochemicals, and crude- and condensate-based petrochemicals. A priority initiative entitled the 'Evaluate Feasibility of Downstream Derivatives' was likewise established as part of the downstream energy development in order to ensure the achievement of the target. Enabling such activity under this initiative could function as a possible extension of the petrochemical chain, which includes ethylene and propylene building blocks.

ENERGY MARKETS

The government regulates the energy market in Brunei Darussalam. In view of the maturing energy markets, especially in the oil and gas industry, the government is now considering whether to adopt a comprehensive policy and regulatory framework in order to support the strategic objectives that have been established for the energy sector. EIDPMO has initially identified four key regulatory policies and frameworks, which include, among others, instituting a regulatory body to monitor the local content requirement in the bidding process for contracts from operators. A Local Business Development (LBD) framework has been enforced to ensure that there is a fair and level playing field in the market.

ELECTRICITY MARKET

The Department of Electrical Services, established in 1921, fulfils the regulatory functions for the power sector. Its purpose includes the management and development of the electricity sector. There are two electrical utilities in Brunei Darussalam, the Department of Electrical Services (DES) and the Berakas Power Management Company Private Limited (BPMC). BPMC is owned by the Brunei Investment Agency and operates as a private company that reports to a board of directors. Brunei Darussalam's electricity generation is almost entirely natural gas fired. The only exceptions are the diesel power station at Belingus (Temburong District) and the 1.2 MW Tenaga Suria Brunei (TSB) photovoltaic demonstration plant. The transmission system consists of three grids operated by the two electrical utilities (DES, 2013).

ENERGY EFFICIENCY

A 20-year roadmap on energy efficiency and conservation (EEC) was established in May 2015 by the economy's National EEC Committee. This roadmap focuses on five major sectors, namely power, residential, commercial, industrial and transportation. This initiative aims to achieve a 63% reduction in total energy consumption of fossil fuel supplies for inland energy use by 2035, which was announced by His Majesty Sultan and Yang Di-Pertuan of Brunei Darussalam at the United Nations (UN) Climate Summit in September 2014 (RTB News, 2014).

In order to ensure that this target is achieved, Brunei Darussalam is actively promoting energy efficiency and conservation through the following implementation of the EEC legislative measures by 2035 (UNFCCC, 2015):

- *Electricity Tariff Reform*—Electricity tariffs were first reformed in the residential sector on the 1 January 2012 with the objective of reducing electricity consumption in this sector. The transition is from a regressive tariff to a progressive tariff. It will be introduced to other sectors when appropriate.
- *Standards and Energy Labelling for Products and Appliances*—The Brunei National Energy Research Institute (BNERI), which serves as the economy's think tank, in collaboration with EIDPMO, is currently developing the Standards and Labelling Order for electrical appliances, which is expected to be implemented in late 2016.
- *EEC Building Guidelines for the Non-Residential Sector*—The EEC Building Guidelines 2015 for Non-Residential Buildings were launched by the Ministry of Development in May 2015. All government and new buildings are obligated to adopt the guidelines whereby an Energy Efficiency Index (EEI) baseline for kilowatt-hours per square metre is set. It is estimated that with the introduction of these baselines, the energy consumption of new buildings could be reduced up to 50%.
- *Fuel Economy Regulation*—EIDPMO is currently working together with the Ministry of Communication for the implementation of fuel economy regulations. In order to support this policy initiative, the introduction of hybrid cars and fuel-efficient vehicles (FEV), as well as electric vehicles, has already been widely undertaken.
- *Financial Incentives*—EIDPMO and the Ministry of Finance are examining the introduction of appropriate financial incentives for energy efficient appliances and vehicles in the form of tax exemptions, tax reductions, or rebate schemes on energy-efficient appliances and products.
- *Energy Management Policy*—Brunei Darussalam is considering the adoption of an energy management policy that is compatible with ISO 50001.
- *Awareness Raising*—The government will continue to increase awareness through energy clubs, energy exhibitions, road shows, seminars and workshops on energy savings and best practices in EEC for Brunei Darussalam.

Further, the government endeavours to improve Brunei Darussalam's power generation efficiency to greater than 45% by 2020 by replacing simple cycle power plants with a combined-cycle or cogeneration plant (CHP plant) and by having a structured maintenance program in place.

BRUNEI DARUSSALAM HOUSEHOLD ENERGY CONSUMPTION SURVEY (2015)

This is the first comprehensive energy consumption survey in Brunei Darussalam. Its purpose is to provide insights into the consumption behaviour of the residential sector and to recommend policy options and measures that have the greatest influence. This project was conducted and supported by the Economic

Research Institute for ASEAN and East Asia (ERIA) in cooperation with EIDPMO and BNERI. The survey was completed in December 2015.

RENEWABLE ENERGY

Brunei Darussalam has set a long-term target that requires 10% of the economy's total power generation mix in 2035 to be from renewable energy. This represents one of the KPIs under the second key strategic goals. Renewable energy development in Brunei Darussalam has four major priority initiatives, namely (EIDPMO, 2014):

- The introduction of a renewable energy policy and regulatory frameworks;
- The growth of the market deployment of solar PV and the promotion of waste-to-energy technologies;
- The growth of awareness and the promotion of human capacity development; and
- Support for research, development and demonstration (RD&D), and technology transfer.

Solar energy is by far the most promising renewable energy, given the economy's exposure to equatorial sunshine. In July 2010, the economy commissioned a 1.2 MW solar power plant known as Tenaga Suria Brunei (TSB). TSB is connected to the national power grid and is designed to produce 1 600 megawatt-hours (MWh) of electricity annually, saving 340 kilolitres of crude oil and avoiding 940 tonnes of CO2 emissions annually. The actual electricity recorded in 2010 was 808 MWh. This saved an equivalent 205 kilolitres of crude oil and avoided 566 tonnes of CO_2 emissions into the atmosphere.

The economy recently completed a waste-to-energy assessment study, which estimated that municipal solid waste production could be developed with a capacity of 10 MW. Other alternative energy sources such as wind power, hydropower and tidal power are currently being researched by the government.

NUCLEAR ENERGY

Brunei Darussalam does not have a nuclear energy industry.

CLIMATE CHANGE

Brunei Darussalam recognises the importance of its economic growth for energy security and environmental sustainability. Environmental policy directions are embedded in Vision Brunei 2035. These include:

- Implementing the highest environmental standards for existing and new industries in accordance with the established international standards and practices;
- Strictly enforcing appropriate regulations on the maintenance of environments that affect public health and safety; and
- Supporting global and regional efforts to address trans-border and regional environmental concerns.

Brunei Darussalam acceded to the United Nations Framework Convention on Climate Change in 2007 and subsequently to its Kyoto Protocol in 2009. It also associated itself with the Copenhagen Accord in 2009. At the 21st session of the Conference of the Parties (COP21) to the UNFCCC, Brunei Darussalam identified some key actions directed at reducing greenhouse gas emissions by 2035 through the following aspirations (UNFCCC, 2015):

- To reduce 63% of the economy's energy consumption in accordance with the BAU scenario;
- To have 10% of the energy mix from the utilisation of renewable energy; and
- To reduce 40% of greenhouse gas emissions from morning peak-hour vehicle use in accordance with the BAU scenario.

NOTABLE ENERGY DEVELOPMENTS

ENERGY INFRASTRUCTURE PROJECTS

Brunei Darussalam seeks to maximise the potential of the economy's oil and gas resources and to take advantage of its strategic location for trading. One of the key initiatives under Vision Brunei 2035 is to designate industrial 'cluster-specific' sites with supporting infrastructures and facilities. The first site, established in 2007, was the Sungai Liang Industrial Park (SPARK), designed specifically for downstream

petrochemical processing activities. The first petrochemical plant constructed at the site, a methanol production plant, was successfully commissioned in April 2010 (BMC, 2010).

A second industrial site is being developed at Pulau Muara Besar (PMB) for oil field support services, such as an integrated marine supply base (IMSB), fabrication yard and further downstream activities. The anchoring project will be a USD 4.3 billion oil refinery and aromatics cracker project to be developed by the Zheijiang Hengyi Group Co. Ltd. The project is expected to begin operation in 2019, with a production capacity of approximately 175 000 bbl/d. In addition, a new 430 MW cogeneration power plant will be built at Pulau Muara Besar in order to provide power and steam to industries including Hengyi.

In the power sector, a memorandum of understanding was signed between Brunei's Government, Brunei LNG and the Brunei Shell Petroleum Company in order to expand the Lumut Co-Generation Power Station to an installed capacity of 246 MW, an increase of 66 MW. This will meet the growing energy demand for the next 15 years and beyond, based on the expected increase in the number of households and industrial activities. The new expanded plant will boost an improved efficiency greater than 60% through the application of combined heat and power integration or cogeneration (EWG, 2012).

Meanwhile, Brunei Gas Carriers Sendirian Berhad (BGC Sdn Bhd.) welcomed its fifth A-Class vessel in the third quarter of 2015. The vessel, named 'Amadi', follows the arrival of its sister ship 'Amani', BGC's largest ship with a capacity of 155 000 cubic metres. The replacement of B-class ships owned by Brunei Shell Tankers (BST), which have a smaller capacity for transporting LNG, to A-class ships is in accordance with a strategic program by the LNG carrier to modernise and localise its service. BGC provides LNG transportation services from Brunei Darussalam to Japan, South Korea, Malaysia and Chinese Taipei (BGC, 2015).

THE US-ASIA PACIFIC COMPREHENSIVE ENERGY PARTNERSHIP (USACEP)

At the seventh East Asia Summit (EAS) in 2012, President Obama of the United States, in partnership with His Majesty the Sultan and Yang Di-Pertuan of Brunei Darussalam and President Susilo Bambang Yudhoyono of Indonesia, announced the formation of the US-Asia Pacific Comprehensive Partnership (USACEP). The United States has made up to USD 6 billion available for the financing of this venture.

Under the auspices of USACEP, a new renewable and alternative power generation (RAPG) work stream was established as part of the energy cooperation initiative of the EAS. The main aim of this RAPG work stream is to encourage new renewable energy collaboration and cooperation in the EAS region. The RAPG projects will coexist and complement current renewable energy activities within ASEAN and dialogue partners to elevate the role of renewable energy in the region. The project areas cover solar photovoltaic, wind and hydro (US DOE, 2013).

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Brunei Economic Development Board—www.bedb.com.bn

Brunei LNG Sdn Bhd—www.bruneilng.com/home.asp

Brunei Shell Petroleum Company Sdn Bhd—www.bsp.com.bn

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PetroleumBRUNEI—www.pb.com.bn

CANADA

INTRODUCTION

In terms of land area, Canada ranks second only after Russia worldwide. The economy is a neighbour of the United States of America (the US) to the south and partly to the west (Alaska). The Canada-US border is the world's longest international border and extends to the Pacific Ocean to the west, the Atlantic Ocean to the east and the Arctic Ocean to the north. Canada is composed of ten provinces and three territories and has a population of 35.9 million (2013). Most Canadians reside near the southern Canadian borders. In 2013, Canada's real gross domestic product (GDP) grew by 2% to USD 1 458 billion. Real GDP per capita grew by 0.8% over the same period (USD 41 470) (EGEDA, 2015).

Canada has an abundance of natural resources, including fossil fuels. Canada is the fourth largest energy producer in the APEC region and the fifth largest in the world behind China, the US, Russia and Saudi Arabia. The energy sector directly contributed 10% to Canada's GDP in 2013 and indirectly contributed (through purchases of goods and services from non-energy industries) an additional 3.5% (NRCan, 2014). In 2013, Canada exported CAD 128 billion worth of energy products and imported CAD 55 billion (NRCan, 2014). Canada is one of the world's top four exporters of crude oil, natural gas, uranium and electricity (IEA, 2015).

The economy has extensive conventional and unconventional oil, natural gas and coal reserves as well as significant uranium deposits. It has the world's third largest amount of proven oil reserves after Venezuela and Saudi Arabia. The reserves were estimated at **171** billion barrels, of which oil sands accounted for 97% (**166.3** billion barrels), at the end of 2014 (CAPP, AER, 2015). The bulk of the oil sands reserves are in the province of Alberta although the province of Saskatchewan is also rich in such reserves. Conventional oil reserves exist in various amounts in six Canadian provinces and territories, namely British Columbia, Saskatchewan, Ontario, Manitoba, the North West Territories (NWT) and the Yukon. However, Alberta and Saskatchewan, and Newfoundland and Labrador have the largest onshore and offshore reserves respectively (NEB, 2015).

Canada has substantial proven gas reserves, which are estimated at more than 2 trillion cubic metres **(**tcm) and equal to 1.1% of global reserves in 2013 (BP, 2015). The largest concentration of gas reserves is in Alberta and British Columbia, although Saskatchewan, Newfoundland and Labrador, New Brunswick, Nova Scotia, the NWT and the Yukon also have reserves to a much smaller extent (NEB, 2015).

Canada currently holds 8.7 billion tonnes of proven resources of coal-in-place, of which 6.6 billion tonnes are recoverable (NRCan, 2016a). More than 90% of Canada's coal deposits are located in western provinces, namely Alberta, British Columbia and Saskatchewan, while the rest are located in the eastern province of Nova Scotia (CAC, 2016).

Canada's uranium reserves (493 900 tonnes in 2012), most of which are located in the Athabasca Basin of northern Saskatchewan, are the fourth largest in the world after those of Australia, Kazakhstan and Russia. This basin has the world's largest high-grade deposits (Natural Resources Canada, Peer Review, 22 April 2016). These reserves are equal to 8% of the world's known resources, which are recoverable at a price of CAD 128.1 (<130 USD) per kilogram. If the price of uranium were to increase in the future, new uranium deposits would become economically recoverable and thus Canada's uranium resources would increase.

Table 1: Key Data and Economic Profile, 2013

Key data[a, b]		**Energy reserves** [c, d, e, f]	
Area (million km^2)	9.9	Oil (million cubic metres)	27 187
Population (million)	35.9	Gas (million cubic metres)	2 097
GDP (2010 USD billion PPP)	1 458	Coal (million tonnes)	8 700
GDP (2010 USD PPP per capita)	41 470	Uranium (kilotonnes U)[c]	494

Sources: a. EGEDA (2015); b. NEB (2015); c. CAPP, AER, 2015; d. NRCan (2016b); e. SC (2015a); f. SC (2015b).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Canada's domestic energy production reached 431 107 kilotonnes of oil equivalent (ktoe) in 2013. This represented an increase of 3.2% compared with 2012 (417 474 ktoe) (ESTO, 2015). Fossil fuel dominated this production with its share of about 84%, which reflected no major change compared with 2012 (83.1%). Oil, including natural gas liquid (NGL), accounted for the largest share (195 249 ktoe, 45%), followed by gas (130 348 ktoe, 30%) and coal (35 039 ktoe, 8.1%). The share of nuclear of the non-fossil energy production was 5.3% (22 756 ktoe), thereby leaving a share of approximately 11% for renewables. These consisted of hydro (33 690 ktoe, 7.8%); other renewables (bioenergy), including biomass, wood and waste (12 958 ktoe, 3%); and geothermal, solar, wind and ocean (1 067 ktoe, 0.2%) (ESTO, 2015). Canada is a leading global producer of energy, as evident in its global production ranks for gas and crude oil (fifth in 2014) and hydro (second in 2014) (NRCan, 2016c).

Canada is a net exporter of oil, gas, coal and electricity. Canada's energy exports go mainly to the US. Between 2000 and 2012, energy exports grew at an average rate of 2.3% per year. Exports continued their growth in 2013 as apparent in their 4.5% increase compared with 2012 (ESTO, 2015). In 2013, Canada exported 262 663 ktoe of energy, which consisted of crude oil and NGL (139 121 ktoe), petroleum products (24 718 ktoe), gas (68 856 ktoe), coal and coal products (23 421 ktoe), electricity (5 772 ktoe) and renewables (776 ktoe) (ESTO, 2015). Energy exports accounted for 30% (CAD 146 billion) of domestic merchandise export revenue (Natural Resources Canada, Peer Review, 22 April 2016).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	431 107	Industry sector	59 793	Total power generation	636 340
Net imports and other	–184 594	Transport sector	61 139	Thermal	139 842
Total primary energy supply	245 940	Other sectors	66 272	Hydro	391 750
Coal	17 372	Non-energy	23 541	Nuclear	87 321
Oil	78 382	Total final energy consumption	210 744	Others	17 427
Gas	83 788	Coal	2 653		
Others	66 398	Petroleum products	95 865		
		Natural gas	59 786		
		Electricity and others	52 440		

Source: EGEDA (2015).

CRUDE OIL

Canada's oil production has increased for the past two decades to turn it into the world's fifth largest oil producer in 2013 (CAPP, 2016). Its production of crude oil, including NGL, in that year was 195 249 ktoe, an increase of 6.3% from 2012 (ESTO, 2015). Oil sands' production, which has increased by 192% since 2000, has been responsible for most of the recent growth in production (CAPP, 2014a). Oil sands' output surpassed conventional oil production for the first time in 2010 (NRCan, 2014a). Production from oil sands, which are mainly located in the Athabasca oil fields in Alberta, has grown consistently since it began in 1967. In 2013, its production reached 1.9 million barrels per day (Mbbl/D) (CAPP, 2014b), an increase of 5.5% over 2012 (CAPP, 2013). Conventional oil production in 2013 was 1.5 Mbbl/D (CAPP, 2014b), an increase of 7.1% from 2012 (CAPP, 2013).

Canada's crude oil production is geographically dispersed, but comes from three principal sources: the resources in the broader Western Sedimentary Basin, offshore Atlantic Canada and the oil sands. In 2013, the bulk of crude oil production (83%) occurred in the Western Canadian Sedimentary Basin provinces, namely Alberta (42%), Saskatchewan (35%), Manitoba (3.7%), British Columbia (1.4%) and the NWT (0.8%). Offshore production in the Atlantic Ocean (the Jeanne d'Arc Basin and the Hibernia field) accounted for almost the entire remaining production (17%), except for small-scale production in Ontario (0.1%) and New Brunswick (0.1%) (CAPP, 2015).

In 2013, the economy's oil exports, including NGL, (139 121 ktoe) and petroleum products (24 718 ktoe) reflected a significant increase over 2012 of 8.8% and 7.4% respectively (ESTO, 2015). The main market was the US.

GAS

Canada holds a relatively small share of the world's proven natural reserves but is a major exporter. In 2013, natural gas production reached 130 348 ktoe, an increase of 0.3% from 2012 (ESTO, 2015). This is a reversal of a declining trend, which began in 2007 after production peaked in 2006 (BP, 2015). Canada is the world's fifth-largest producer of natural gas (NRCan, 2015a).

Western Canada accounted for the bulk (99%) of the economy's gas production in 2013 with Alberta as the largest producer (69%) followed by British Columbia (26%), Saskatchewan (3.2%) and the NWT (0.1%) (CAPP, 2015). Eastern Canada's gas production is mainly offshore in the Atlantic Ocean (1.2%) together with small-scale production in New Brunswick (approximately 0.1%) (CAPP, 2015).

The economy is the world's fourth-largest exporter of natural gas (NRCan, 2015a). In 2013, the volume of its gas exports was 68 856 ktoe, a decrease of 6.4% compared with 2012 (ESTO, 2015).

Although conventional natural gas reserves have depleted, technological advances and rapid investment in the Western Canadian Sedimentary Basin have renewed the growth potential from shale gas, tight gas and coal-bed methane. Shale gas is emerging as the new low-cost source of natural gas in North America, resulting in greater investment and research for its development. In Canada, shale gas resources are found in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick and Nova Scotia. Most of the current drilling and production activities occur in north-east British Columbia in the Montney and Horn River shale basins (NRCan, 2012).

COAL

Annual coal production has experienced minor fluctuations since 2004 (BP, 2015). In 2013, Canada produced 35 039 ktoe) of coal, indicating a 4.6% increase over its 2012 production (ESTO, 2015). All of Canada's coal production occurs in the Western provinces of Canada, including Alberta, British Columbia and Saskatchewan (NRCan, 2015b).

Canada is a mid-size coal producer. Approximately half of its annual production of 69 million tonnes (Mt) is metallurgical (coking coal), which is used in steel manufacturing and largely exported, while the other half is thermal coal, which is used domestically for electricity generation (NRCan, 2015b).

Canada exported 67% (23 402 ktoe) of its coal production in 2013, a 12% increase over its 2012 exports (ESTO, 2015). Coking coal accounted for 90% of the exports (NRCan, 2015b). Asia is the primary export market, accounting for more than three quarters of Canadian exports, while the rest is exported to a number of European countries, the US, Mexico, and Latin America (NRCan, 2015b). The importance of coal exports for Canada is evident in the value of its 2013 exports (CAD 5.5 billion) (NRCan, 2015b).

URANIUM

Canada is among the three leading producers of uranium along with Kazakhstan and Australia. Collectively, these three exporters accounted for about 65% of total global output in 2013(WNA, 2016). Canada maintained its position as the world's second largest uranium producer in 2013 when it produced 9331 tonnes of uranium metal (tU) (WNA, 2016). This production passed the 2013 level by 3.6% and accounted for 16% of global production (WNA, 2016). Current production is concentrated in the Athabasca Basin of northern Saskatchewan (NRCan, 2015c).

The mining and milling of uranium is a major industry (CAD 2 billion per annum) and directly employs over 3 000 Canadians at the mine sites (NRCan, 2015d). Uranium continues to rank among Canada's top 10 metal commodities in terms of output value. (NRCan, 2015c).

NEW AND RENEWABLE

Canada has substantial renewable energy resources including bioenergy, hydro, solar, wind, geothermal and ocean energy. In 2013, the economy's total renewable production was 47 715 ktoe consisting of hydro (33 690 ktoe), bioenergy (12 958 ktoe) and solar, geothermal, wind and ocean (1 067 ktoe) (ESTO, 2015). Production was 4.5% above the 2012 level (ESTO, 2015). Renewables accounted for slightly more than 11% of total indigenous energy production in 2013 (ESTO, 2015).

FINAL ENERGY CONSUMPTION

Canada's total final energy consumption (TFEC) in 2013 reached 210 744 ktoe, a slight increase of 0.8% over that of 2012 (ESTO, 2015). This consumption makes Canada the APEC region's fifth largest energy consumer after China, the US, Russia and Japan (ESTO, 2015).

The single largest sectoral contributor to consumption was the transport sector (61 139 ktoe, 29%) followed by industry (59 793 ktoe, 28%). A combination of smaller sectors, namely residential, commercial and public services together with agriculture and non-specified others, accounted for the largest consumers

(66 272 ktoe, 31%) (EGEDA, 2015). The share of non-energy of Canadian TFEC was 11% (23 541 ktoe) (EGEDA, 2015).

Fossil fuels accounts for the largest share of TFEC (75%), consisting of petroleum products (95 865 ktoe, 46%), gas (59 786 ktoe, 28%) and coal and coal products (2 653 ktoe, 1.2%) (ESTO, 2015). The remainder is the share of renewables (10 072 ktoe, 4.8%), electricity (41 726 ktoe, 20%) and heat (542 ktoe, 0.3%) (ESTO, 2015). However, reductions in consumption of coal and coal products (1.5%) and petroleum products (approximately 1.8%) compared with 2012 and increases in consumption of gas (6.1%) and renewables (11%) suggest that the economy is becoming less carbon intensive (ESTO, 2015).

Factors contributing to Canada's higher consumption of energy relative to that of other industrialised countries include cold climate that requires long periods of heating, long distances between major cities, extensive use of private vehicles and the prevalence of energy-intensive industries.

POWER GENERATION

Canada generated 636 340 gigawatt-hours (GWh) of electricity in 2013, an increase of 0.5% from the previous year (EGEDA, 2015). Renewables accounted for the largest share of this generation (64%) with hydro as the major contributor (62%). Other renewables (solar, wind, geothermal etc.) accounted for the remainder. Nuclear's share was 13.7%, which increased the combined share of non-fossil energy to 78%. The share of oil, gas and coal-fuelled thermal generators was 22% (EGEDA, 2015). Coal accounted for the largest share of the latter (46%) followed by natural gas (40%) and other fossil fuels such as diesel, light fuel oil, heavy fuel, wood and spent pulping liquor (14%) (SC, 2015c).

Canada has been increasing the share of renewables, including hydroelectricity, for electricity generation since 2000. For example, some provinces have introduced policies and programs to promote renewable energy, while discouraging continued use of coal-fired power plants. In 2013 and early 2014, Ontario, Canada's largest energy consumer, shut down its remaining coal-fired power plants (NEB, 2014a). In December 2013, the NWT released a three-year Energy Action Plan calling for the greater use of hydro, wind, biomass and solar resources instead of imported oil. The territory has developed 55 megawatts (MW) of an estimated 11 500 MW of its hydro potential (NEB, 2014a).

As part of its 2013 Long Term Energy Plan, Ontario intends for nuclear to continue to be a major source for the province's electricity supply. To this end, the province has announced a CAD 25 billion investment into the refurbishment of 10 nuclear reactors: four at the Darlington Nuclear Generating Station and six at the Bruce Nuclear Generating Station. These refurbishments will add about 25–30 years to the operational life of each unit. Refurbishment at Darlington is to start in 2016 with one reactor, and commitments on subsequent reactors will take into account the cost and timing of preceding refurbishments, with appropriate off-ramps in place. Refurbishment at Bruce is to start in 2020. This investment will annually displace 31 to 52 Mt in greenhouse gas (GHG) emissions relative to coal or gas-fired electricity.

Low natural gas prices, the rapidly decreasing cost of renewable energy and new regulations which limit the use of coal have all made Canada's electricity sector increasingly 'greener' (NEB, 2014a). Canada is the APEC region's and the world's second largest hydroelectricity producer after China (IEA, 2015). Canada's rich water resources enable many parts of the economy to rely on hydropower.

The electricity networks of Canada and the US are highly integrated and, the US is a net importer of electricity from its northern neighbour. In 2013, Canada exported 5 772 ktoe of electricity to the US while importing 1 472 ktoe (EGEDA, 2015). This makes Canada APEC's largest exporter of electricity and the world's second largest after Germany (IEA, 2015). The bulk of the electricity trade with the US occurs between the provinces of Québec, Ontario, Manitoba and British Columbia and the neighbouring American states (NEB, 2015). The excess supply of hydro and nuclear power in 2013 resulted in Canadian net exports reaching a 10-year high (NEB, 2015).

ENERGY INTENSITY ANALYSIS

Certain factors make Canada a highly energy-intensive economy. They include its vast geography, cold climate and an industrial structure with a high rate of energy-intensive industries. The economy's abundant fossil energy reserves and renewable capacity (particularly hydro) at relatively low costs also play a role.

Nevertheless, Canada has been successful at gradually reducing its energy intensity over the past few decades, as apparent in the respective 2013 figures. Primary energy intensity and final energy consumption intensity fell by 4.1% and 1.1% from 2012 respectively (EGEDA, 2015). This was mainly because of a significant decrease in the energy intensity of the residential, commercial, public services and agricultural sectors, which registered a 3.8% reduction in their energy intensity compared with 2012. Increasing energy efficiency and reducing energy intensity have been policy goals for the Canadian Government as a means to mitigate climate change and conserve energy. Among other factors, major improvements in energy intensity

have been the result of substantial efficiency improvements supported by various measures, programs and regulations introduced by Canadian federal, provincial and municipal governments. An example at the federal level is the development by Natural Resources Canada of policy guidelines and programs such as eco-energy efficiency for buildings, housing, industries and vehicles.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	176	169	–4.1
Total final energy consumption	146	145	–1.1
Industry	29	41	4.7
Transportation	41.8	41.9	0.4
Others	47	46	–3.8
Non-energy	18	16	–11

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Canada's federal government and those of its 10 provinces and three territories have all a role in shaping the economy's energy policy. Energy policy at any of these levels of government is market-based for determining supply, demand, price and trade. The fundamental principles include respect for jurisdictional power granted under the Constitution Act of 1867 and targeted intervention in the market process in order to achieve specific policy objectives (e.g. pipeline regulation) through regulation and other means (GOC, 2016a; NEB, 2014a).

The Canadian provinces are the owners of ground resources and mineral rights within provincial boundaries, excluding the resources located in aboriginal lands and frontier lands (i.e. national parks and international waters) in accordance with Sections 91 and 92 of the Canadian Constitution (GOC, 2016b; NEB, 2014a). The provincial governments have the primary responsibility for shaping policies in their jurisdictions; consequently, energy policy varies from jurisdiction to jurisdiction. Unlike the provinces, the three territories do not own the ground resources but do share partial management responsibility. In addition to frontier lands, the federal government is responsible for regulating uranium resources and nuclear energy, interprovincial/international trade and commerce, trans-boundary environmental impacts, interprovincial work (e.g. pipelines) and developing policies in the national interest (economic development, health and safety, and energy security) (GOC, 2016c; NEB, 2014a).

Energy policy at the federal level involves a number of government agencies with regard to the development and implementation of such policy. Natural Resources Canada (NRCan) is the federal department that is mandated to develop 'policies and programs that enhance the contribution of the natural resources sector to the economy and improve the quality of life for all Canadians' (NRCan, 2016d). The National Energy Board (NEB) is an independent federal regulator responsible for pipelines, energy development and trade issues in the Canadian public interest. Other important government agencies include Environment and Climate Change Canada, Fisheries and Oceans Canada, Indigenous and Northern Affairs Canada and Global Affairs Canada.

ELECTRICITY MARKETS

The federal and non-federal actors have distinct roles in the Canadian electricity market. The federal government is responsible for electricity exports, international and designated interprovincial power lines and nuclear policy, including regulation and safety. These issues are especially important because the economy-wide market is interconnected at many points with the United States in order to form a larger grid (NEB, 2014b). The provinces and territories have jurisdiction over the generation, transmission and distribution of electricity within their boundaries. Such jurisdiction also encompasses restructuring initiatives and electricity prices (NEB, 2014b).

The electricity industry in most provinces is highly integrated. The bulk of generation, transmission and distribution services are provided by one or two dominant utility providers. Some of them are privately owned, while many are Crown corporations owned by the provincial governments. Exceptions appear in the provinces of Alberta, which has moved to full wholesale and retail competition, and Ontario, which has established a hybrid system with competitive and regulated elements.

Retail electricity prices vary across the provinces in terms of their levels and the mechanisms by which they are set. Provinces with an abundant supply of hydroelectricity generally have the lowest prices. In most provinces, the regulator sets the prices according to a formula that determines the cost of generation plus a reasonable rate of return. Whereas retail electricity prices in Alberta are more market-based than in other provinces and territories, and the remaining regulated price plan is gradually being phased out in Ontario, both regulated and deregulated price plans are offered (NEB, 2013).

Institutional arrangements have been made to improve the reliability of the electricity power system. The United States Energy Policy Act 2005 called for the creation of an Electric Reliability Organisation (ERO) in order to address concerns about the reliability of the North American grid, which had been prompted by the 2003 blackout. In July 2006, the Federal Energy Regulatory Commission of the United States (FERC) certified the North American Electric Reliability Corporation (NERC) as the ERO authorised the NERC to enforce reliability standards on the owners, operators and users of the bulk power system in both Canada and the United States (FERC, 2014). The Canadian and United States governments also established the Bilateral Electric Reliability Oversight Group as a forum in which the United States Department of Energy, the FERC, the NRCan and the provincial energy ministries can discuss issues of mutual concern (FERC, 2014).

ENERGY MARKET

OIL AND NATURAL GAS

Canada's wellhead oil and natural gas prices have been fully deregulated since the conclusion of the Western Accord and the Agreement on Natural Gas Markets and Prices between the Canadian federal government and the Canadian energy-producing provinces in 1985. The latter opened up the oil and gas markets to greater competition by permitting more exports, allowing users to buy directly from producers and unbundling production and marketing from transportation services (NEB, 1996). Oil and gas pipeline networks continue to be regulated as natural monopolies

Private and state-owned international oil companies' investments in Canada's oil and gas sector have risen rapidly. As per the February 2015 briefing note, addressed to Deputy Finance Minister Paul Rochon, foreign investors are estimated to own 40–50% of the Canadian oil and gas sector (TCP, 2016).

Federally, the Investment Canada Act, which had stipulated that any large investment greater than CAD 325 million in Canada had to be a net benefit to Canada, was revised as per subsections 14.1(1) and (2) of the Investment Canada Act. For private sector World Trade Organization (WTO) investments, the review threshold was increased to CAD 600 million starting from 24 April 2015, to be increased to CAD 800 million on 24 April 2017 and CAD 1 billion on 24 April 2019 (ISEDC, 2013). From 24 April 2021 onwards, the threshold level will be adjusted annually based on growth in nominal GDP in accordance with the formula set out in subsection 14.1(2) (i.e., the growth in Nominal GDP at market prices multiplied by the threshold amount determined for the previous year) (ISEDC, 2013).

For state-owned enterprise WTO investments, "the review threshold for 2016 is CAD 375 million in asset value for investments to directly acquire control of a Canadian business by:

1. WTO investors that are state-owned enterprises; and
2. Non-WTO investors that are state-owned enterprises where the Canadian business that is the subject of the investment is, immediately prior to the implementation of the investment, controlled by a WTO investor."

"This threshold will be annually revised to reflect the change in Canada's nominal gross domestic product (GDP) in accordance with the formula set out in subsection 14.1(2) (i.e., the annual change in Nominal GDP at market prices multiplied by the threshold amount determined for the previous year)" (ISEDC, 2013).

COAL

Canada is rich in coal resources. The largest known reserves are located in the western provinces, which are also Canada's principal producers. Together with provincial-level law and regulations, 35 federal acts and regulations relate to the mining industry (CAC, 2012).

Among the many existing regulations, a recent regulation adopted in August 2012 places a performance standard on new coal-fired electricity. This should further reduce coal consumption in Canada but not necessarily coal production. The regulation, adopted under the Canadian Environmental Protection Act 1999, is a performance standard that sets an emissions intensity level for Natural Gas Combined Cycle (NGCC) technology, a high-efficiency type of natural gas generation, at 420 tonnes per GWh (GOC, 2016d). It also contains a caveat in order to encourage new technology for the reduction of greenhouse gas (GHG) emissions whereby units which incorporate carbon capture and storage (CCS) technology can apply to receive a temporary exemption from the performance standard until 31 December 2024 (GOC, 2016d).

ENERGY EFFICIENCY

The federal and provincial governments have joint responsibility for energy efficiency; but their roles and responsibilities vary and target different aspects of efficiency. Each province has ministries responsible for administering energy and environmental policies and programs, including energy efficiency programs. Examples of energy efficiency programs include energy-efficient building codes, equipment standards and consumer rebates. The foundation of all provincial policies rests upon the federal Energy Efficiency Act 1992, which was amended in 2009 to expand its scope and effectiveness (GOC, 2016e). This Act provides for the creation and enforcement of regulations on the energy efficiency of products and supports the replacement of the least efficient products with high-efficiency, cost-effective ones.

The Energy Efficiency Act 1992 and related efficiency issues are administered at federal level by the NRCan through its Office of Energy Efficiency (OEE). The aim is to improve the utilisation of energy by 'leading Canadians to [improve] energy efficiency at home, at work and on the road' (NRCan, 2015f). The OEE delivers the ecoENERGY Efficiency program in order to improve energy efficiency for a cleaner environment and reduced GHG emissions, while saving Canadians money and making the most of Canada's natural resources (NRCan, 2015g). Since 2011, the ecoENERGY Efficiency program has invested CAD 195 million to improve energy efficiency in all end-use sectors, thereby making the housing, building and equipment stock more energy-efficient, energy performance more visible and industrial and vehicle operations more efficient. The ecoENERGY efficiency program addresses the following components of efficiency.

- ecoENERGY Efficiency for Buildings provides information and benchmarking tools to improve the building energy performance of new and existing buildings.
- ecoENERGY Efficiency for Housing encourages the construction and retrofit of low-rise residential housing, making the stock more energy-efficient.
- ecoENERGY Efficiency for Equipment Standards and Labelling introduces or raises energy efficiency standards for a wide range of products and promotes energy-efficient products through the ENERGY STAR® initiative in Canada.
- ecoENERGY Efficiency for Industry aids the adoption of an energy management standard and accelerates energy-saving investments and the exchange of best practice information within Canada's industrial sector.
- ecoENERGY Efficiency for Vehicles provides individual Canadians and Canada's commercial/institutional fleet sector with decision-making tools for buying and operating their vehicles in order to reduce fuel consumption. It also promotes vehicle efficiency by introducing improved vehicle fuel consumption labels and a light-duty tyre information system (NRCan, 2015g).

Apart from the aforementioned CAD 195 million, the government has been investing in alternative fuels and biofuels in order to diversify its energy sources. Since 2011, the federal government has committed CAD 3 million to support alternative fuels used in the transport sector (NRCan, 2015g). Federally, there is a further CAD 1.5 billion of funding available in the period 2008–17 to support the production of renewable alternatives to gasoline and diesel for the development of a competitive domestic industry (NRCan, 2015g).

Additionally, the Canadian Government has introduced the Federal Buildings Initiative (FBI) (NRCan, 2015h). This is a voluntary program that helps facilitate energy efficiency retrofit projects in buildings owned or managed by the government. Developed and administered by NRCan's OEE, the FBI enables federal organisations to implement these projects through third-party energy performance contracts without necessarily using their own capital funds. The initiative enables third parties to work with representatives

from federal organisations to help implement successful retrofit projects. As of 2015, over 80 retrofit projects attracted CAD 360 million in private sector investment in order to generate over CAD 47 million in annual energy cost savings. These projects demonstrated average energy savings of 15–20% and cut GHG emissions by 295 kilotonnes (NRCan, 2015h).

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RENEWABLE ENERGY

Canada has an abundance of renewable energy resources. Canada is a world leader in the production and use of renewable energy, with 19.5% of its total primary energy supply in 2013 originating from renewable energy resources (ESTO, 2015). At the federal level, NRCan's CanmetENERGY research centre leads clean energy research and development. The federal government supports renewable energy, namely small hydro, wind, solar, bioenergy and marine energy, by funding CanmetENERGY. This organisation engages in research, development and demonstration to accelerate renewable technologies towards commercialisation and self-sustainability (NRCan, 2015i).

Budget 2016 provided funding in three main areas for energy R&D: 1) CAD 82.5 million over two years to support the research, development and demonstration of clean energy technologies; 2) CAD 62.5 million over two years to support the deployment of infrastructure for alternative transportation fuels, including a charging infrastructure for electric vehicles and natural gas and hydrogen refuelling stations; and 3) CAD 50 million over two years to invest in technologies that will reduce GHG emissions from the oil and gas sector. Budget 2016 was a first step in the government's plans to support clean technology and innovation. These investments will contribute to Canada's Mission Innovation commitment. Budget 2016 also signals the government's plan to provide over CAD 1 billion over four years, starting in 2017–18, to support clean technology, including in the natural resources sector. Further details about the allocation of this funding will be provided as part of the implementation of the Government's upcoming Innovation Agenda.

Hydro is the most important source of renewable energy in Canada, supplying 62% of Canada's electricity generation in 2013 (EGEDA, 2015). In 2013, Canada's installed hydraulic capacity was over 75 873 MW (SC, 2013). Among several potential options, Canada promotes small hydropower technologies as one of the best alternatives to the highly polluting and very costly diesel generation used for electricity generation in the economy's most remote communities (NRCan, 2015j). The installed small capacity was approximately 3 636 MW in 2014.

Canada has access to large and diversified biomass resources for energy production owing to its large landmass filled with active forests and agricultural industries. In 2013, bioenergy was the second most important form of renewable energy, with biofuels and renewable waste representing 3% of Canada's total primary energy supply (ESTO, 2015).

Canada had 67 bioenergy power plants with a total installed capacity of 1 580 MW in 2013. Most of this capacity is built around the use of wood biomass, spent pulping liquor and landfill gas. Biofuel is also a growing form of bioenergy in Canada and accounts for 2% of world biofuel (ethanol and biodiesel) production in 2014, making Canada the fifth largest producer after the United States, Brazil, the European Union and China (NRCan). The bioenergy sector has been growing significantly as evident in the number (70) and the installed capacity (2 043 MW) of bioenergy power plants in 2014 (NRCan, 2015e). The federal government, alongside the provinces, has introduced regulations on renewable content to increase future production and the use of biofuels. The Canadian Government has developed a comprehensive renewable fuels strategy consisting of four elements:

- A Renewable Fuels Regulation which establishes a minimum renewable fuel content of 5% renewable content based on the gasoline pool and 2% renewable content in diesel and heating oil;
- A commitment of CAD 200 million over four years to the ecoAgriculture Biofuel Capital Initiative to support farmer participation in the industry;
- A commitment of CAD 1.5 billion over nine years to the ecoENERGY for Biofuels program to support domestic production; and
- A commitment of CAD 500 million to the Next Gen BioFuels Fund™ to support next-generation technologies from non-conventional feedstock (NRCan, 2015e).

Wind is also an important renewable energy source whose provincial leaders are Ontario, Quebec, and Alberta (NRCan, 2015e). However, other provinces with wind potential are increasing the share of wind

energy in their power mix. Prince Edward Island (PEI) is a major electricity importer from New Brunswick, which uses coal and nuclear among others. PEI's indigenous electricity generation is almost entirely wind, but this only accounts for 17% of its demand (NRCan, 2015k).

Canada has vast areas with significant potential for wind resources to make the expansion of wind-generated power very economical. Installed wind power capacity has expanded rapidly in recent years and is forecasted to grow at a rapid pace given the government initiatives in place support its growth. In 2013, Canada had over 5 100 wind turbines in operation in 187 wind farms, with a total installed capacity of 7 801 MW. In 2014, installed capacity increased further to 9 694 MW (CanWEA, 2015). In May of 2015, Canada surpassed the 10 000 MW threshold to place it seventh in the world for installed capacity (CanWEA, 2015).

Solar energy has also experienced continuous growth both in thermal and photovoltaic (PV) power. Cumulative PV power capacity grew to 1 211 MW (±3%) in 2013 (IEA, 2014). Ontario was the leading province in terms of solar capacity in that year (1 020 MW) (IEA, 2013). Off-grid capacities are not reported in 2013 but were estimated at approximately 1% of the total installed capacity (IEA, 2014). Other Canadian provinces, including British Columbia, Alberta and Saskatchewan, were also expanding their solar capacity in 2014.

Canada has access to a significant energy source in the form of ocean waves and tides because of its proximity to the Atlantic and Pacific Oceans. It has one of the world's few tidal power plants in Nova Scotia, generating 20 MW of electricity, and two wave and tidal current technology demonstration projects in British Columbia and Nova Scotia. In British Columbia, wave energy capacity is 100 kilowatts (kW). The 4 MW project in Nova Scotia will be the first deployment of commercial-scale tidal turbines in Canada (NRCan, 2015e).

Geothermal power has not experienced similar momentum as solar, wind and biomass. A number of heat and power generation projects are being considered in Alberta, British Columbia, the NWT and the Yukon where the highest temperature geothermal resources are located. Demonstration projects are under way in Western Canada, including the South Meager project in British Columbia, the most advanced geothermal power plant in Canada. In 2010, there were over 95 000 ground-source heat pumps with the installed capacity of about 1,045 megawatts of thermal energy (NRCan, 2015e). CanmetENERGY has been financially supporting the demonstration projects in British Columbia, the NWT, the Yukon and Alberta. These demonstration projects are not commercially viable.

NUCLEAR ENERGY

Nuclear energy is an important component of Canada's energy mix. In 2013, nuclear energy accounted for 14% of its electricity generation (EGEDA, 2015). Canadian nuclear power generation is concentrated in the provinces of Ontario (18 reactors) and New Brunswick (one reactor). In 2012, Gentilly 2, the province of Québec's only nuclear plant, was permanently shut down and put in a safe storage state following the decision of the provincial energy utility provider, Hydro-Québec, not to proceed with refurbishment because of the high cost (Canadian Nuclear Association, 2014). Hydro-Québec is now proceeding with a 50-year decommissioning plan.

Nuclear energy falls within federal jurisdiction, unlike other energy sources. The federal government is responsible for all regulation of nuclear materials and activities along with supporting research and development (R&D). Concerned with the impact of nuclear activities on health, safety, security and the environment, the federal government has put in place a comprehensive nuclear legislation framework. The latter comprises the Nuclear Safety and Control Act 1997, the Nuclear Energy Act 1985, the Nuclear Fuel Waste Act 2002 and the Nuclear Liability Act 1985[2] (NRCan, 2015l). They provide the framework for developing nuclear energy in Canada. Nuclear energy issues are administered through a layered organisational approach. The involved organisations in this regard include the following.

- Natural Resources Canada: Responsible for developing 'policies and programs which enhance the economic and environmental well-being of Canadians'. The Department provides advice on energy policy, as well as institutional, legislative and financial frameworks for the nuclear industry.

[2] The Nuclear Liability and Compensation Act (NLCA), Part 2 of the Energy, Safety and Security Act, received Royal Assent on 26 February 2015. The NLCA provides stronger legislation in order to deal more effectively with liability for a nuclear accident within Canada, and allows Canada to join the International Atomic Energy Agency (IAEA) Convention on Supplementary Compensation for Nuclear Damage. The NLCA would increase the operator's liability limit from CAD 75 million under the current Nuclear Liability Act to CAD 1 billion. Subject to the approval of the Government, the new Act could enter into force on 1 January 2017 once regulations are completed and ministerial decisions are taken on insurance and government financial cover. The NLCA would repeal and replace the existing *Nuclear Liability Act* of 1985

- Canadian Nuclear Safety Commission: An independent agency of the Canadian Government tasked with 'regulating the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy'.
- Atomic Energy of Canada Limited (AECL) is a federal Crown corporation with the mandate to enable nuclear science and technology and fulfil Canada's radioactive waste and decommissioning responsibilities. By enabling nuclear science and technology activities, AECL enables work that has benefits and applications in the areas of health, safety, security, energy, non-proliferation, environmental protection and emergency response. AECL's Chalk River Laboratories in Ontario is home to Canada's largest research and development complex.
- Following a multi-year restructuring process, AECL now delivers on its mandate through a long-term contract with the private sector for the management and operation of its sites, facilities and assets under a government-owned, contractor-operated model. AECL works to monitor performance under this model in order to meet government objectives. Canadian Nuclear Laboratories is responsible for the day-to-day management and operation of AECL's sites, including the Chalk River Laboratories, the Whiteshell Laboratories and the Port Hope Area Initiative Management Office.
- Global Affairs Canada (GAC) is responsible for managing Canada's international commitments with regard to nuclear energy, and is the lead on issues of non-proliferation and nuclear security. GAC also supports the Canadian nuclear industry in terms of pursuing export opportunities.
- Health Canada (HC) is responsible for coordinating the Federal Nuclear Emergency Plan (FNEP), a multi-departmental event-specific plan that outlines the roles and responsibilities of federal organisations in preparing for and responding to a nuclear emergency.
- Other departments, such as Transport Canada and Innovation, Science and Economic Development Canada are not directly involved in nuclear legislation or policy development but have jurisdiction over areas affecting nuclear energy, such as transportation and research (NRCan, 2015l).

The federal government is the central body, which regulates nuclear energy, but the decision to invest in nuclear power plants for electricity generation rests with the provinces (in concert with relevant provincial energy utilities) (NRCan, 2015l). Given the current context and the outlook of each provincial electricity utility, no new nuclear capacity is projected, although existing operational plants will undergo refurbishment. Ontario has announced a CAD 25 billion investment into the refurbishment of 10 nuclear reactors: four at the Darlington Nuclear Generating Station and six at the Bruce Nuclear Generating Station. These refurbishments will add about 25–30 years to the operational life of each unit. Refurbishment at Darlington is to start in 2016 with one reactor, and commitments on subsequent reactors will take into account the cost and timing of preceding refurbishments, with appropriate off-ramps in place. Refurbishment at Bruce is to start in 2020.

CLIMATE CHANGE

Canada is fully committed to address climate change in a meaningful manner while ensuring the competitiveness of its economy (GOC, 2016f). Climate change is a complex issue making Canada's approach multifaceted and layered at the provincial, federal and international levels. All these levels work in collaboration to ensure that policies, regulations and initiatives are aligned and work in concert.

PROVINCIAL

Provinces/territories hold the jurisdictional authority to regulate natural resources. Consequently, they play an integral role in climate policies since energy production and consumption contribute significantly to Canada's GHG emissions. As such, each province develops and implements policies, regulations and initiatives in an effort to mitigate climate change and reduce GHG emissions. Examples of regulations and programs that focus on reducing direct GHG emissions include the following.

- Alberta: This province passed the Specified Gas Emitters Regulation 2007, as amended in 2015. This requires facilities emitting more than 100 000 tonnes of GHG to reduce emissions by 12%. Among other options, companies may choose to pay CAD 15 per tonne for every tonne over their target if they do not physically reduce their emission levels (PA, 2015).

- British Columbia: A revenue neutral carbon tax has been applied to the purchase or use of fuels within the province at a current rate of CAD 30 per tonnes of CO_2 equivalent (British Columbia Ministry of Finance, 2015).
- Nova Scotia: The Greenhouse Gas Emissions Regulations 2009 places a cap on electricity sector emissions from all facilities with targets that have been set until 2030 (PNS, 2013).
- Ontario: As of April 2014, the province no longer uses coal to generate electricity. Further, the provincial government has proposed a regulation to ensure no future coal-burning, grid-connected electricity generation (PO, 2014). The government also introduced the Green Energy and Green Economy Act 2009, which implemented a feed-in tariff that promotes and facilitates the connection of renewable generating facilities (Ontario Power Authority, 2014). Ontario's nuclear plant refurbishments, a CAD 25 billion investment, also represent a major component of the province's climate change mitigation strategy by ensuring that the province's electricity supply remains almost entirely non-emitting.
- Quebec: This province is part of the Western Climate Initiative, a GHG emissions cap-and-trade system with Ontario and California. It has placed a small levy on fuel and fossil fuels (PQ, 2012).
- Saskatchewan: The provincial power utility, SaskPower, has made the world's largest per-capita investment in carbon capture and storage (CCS) technology at its electricity generating facility at Boundary Dam. In its first year of operation, the plan captured 400 000 tonnes of carbon dioxide. The province is also home to all of Canada's active uranium mines, operating under the province's *Mineral Industry Environmental Protection Regulations*. Saskatchewan uranium fuels nuclear power plants in Ontario, New Brunswick and other plants internationally, displacing between 230 and 550 million tonnes of the world's GHG emissions each year.

FEDERAL

Energy production and consumption contribute significantly to Canada's GHG and air pollution emissions. The Canadian Government's policies aim at promoting energy efficiency and cleaner technologies, boosting renewable energy supplies and reducing GHG emissions. Since 2006, the federal government has invested more than CAD 10 billion to reduce GHG emissions and build a more sustainable environment through investments in green infrastructure, energy efficiency, clean energy technologies and the production of cleaner energy (EC, 2013a). Closely related to this, the Canadian government promotes investment in clean technology to help address climate change. Towards this end, its 2016 budget "proposes to provide over CAD 1 billion over four years, starting in 2017–18, to support clean technology, including in the forestry, fisheries, mining, energy and agriculture sectors" (Budget, 2016).

The government also takes measures to help Canada adapt to climate change impacts, including with respect to public infrastructure. Thus, the 2016 budget "proposes to provide [CAD] 129.5 million over five years, starting in 2016–17, to seven federal departments and agencies to implement programming focused on building the science base to inform decision-making, protect the health and well-being of Canadians, building resilience in the North and Indigenous communities and enhancing competitiveness in key economic sectors" (Budget, 2016). It also proposes to provide an additional CAD 40 million over five years starting in 2016–17 to "integrate climate resilience into building design guides and codes" (Budget, 2016).

The federal government is regulating GHG emissions through a sector-by-sector approach, with regulations already in place in two of the largest emission sectors: electricity and transportation.

- Electricity Sector: In 2012, the Canadian Government announced stricter regulations concerning coal-based electricity generation, with new standards applicable for new and old power plants that have reached the end of their economic life. The expected result is a cumulative reduction in GHG emissions of approximately 214 Mt in the first 21 years (EC, 2013a).
- Transportation Sector: The proposed final regulation in the transportation sector aims to ensure that 2 025 passenger vehicles and light trucks will emit around 50% less GHG than 2008 models while emissions for 2018 model heavy duty vehicles will be reduced by up to 23% (EC, 2013a). The transportation regulations were developed to align with US Environmental Protection Agency (EPA) standards, in order to work collaboratively towards a common North American standard (EC, 2013a).

The federal government has constitutional authority to regulate emissions with regard to certain aspects of climate change, even though the provinces have jurisdiction over natural resources and thus authority over other aspects.

Thus, "the federal government has jurisdiction to regulate air pollution that is released from a source in Canada and experienced in a country outside Canada. Under the *Canadian Environmental Protection Act, 1999*, the federal Minister of the Environment must first offer an opportunity for the government responsible for the area in which the source is situated to prevent, control or correct the air pollution, before acting" (PA, 2013).

With regard to industrial emissions, the Canadian provinces "have jurisdiction over most types of industries, including mining and manufacturing, and therefore they also have jurisdiction to regulate emissions from these industries. The federal government, in turn, regulates emissions from those industries that come under its jurisdiction, including several that may have a significant environmental impact, such as aviation and interprovincial and international transportation" (PA, 2013).

However, the federal and provincial governments have both authority when it comes to addressing GHG and climate change per se. The provincial governments have jurisdiction to regulate most types of buildings, businesses, industries and intraprovincial transportation, and therefore they also have jurisdiction to control the greenhouse gas emissions related to these matters. While the federal government has jurisdiction over certain industries [mentioned above], its jurisdiction to regulate the emission of greenhouse gases is based in its power to regulate toxic substances as an aspect of criminal law. In 2005, the government added six greenhouse gases to the List of Toxic Substances set out in Schedule 1 of the *Canadian Environmental Protection Act, 1999*, and therefore it now, arguably, has jurisdiction to regulate the emissions of these greenhouse gases (PA, 2013).

In 2012, the federal government used this jurisdiction as it "made regulations to reduce the emission of carbon dioxide from coal-fired generation of electricity. Since no court has ruled on the constitutionality of this exercise of federal jurisdiction, which some people might characterise as relating to electricity generation (a subject matter of exclusive provincial jurisdiction – the regulations remain in effect"(PA, 2013).

In the following year, the federal government "again made regulations under the *Canadian Environmental Protection Act, 1999* to reduce greenhouse gas emissions, this time in relation to emissions from heavy-duty vehicles and engines. However, this exercise of federal jurisdiction was not based on the federal power to regulate toxic substances as an aspect of criminal law. Rather, it relied on the federal government's power to regulate international and interprovincial trade and commerce, since the regulations set emissions standards that heavy-duty vehicles and engines must meet in order to be imported or transported across a provincial border. Accordingly, while the most obvious means for the federal government to regulate the emission of greenhouse gases might be by using its power to regulate toxic substances as an aspect of the criminal law, other federal powers might also be used, depending on how a regulation is structured" (PA, 2013).

This creates a dichotomy between the two institutional powers in terms of regulating emissions coming from natural resource production. The federal government has indicated the next step of the Canadian climate change plan is to regulate the remaining major sources of emissions, including the oil and gas sector (EC, 2013a). The federal government has been in negotiations with industry and all provincial governments since 2012.

INTERNATIONAL

Canada's international commitments are a driver of action at the federal and provincial levels. Canada is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC). In 2009, Canada signed the Copenhagen Accord and committed to reducing GHG emissions to 17% below 2005 levels by 2020 (EC, 2013b). Since the end of the Doha round of negotiations under the UNFCCC in December 2012, Canada has continued its engagement in the UNFCCC negotiations to support the establishment of a fair and comprehensive global climate change regime. The Cancun Agreement endorsed this approach. The intention is to develop a possible future cap-and-trade system, and develop and deploy clean energy technologies in a regionally focused effort.

Canada actively participated in the Twenty-First Conference of the Parties (COP21) in Paris (December 2015) and made a full commitment to the resulting agreements. As laid out by Prime Minister Justin Trudeau in November 2015, the "five principles upon which Canada's actions on climate change would be based and on which "Canada delivered concrete actions" at the Twenty-First Conference of the Parties are as follows (EC, 2016).

- **Canada will act based on the best scientific evidence and advice**

  Throughout the negotiations, Canada actively supported including in the agreement of the need to limit average global temperature rises to well below 2 degrees Celsius above pre-industrial levels, as well as pursuing efforts to limit increases to 1.5 degrees. Canada has advocated for this

recognition of the urgency of the threat to small-island states, like the Marshall Islands with whom we [Canada] now stand as part of the High Ambition Coalition.

- **Canada will support and implement policies that contribute to a low-carbon economy**

  Canada joined the Carbon Pricing Leadership Coalition (CPLC), which brings together leaders from government, business and civil society, to support the introduction and implementation of carbon pricing practices around the world. Canada also endorsed the Fossil Fuel Subsidy Reform Communiqué in support of accelerating action to eliminate inefficient fossil-fuel subsidies.

- **Canada will work with our provinces, territories, cities and Indigenous leaders**

  Canada has emphasized a collaborative and inclusive approach, setting out with a Canadian delegation of dedicated federal, provincial and territorial representatives including Premiers and Ministers of the Environment, leaders and members of opposition parties, Indigenous leaders, representatives from youth organisations, environmental NGOs and members of the business community. And throughout the negotiations, Canada consistently advocated for the inclusion in the Paris Agreement of language that reflects the importance of respecting the rights of Indigenous Peoples.

- **Canada will help the developing world tackle the challenges of climate change**

  Canada pledged [CAD] 2.65 billion over the next five years to support developing countries' transition to low-carbon economies that are both greener and more climate-resilient. This is the most significant Canadian climate finance contribution ever. During COP 21, Canada announced financial support totalling [CAD] 275 million for the Least Developed Countries Fund, the Climate Risk and Early Warning Systems, the G7 Initiative on Climate Risk Insurance, the G7 African Renewable Energy Initiative, and to address short-lived climate pollutants. Canada continues to support countries in need and recognises the specific circumstances of the least-developed countries and small-island developing states.

- **Canada views climate change not just as a challenge, but as an historic opportunity to build a sustainable economy**

  Prime Minister Trudeau joined French President François Hollande, US President Barack Obama and Bill Gates to announce the launch of Mission Innovation, an ambitious clean technology initiative that seeks to double government investment over the next five years in clean energy research and development, and to spur business investment in clean technology.

Canada has taken measures to ensure the fulfilment of its commitments under COP21. They include an agreement between all the Canadian provinces and territories and federal government reached at the First Ministers' Meeting on 3 March 2016 to work together to "create the Vancouver Declaration on Clean Growth and Climate Change. The Declaration is the first step in developing a concrete plan to achieve Canada's international commitments to reduce greenhouse gas emissions and build on the momentum of the United Nations Paris Agreement" (Budget 2016). Moreover, the Canadian 2016 budget proposes to provide "almost [CAD] 2.9 billion over five years, starting in 2016–17, to address climate change and air pollution issues" (Budget, 2016).

To ensure the continued active engagement of Environment and Climate Change Canada, Natural Resources Canada and Global Affairs Canada towards advancing Canada's climate change and air pollution objectives, the 2016 budget proposes to provide CAD 61.3 million over five years, starting in 2016–17 (Budget, 2016). The objective is to ensure Canada's continuing leadership role in international environmental organisations, such as the UNFCCC, and "will allow Canada to work toward a North American clean energy and environmental agreement with the United States and Mexico (Budget, 2016).

NOTABLE ENERGY DEVELOPMENTS

LNG TERMINAL PROJECTS

A dramatic shift occurred in the North American liquefied natural gas (LNG) market over the past decade. In the early 2000s, mounting concerns over decreasing conventional supplies of domestic natural gas resulted in bullish forecasts about future LNG demand in North America, prompting an investment boom in building LNG import facilities (NRCan, 2015m). One such investment included the Canaport LNG

terminal in Saint John, New Brunswick, which began gas-import operations in 2009 and has remained Canada's only operating LNG facility (regasification) since.

However, despite these early concerns, natural gas production in Canada and the US surged because of the technological advancements made in unconventional natural gas production. Greater supply from shale gas and tight gas formations outpaced the growth in natural gas demand, which ultimately enabled the US to become increasingly self-sufficient in natural gas. Given this significant shift in the US, Canadian exports to the US have declined.

Canada intends to diversify its market by exporting its gas in the form of LNG to overseas markets. This objective requires LNG export terminals. The west coast of Canada has experienced a significant number of proposed LNG facilities to address the growing demands of the Asia-Pacific region. However, these projects involve long lead times, which are needed for obtaining approvals, establishing markets and constructing facilities (NEB, 2014a).

In 2016, Canada does not have any operational export facilities. However, as of early October 2015, the National Energy Board (NEB) "approved 23 applications for long-term LNG export licences, and another seven applications [were also] before the Board" (NEB, 2016). The majority of the proposed LNG projects are in British Columbia although there are proposed LNG projects in Nova Scotia, New Brunswick and Quebec (NEB, 2016). In fact, in the third quarter of 2015, the NEB issued three competing LNG export licences in New Brunswick and Nova Scotia. However, the NEB stated that the issuance of the licences did not mean that plants would necessarily be constructed because market considerations would determine any such plans (CBC, 2015).

According to the NEB, "there is considerable uncertainty regarding how much LNG will be exported from Canada. The numerous projects currently under construction around the world could provide sufficient capacity to meet global LNG demand for many years to come, leaving limited room for Canada in the market. However, Canada's advantageous location relative to the Asian market, and its abundant natural gas supplies, could make it a competitive player in the global LNG market. Other uncertainties that could impact Canada's future LNG export volumes include North American and global natural gas prices, crude oil prices, the pace of global LNG demand growth and the ability of LNG proponents to address environmental and social concerns" (NEB, 2016).

As of December 2015, British Columbia's planned LNG export terminals are all awaiting approval and/or final investment decisions; thus, their construction is yet to start (LWS, 2015). Final investment decisions will be influenced by factors, including construction costs, pricing arrangements and competition with other existing or potential LNG exporters (NEB, 2014a).

To encourage investment in LNG projects, the Canadian federal government's 2016 budget maintains the existing accelerated capital cost allowance (CCA, which is currently available for certain LNG facilities (Budget, 2016). Accordingly, for assets acquired before 2025, an "effective CCA rate of 30 per cent is available for eligible liquefaction equipment and 10 per cent for related buildings. This treatment serves as an incentive to invest in new facilities that supply LNG to new markets" (Budget, 2016). This is "consistent with Canada's G20 commitment to eliminate fossil fuel subsidies over the medium term" for which "the government intends to maintain this tax preference as currently legislated and allow it to expire as scheduled" (Budget, 2016).

Once in operation, an LNG terminal generally falls under provincial regulations. However, LNG terminal proposals require numerous federal and provincial environmental assessments and permits. Among other federal requirements, a licence from the NEB is required to export LNG. The NEB ensures that the proposed volume of gas exports does not exceed the surplus, which is needed to meet estimated domestic demand (NRCan, 2015m).

PIPELINE DEVELOPMENTS

Oil exports through pipelines are a major means for securing new markets for the long-term success of Canada's landlocked oil economy, which is based mainly in Alberta, Saskatchewan and Manitoba. Although the industry is experiencing growth in production from oil sands and new light oil prospects, its location is not ideal. The distance is far from the major refining hub on the US's Gulf Coast and ocean ports, which would provide access to the expanding overseas market. The government and industry are working together to find options to access markets. Consequently, numerous pipeline proposals are in the regulatory process or have recently received approval. One such proposal, of major significance, is the Keystone XL, which is intended to increase oil exports to the US. However, in November 2015, the US Government rejected TransCanada's request for its construction (New York Times, 2015).

Meanwhile, TransCanada began leading the proposed Eastern Mainline Pipeline (4 600 km). The USD 12 billion project would transport 1.1 million barrels per day (bbl/d) of oil from Alberta and Saskatchewan to refineries and port terminals in Eastern Canada by converting an existing west-east gas pipeline and adding an extension to connect it to Canada's Atlantic ports, from which oil could be shipped to the US and other export markets by tankers. The extension would link Canada's Ontario-Quebec border to the Port of Saint John, New Brunswick (Pipeline International, 2015).

ABORIGINAL ENGAGEMENT

The participation of Aboriginal peoples is a critical factor in Canada's ability to realise the full benefits of energy resource development. A key reason for the importance of this participation, on a number of levels, is the close proximity of energy development projects to indigenous communities, lands and traditional territories. Moreover, consultation with Aboriginal groups is also a requirement, both for the Crown, in fulfilling its legal and constitutional accountabilities to respect and uphold Aboriginal or treaty rights, and for the private sector, as part of its regulatory requirements.

The Canadian Government has undertaken efforts and adopted initiatives in recent years to enhance its engagement and consultation efforts with Aboriginal communities. As part of this policy, and building on certain court decisions, Aboriginal consultations are integrated into environmental assessment and regulatory processes as a way of identifying and addressing potential rights-based impacts before decisions are made. Further, consultation protocols or agreements with Aboriginal groups are also established for project reviews. In 2012, the Canadian Government introduced the Responsible Resource Development plan.

As many proposed energy infrastructure projects on Canada's west coast pass through or near Aboriginal communities, and to enhance relationship building, the Major Projects Management Office, West (MPMO West), was established in 2014. This serves as a single window for coordinating activities on energy infrastructure development with the BC government, Alberta First Nations and industry (GOC, 2011).

Green infrastructure on reserves, including for water, is an important issue and closely related to energy and climate change. Appreciating its importance for this matter among others, the Canadian government, through its 2016 budget, aims to improve the "reserve water and wastewater infrastructure and waste management by providing [CAD] 2.24 billion to First Nations communities to support such improvements" over the next five years (Budget, 2016). The proposed investment is part of the first phase of its 10-year plan "to invest in green infrastructure. The second phase of this plan will include additional investments in green infrastructure in Indigenous communities" (Budget, 2016).

ARCTIC AND OFFSHORE ENERGY

Exploration and study by the oil and gas industry and the Canadian Geological Survey has indicated strong potential for petroleum discoveries in Canada's northern region, particularly its Arctic section, since the 1950s. However, the respective costs of developing the fields and transporting their fuels to the market have been quite high. In particular, the low oil prices of the previous decades and transportation bottlenecks have made discoveries uneconomical to develop (NRCan, 2007). However, interest in the region's vast oil and gas potential has grown on the assumption of high oil and gas prices, and the promise of new pipeline systems. For example, the potential of the offshore continental shelf is considered quite high with 19 significant discovery licences issued for the Arctic islands and 60 licences in the Mackenzie Delta/Beaufort Sea region (NEB, 2014a). Discoveries in these regions exceed 1 billion barrels of oil and 10 trillion cubic feet (Tcf) of gas.

Canada's oil and gas industry in the north, including offshore drilling in the Arctic, is regulated by the NEB, as set out in the Canada Oil and Gas Operations Act (COGOA), the Canada Petroleum Resources Act (CPRA) and the National Energy Board Act. However, Canada's Atlantic offshore oil and gas industry is regulated by the Canada-Nova Scotia Offshore Petroleum Board and the Canada-Newfoundland and Labrador Offshore Petroleum Board. It is important to note that a 1972 federal moratorium restricts offshore field development off the Pacific coast of Canada, where there is an estimated 9.8 billion barrels of recoverable resources (NRCan, 2013).

In order to enhance responsible resource development, the Canadian Minister of Natural Resources introduced legislation in early 2014, which is intended to change Canada's offshore oil and gas regime. The Energy Safety and Security Act (2015) (GOC, 2015) contains amendments to the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, *Canada-Newfoundland Atlantic Accord Implementation Act,* the *Canada Oil and Gas Operations Act* (COGOA) and the *Canada Petroleum Resources Act* (CPRA) (NRCan, 2014b).

The proposed changes to the mentioned Acts "focus on four main areas: prevention, response, accountability and transparency. They help to strengthen safety and security further in order to prevent incidents and ensure a swift response in the unlikely event of a spill." (NRCan, 2014b)

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Canadian Nuclear Association—www.cna.ca

Canadian Nuclear Laboratories—www.cnl.ca

Environment Canada—www.ec.gc.ca

National Energy Board—www.neb.gc.ca

Natural Resources Canada—www.nrcan-rncan.gc.ca

Statistics Canada—www.statcan.ca

Transport Canada—www.tc.gc.ca

CHILE

INTRODUCTION

Chile joined APEC in November 2004 and is one of the two South American member economies. Located in South America, it shares borders with Peru to the north, Bolivia to the north-east and Argentina to the west. Its coastline runs along the Pacific Ocean for 6 435 km, with an average width of 175 kilometre (km) and a land area of 756 102 square kilometres (km^2). Administratively, Chile is divided into 54 provinces and 15 regions headed by regional governors (*Intendente*) appointed by the President. In 2013, the economy's population was around 18 million, with 87% living in urban areas (INE, 2013b). Forty per cent of the population resides in Santiago, the capital (INE, 2013a). Given the size and shape of its territory and number of inhabitants, Chile's average population density was almost 23 inhabitants per km^2 in 2013, although it is much higher in metropolitan areas such as Santiago and Valparaíso, having as many as 455 and 110 people per km^2, respectively (INE, 2013a).

Chile's economic growth is based in solid macroeconomic fundamentals, such as fiscal responsibility, an independent central bank and a floating exchange rate. Chile has more than doubled its gross domestic product (GDP) per capita, from USD 8 728 in 1990 to USD 19 973 in 2013 (2010 USD purchasing power parity [PPP]). It is one of the fastest growing economies in South America with an average annual growth rate (AAGR) of 3% between 1990 and 2013. In 2013, Chile's GDP reached USD 349 billion (2010 USD PPP), which represents an increase of 3.1% from 2012 levels, led by retail sales (7.2%), mining (6.1%) and business services (3.5%). Copper accounted for nearly 93% of mining exports and 41% of total exports (BCL, 2014). Foreign direct investment, closely related to mining investment, decreased by 35% to USD 17 billion in 2013 owing to lower commodity prices (UNCTAD, 2015). Despite Chile's economic activity being highly correlated with final energy consumption, where the mining and industry sectors accounted for 35% of final energy consumption in 2013 and represented around 25% of Chile's economic activity (BCL, 2015), the economy has shown a remarkable reduction in energy intensity. Almost 98% of the total exports were under trade agreements with 60 economies, including the European Union, Mercosur (a regional trade group comprising Argentina; Brazil; Paraguay; Uruguay and Venezuela), India, China, Japan, Korea, Mexico and the United States.

Despite the diverse geography and abundant natural resources, the territory is very limited in fossil fuel resources, making Chile a net energy importer; thus, one of its mainstay priorities revolves around a steady energy supply. Fossil fuel reserves are limited, so nearly the entire fossil fuel supply is imported (around 65% of total primary energy supply (TPES) in 2013). Chile imports around 98% of its oil and 71% of its gas, but despite high oil and gas import dependence, hydro and biomass contributed about 30% of TPES in 2013.

Oil production declined from 15 million barrels in 1981 to 1.1 million barrels in 2013 (Agostini and Saavedra, 2009; ENAP, 2014), maintaining proven oil reserves of 1.9 million cubic metres (mcm) in 2013. The government is currently focusing on exploration investment through the National Petroleum Company (ENAP in Spanish), as evidenced by an increased exploration budget of USD 800 million annually until 2020.

Table 1: Key data and economic profile, 2013

Key data[a]		**Energy reserves**[b, c, d]	
Area (km^2)	756 102	Oil (million barrels)	150
Population (million)	17.8	Gas (million cubic metres)	9.0
GDP (2010 USD billion PPP)	349	Coal (million tonnes)	171
GDP (2010 USD PPP per capita)	19 973	Uranium (kilotonnes of U)	3.7

Sources: a. EGEDA (2015); b. MEC (2014); c. EIA (2014); d. CCHEN (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

According to Expert Group on Energy Data Analysis 2015, APEC Energy Working Group (EGEDA), Chile's TPES increased by 3.9% from 2012 to 2013 to reach 38 649 kilotonnes of oil equivalent (ktoe). Approximately 41% of this energy volume was supplied in the form of crude oil and its by-products, 17% as coal, 11% as natural gas and the remaining 31% as other sources, particularly biomass and hydropower. Given its limited natural endowment in hydrocarbons, Chile is a net importer of primary energy, especially fossil fuels. Its net primary energy imports represent 65% of the TPES, having reduced by nearly 2% from 2012 to reach 25 207 ktoe in 2013. Despite its small contribution to the TPES, Chile's energy output from non-fossil sources increased by 8.6% from 2012 to 2013.

In regard to fossil energy resources, Chile's proved crude oil reserves amounted to 1.9 mcm by the end of 2014, with most of it located in the southern Magallanes region. In light of the low domestic production, nearly all of Chile's crude oil supply of 15 844 ktoe in 2013 came from imports that also included by-products such as diesel, gasoline and liquefied petroleum gas (LPG) (EGEDA, 2015). Eighty per cent of Chile's demand of 4 055 ktoe for natural gas in 2013 was met by imports and the rest by domestic production (EGEDA, 2015). Chile's domestic coal production is mainly located in the region of Magallanes, with total recoverable coal reserves estimated at 171 million tonnes. By 2013, domestic production accounted for 25% of the total supply (EGEDA, 2015).

Chile is abundant in renewable energy (RE) resources, whose contribution to the TPES is high, totalling 12 106 ktoe and representing nearly 85% of the economy's total domestic energy production in 2013 (EGEDA, 2015). Chile's primary supply of non-fossil energy in 2013 mainly comprised biomass and hydropower.

In 2013, Chile's total net installed electricity capacity was 17 997 megawatts (MW), representing an increase of 255 MW (1.5%) from 2012, with thermal power plants representing 65% of the total capacity. The remainder was contributed mainly by hydropower (33%). It is important to mention the drastic change in the contribution of hydro and thermal sources to the TPES since 2006, when they respectively comprised 54% and 46% of the total electricity capacity, respectively.

By 2013, Chile's electric system was organised around the following systems:

- Northern Grid (SING): 3 759 MW, 100% thermal (51% coal and 39% natural gas, and 10% oil and diesel);
- Central Interconnected System (SIC): 13 826 MW, 55% thermal (21% diesel, 18% natural gas, and 16% coal), 43% hydro and 2% wind;
- Aysen Grid: 50 MW, 51% thermal (100% diesel), 45% hydro and 4% wind;
- Magallanes Grid: 100 MW, 100% thermal (85% natural gas and 15% diesel); and
- Los Lagos Grid: 6.2 MW, 88% thermal (100% diesel) and 12% hydro.

FINAL ENERGY CONSUMPTION

During 2013, Chile's total final energy consumption was 26 581 ktoe, representing an increase of 6.4% from the previous year.

Energy demand was fairly balanced between the industrial (37%), transport (31%), and the residential, commercial and public sectors – jointly grouped as 'other sectors' – (30%), and the remaining 2.4% represented non-energy use.

By energy source, more than half of Chile's final energy demand was met by petroleum products (51%) which were primarily consumed by the transport and industrial sectors, followed by electricity and other sources (43%), natural gas (5.4%) and a marginal share of coal. Oil consumption increased by 7.6%, while gas and coal consumption decreased by 0.6% and 21%, respectively, and electricity consumption rose by 6.6% (EGEDA, 2015).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	14 955	Industry sector	9 903	Total power generation	73 065
Net imports and others	25 207	Transport sector	8 148	Thermal	46 841
Total primary energy supply	38 649	Other sectors	7 899	Hydro	19 737
Coal	6 644	Non-energy	631	Nuclear	–
Oil	15 844	Total final energy consumption	26 581	Others	6 487
Gas	4 055	Coal	151		
Others	12 107	Oil	13 541		
		Gas	1 432		
		Electricity and others	11 456		

Source: EGEDA (2015).

ENERGY INTENSITY ANALYSIS

Energy intensity has been declining since 2005, thus indicating more efficient use of energy sources. The transport, and residential, commercial and public sectors showed a reduction of 4.2% in energy use since 2005.

Chile's primary energy supply in 2013 was 106.9 tonnes of oil equivalent per million USD (toe/million USD), down 0.3% from 107.3 toe/million USD in 2012. The energy intensity for the final energy demand increased by 2.1% to 74 toe/million USD in 2013 from 72 toe/million USD in 2012. The final energy demand for both the transport and industry sectors increased by 4.8%. Energy intensity reduced by 1.6% in the 'others' sector, while non-energy use fall by 18% in 2013 compared to 2012.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	107.3	106.9	–0.3
Total final energy consumption	72	74	2.1
Industry	26	27	4.8
Transportation	22	23	4.8
Other sectors	22.2	21.9	–1.6
Non-energy	2.1	1.8	–18

Source: EGEDA (2015).

ENERGY POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Since the 1980s, Chile has embarked upon developing an economy based on international trade and the rules of the free market. It has reaped various benefits as the economy has grown significantly. From the 1980s to 2013, Chile has more than doubled its income per capita and has been one of the fastest growing economies in Latin America. In addition, it provides a business environment conducive to foreign investments, given its streamlined administrative processes and simplified tax payments. Chile is ranked 34 among 183 economies in the report *Doing Business 2014*.

Being an open-market economy, Chile is highly integrated with the world markets. Its participation in free trade agreements has increased its options for sustainable development, as evidenced by increased trade opportunities, reduction of its dependency on mineral exports and creation of trade products with higher value-added.

In line with these principles, Chile's energy policy is based on the development of a free market economy and oriented towards enhancing its economic efficiency and energy security by reducing its vulnerability to supply shocks and high dependence on imports.

The Chilean Parliament approved the creation of a Ministry of Energy in November 2009 and in February 2010 the new Ministry of Energy started operations. It centralises the functions of developing, proposing and evaluating public policies in this area, including the definition of objectives, regulatory framework and strategies to be applied and development of public policy instruments.

In December 2015, the Chilean Ministry of Energy presented the *Energy 2050: Chile's Energy Policy* to guide energy policy in the economy in the long term (MEC, 2015a).

FISCAL REGIME AND ENERGY PRICES

Since 2001, Chile's fiscal policy has been guided by the rule of cyclically adjusted balance, also known as the Structural Balance Rule. This policy aims to maintain medium-term equilibrium in fiscal accounts, adjusting the government's incomes by the economic cycle and approving the government spending according to this income. The 2006 Fiscal Responsibility Law introduced new rules on the investment of accumulating assets. In addition, it covers central government agencies, but not the central bank, public non-financial enterprises, the military sector or municipalities.

PETROLEUM-BASED FUELS

In Chile, prices for petroleum-based fuels are set by international market conditions and across all stages of the value chain, including retail sales at service stations. However, specific excise taxes (IEC in Spanish) are charged on transport fuels (gasoline, diesel, liquid petroleum gas (LPG) and compressed natural gas (CNG)).

In February 2011, the government introduced the Consumers' Protection System for Volatility in International Oil Prices (SIPCO) to reduce uncertainty over domestic prices for oil products. This system was replaced in July 2014 by a new mechanism called the Fuel Prices Stabilisation Mechanism (MEPCO in Spanish), which changes the previous SIPCO mechanism by reducing the price's band and setting a limit on the weekly variation of fuel prices to no more than CLP 5 per litre per week. Finally, MEPCO converts the oil international price in local currency to assess the value of the final price protection on the consumer.

Under this system, a price band is determined around the average price between the historical and future prices of a fuel; if the price of the fuel rises or falls outside this band, the excise tax is adjusted to counteract the price change. Thus, significant variations in price are absorbed into the IEC excise tax system, and consumer risk is minimised.

ELECTRICITY

Costumers in the electricity market are divided into regulated and non-regulated customers.

- Regulated customers: This term refers to customers with a power connection below 2 000 kilowatts (kW) and who are connected to the grid through a local distribution company. The regulated price considers the distribution fee, node price based on the marginal cost of energy of the respective tender, capacity charge and transmission charge.
- Non-regulated customers: This term refers to customers with a maximum demand above 2 000 kW, who are free to negotiate directly with the power generation companies.

Chile has four different energy grid systems. The two most important are the SIC and SING. By law, they have to coordinate the operation of their power plants through the respective Economic Dispatching Centres (CDEC-SIC and CDEC-SING). These centres are independent entities in charge of coordinating and programing the dispatch of energy to meet the demand at the least possible cost, which is based on the marginal cost of generation.

ENERGY MARKETS

The electricity market in Chile encompasses power generation, transmission and distribution. The regulatory framework for Chile's electricity supply industry is based on the principle of competitive markets for generation and supply. Private companies wholly serve the electricity market, while the government remains as a regulator, policy-maker and technical consultant to identify the requirements to meet the projected

demand growth. The Ministry of Energy is the main regulator of the electricity industry in Chile and is supported by the National Energy Commission (Comisión Nacional de Energía or CNE) and the Superintendence of Electricity and Fuels (Superintendencia de Electricidad y Combustibles or SEC).

ENERGY EFFICIENCY

Energy efficiency is among Chile's priorities as it works towards achieving its key goal of enhancing its energy security. These efforts also encompass the stabilisation of demand growth through energy efficiency measures.

In terms of energy efficiency, the Ministry of Energy is responsible for the development of policies and guidelines, including the promotion and enhancement of economy-wide efficient energy use as a means of contributing to the achievement of this goal. Furthermore, in pursuing these objectives, the Ministry of Energy entrusts them to the Chilean Energy Efficiency Agency, which is responsible for implementing many of these policies by promoting, disseminating and implementing dedicated programs, opening new markets and exploring opportunities in the field of energy efficiency, and developing energy efficiency markets to recognise and reward leading energy efficiency companies. The current goal is to foster the efficient use of energy as an energy resource. The government has established a 20% savings goal by the year 2025 after considering the expected growth in energy consumption for the economy.

The government promotes energy efficiency measures through the Action Plan on Energy Efficiency 2020, which aims to reduce final energy demand by 12% by 2020 (MEC, 2012). These measures are applicable to industry and mining, transport, buildings, end-use devices and heating.

Table 4: Chile's Action Plan on Energy Efficiency 2020

Industry and mining	• Promote energy management systems. • Promote energy cogeneration. • Encourage efficient technologies.
Transport	• Improve energy efficiency standards for light- and heavy-duty vehicles. • Use new transport technologies in heavy-duty vehicles. • Promote public transportation. • Promote electric vehicles.
Buildings	• Encourage efficient technologies. • Promote building labelling.
End-use devices	• Enhance appliance labelling. • Establish minimum efficiency standards. • Promote minimum lighting efficiency standards.
Heating	• Encourage new technologies in the use of firewood. • Improve firewood quality.

Source: MEC (2012).

The government is implementing the Action Plan for Energy Efficiency 2020. Since 2012 the Superintendency of Electricity and Fuels certifies security, emission levels and energy efficiency standards on firewood home appliances, which have been part of the institutional framework for energy efficiency policies owing to the importance of firewood residential consumption in Chile (MEC, 2012). In addition, in 2014, the Chilean government approved the Minimum Energy Efficiency Standards Act that applies to refrigerators and lamps, and new regulations on vehicle labelling and water heating were also approved.

RENEWABLE ENERGY

In April 2008, Law 20.257 (Law of Non-Conventional Renewable Energy) was enacted. It added to previous amendments to the Electricity Law introduced through Law 19.940 (2004) and Law 20.018 (2005). It mandates that electricity companies include a percentage of non-conventional RE (RE excluding large hydropower plants, NCRE) as a share of the total energy sold.

Specifically, the law requires that between 2010 and 2014, 5% of the total annual withdrawals of electricity generators that obtain energy from electric systems with an installed capacity greater than 200 MW must be sourced from non-conventional renewable sources. Beginning in 2015, the required level of non-conventional energy sources is slated to rise by 0.5% annually, to reach 10% of the total energy production by 2024.

In October 2013, the government of Chile enacted Law 20.698 to promote the expansion of Non-Conventional RE. This law doubles the goal previously set by Law 20.257 and specifies that 20% of the electricity sold by 2025 must come from non-conventional renewable energies. In addition, it requires the Ministry of Energy to conduct annual public procurement of energy blocks generated from non-conventional RE, which will serve to fulfil the required NCRE quotas. These actions would occur only if it is foreseen that the market will not meet the requirement by itself.

At the end of March 2016, Chile's energy matrix had an installed capacity of 2 864 MW of NCRE, with solar and wind representing 37% and 32%, respectively. Similarly, an additional 2 693 MW is under construction, 18 907 MW worth new projects have secured the required environmental permissions and 7 328 MW are under environmental evaluation.

Table 5: Chile's NCRE capacity

March 2016	Operation (MW)	Construction (MW)	EQR-approved (MW)	Under Evaluation (MW)
Biomass	417	0	112	47
Biogas	48	0	8	0
Wind	910	428	5 966	1 905
Geothermal	0	48	120	0
Mini hydro	433	25	455	75
Solar – PV	1 056	2 082	11 266	4 826
Solar – CSP	0	110	980	475
Total	2 864	2 693	18 907	7 328

Note: EQR = Environmental Qualification Resolution.
Source: CIFES (2016).

The rising demand for electricity and policy incentives make renewables[3], especially solar energy, an attractive option for increased domestic power generation, because of high solar radiation in the north. The capacity potential of solar photovoltaic (PV) and concentrated solar power (CSP) is about 1 200 gigawatts (GW) and 548 GW, respectively, which is sufficient to cover local electricity demand. Additionally, wind potential is estimated at 37 GW and hydro at 12 GW (MEC, 2014).

After the publication of the Energy Agenda in 2014, the Chilean government established the National Centre for the Innovation and Development of Sustainable Energies (CIFES) to provide support to the Ministry of Energy and the Chilean Economic Development Agency (CORFO) in the design, implementation and evaluation of strategic projects in sustainable energy. CIFES replaces the former Centre for Renewables Energies.

CIFES is a government institution that aims to strengthen the development of non-conventional energy sources in Chile by providing financial and technical support.

The main objectives include:

- Promoting the use of RE sources by reducing financial and technical barriers against their implementation.
- Facilitating the development of a local energy industry through technological transfer and development of capabilities and knowledge in sustainable energies.
- Promoting demand for technologies based on renewable energies.
- Encouraging the local development of scientific and technological knowledge in renewable energies.

CIFES runs the following programs to support the development of renewable energies:

[3] 'Renewables' include hydro, solar, wind, geothermal, biomass and marine energy. The term 'other renewables' excludes hydropower.

- The Solar Strategic Program, which focuses on developing projects based on solar technologies, including generation, storage and technological services.
- The Sectorial Self-sufficiency Program, which aims to reduce production energy costs and provide energy independency to projects without a constant energy supply or with high levels of contamination.
- Support program for the development of mini hydro projects, which promotes and develops the use of mini hydro projects aligned with the 100 Mini Hydro Plan led by the Ministry of Energy.
- Program to develop and promote the use of marine energy with assistance from the Marine Energy Research and Innovation Centre (MERIC). MERIC has a budget of USD 20 million, of which around 80% is from CORFO.

NUCLEAR ENERGY

In 1964, Chile created the Commission on Nuclear Energy (Comisión Chilena de Energía Nuclear or CCHEN) to address problems related to the production, acquisition, transfer, transport and peaceful uses of atomic energy. Further, the CCHEN is in charge of the operation and regulation of the two reactors located in the Santiago metropolitan region, which have been used for research and civil purposes. In 2007, the Nuclear Power Working Group was created to assess the potential advantages and risks associated with the use of nuclear energy for power generation. Its duties are as follows:

- To provide technical and legal advice to the government on nuclear issues related to energy and radiation;
- To conduct research and development in peaceful uses of nuclear energy;
- To regulate, control and supervise nuclear facilities; and
- To undertake technology transfer and its applications.

Given the energy requirements of the Chilean economy, the use of nuclear energy has been subject to concerted debate. In 2007, the Nuclear Energy Working Group was formed to study the feasibility of implementation and use of nuclear energy in Chile. This study concluded that according to international experience and despite the risks of earthquakes faced by Chile and potential waste management problems, nuclear energy is a viable option (MEC, 2007).

In 2010, the study *Nuclear Electricity: Possibilities and Challenges* (MEC, 2010) stated that the development of nuclear energy in Chile should aim to close the identified gaps: '…technological, institutional and fundamental knowledge such as a complete geological information of the economy, modify the current legal and regulatory institutions, implement a plan to meet the human resources necessities and finalise other complementary studies'. The study also concludes that public approval is not only a fundamental requirement but also the biggest challenge to solve before considering nuclear power as an energy alternative. If these problems are solved by the mid-2010s, the study estimates that nuclear power plants may be included as part of Chile's energy matrix by the year 2024.

The Presidential Advisory Commission for Electricity Development was established in 2011. One of the main conclusions of a study undertaken by it is that nuclear power would be a 'strategic insurance that would ensure sustainable energy supply in the long term'. The study predicted that nuclear energy could become part of Chile's energy matrix as early as 2030. In the National Energy Strategy 2012–30, the Chilean government enacted a moratorium on nuclear energy to generate electricity (MEC, 2011).

In January 2015, the Government of Chile created the Nuclear Power Energy Committee, which prepared the report *Nuclear Power Generation in Chile: Towards a Rational Decision* (MEC, 2015b). This report agrees with a previous report from 2010 in that the economy must continue working to close the gaps inhibiting the proper implementation of nuclear energy, and that the possibility of using nuclear energy should not be discarded without a 'rational and comprehensive analysis and considering all relevant aspects of this technology and the feasibility of its use in Chile'. Finally, the report concludes that social approval is crucial to start any project involving nuclear energy development in Chile.

Clearly, from the perspective of the Chilean government, despite the exclusion of nuclear energy from the final Energy Agenda in 2014, its possible use in the future has not been ruled out. In fact, the need for additional studies related to technology, location, waste management and public approval has been recognised. Energy 2050 notes that nuclear energy is not an option for Chile at the present time, and its uptake depends on further research regarding security and economic rationality as well as community

acceptance. Moreover, the Chilean government established the Nuclear Energy Power Committee in 2015 to undertake comprehensive research on these issues.

CLIMATE CHANGE

Chile became a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and ratified the Kyoto Protocol in 2002. In December 2008, Chile published the National Action Plan on Climate Change 2008–12. This action plan assigns institutional responsibilities for adapting, mitigating and strengthening Chile's response to climate change (CONAMA, 2008). According to the results of vulnerability studies conducted by the Ministry of the Environment (MMA in Spanish), the effects of climate change can summarised as follows:

- There has been a decrease in precipitation in some regions up to 75%, a temperature increase up to 1.5% and a decrease to 77% in the flow rate in some regions.
- There is a marked reduction in the recorded population of a vast majority of species.
- Regions that are predominately small in area and have low levels of technological access show the greatest vulnerability to climate change.

While Chile's contribution to global carbon emissions is very low, at around 0.2% of the total carbon dioxide emitted globally in 2010 (UN Stats, 2013), its territory is highly vulnerable to the effects of climate change. Glacial melting, shifts in rainfall patterns, expanding deserts and the greater frequency of El Niño weather patterns will have an impact on the economy's water supply, food production, tourism industry and migration, as well as on its socio-economic development and energy security. In this regard, Chile's action plan identified hydroelectric resources, food production, urban and coastal infrastructure and energy supply as the four areas most vulnerable to climate change, where adaptation would be required.

In July 2014, the Plan for the Adaptation to Climate Change in Biodiversity was approved. This plan contains 50 measures that aim to reduce and mitigate the effects of the climate change on biodiversity in the four areas most vulnerable to climate change.

The government's Intended National Determined Contribution (INDC) is to reduce greenhouse (GHG) intensity by 30% by 2030, based on 2007 levels. The INDC goals are established on intensity-based targets. To reach the targets outlined in the INDC and to ensure the sustainability of Chile's energy future, the government is preparing the *National Action Plan for Climate Change 2016–21*. This document contains the following thematic axes and strategies.

THEMATIC AXES	STRATEGY
Adaptation	Strategic guidelines for determining vulnerability, disaster risk reduction and strengthening cross-adaptation.
Mitigation	GHG inventories; implementation of mitigation actions, accounting actions mitigation and compliance with international commitments.
Creation and capacity building	Communication, education and outreach; institutional strengthening; scientific investigation; development of trading strategies for Chile; development, transfer and adoption of technology; and funding sources to implement the Plan.

Source: MMA (2015).

NOTABLE ENERGY DEVELOPMENTS

Energy 2050 is an effort to establish a long-term vision on energy policy. The main goal of Energy 2050 is to document Chile's long-term energy policy, which will be approved by Chilean citizens. The policy addresses the citizens' concerns as well as aims to work towards improving energy security and reliability. The creation of this document is envisaged across the following stages and goals (MEC, 2015a):

1. Energy Agenda (May 2014): The aim here is to design and execute a long-term energy policy with technical, political and social support. The Agenda considered the development of regulations, energy standards and

the legal framework required to have a sustainable and reliable energy matrix by 2025. The goals and purposes of the Energy Agenda 2014 can be summarised as follows:

- Reduce the electricity marginal cost by 30% in the Central Interconnected Grid (SIC);
- Reduce the prices of the electricity supply bids by 25%;
- Lift existing barriers for Non-Conventional Renewable Energies to increase the participation of renewal energies up to 45% of the new electric generation capacity by 2025;
- Foster the efficient use of energy as an energy resource, establishing a 20% savings goal by the year 2025, considering the expected energy consumption growth in the economy as of that date;
- Set up a fuel price stabilisation system to reduce the volatility of internal fuel prices;
- Turn ENAP (National Oil Company) into a main actor to tackle the energy challenges of the member economy government; and
- Develop by 2015 a long-term energy policy that will be validated by the Chilean citizens.

2. Energy Road Map: This road map is oriented to create agreements and build a shared long-term vision for the sector under the concepts of sustainability and inclusion. According to the Energy Road Map, the economy's future energy policy needs to consider the following features:

- Compatibility with the environment and communities;
- Universal and equitable access;
- Essential condition for development;
- Opportunity for innovation;
- Efficient production and consumption; and
- Energy security.

3. Energy 2050 – Chile's Energy Policy: released in December 2015, describes the four pillars of Chile's energy policy: 1) energy security and energy supply quality; 2) energy as a development engine; 3) environmental compatibility; and 4) energy efficiency and education. Nuclear energy is not a short-term option under the Energy 2050, but it is proposed that further research be considered in the next review of the Energy Policy.

The main goals of Energy 2050 are summarised in following table.

Table 6: The main goals of Energy 2050 by 2035 and 2050

By 2035	By 2050
Interconnection with other Andean Electric Interconnection System members (Peru, Ecuador, Colombia and Bolivia) and with other South American economies, particularly Mercosur economies (Brazil, Venezuela, Paraguay, Uruguay, Argentina, Bolivia and Venezuela).	Energy sector GHG emissions below limits established in the economy-wide goals.
Energy disruption reduced to less than four hours per year.	Energy disruption reduced to less than one hour per year.
Continuous and reliable access to energy services for all new vulnerable dwellings.	Universal and equitable access to reliable and modern energy services.
All projects developed have associativity mechanisms between project developers and communities to foster local development and better performance.	Territorial, regional and local planning and management tools conforming to the energy policy are in place.
Be among the five economies having lowest residential and industry energy costs.	Be among the three economies having lowest energy costs.
At least 60% of electricity generation from renewable sources.	At least 70% of electricity generation from renewable sources.
Thirty per cent emissions intensity reduction in comparison with 2007.	Energy consumption decoupled from GDP growth.
All large energy consumers (industry, mining and transport) to apply energy efficiency measures.	All new buildings will be constructed as per the Organisation for Economic Co-operation and Development (OECD) standards of efficient construction and smart systems of energy management.

All municipalities to adopt regulations declaring traditional biomass as solid fuel, thus including it in calculations of GHG emissions levels.	Hundred per cent of the main categories of appliances in the Chilean market are energy efficient.
All new passenger vehicles to be evaluated under energy efficiency standards.	Energy efficiency practiced at all levels of society.

Source: MEC (2015a).

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USEFUL LINKS

Chilean Commission of Energy (CNE)—www.cne.cl

Chilean Energy Efficiency Agency (AChEE)—www.acee.cl

Economic Load Dispatch Centre of Central Interconnected System—www.cdec-sic.cl

Economic Load Dispatch Centre of the Northern Interconnected System—www.cdec-sing.cl

Government of Chile—www.gobiernodechile.cl

Ministry of Economy, Development and Reconstruction—www.economia.cl

Ministry of Energy—www.minenergia.cl

Ministry of Environment—www.mma.gob.cl

National Centre for Innovation and Development of Sustainable Energy (CIFES)—www.cifes.cl

Nuclear Energy Chilean Commission (CCHEN)—www.cchen.cl

National Energy Commission (CNE)—www.cne.cl

National Institute of Statistics (INE)—www.ine.cl

National Oil Company (ENAP)—www.enap.clSuperintendence of Electricity and Fuel (SEC)—www.sec.cl

CHINA

INTRODUCTION

China is one of the world's most important emerging economies. It is located in north-east Asia and is bordered by the East China Sea, the Yellow Sea and the South China Sea. Its population of 1.4 billion is approximately one-fifth of the world's population. China has a land area of approximately 9.6 million square kilometres (km^2), with diverse landscapes, which consist of mountains, plateaus, plains, deserts and river basins. Its total maritime area is 4.7 million km^2 and the length of its coastline is 32 000 km (NBS, 2015).

After reforming and opening up its economy in 1978, China entered a new period of high-speed growth. Its entry to the World Trade Organization (WTO) in 2001 contributed further to its prosperity in the first decade of the twenty-first century. In 2004, China overtook Japan as the leading Asian exporter and in 2009, surpassed Germany to become the world's leading exporter. By 2014, China's merchandise exports accounted for 12% of the world's trade exports (WTO, 2015). In 2013, China's gross domestic product (GDP) was 13 246 billion (2010 USD purchasing power parity [PPP]), with the primary, secondary and tertiary industries accounting for 4.8%, 47% and 48% respectively (EGEDA, 2015; NBS, 2015).

Because of its huge population and booming economy, China plays an increasingly important role in the world's energy markets. According to BP, despite the slowing consumption and production growth from historical averages, China still dominates the world energy market as the world's largest energy consumer, producer and net importer (BP, 2015). In 2014, China accounted for 23% of the world's total primary energy consumption (BP, 2015). However, its per capita primary energy supply, at 2.2 tonnes of oil equivalent in 2013, is far lower than that of many developed economies and below APEC's average of 2.9 tonnes of oil equivalent (toe) (EGEDA, 2015).

China is rich in energy resources, particularly coal. According to BP statistics published in June 2015, China had recoverable coal reserves of approximately 114 500 million tonnes, proven oil reserves of 18.5 billion barrels and proven natural gas reserves of 3.5 trillion cubic metres (tcm) (BP, 2015). In addition, China has 400 gigawatts (GW) of economic hydropower potential, more than any other economy. Coal and oil resources have been utilised more extensively than natural gas and hydro for power generation and industrial development.

The reserves per capita of coal, oil and gas are all well below the worldwide average levels. The limitations of its energy reserves per capita force China to conserve its resources. From 2000 to 2013, the compound annual growth rate (CAGR) of final energy demand is 6.9% and the CAGR of GDP is 6.1% (EGEDA, 2015).

Table 1: Key data and Economic Profile, 2013

Key data[a, b]		**Energy reserves**[c, d]	
Area (million km^2)	9.6	Oil (billion barrels)	18.5
Population (million)	1 363	Gas (trillion cubic metres)	3.5
GDP (2010 USD billion PPP)	13 246	Coal (million tonnes)	114 500
GDP (2010 USD PPP per capita)	9 722	Uranium (kilotonnes of U)	181

Sources: a. EGEDA (2015); b. NBS (2015); c. BP (2015); d. OECD-NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001. This expansion has been driven mainly by rapid economic growth, especially in energy consumption by heavy industry. In 2013, the total primary energy supply increased 2.5% compared with 2012, reaching 2 856 million tonnes of oil equivalent (Mtoe), including net imports and other. Of this, coal was the dominant source, accounting for 71%, followed by oil (24%), gas (7.9%) and others (9.5%) (EGEDA, 2015).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 456 051	Industry sector	1 054 350	Total power generation	5 431 637
Net imports and others	461 545	Transport sector	227 499	Thermal	4 247 009
Total primary energy supply	2 856 420	Other sectors	448 188	Hydro	920 291
Coal	2 018 271	Non-energy	71 921	Nuclear	111 613
Oil	487 563	Total final energy consumption	1 801 957	Others	152 724
Gas	159 218	Coal	753 027		
Others	191 368	Oil	451 443		
		Gas	107 615		
		Electricity and others	489 872		

Source: EGEDA (2015).

Since the 1990s, Chinese authorities have encouraged fuel switching (for example, from coal to cleaner fuels), introduced energy-efficiency initiatives in order to reduce pollution and emissions from energy use and optimised the existing energy structure. However, with lean oil and gas resources, the share of coal in total domestic energy production is still at a comparatively high level. In 2014, coal production reached 1 845 Mtoe, 2.6% lower than 2013. Total coal consumption reached 1 962 Mtoe, 0.1% higher than 2013. This figure also represented 51% of global coal consumption in 2014 (BP, 2015).

China has been the world's second-largest economy in terms of electric power generation capacity since 1996. Its electric power industry experienced a serious oversupply problem in the late 1990s, due largely to lower demand after the closure of inefficient state-owned industrial units that were major consumers of electricity. Subsequently, however, a power supply shortage developed because of rapid economic expansion after 2001. From 2000–13, electricity generation output increased quickly from 1 356 terawatt-hours (TWh) to 5 437 TWh, of which thermal power generation accounted for 77% of total power generation. In 2013, installed generation capacity reached 1 342 GW (EGEDA, 2015).

The power supply structure has diversified, with wind power and nuclear energy generation increasing rapidly. In 2013, total power generation in China was 5 432 TWh. Thermal power accounted for 78% (4 247 TWh of total generation, hydropower 17% (920 TWh), nuclear energy 2.1% (112 TWh) and others 2.8% (153 TWh) (EGEDA, 2015).

FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1 802 Mtoe in 2013, 1.1% higher than in 2012. The industrial sector was the largest consumer, accounting for 58.5% of total final energy consumption, followed by the transport sector (13%). Other sectors, including residential, commercial and agricultural, totalled 25%, and non-energy use was 4% (EGEDA, 2015). By energy source, coal accounted for 42% of total final energy consumption, following by electricity and others (27%), oil (25%) and gas (6%).

ENERGY INTENSITY ANALYSIS

China has reduced energy intensity in the last two decades. The intensity of primary energy supply and final energy demand in 2013 have been reduced by 53% and 61% respectively compared with 1990. These are the biggest reductions among the APEC economies. However, energy intensity is still very high and there is a lot of room for improvement (EGEDA, 2015).

In 2011, China eliminated more than 3 GW of small thermal power plants and 24 million tonnes (Mt) of backward cement production capacity (MEP, 2012). With all these efforts, the intensity of final energy demand has decreased 1.2% year-on-year in the industry sector. However, because of the booming economy and transportation needs, car purchases are high, which has resulted in increased energy intensity in the transportation sector.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	191	182	–4.8
Total final energy consumption	122	115	–6.1
Industry	74	67	–9.8
Transportation	15	14.5	0.2
Others	28.5	28.6	0.1
Non-energy	4.9	4.6	–5.5

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

China's energy consumption is growing rapidly, in line with robust economic development and accelerated industrialisation. Energy has become an important strategic issue for China's economic growth, social stability and security. China aims to be a low-carbon economy. The structural transformation of energy is the key to economic restructuring, which is also an important indicator of social progress. Achieving the goal of a low-carbon and orderly energy structure is the basis of China's energy strategy.

During the Twelfth Five-Year Plan for National Economic and Social Development (2011–15), China secured an annual GDP growth rate of 7.8% and an annual energy consumption rate of 3.6%. Further, the installation scale of hydropower, nuclear power, wind power and solar increased by factors of 1.4, 2.6, 4 and 168 fold respectively.

The Thirteenth Five-Year Plan for National Economic and Social Development (2016–20) was approved at the National People's Congress in March 2016. It has five major energy-related objectives:

- Enhance energy supply capability;
- Make a breakthrough with key technology;
- Greatly increase the share of non-fossil fuel consumption; and
- Make a breakthrough in the clean use of fossil fuels.

ORGANISATION

The National Energy Committee is a high-level body that coordinates overall energy policies. The committee, chaired by the Premier, is in charge of formulating China's energy strategy and deliberating on major issues in energy security. In March 2013, the State Electricity Regulatory Commission (SERC) merged into the National Energy Administration (NEA) under the administration of the National Development and Reform Commission (NDRC). The NEA is currently composed of 12 departments and has an authorised staffing complement of 240 civil servants. It is responsible for developing and implementing energy industry planning, and industrial policies and standards. In addition, it is in charge of administering the energy sector, which includes coal, oil, natural gas, other forms of power such as nuclear energy, and new and renewable sources of energy. The NEA has also assumed responsibility for the Office of the National Energy Committee. Some departments within the NDRC also contribute to energy conservation and climate change issues.

In 2009, China established the National Energy Conservation Centre under the NDRC in order to provide technical support to the government for the implementation of energy efficiency and conservation management initiatives. Its main duties include energy efficiency and conservation policy research; the assessment of fixed asset investment projects; information dissemination; the promotion of technologies, products and new mechanisms; label management; and international cooperation in the field of energy conservation.

LAW

The laws relating to energy in China include the Coal Law (issued in 1996 and revised in 2013), the Electricity Law (issued in 1995 and revised in 2015), the Renewable Energy Law (issued in 2005 and revised in 2009), the Energy Conservation Law (issued in 1997 and revised in 2007) and the Environmental Protection Law (issued in 1989 and revised in 2014). A comprehensive legal basis for the energy sector, the Energy Law, is currently under consideration. The Standing Committee of the National People's Congress endorsed the amended version of the Renewable Energy Law on 26 December 2009. It came into effect on 1 April 2010. It more clearly defines the responsibilities of the power grid and power generation enterprises. It also emphasises the completely secure purchase of power from renewable energy sources and the establishment of a development fund for renewable energy. The amendment provides that power grid companies receive all of the revenue generated from the surcharge on retail power tariffs. In addition, it sets a minimum target for the amount of renewable electricity, which grid companies must buy from renewable energy projects (Qiu and Li, 2012).

The Oil and Natural Gas Pipeline Protection Law, endorsed on 25 June 2010, came into effect on 1 October 2010. This requires that oil and pipeline companies take safety measures while constructing pipelines. These measures include ensuring the quality of construction materials, conducting regular patrols of pipelines and promptly eliminating any hazards.

The State Council approved the Regulation on Electricity on 15 February 2005. It became effective on 1 May 2005. This regulation clarifies the content and responsibilities of electricity regulation.

The State Council approved the Regulation on the Administration of Urban Gas on 19 November 2010. It came into effect on 1 March 2011. This regulation clarified the responsibilities and duties of gas operators, unified gas market management into a regular channel and set the basis for local governments' activities.

ENERGY SECURITY

On 13 June 2014, the Chinese leader Xi Jinping presided over the sixth meeting of the Leading Group for Central Financial Work, stressing that energy security is a global and strategic issue that is related to national economic and social development. In order to secure national energy security, Xi Jinping proposed the promotion of a revolution in energy production and consumption. This revolution is a long-term strategy with five major requirements as follows.

- The promotion of an energy consumption revolution, which curbs irrational energy consumption. This involves the firm control of total energy consumption, the effective implementation of an energy-saving priority principle, energy saving throughout the whole process of economic and social development and the adjustment of the industrial structure, significant emphasis on urban energy-saving, the establishment of the concept of thrifty consumption, and the acceleration of the formation of an energy-saving society.

- The promotion of an energy revolution and the establishment of a multi-supply system. These are based on domestic supply with the goals of ensuring safety; vigorously promoting the efficient use of clean coal; focusing on the development of non-coal energy; forming a multifaceted coal, oil, gas, nuclear, new energy and renewable energy supply system; and strengthening the energy transmission and distribution network, and storage facilities.

- The promotion of an energy technology revolution and industrial upgrading. These are based on China's national conditions and follow the new trend of the international energy technology revolution. The goals are to be guided by the principle of green, low carbon energy; promote technological, industrial and business model innovation; promote high-tech fields vigorously; and cultivate technology and related industries in order to upgrade the status of energy as domestic industry's new growth point.

- The promotion of an energy system revolution, which is achieved through fast-track energy development. The goals are not to stagnate or retreat but to develop the revolution, thereby reducing energy commodity attributes, constructing a market structure and system that has effective competition, ensuring that the formation of the market structure and system is mainly determined by the market mechanism of energy price, transforming government energy regulation, and establishing and improving the energy law system.

- All-round strengthening of international cooperation in order to achieve energy security in accordance with the foregoing requirements. On the precondition that the energy production is mainly domestic, to strengthen international cooperation in all aspects of the energy production and consumption revolution and make effective use of international resources.

ENERGY MARKET

Because energy market reform is a driving force behind the acceleration of China's steps towards a market economy, the Chinese Government has promoted such reform in the past few years. The Chinese Government has announced that the entire range of projects included in the National Energy Plan is open to private investment, except those prohibited by laws and regulations. In 2010, the State Council issued *Several Opinions of the State Council on Encouraging and Guiding the Healthy Development of Private Investment*. These encourage private capital to participate in the exploration and development of energy resources, oil and gas pipeline network construction, power plant construction, coal processing, energy conversion, the refining industry and a comprehensive, new renewable energy industry.

COAL MARKET

Owing to the abundant domestic reserves and lower cost, coal has always been the primary energy fuel in China. However, because of the seriously deteriorating air quality in recent years, China is acting to reduce coal consumption in order to cope with air pollution issues and climate change.

In October 2013, several organisations, including government think tanks, research institutes and industry associations, jointly launched the China Coal Consumption Cap Project. This aims to develop a comprehensive roadmap and policy package to cap coal consumption.

In November 2014, China's State Council launched the Energy Development Strategy Action Plan (2014–20). This sets the target for capping coal consumption at no more than 4.2 billion tce, with the share of coal in primary energy consumption kept below 62%.

In November 2015, the China Coal Cap Project issued a report entitled the *China Coal Consumption Cap Plan and Research Report: Recommendations for the Thirteenth Five-Year Plan*. This presents recommendations for controlling and reducing China's coal use to below 3.8 billion tons and 3.4 billion tons by 2020 and 2030 respectively. In addition, the report recommends that the economy's total energy consumption should be at or lower than 4.7 billion tons of standard coal equivalent by 2020, and the share of coal within primary energy consumption during this period should be reduced to less than 57%.

Further, in December 2015, the Chinese State Council pledged to upgrade coal-fired power plants in order to cut pollutant discharge by 60% before 2020, thereby saving approximately 100 Mt of raw coal and reducing carbon dioxide emissions by 180 Mt annually. In addition, China aims to cut total coal consumption to below 65% of total primary energy consumption by 2017 as part of an energy supply structural transformation (SCC, 2015).

OIL MARKET

In April 2015, China surpassed the United States as the world's largest oil importer. According to Chinese customs data, crude oil purchases from overseas reached a new record of 7.4 million barrels per day (Mbbl/D) in April. This is approximately 7.7% of the world's oil consumption per day and exceeds United States imports of 7.2 Mbbl/D. Larger shipments from Iran, Oman and Abu Dhabi partly contributed to the soaring increase in oil imports in China.

Although China faces a challenge of slow economic growth, oil consumption is still increasing instead of decreasing. Thus, China's state-owned oil traders such as Unipec and China Oil have a much more visible presence in the global crude oil market.

However, with China's increasing dependence on overseas oil imports of more than 60%, it must establish strategic oil reserves in order to secure its energy supply. As of the middle of December 2015, China's strategic crude oil reserves had reached 26 Mt, or approximately 191 million barrels. This occurred at a time of low oil prices. Consequently, China has taken advantage of the prices in order to stockpile crude.

According to the Statistics Bureau, the reserves are stored in seven above-ground facilities at Zhoushan, Zhenhai, Dalian, Huangdao, Dushanzi, Lanzhou and Tianjin, and one underground facility at Huangdao with a total capacity of 29 mcm (or approximately 180 million barrels) (FT, 2015; Reuters, 2015).

NATURAL GAS MARKET

Natural gas has not been a major component of China's primary energy supply. However, its share in the economy's energy mix has been increasing rapidly. In the first half of 2015, the consumption of natural gas

was 91 billion cubic metres (bcm). This represented a rise of 2.1% from the same period in 2014 and was 5.5% of the energy mix. Production in the same period increased 3.8% year-on-year to 66 bcm.

Securing the energy supply is one of China's energy strategies. Thus, China has been striving to encourage the transportation of gas from west China and countries around China, such as Russia and the Central Asian countries where there are significant resources, to east China where demand is at its strongest and where an energy shortage is apparent.

China's first West-East Gas Pipeline was built by the China National Petroleum Corporation (CNPC) and completed on October 2004. At 2 722 miles, this is China's longest natural gas pipeline, with one trunk line and three branch lines. The pipeline has an annual capacity of 600 billion cubic feet per year (Bcf/y).

In August 2007, the CNPC announced proposals for a second West-East Gas Pipeline with a capacity of 1.1 trillion cubic feet per year (Tcf/y) and a length of more than 5 480 miles, including the trunk line and eight main branch lines. This natural gas pipeline now transports gas from Central Asia and western China's Xinjiang province to the south-eastern provinces. The western section of the line runs parallel to the first West-East Gas Pipeline to Zhongwei in north-central China. The eastern section transports natural gas from Zhongwei to southern Guangdong province and Shanghai in the East.

In order to meet the rising gas demand in China, the CNPC began constructing the third West-East Gas Pipeline with a capacity of 1.1 Tcf/y. The western section of the pipeline was launched in 2014. The eastern section was in operation by the end of 2015. This pipeline runs parallel to the second West-East Gas Pipeline for most of its length and ends in the south-eastern province of Fujian (EIA, 2015; Primeline, 2015).

Apart from the demand issues, the NDRC announced a reduction in the wholesale price of natural gas for non-residential users in November 2015. This lowers the gas price by an approximate average of 0.1 USD (or approximately 28%) per cubic metre. This reduction has been prompted by the decrease in gas procurement costs following the fall in oil and gas prices. It is also intended to make natural gas an alternative to coal for electricity generation. The NDRC predicts total operational cost savings of CNY 43 billion for industrial users, power generation companies, concentrated heating suppliers, taxi drivers, commercial entities, service providers and others in the downstream.

In addition, the NDRC has also announced that the gas pricing mechanism will be reformed by introducing 'benchmark city station gate prices' for non-residential gas. These will replace the rigid 'ceiling city station gate prices' (China, 2015).

ELECTRICITY MARKET

In the Thirteenth Five-Year Plan, the main objectives for electricity market development are to accelerate structural reformation and innovation, transform to green energy and relax the regulations regarding electricity supply. In order to reach these objectives, there are five major strategies (FE Group, 2015).

- The innovation of the electricity market structure. In 2015, the Chinese government finalized the Deepening Reform of the Power Sector, a policy document co-signed by the Central Committee of the Communist Party and the State Council, in order to accelerate the innovation of the electricity market structure. Further, an investment regime must be established by opening public bidding in a specific orderly manner, thereby developing innovation for the electricity market and its business model.
- Coherent development. The development of the electricity market and economics in upstream and downstream industries must be coordinated in a way that emphasises electricity demand rather than supply. The planning of the electricity market, regional strategy, transmission lines and energy fuel allocation for peak hours must be strengthened.
- The continuation of green development. The objectives are to continue increasing the share of non-fossil fuels in power generation, optimise the energy mix for power generation with hydropower and nuclear energy as the prioritised choices in the energy mix, promote green transformation in the power generation structure and develop a low carbon approach in order to secure a stable and economic supply of electricity in the long term.
- Continuation of the open market. Domestic and international resources and markets must be combined in order to implement a One Belt, One Road strategy, especially in order to export nuclear energy, hydropower and thermal power to overseas markets.

- Share the development. Trading in the electricity market must begin by establishing an electricity market trade platform, enhancing the service level of the electricity industry and accelerating the upgrade of the power distribution network.

Further, on 30 November 2015, China announced reforms of its electricity sector in order to improve competition in the marketplace. These reforms will end the monopoly of electricity distribution by state-owned enterprises (SOEs). The government will expand pilot programs that are related to the cost of building transmission lines, thereby allowing electricity consumers to negotiate directly with electricity generators (OilPrice, 2015).

ENERGY EFFICIENCY

In June 2015, the Chinese Government announced its intention to develop an energy revolution that focuses on reducing energy consumption, increasing energy supply and improving energy efficiency. With regard to the energy efficiency improvement policy, there are two major strategies (USCBC, 2015).

- Eliminate inefficient facilities. In May 2014, the NEA issued a notice called the *2014 Elimination of Outdated Production Capacity for the Power Industry*. Shortly after this notice was issued, provincial-level NDRCs launched implementation plans. Meanwhile, the central government has made plans to develop large-scale power plants and combine heat and power stations in order to replace small power stations. At the State Council Executive meeting in June 2014, Prime Minister Li Keqiang stated that new coal power plants would be prohibited in the Beijing, Tianjin and Hebei region. Instead, large-scale coal power plants in central and western China will play a more significant role in power production and transmission.
- Establish a market-oriented energy pricing mechanism. Energy inefficiency in China is mainly caused by governmental control of energy pricing and the monopolies of SOEs. In order to encourage competition and weaken the power of SOEs, the Chinese Government will invite more private companies into the sector through a bidding process for power transmission, distribution and sales as part of the policy reform.

On 23 April 2015, the State Council introduced 80 pilot projects in order to attract private investment to national infrastructure projects. These projects include hydropower, wind power, photovoltaic (PV) power, oil and gas pipelines, energy storage facilities, the modern coal chemical industry and the petrochemical industry. The State Council said that these projects would be put out to public tender in order to attract private capital through joint venture, sole proprietorship or franchise arrangements. With regard to the next step, the government will release more projects from other sectors. These will include oil and gas exploration and water conservancy.

Carbon-trading schemes are also being used by central government to promote market-based energy-pricing structures. In February 2014, the NDRC decided to promote a carbon-trading system further by introducing it across the economy. As of 12 July 2015, Hebei was the sixth city in China to open a carbon emissions trading market after Shenzhen, Shanghai, Beijing, Guangdong and Tianjin.

RENEWABLE ENERGY

China is the world's leading producer of renewable energy. It is also the largest investor in clean energy with a record USD 89.5 billion invested in renewable energy in 2014. This figure is 32% higher than the USD 60.8 billion invested in 2013. Consequently, renewable electricity generation investment in China exceeded investment in fossil fuel and nuclear energy.

In 2013, China had a total of 399 GW of renewable energy capacity (including hydro). This is more than double the capacity of renewable energy in the United States. China's goal of generating 20% of its energy from non-fossil fuel sources by 2030 will require the installation of an additional 800–1 000 GW of renewable energy, an amount which is equal to the size of the entire current US electricity grid.

WIND

Wind offers one of the greatest opportunities for renewable energy growth in China. During 2007–14, China's wind energy increased nearly twentyfold, growing from 5.9 GW to 116 GW, and is expected to continue to grow. Since 2010, China has been the largest wind power producer in the world. In 2013, the electricity generation output of wind reached 141 TWh, making it the third most popular energy source in the economy after coal (4 111 TWh) and hydro (910 TWh) (EGEDA, 2015).

However, the wind power industry faces the challenge of abandoning wind power because of the limitations of wind farms and grid capacity. The abandonment of wind power has occurred in China since 2010 and reached a peak in 2012 with a total of 21 billion kWh of wind power electricity. This accounted for just 17% of wind power electricity generated in that year, leading to a direct economic loss of CNY 100 billion.

In 2013, the situation improved because the wind power abandonment rate fell to 11% and decreased further to 8.5% in 2014. However, in the first half of 2015, the abandonment rate rose to 15% (NEA, 2015).

SOLAR

The solar PV industry in China has long depended on subsidies and is expected to experience a crucial period of transformation in 2016–20. Under the economy's energy transformation policy, China's solar PV industry is changing towards intelligent manufacturing for stronger competitive advantages. This is because China is endeavouring to accelerate energy technology innovation in order to construct a clean, low-carbon and high-efficiency energy system.

In 2015, China's installed solar PV capacity surpassed Germany and had the largest capacity, 43 GW, in the world (PV Magazine, 2016). Indeed, China has been the world's largest market for solar PV since 2013, when it had 17.5 GW.

In December 2015, the NEA issued the draft of a suggestion for solar energy in the Thirteenth Five-Year Plan, setting a target for solar PV capacity to reach 150 GW by 2020. The basis of this target is that the economy will continue to expand solar PV generation in the next five years.

In addition, the NDRC is currently soliciting opinions on reducing the benchmark on-grid price of electricity generated by wind and solar PV power. The opinions requested are those of local governments and power companies. The intention is that a lower price will help the industry to expand (Xinhua Finance Agency, 2015).

HYDRO

Hydropower is a big part of China's renewable energy mix. However, it cannot be scaled up indefinitely. China is the world leader in terms of hydropower capacity. The installed capacity at the end of 2013 was 281 GW, making it by far the economy's single largest renewable power source. Although China has set a goal to increase capacity to 350 GW over the next five years, the potential for new large and small hydro capacities is not infinite. Thus, the proportion of hydropower in China's renewable energy mix is likely to decrease in the near future. (EGEDA, 2015)

NUCLEAR ENERGY

Because China is striving to reduce air pollution from coal-fired power plants, it is aiming to construct more nuclear power plants. Currently, 30 nuclear power reactors are in operation with 24 under construction and more to be constructed. In 2015, the electricity generation output of nuclear was 169 TWh, which was approximately 3% of total power generation. The installed capacity was 26 GW, which was approximately 1.75% of total capacity. 2015 also saw the beginning of the greatest number of nuclear power projects in a single year in China since the 2011 crisis, with eight new units being approved for construction.

Following Japan's Fukushima Daiichi crisis in early 2011, China reviewed its nuclear plant safety requirements. On 25 October 2012, the State Council approved new safety rules and a nuclear power development plan, which prioritise safety and quality in Chinese regulations and set a target of 58 GW nuclear capacity by 2020 (WNA, 2015). The Chinese Government has said that it will approve a small number of plants along the coast in accordance with new stricter safety rules, and no plants were approved for inland areas during the period of the Twelfth Five-Year Plan (2011–15) (NNSA, 2013). According to the Energy Development Strategy Action Plan 2014–20, all new nuclear plants must meet the strictest world safety standards (SCC, 2014).

China now pays significant attention to the next generation of nuclear power. In China's nuclear development plan, pressurised-water reactors (PWRs) are to be the main type of nuclear reactor before 2030. Fourth-generation reactors (such as high temperature reactors, molten-salt reactors, gas-cooled fast reactors, sodium-cooled fast reactors and lead-cooled fast reactors), which have improved operating safety features, will be available for commercial construction in approximately 2030. Then, the fourth-generation reactors will gradually replace the current PWRs. By 2040, new technology will play an important role in China's energy supply (World Nuclear, 2016).

CLIMATE CHANGE

In June 2015, China submitted a climate action plan called the Intended Nationally Determined Contribution (INDC) to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC). In the action plan, China reaffirmed the bilateral climate deal agreed with the United States in November 2014. It also pledged to reach a total emissions peak by approximately 2030 and to try its best to peak earlier. Further, China committed itself to increase the share of non-fossil fuels in its energy mix to 20% by 2030.

China also announced two goals in addition to the November deal with the United States. These are to reduce carbon intensity by 60% to 65% of the 2005 level and to restore approximately 4.5 bcm of forested land beyond the 2005 level. This is an important change because the economy is increasingly decoupling its economic growth from greater growth in carbon emissions.

The cooperation between China and the United States on addressing climate change has injected momentum into UNFCCC negotiations. In 2013, the US and China also came to a joint bilateral agreement to work through existing Montreal Protocol and UNFCCC mechanisms in order to reduce the use of hydrofluorocarbons (HFCs), which are potent greenhouse gases emitted through a variety of industrial processes.

NOTABLE ENERGY DEVELOPMENTS

STRUCTURAL CHANGE AND GREEN LEAP FORWARD

To reduce greenhouse gas (GHG) emissions and address air quality impacts, China needs to move its energy structure from fossil fuel dominance to renewables and nuclear. A host of policies and regulations support China's ambitious push for renewables and encourage energy efficiency and domestic renewable energy deployment. China's five-year plans have pursued an aggressive renewable energy policy, pushing for an increase in renewable energy production to 15% of the total energy mix by 2020. In March 2015, China's State Council announced a plan to reform the power sector by improving the share of renewable energy in electricity generation, encouraging competition and developing greater efficiency.

Heavy government investment and subsidies could be the key drivers for success with these goals. According to the Statistics Bureau, China's solar and wind energy capacity increased by 74% and 34% respectively in 2015, while coal consumption dropped by 3.7%. China broke two new records in 2015, installing a record 32.5 GW of wind and a record 18.3 GW of solar, both of which were higher than initial estimates.

NUCLEAR POWER RENAISSANCE

Nuclear power has been recognised as a key part of China's plan to reshape its energy mix away from coal, to clean up its skies and to limit carbon emissions. At the beginning of 2015, the State Council approved construction of its first nuclear power project, the Hongyanhe Nuclear Plants located in the north-west of China, since the Fukushima disaster almost four years ago. The State Council then approved the first indigenous nuclear plant and two Hualong-one units to be built in southern Fujian province. In December 2015, the State Council gave its approval for the construction of two more nuclear units at each of the Tianwan and Fangchenggang nuclear power plant sites. At present, China's nuclear reactors under construction account for almost 40% of the world's total.

NEW ENERGY VEHICLES

A proposal in the Thirteenth Five-Year Plan, issued on 3 November 2015, states that the Chinese Government will implement a neighbourhood electric vehicle (NEV) popularisation program. It will also upgrade the industrialisation level for electric car manufacturing in order to ensure the long-term development of China's NEV industry. The proposal expects that a market-oriented NEV industrial system will be developed by 2020. Further, an independent, controllable and complete NEV industrial chain will be built which will produce three million NEV units each year.

The proposal has three aims:

- A greater than 80% share of the Chinese NEV market by domestically produced brands;
- The placement of two Chinese vehicle enterprises among the world's top 10 for NEV sales, with overseas sales accounting for 10% of total sales; and
- Automobile industry advances through NEV development while foreign automobile makers remain inactive in promoting NEV.

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China Electricity Council (CEC)—www.cec.org.cn

Energy Research Institute of National Development and Reform Commission (ERI)—www.eri.org.cn

Ministry of Environmental Protection (MEP)—www.zhb.gov.cn

Ministry of Housing and Urban-Rural Development—www.mohurd.gov.cn

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HONG KONG, CHINA

INTRODUCTION

Hong Kong, China is a special administrative region of the People's Republic of China. It is a world class financial, trading and business centre of some 7.2 million people located at the south-eastern tip of China. Hong Kong, China has no natural resources and thus all of its energy demand is imported. The energy sector consists of investor-owned electricity and gas utility services.

In 2013, the per capita gross domestic product (GDP) of Hong Kong, China was 50 611 (2010 USD purchasing power parity [PPP]), among the highest of the APEC economies, and GDP increased 9.9% in real terms after 2010 to 364 billion (2010 USD PPP). The services sector remained the dominant driving force of overall economic growth, accounting for 90% of GDP in 2013 (EGEDA, 2015). Hong Kong, China is driven by its financial, higher value-added and knowledge-based services. To stay competitive and attain sustainable growth, Hong Kong, China needs to restructure and reposition itself not only in light of the challenges posed by globalisation, but also due to its closer integration with mainland China. The Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) is a manifestation of the advantages of 'one country, two systems'. As part of the liberalisation of trade in goods under CEPA, all products imported from Hong Kong, China to mainland China enjoy tariff-free treatment.

With the support of mainland China under CEPA and the Framework Agreement on Hong Kong/Guangdong Cooperation, Hong Kong, China is poised to reinforce and enhance its status as an international centre for financial services, trade and shipping, as well as an advanced global manufacturing and modern services base. The central government has announced that it will actively liaise with Guangdong to identify favourable treatment and implement opportunities for Hong Kong's people and enterprises in the planning and development of Nansha, Qianhai and Hengqui. It will also increase the number of Economic and Trade Offices in Asia to help business and investors tap Asian markets. Moreover, the government has invited the submission of proposals to complement the National 13th Five-Year Plan (Policy Address, 2015).

Table 1: Key data and economic profile, 2013

Key data		Energy reserves	
Area (km²)	1 104	Oil (million barrels)	–
Population (million)	7.3	Gas (billion cubic metres)	–
GDP (2010 USD billion PPP)	364	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	50 611	Uranium (kilotonnes of U)	–

Source: EGEDA (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Hong Kong, China has no domestic energy reserves or petroleum refineries; it imports all of its primary energy needs. A substantial share of imported energy is converted into secondary energy such as electricity and gas for final consumption. The total primary energy supply in Hong Kong, China was 14 (million tonnes of oil equivalent (Mtoe) in 2013, 0.3 Mtoe higher than 2012. Coal maintained the highest share of the total primary energy supply (55%), followed by oil (23%), gas (16%) and other sources (6%) (EGEDA, 2015).

In 2014, the total installed electricity generating capacity in Hong Kong, China was 12 645 megawatts (MW) (EGEDA, 2015). All locally generated power is thermal fired. Electricity is supplied by CLP Power Hong Kong Limited (CLP Power) and The Hong Kong Electric Company, Limited (HKE). CLP Power supplies electricity from its Black Point (2 500 MW), Castle Peak (4 108 MW) and Penny's Bay (300 MW) power stations. Natural gas and coal are the main fuels used for electricity generation at the Black Point and Castle Peak power stations. CLP Power has arrangements with China National Offshore Oil Corporation and PetroChina International Company to procure gas supplies from the Mainland. HKE's electricity is

supplied by Lamma Power Station, which has a total installed capacity of 3 757 MW. Natural gas used at HKE's power station is mainly imported through a submarine pipeline from the Dapeng liquefied natural gas (LNG) terminal in Guangdong, mainland China. HKE has also operated wind turbines (capacity 800 kilowatts [kW]) since 2006, and a photovoltaic (PV) system (1 MW) since 2010 (CLP, 2015; HKEI, 2015a, 2015b, 2015c).

While natural gas and liquefied petroleum gas (LPG) are the main types of gaseous fuels used in Hong Kong, China, town gas serves as another fuel product. Town gas, which is manufactured locally using naphtha and natural gas as feedstock, is being distributed by The Hong Kong and China Gas Company Limited (Towngas, 2013).

FINAL ENERGY CONSUMPTION

In 2013, the total final energy consumption in Hong Kong, China was 6 746 kilotonnes of oil equivalent (ktoe), a decrease of 1.3% from the previous year. The residential and commercial sectors accounted for the largest share of energy used (63%), followed by the transport sector (31%) and the industry sector (5.2%). By energy source, electricity and 'others' made up 55% of end-use consumption, followed by petroleum products (35%) (EGEDA, 2015).

Town gas and LPG are the main types of fuel gas used in the domestic, commercial and industrial sectors. LPG is also used as fuel for taxis and light buses while natural gas is used for electricity generation and town gas production.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	64	Industry sector	348	Total power generation[a]	39 103
Net imports and others	28 640	Transport sector	2 121	Thermal	39 061
Total primary energy supply	14 118	Other sectors	4 276	Hydro	1
Coal	7 769	Non-energy	0	Nuclear	–
Oil	3 189	Total final energy consumption	6 746	Others	41
Gas	2 307	Coal	–		
Others	853	Oil	2 366		
		Gas	682		
		Electricity and others	3 698		

Note: 'Total' does not include electricity generated by hydro and nuclear energy facilities located in the mainland.
Source: EGEDA (2015).

ENERGY INTENSITY ANALYSIS

In terms of primary energy or final energy demand, the energy intensity of Hong Kong, China is the lowest among APEC economies. The primary energy intensity in 2013 was only 38.8 tonnes of oil equivalent per million USD (toe/million USD) compared with the median value of 168 toe/million USD for APEC economies, while the final energy demand was only 18.5 toe/million USD compared with the median value of 111 toe/million USD (EGEDA, 2015).

Hong Kong, China endeavours to develop sustainably and fully supports APEC's Honolulu Declaration in 2011, seeking to reduce 45% of energy intensity by 2035. To step up energy efficiency and conservation, various policies are implemented, such as the Mandatory Energy Efficiency Labelling Scheme, Energy Efficiency Registration Scheme for Buildings, Building Energy Efficiency Ordinance as well as the Scheme on Fresh Water Cooling Towers (GHK, 2015a).

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	39.2	38.8	–0.9
Total final energy consumption	19.4	18.5	–4.3
Industry	1.0	0.96	–3.9
Transportation	6.2	5.8	–5.4
Others	12.2	11.8	–3.8
Non-energy	–	–	–

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The government of Hong Kong, China has four key energy policy objectives: to ensure the energy needs of the community are met safely, efficiently and at reasonable prices, while minimising the environmental impact of electricity generation. The government also promotes efficient use and conservation of energy. In combating climate change, reducing greenhouse gas (GHG) emissions and developing a low-carbon economy, Hong Kong, China's emissions reduction strategy emphases the wider use of cleaner and low-carbon energies and fuels in power generation.

In keeping with the free market economic policy of Hong Kong, China, the government intervenes only when necessary to safeguard the interests of consumers, ensure public safety and protect the environment. The government works with the oil companies to maintain strategic reserves of gas, oil and naphtha. It monitors the performances of the power companies through the Scheme of Control Agreements (SCAs) (the present SCAs were signed in 2008) to encourage energy efficiency, quality services and renewable energy (RE) use.

Specifically, Hong Kong, China proposes to optimise the fuel mix for power generation. The government conducted a public consultation on the future fuel mix for electricity generation in Hong Kong in 2014 to solicit the public's views on the subject. Two fuel mix options were put forward for public consultation. They are, firstly, to import more electricity through purchase from the Mainland power grid, and, secondly, to use more natural gas for local generation. Having considered the public's views, the government plans to increase the percentage of natural gas generation to around 50% by 2020, and maintain the current interim measure of importing 80% of nuclear output from the Daya Bay Nuclear Power Station, so that nuclear import would account for around 25% of the total fuel mix. Subject to public views on the tariff implications, the government is preparing to develop more RE and enhance efforts to promote energy saving. The remaining demand will be met by coal-fired generation. This will help Hong Kong achieve the environmental targets for 2020, including its target to reduce carbon intensity by 50%-60% in 2020, compared with the 2005 level. Hong Kong, China will also endeavour to enhance energy efficiency, promote green buildings, advocate electricity savings, facilitate low-carbon transport, reduce waste and develop facilities to turn waste into energy (ENB, 2015a).

A major target for the economy's energy policy, as stated in the Energy Saving Plan for Hong Kong's Built Environment 2015~2025+ unveiled in 2015, is to reduce its energy intensity by 40% by 2025 based on the 2005 level. The actions are:

- Promoting energy saving and green building development by enhancing the green performance of government buildings, public housing and public sector developments;
- Conducting periodic reviews to expand and/or tighten relevant energy-related standards including the statutory requirements under the Buildings Energy Efficiency Ordinance, the Building (Energy Efficiency) Regulation, and the Energy Efficiency (Labelling of Products) Ordinance;
- Updating schools and public education programmes and strengthen Government energy saving efforts by appointing Green Managers and Energy Wardens, and encourage public sector institutions to save energy; and

- Supporting community campaigns through government funding schemes, and collaborate with key energy consumers in the commercial sector to develop sector-specific campaigns to promote energy saving. More importantly, the Secretary for the Environment is engaging built environment leaders to accelerate green building adoption in the private sector.

ENERGY MARKETS

A memorandum of understanding (MOU) was signed by the Hong Kong, China Government and the National Energy Administration of the People's Republic of China on 28 August 2008. To ensure the prosperity and stability of Hong Kong, the Central Government of China will continue to support energy co-operation between the mainland and Hong Kong, China over the long term, which will include efforts to provide a stable supply of nuclear electricity and natural gas to Hong Kong. The inter-governmental MOU contemplates the delivery of natural gas to Hong Kong, China from three sources:

- Existing and new gas fields planned for development in the South China Sea;
- A second West-to-East Gas Pipeline, transporting gas from Central Asia; and
- An LNG terminal to be located in Shenzhen, mainland China.

The MOU also contemplates the on-going supply of nuclear-generated electricity to Hong Kong, China. An extension of the Guangdong Daya Bay Nuclear Power Station joint venture and supply contracts was approved by the Hong Kong, China Government in September 2009. These contracts will enable the continued supply of non-carbon-emitting electricity to Hong Kong, China for a further term of 20 years from 2014, and CLP has successfully negotiated an increase in the portion of electricity supply from the Guangdong Daya Bay Nuclear Power Station to Hong Kong, China, increasing the plant's generation from 70% to about 80% from late 2014 to 2018 (CLP, 2014a, 2014b).

ENERGY EFFICIENCY

Buildings consume about 90% of the electricity used in Hong Kong, China. Therefore, one of the government's first priorities is to conserve the energy used by buildings. Efforts are made to improve public awareness of energy efficiency to drive behavioural changes.

ENERGY DATA

To help monitor the energy situation, Hong Kong, China has developed an energy end-use database. The database provides useful insight into the energy demand situation, including the energy consumption patterns, trends and usage characteristics of each sector and segment. A basic data set is publicly available on the internet. The government is able to analyse the current system based on the data and develop policy and strategy revisions for future implementation, while the private sector can use the data to benchmark their own energy efficiency while seeking improvements in their energy consumption systems (EMSD, 2015a).

BUILDINGS

To strengthen its efforts toward building energy conservation, the government has enhanced the regulatory system for building energy efficiency. The Buildings Energy Efficiency Ordinance was fully implemented on 21 September 2012. The three key requirements of the Ordinance are as follows (EMSD, 2012a):

- The developers or building owners of newly constructed prescribed buildings should ensure that the four key types of building services installations (air conditioning, lighting, electrical, and lift and escalator installation) comply with the design standards of the Building Energy Code (BEC);
- When carrying out 'major retrofitting works', responsible persons of prescribed buildings (i.e. owners, tenants or occupants, etc.) should ensure that the four key types of building services installations comply with the design standards of the BEC; and
- The owners of commercial buildings, including the commercial portions of composite buildings, should conduct an energy audit for the four key types of central building services installations in accordance with the Energy Audit Code (EAC) every 10 years. The first energy audit should be carried out within four years of the commencement of the Ordinance in accordance with the timetable set out in Schedule 5 to that Ordinance.

The BEC is reviewed once every three years to meet public aspiration, the international trend and the latest technology development. The first comprehensive review completed in 2015 and the new standards require a further 10% improvement in energy efficiency. It is estimated that up to 2025, energy savings from

all new buildings in Hong Kong will be about 5 billion kilowatt-hours of electricity, equivalent to a reduction in carbon dioxide (CO_2) emissions of about 3.5 million tonnes (Mt).

The government continues to utilise government buildings to demonstrate state-of-the-art energy-efficient designs and building energy conservation technologies. These are based on an environmental performance framework that covers energy efficiency, GHG reduction, RE application, waste reduction, water management and indoor air quality. All newly built government buildings over 10 000 square metres should aim to obtain not lower than the second-highest grade under the Hong Kong Building Environmental Assessment Method (BEAM).

In April 2009, the government promoted a comprehensive target-based green performance framework for new and existing government buildings and set targets for various aspects of environmental performance. It has achieved the target of a 5% savings on the total electricity used in government buildings from 2009–10 to 2013–14 after discounting activity changes, using electricity consumption in 2007–08 as the baseline. Building on this success, the Government has set a new target of 5% saving in the electricity consumption of government buildings in the next five years from 2015-16 to 2019-20 under comparable operating conditions, using the electricity consumption in 2013-14 as the baseline. In April 2009, the government introduced Buildings Energy Efficiency Funding Schemes worth HKD 450 million in total to subsidise environmental performance reviews and upgrades for communal areas in residential, commercial and industrial buildings. The Schemes also cover energy/carbon audits and upgradation of the energy efficiency performance of building services installations. The subsidy can cover up to 50% of the expenditure. These funding schemes were closed in April 2012 (EMSD, 2012a).

Water-cooled air conditioning systems

Water-cooled air conditioning systems (WACS) using fresh water cooling towers are generally more energy efficient than air-cooled systems. Examples of adopting the energy-efficient WACS in Hong Kong include the WACS using fresh water cooling towers for individual buildings, WACS using seawater cooling for individual buildings and the large-scale District Cooling System for numerous buildings (EMSD, 2015b).

The government implements a District Cooling System (DCS) at the Kai Tak Development to supply chilled water for centralised air conditioning to buildings in the new development. The DCS is the first project of its kind implemented by the government. It is an energy-efficient air conditioning system as it consumes 35% and 20% less electricity as compared with traditional air-cooled air conditioning systems and individual WACS using fresh water cooling towers, respectively. The project would be implemented in three phases: Phase I and II were completed in 2013 and 2014 respectively and the construction of Phase III commenced in 2013 and is expected to be completed by 2022 (EMSD, 2015c).

ENERGY CONSUMPTION INDICATORS

In 2011, the government reviewed and updated 68 groups of energy consumption indicators covering the residential (6 groups), commercial (32 groups) and transport (30 groups) sectors. The energy consumption indicators and benchmarks assist the energy-consuming groups to understand their energy consumption levels and performance with respect to their corresponding peers. They help foster the concept of efficient energy consumption and promote general awareness (EMSD, 2014).

ENERGY EFFICIENCY LABELLING

Hong Kong, China has a voluntary Energy Efficiency Labelling Scheme that covers 22 types of household and office appliances, including 13 types of electrical appliances (refrigerators, washing machines, non-integrated type compact fluorescent lamps (CFLs), dehumidifiers, electric clothes dryers, room coolers, electric storage water heaters, televisions, electric rice cookers, electronic ballasts, light-emitting diode (LED) lamps, induction cookers and microwave ovens), 7 types of office equipment (photocopiers, fax machines, multifunction devices, printers, laser crystal display (LCD) monitors, computers and hot/cold bottled water dispensers) and 2 types of gas appliances (domestic instantaneous gas water heaters and gas cookers). The scheme was extended to cover passenger cars running on petrol (EMSD, 2015d).

To further assist the public in choosing energy-efficient appliances and to raise public awareness of energy saving, the government has introduced a Mandatory Energy Efficiency Labelling Scheme (MEELS) through the Energy Efficiency (Labelling of Products) Ordinance, Cap. 598. The MEELS covers five types of products, namely room air conditioners, refrigerating appliances, CFLs, washing machines and dehumidifiers. Under the MEELS, energy labels must be displayed on the products being supplied to Hong Kong, China to inform consumers of their energy efficiency performance (EMSD, 2012b).

TRANSPORT

Land transport accounts for about 17% of the total GHG emissions in the economy and is the second most significant contributor of emissions. In order to reduce carbon emissions from the transport sector, Hong Kong, China, has undertaken the following efforts.

EXTENSION OF THE PUBLIC TRANSPORT SYSTEM

An extensive and energy-efficient public transport system in Hong Kong, China is instrumental in helping to maintain low levels of GHG emissions. Some 90% of commuter trips each day are made via the public transport system. The government is committed to further expanding and upgrading its public transport infrastructure, with an emphasis on the railways.

PROMOTION OF CLEANER VEHICLES

The government actively promotes wider use of electric vehicles. The FRT for electric vehicles has been waived until the end of March 2017. The government liaised with the EV manufacturers and dealers to encourage them to introduce EVs into Hong Kong; as a result, Hong Kong is one of the leading APEC economies in EV use. The government has been working with the private sector to expand the charging infrastructure for EVs in Hong Kong. There are about 1300 different types of public EV chargers, including over 200 medium chargers and 157 quick chargers.

The government's ultimate policy objective is to have zero emission buses running across the territory. As such, the government has allocated about HKD 213 million to fully subsidise the franchised bus companies to purchase 36 single-deck electric buses and 6 double-deck hybrid buses for trial. If the trial results are satisfactory, the government will encourage the franchised bus companies to use these green buses on a larger scale, taking into account affordability for the bus companies and passengers.

CREATION OF THE PILOT GREEN TRANSPORT FUND

To encourage the public transport sector and non-profit organisations to test green and innovative transport technologies, the government set up a HKD 300 million Pilot Green Transport Fund in March 2011 (GHK, 2015b). The government has been encouraging vehicle suppliers and technology companies to introduce more transport means and technologies, and the transport sector to carry out trials with subsidies from the Fund. At the end of February 2016, 87 trials have been approved under the Fund, including 67 electric commercial vehicles (taxis, light buses, buses and goods vehicles), 63 hybrid commercial vehicles (goods vehicles and light buses), 1 solar air-conditioning system, 4 electric inverter air-conditioning systems, and retrofitting a ferry with a diesel-electric propulsion system and a seawater scrubber.

PROMOTION OF BIODIESEL AS A MOTOR VEHICLE FUEL

In order to facilitate the use of biodiesel in motor vehicles, the government has adopted a duty-free policy for biodiesel since 2007. In 2010, it introduced regulatory control for motor vehicle biodiesel, to help safeguard its quality and encourage drivers to use it.

RENEWABLE ENERGY

Despite the geographical and natural constraints in developing wind energy, both power companies (CLP Power and HKE) have started to explore the feasibility of offshore wind farm projects.

CLP Power is currently conducting a feasibility study for an offshore wind farm. An offshore meteorological wind mast was installed to collect site environmental data. CLP Power completed the installation of an RE power system of about 200 kW on Town Island in late 2012. The system now consists of 672 solar panels and 2 wind turbines supplying RE to the Island.

The RE assets of HKE also performed well, with Lamma Winds generating an average of 800 to 1 000 megawatt-hours (MWh) of electricity since being commissioned in 2006. A thin-film photovoltaic (TFPV) solar power system of 1 MW was installed at Lamma Power Station, generating 1 100 MWh annually, offsetting 1 715 tonnes of CO_2 emissions together with the wind turbines every year on average (HKEI 2015b, 2015c).

To increase its RE portfolio, HKE plans to install up to 33 offshore wind turbines at a capital cost of about HKD 3 billion and a total generation capacity of around 100 MW, producing 175 gigawatt-hours (GWh) of electricity and offsetting 150 000 tons of CO_2 emissions annually after completion. In 2012, HKE commenced a wind monitoring station at its offshore wind farm site to collect meteorological and oceanographic data for detailed design purposes (HKEI, 2015d).

In 2007, a landfill gas processing plant at the North East New Territories Landfill started operation, with a peak supply of 8 000 square metres per hour of synthetic natural gas (SNG) from landfill gas. As a

result, the consumption of naphtha at the town gas production plant in Tai Po was reduced by approximately 40 000 tonnes, in turn reducing CO_2 emissions up to about 135 000 tonnes annually (Towngas, 2013).

The government has taken the lead in using RE by installing a 350 kW PV system on the roof of the Electrical and Mechanical Services Department headquarters. The installation of an 850 kW PV system has been planned by the Drainage Services Department at Siu Ho Wan Sewage Treatment Works and is scheduled for completion in mid-2016. The government also installed large-scale solar water heating devices on government buildings, including those with swimming pools, to save power in heating water.

In its effort to convert waste to energy and to reduce GHG emissions, the government is planning to construct an integrated waste management facility, two organic waste treatment facilities and a sludge treatment facility, expecting them to meet about 1% of the total electricity demand by 2020. Phase 1 of the Sludge Treatment Facility has been operating since 1 April 2015.

NUCLEAR ENERGY

Currently, CLP Power is contracted to purchase around 70% of the electricity generated by the two 984 MW pressurised water reactors at the Guangdong Daya Bay Nuclear Power Station in mainland China to help meet the long-term demand for electricity in its supply area. This arrangement meets some 22% of the electricity demand in Hong Kong, China. In September 2009, the government approved the extension of CLP Power's contract for the supply of nuclear-generated electricity from Guangdong Daya Bay Nuclear Power Station for another 20 years, starting 7 May 2014. The extension of the contract ensures a continued supply of cleaner electricity to Hong Kong, China, which will help alleviate air pollution and GHG emissions locally. To ensure that more clean and cost-competitive energy is provided to Hong Kong, an agreement has been reached, whereby Daya Bay will increase its electricity supply to Hong Kong from 70% of its output to approximately 80% for late 2014–18 (CLP, 2014a, 2014b).

CLIMATE CHANGE

Hong Kong, China is committed to working closely with the international community to combat climate change. The government is pursuing measures set out in the Hong Kong's Climate Change Strategy and Action Agenda (EPD, 2010) to reduce the territory's carbon intensity by 50% to 60% by 2020, with reference to the 2005 level. The government also published in November the Hong Kong Climate Change Report 2015, which outlines the work and joint efforts of the government and the key private-sector stakeholders in responding to climate change. It also provides an account of Hong Kong's climate change actions so that the public can have a more complete picture of Hong Kong's contributions to concerted global action.

The major contributors of GHGs in Hong Kong, China are the power generation and land transport sectors, accounting for about two-thirds and one-fifth of the territory's GHG emissions, respectively. In addition, energy consumption in buildings contributes about 90% of total electricity consumption. Therefore, the government is focussing on decarbonising the future fuel mix for power generation, enhancing building energy efficiency and greening road transport to reduce carbon emissions.

The GHG emissions reduction measures can be classified as follows.

REVAMPING THE FUEL MIX FOR ELECTRICITY GENERATION

The government aims to increase the use of non-fossil, clean and low-carbon fuels for future electricity generation. The government promulgated in 2015 the fuel mix for 2020, which is to increase the proportion of natural gas for power generation from around 20% in 2014 to around 50% in 2020 with a view to reducing the territory's carbon intensity by 50 to 60% by 2020, using 2005 as the base level.

MAXIMISING ENERGY EFFICIENCY

In particular, measures to improve energy efficiency in buildings include reducing the energy demand of air conditioning and other major electrical equipment. Specific measures include:

- Expanding the scope and tightening the requirements of the Building Energy Codes, so that by 2020 major electrical equipment in all new commercial buildings will be up to 50% more energy efficient compared with buildings in 2005;
- Expanding the use of district cooling or water-cooled air conditioning, so that by 2020 up to 20% of all commercial buildings will have up to 50% better refrigeration performance compared with buildings using regular air conditioners;
- Reducing energy demand in new buildings by various means, such as tightening overall thermal transfer value standards and promoting the wider adoption of green roofing, so that by 2020 all

new commercial buildings will reduce their energy demand by up to 50% compared with new buildings in 2005;

- Improving energy efficiency in commercial buildings through good housekeeping, information technology products and intelligent building environmental management systems, so that by 2020 up to 25% of existing commercial buildings will be 15% more energy efficient compared with 2005; and
- Expanding the scope and tightening the energy efficiency of electrical appliance standards for domestic use, so that by 2020 all major domestic appliances sold in the market will be 25% more energy efficient compared with those sold in 2005.

GREENING ROAD TRANSPORT

These initiatives include measures to promote the use of electric vehicles and to implement energy efficiency standards for vehicles. Specific measures include:

- Expanding access to public transportation, and establishing pedestrian areas and covered walkways, etc. to reduce transport needs;
- Promoting wider use of alternative fuelled vehicles such as hybrid and EVs;
- Expanding railway network and controlling the number of vehicles;
- Waiving the first registration tax on EVs until 31 March 2017;
- Allowing enterprises to have 100% profits tax deduction for the capital expenditure in the first year of EV procurement;
- Implementing importers' average fleet efficiency standards, so that new vehicles will be 20% more energy efficient than the 2005 market average; and
- Promoting the use of clean fuels (biofuels) for motor vehicles.

TURNING WASTE INTO ENERGY

These initiatives comprise measures to explore the potential of RE. Specific measures include:

- Developing and fully operating one integrated waste management facility, two organic waste treatment facilities and one sludge treatment facility; and
- Fully utilising recovered landfill gas and gas generated from wastewater treatment.

LONG-TERM CLIMATE STRATEGY

With the positive outcome of the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), the HKSAR Government recognised the need to step up climate actions and to draw up long-term policies. The Chief Executive announced in the 2016 Policy Address the establishment of an inter-departmental committee (namely, the Steering Committee on Climate Change) under the leadership of the Chief Secretary for Administration. The Steering Committee is composed of members from 10 policy bureaux and 3 departments. It seeks to, among others, steer the overall direction of the HKSAR Government in combating climate change, including the setting of post-2020 carbon reduction target as well as our long-term climate strategies, having regard to the UNFCCC and the Paris Agreement.

NOTABLE ENERGY DEVELOPMENTS

PUBLIC CONSULTATION ON THE FUTURE DEVELOPMENT OF THE ELECTRICITY MARKET

The current SCAs between the government and the two power companies will expire in 2018. Hong Kong needs to consider how to further develop its electricity market, regarding to its four energy policy objectives of safety, reliability, affordability and environmental protection, as well as its goal to introduce competition when the requisite market conditions are present. The government therefore launched a three-month-long public consultation on 31 March 2015 to solicit the public's views on the future development of the electricity market. The consultation document put forward questions on various major issues regarding (ENB, 2015b) the following.

- Introduction of competition: The public held different views on the subject of introducing competition. The majority of the respondents considered that the current power supply in Hong Kong is reliable, safe and affordable, and that there is no need for introducing competition for expanding choices available to the public. Some respondents considered that while choice had its merits, the requisite conditions for introducing competition were not present at this stage.
- Devising the future regulatory framework and delineating possible areas for improvement: Regarding the regulatory arrangement, while almost all respondents considered that the current contractual arrangement by SCAs had worked well by and large and allowed the economy to achieve the energy policy objectives. It was generally agreed that improvements should be made to the current SCAs in respect such areas as the level of permitted rate of return, mechanism to promote energy saving and RE etc.
- Development of RE: The community's views on the development of RE were generally positive. Around half the respondents supported further development of RE despite its higher tariff implications. Some respondents suggested that specific measures should be introduced to promote RE, such as improving the grid access arrangements for distributed RE generators and encouraging their connection to the power grids.

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USEFUL LINKS

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Environment Bureau—www.enb.gov.hk

Environmental Protection Department—www.epd.gov.hk

The Hong Kong Government—www.gov.hk/en

INDONESIA

INTRODUCTION

Indonesia is a large archipelago located south-east of mainland South-East Asia, between the Pacific Ocean and the Indian Ocean. Indonesia's territory encompasses 17 508 large and small islands and large bodies of water at the equator over an area of 7.9 million square kilometres (km²). This constitutes Indonesia's exclusive economic zone. Indonesia's total land area (25% of its territory) is about 1.9 million square kilometres. The population was 251.3 million in 2013.

Indonesia had a gross domestic product (GDP) of around USD 2 381.8 billion and a per capita GDP of USD 9 479 in 2013 (2010 USD purchasing power parity [PPP]). Excluding the oil and gas sector, manufacturing industries accounted for the largest component of GDP in 2013 (21%), followed by agriculture, forestry and fishing with a combined share of about 13.4%. In terms of exports, the main export products of the economy are mineral fuels, lubricants and related products, which together account for about 31% of total export value, followed by machinery and transport equipment at 12%. In 2013, Indonesia attained economic growth of 5.6%, a decrease of 0.4% from 2012 (BPS, 2015)

Domestic oil, gas and coal reserves have played an important role in Indonesia's economy as sources of energy, industrial raw materials and foreign exchange. In 2013, oil and gas exports contributed 14% and coal exports contributed 14% of Indonesia's total exports. Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 31% of the Indonesian Government's budget in 2013 (ESDM, 2014a).

Indonesia's proven fossil energy reserves at the end of 2013 consisted of 7.6 billion barrels of oil, 4.3 trillion cubic metres of natural gas and 31 billion tonnes of coal.

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b, c]	
Area (million km²)	1.9	Oil (billion barrels)	7.6
Population (million)	251.3	Gas (trillion cubic metres)	4.3
GDP (2010 USD billion PPP)	2 382	Coal (billion tonnes)	31
GDP (2010 USD PPP per capita)	9 479	Uranium (kilotonnes U)	6.3

Sources: a. EGEDA (2015); b. ESDM (2014b); c. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2013, Indonesia's total primary energy supply (TPES) was 191 920 kilotonnes of oil equivalent (ktoe) of commercial energy, consisting of oil (46%), coal (30%), natural gas (18%), other energy (mainly hydropower and geothermal) (5.9%) and 44 834 ktoe of biomass. Indonesia is a net exporter of energy; overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal totalled 224 060 ktoe in 2013. Total energy exports in 2013 slightly increased by 1.9% from 2012 (4 340 ktoe), a decrease driven primarily by a decrease in the price of exported coal.

OIL

In 2013, Indonesia produced 47 752 ktoe of crude oil and condensates; of this, 17 945 ktoe (38%) was exported, an increase of 1.8% compared to 2012. Because oil production has declined significantly over the past decade (in 1997 Indonesia produced 72 474 ktoe of crude oil and condensates), the economy imported 18 091 ktoe of crude oil and 31 660 ktoe of petroleum products in 2013 in order to meet its domestic oil requirements. This represents an increase of 23% from a total of 50 ktoe in 2012 (EGEDA, 2015).

Most crude oil is produce onshore from two of Indonesia's largest oil fields: the Minas and Duri oil fields in the province of Riau on the eastern coast of central Sumatra. Because these fields are considered mature, the Duri oil field in particular has been subject to one of the world's largest enhanced oil recovery efforts.

NATURAL GAS

Indonesia produced 66 955 ktoe of natural gas in 2013, a decrease of 3.6% from the 69 435 ktoe produced in 2012 (EGEDA, 2015). Of total natural gas production, 51.6% was converted to LNG for export. The economy produced 32 384 ktoe of LNG in 2013, an increase of 19.6% from 27 077 ktoe in 2012. In 2013, Indonesia also exported 23 307 ktoe of natural gas (35% of its total natural gas production) through pipelines to Singapore and Malaysia (ESDM, 2014b). Overall, 45.6% of Indonesia's natural gas production is exported. The balance is made available for domestic requirements.

Indonesia's large natural gas reserves are located near Arun in Aceh, around Badak in East Kalimantan, South Sumatra, the Natuna Sea, the Makassar Strait and Papua, with smaller gas reserves offshore in West and East Java. LNG exports from Tangguh, Papua began in 2009 with gas supplied from the onshore and offshore Wiriagar and Berau gas blocks, which are estimated to have reserves of 14 trillion cubic feet (Tcf).

COAL

In 2013, Indonesia produced 264 059 ktoe of coal, an increase of 16.3% from 226 909 ktoe in 2012. Most of Indonesia's coal production in 2013 (193 301 ktoe, or 73%) was exported. Domestic demand (135 499 ktoe in 2013) originated from power generation (82%) and industrial uses (19%) (EGEDA, 2015).

About 57% of Indonesia's total recoverable coal reserve is lignite, 27% is sub-bituminous coal, 14% is bituminous coal and less than 0.5% is anthracite. Most of Indonesia's coal reserves are in South Sumatra and East Kalimantan. Relatively small deposits of coal are in West Java and in Sulawesi. As a result, although Indonesian coal's heating value can range from 5 000 to 7 000 kilocalories per kilogram, it is generally distinguished by its low ash and sulphur content (typically less than 1%).

ELECTRICITY

Indonesia had 50 898 megawatts (MW) of electricity generation capacity in 2013. This was held by the state-owned electricity company (PLN) and independent power producers (IPPs). In 2013, 216 terawatt-hours (TWh) of electricity were generated, of which 24% was supplied by IPPs and 1.5% was imported from Malaysia. In 2013, several types of power plant produced electricity; namely, coal-steam power plants (52%), gas power plants (combined gas-steam power plants, gas turbine power plants and gas engine power plants) (24%), renewable energy power plants (geothermal, hydro, biomass, solar and wind) (12%) and oil power plants (diesel power plants and oil-powered thermal plants (12%) (DJK, 2015a).

FINAL ENERGY CONSUMPTION

Total final energy consumption was 140 029 ktoe in 2013, an increase of 6.3% from 131 763 ktoe in 2012. The share of final energy consumption by sector in 2013 was 43.4% for industry, 35% for transport, 17% for other sectors and 5.5% for non-energy use. Indonesia's economy is highly dependent on oil: final energy consumption of oil in 2013 was 81 149 ktoe (58% of the total final energy consumption) (EGEDA, 2015).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (MW)	
Indigenous production	389 764	Industrial sector	60 705	Total power generation	216 146
Net imports and other	–193 983	Transport sector	48 483	Thermal	189 567
Total primary energy supply	191 920	Other sectors	23 111	Hydro	16 930
Coal	57 479	Non-energy	7 730	Nuclear	–
Oil	88 612	Total final energy consumption	140 029	Others	9 649
Gas	34 571	Coal	25 054		
Others	11 259	Oil	81 149		
		Gas	17 697		
		Electricity and others	16 129		

Note: Indigenous production excludes biomass.
Source: EGEDA (2015).

ENERGY INTENSITY

In 2013, Indonesia's primary energy intensity was 80.6 tonnes of oil equivalent per million USD (toe/million USD), a slight decline of 0.5% from the level of the year before. This indicates Indonesia's primary energy intensity has improved in recent years; however, there remains scope for the economy to improve its energy

efficiency. In terms of final energy consumption, energy intensity amounted to 59 toe/million USD, a slight increase of 0.7% from 2012. This was mostly driven by increasing energy consumption in other sectors.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	81.0	80.6	–0.5
Total final energy consumption	58	59	0.7
Industry	26	25	–0.7
Transportation	19.8	20.4	2.90
Others	9.4	9.7	3.2
Non-energy	3.6	3.3	–9.2

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

THE ENERGY LAW

On 10 August 2007, Indonesia enacted the Energy Law (Law No. 30/2007). This law contains principles regarding the utilisation of energy resources and final energy use, the security of supply, energy conservation, the protection of the environment with regard to energy use, the pricing of energy and international cooperation. It defines the outline of the National Energy Policy (Kebijakan Energi Nasional, or KEN); the roles and responsibilities of the government and regional governments in planning, policy and regulation; energy development priorities; energy research and development; and the role of businesses.

Under the Energy Law, the National Energy Policy addresses the need to have sufficient energy to meet the economy's needs, energy development priorities, the utilisation of indigenous energy resources and energy reserves. The Energy Law mandates the creation of a National Energy Council (Dewan Energi Nasional, DEN). The tasks of the DEN are to:

- Draft the National Energy Policy (KEN);
- Endorse the National Energy Master Plan (Rencana Umum Energi Nasional, RUEN);
- Declare measures to resolve energy crises and energy emergencies; and
- Provide oversight on the implementation of energy policies that are cross-sectoral.

The President chairs the assembly of DEN members. As an institution, the DEN is headed by the minister responsible for energy affairs and has 15 members: seven ministers and high-ranking government officials responsible for the supply, transportation, distribution and use of energy; and eight stakeholder members from industry, academia, expert groups, environmental groups and consumer groups. The selection and appointment of members of the DEN was finalised in late 2008.

After obtaining approval from the parliament (the DPR), on 17 October 2014 the government issued the new National Energy Policy under Government Regulation No. 79/2014. This replaced the existing National Energy Policy, which was established by Presidential Regulation No. 5/2006. The new policy is intended to create energy security and resilience through an energy management strategy from 2014 to 2050.

The RUEN implements the KEN. By law, the RUEN is drafted by the government, namely the Ministry of Energy and Mineral Resources, in a process that involves related ministries and other government institutions, state-owned companies in the energy sector and regional governments. The process also includes academia and other energy stakeholders and pays due regard to input from the public. In order to give guidance on how to draft the RUEN, the Government issued Presidential Regulation No. 1/2014 on 2 January 2014. Under this regulation, the RUEN should be prepared based on the KEN, engagement with local government and consideration of public opinion and input.

ENERGY MARKETS

Over the past decade, Indonesia has reformed its energy sector through a series of new laws: the Oil and Gas Law (Law No. 22/2001); the Geothermal Energy Law (Law No. 27/2003, which was replaced with Law No. 21/2014); the Mineral and Coal Mining Law (Law No. 4/2009); and the Electricity Law (Law No. 30/2009).

These laws were established in order to promote an increased role for business in the energy supply chain. They cover issues such as fair competition on an equal playing field as an alternative to a monopolistic industry, direct contracts between energy producers and buyers and a transparent regulatory framework.

THE OIL AND GAS LAW

Indonesia's oil and gas industry is currently undergoing regulatory changes. The industry was reformed in 2001 under the Oil and Gas Law (Law No. 21/2001). The regulatory bodies, known as BP MIGAS and BPH MIGAS, were created to address oil upstream and downstream activities respectively. Exploration and production activities were conducted based on a fiscal contractual system, which relied mainly on production sharing contracts (PSCs) between the government and private investors. Such investors could include foreign and domestic companies as well as the government-owned oil company Pertamina.

However, on 13 November 2012, the Constitutional Court declared that the existence of BP MIGAS conflicted with the Constitution of 1945 and ordered its dissolution. At the time of writing, the government is drafting a new Oil and Gas Law that will determine a new industry structure. Until this law can be enacted, an Interim Working Unit for Upstream Oil and Gas Business Activities (SKSPMIGAS) has been established under the Ministry of Energy and Mineral Resources (MEMR) to assume all BP Migas roles and responsibilities. Further, on 14 January 2013, the government issued Presidential Regulation Number 9 Year 2013 as the umbrella regulation for the establishment of the Working Unit for Upstream Oil and Gas Business Activities (SKKMIGAS), the job of which is to manage the upstream oil and gas business in Indonesia.

BPH MIGAS has supervisory and regulatory functions in the downstream oil and gas sector. Its aim is to ensure the availability and distribution of fuel throughout Indonesia and the promotion of gas utilisation in the domestic market through fair and transparent market competition.

The enactment of the Oil and Gas Law required that the state-owned oil company, Pertamina, should relinquish its governmental roles to the new regulatory bodies, BP MIGAS (which has now passed on its tasks to SKKMIGAS) and BPH MIGAS and mandated the termination of Pertamina's monopoly in upstream oil and gas activities.

THE MINING LAW

On 16 December 2008, parliament passed a new law on minerals and coal mining to replace Law No. 11/1967, which had been in place for 41 years. The government enacted the new law on 12 January 2009 as Law No. 4/2009 on mineral and coal mining.

In essence, the new Mining Law ended the concession of work areas by contracts of work (COW) and by work agreements for coal mining businesses known as Perjanjian Karya Perusahaan Pertambangan Batubara (PKP2B). Concessions are now based on permits issued from central government and regional governments.

Prior to the new law, the government arguably had less regulatory control over its concessions. For example, any changes to concession terms needed to be agreed by both the government and the investor. By instituting permits, the government expects to be better positioned to promote investment and regulate mining.

The new law creates greater opportunities for smaller investments in mining and gives regional governments a greater role in regulating the industry and its revenue. The Mining Law called for regulations on:

- Concession areas and concession periods (for exploration permits) and production limits (for production permits) with regard to mining for metals, non-metals and specific non-metals;
- A requirement that prospective investors submit post-mining and reclamation plans before applying for a permit;
- An obligation for permit holders to build smelters;
- An obligation for foreign companies to divest shares to the government or to state-owned businesses and private companies registered in Indonesia;

- Payment of taxes and fees, and the allocation of profits; and
- Reclamation and post-mining costs.

A set of government regulations with regard to the Mining Law was completed in 2010. These are now operational.

ELECTRICITY LAW

In 2004, the Constitutional Court rejected an advanced reform of the electricity sector, which would have established the possibility of direct competition in power generation through Law No. 20/2002 (currently annulled).

On 23 September 2009, the government enacted Law No. 30/2009 regarding electricity. This new Electricity Law replaced Law No. 15/1985, which the Constitutional Court had reinstated in December 2004 as a provisional law upon annulment of Law No. 20/2002.

A notable difference between Law No. 30/2009 and Law No. 15/1985 is the absence of a Holder of Electricity Business Authority (Pemegang Kuasa Usaha Ketenagalistrikan, PKUK). Under Law No. 15/1985, the government had appointed the state-owned electricity company, PLN, as the sole PKUK and in consequence had made it responsible for providing electricity to all parts of Indonesia.

Under the new Electricity Law, the electricity industry comprises electricity business entities, which are title-holders of electricity supply business licences or Izin Usaha Penyediaan Tenaga Listrik (IUPTL). The IUPTL integrate electricity supply, power generation, transmission, distribution and retailing of electricity. Indonesia's electricity systems retain vertically integrated configurations. However, these consist of several licenced systems, such as PLN's numerous power systems, provincial government-owned systems (to be established, where necessary) and private sector power systems, each operating within their respective business areas. Licence holders of specific electricity supply types (such as the IPPs, which are licence holders in power generation for the supply of electricity to the public) participate in the vertically integrated systems.

By law, the government and regional governments regulate the electricity industry within their respective jurisdictions and through electricity regulatory authorities. The Electricity Law allows electricity tariffs to be differentiated by region to allow for different costs of supply. Under the previous Electricity Law, Indonesia had a uniform electricity tariff regime and applied cross-subsidies among regions. At the time of writing, there was no ruling as to whether PLN will implement tariff differentiation over its extensive power systems across Indonesia.

As mandated by Law No. 30/2009, the MEMR issued three government regulations (GRs), namely GR No. 14/2012 on electricity supply businesses activity, GR No. 42/2012 on the buying and selling of electricity across Indonesia's borders and GR No. 62/2012 on electricity support businesses.

GEOTHERMAL LAW

Geothermal development activities are defined as mining activities under the Geothermal Law No. 27/2003. Further, according to the Forestry Law, no mining activities are allowed to occur in protected forest areas (protection and conservation forests). As a result, geothermal energy cannot be developed if it is located in protected forest areas. This situation has been one of the major barriers to developing geothermal electricity in Indonesia.

In order to remove the restriction to develop geothermal electricity in protected forest areas, the government has issued the New Geothermal Law No. 21/2014 on 17 September 2014. Under the new law, geothermal development activities are not considered as mining activities because the government has changed the permit scheme from that of a 'Geothermal Mining Permit' to a 'Geothermal Permit'. This new law states that geothermal energy can be developed in production, protection and conservation forests after obtaining a permit from the Ministry of Forestry under the category of an environmental service use permit.

The new regulation also states that the government sets the tariff on geothermal electricity. This approach offers incentives to developers and affirms that central government holds the authorisation power to conduct tenders for geothermal working areas (GWA) and then to control the projects. However, local government is authorised to utilise geothermal energy for direct use (other than electricity generation).

Geothermal exploration and exploitation are based on the award of licences. The process involves central government offering GWA for competitive bidding to prospective business investors. Public, private and cooperative entities may submit bids on such GWA. Successful bidders are awarded GWA. The width of the concession areas is determined according to the capacity of the individual geothermal system. The successful bidders have the right to conduct exploration for five years with two extensions of up to one year each. They also have the right to 30 years for exploitation from the date on which a feasibility study has

been approved by the government. The government can approve extensions to permission for the exploitation of geothermal resources for an additional 20 years per extension approval. Working areas are subject to tax, land rent and royalties determined by the government. Laws and regulations that govern the electricity industry apply to the utilisation of geothermal energy for electricity generation.

FISCAL AND INVESTMENT REGIME

In late 2008, Indonesia announced an overhaul of its taxation system, effective from 2009, with improvements to tax collection and lower tax rates. The general corporate income tax rate for the 2009 tax year was reduced to a flat rate of 28% from the prior maximum progressive rate of 30%. Tax rates are to be further reduced to a flat rate of 25% in 2010 (ASEAN, 2008).

OIL AND GAS

The PSC (production sharing contract) regime (outlined in the earlier section on 'The Oil and Gas Law') was introduced in Indonesia in the mid-1960s and reportedly became the fiscal system of choice for many economies over many years. Worldwide, slightly over half of those governments whose economies produce hydrocarbons now use PSCs (Johnston, 1994). Several types of PSC have since emerged internationally.

Technically, PSCs do not have the type of royalty that applies to royalty/tax systems of concessions or licences in the oil and gas industry. However, industry analysts argue that there are equivalent elements in PSC and royalty/tax systems and that the major difference is in the title transfer of oil or gas (Johnston et al., 2008). In a PSC, title to the hydrocarbons passes to the contractor at the export or delivery point.

In 1988, Indonesia's third-generation PSC introduced a new contract feature called first tranche petroleum (FTP). The contractor's share of FTP is taxed and the remaining production is available for cost recovery. Some industry analysts view FTP as a royalty (Johnston, 1994). Indonesia has other types of joint contract schemes for oil and gas such as technical assistance (TACs) and enhanced oil recovery (EOR) contracts. A TAC is a variant cooperation contract or a PSC, and is typically used for established producing areas; thus, it usually covers exploitation only. Operating costs are recovered from production and the contractor does not typically share in production. A TAC can cover both exploitation and exploration if it involves an area where the Indonesian government has encouraged exploration. In accord with the new Oil and Gas Law, existing TACs will not be extended. In addition, participants in PSCs, TACs and EOR contracts may also enter into separate agreements known as joint operating agreements (JOA) and joint operating bodies (JOB).

Since 2008, fifth generation PSCs have been introduced. The key differences between the later generation PSCs and earlier generations are as follows:

- Rather than a fixed production historical after-tax share, there is some flexibility in the production-sharing percentage offered;
- PSCs now provide for a domestic market obligation for natural gas;
- BP MIGAS is entitled to FTP of 10% of the petroleum production which is not shared with the contractor;
- The profit-sharing percentages which appear in the contract are determined on the assumption that the contractor is subject to a dividend tax on after-tax profits under Article 26 (4) of the Indonesian Income Tax Law, which is not reduced by any tax treaty;
- Certain pre-signing costs (e.g. for seismic purchases) may be cost recoverable;
- BP MIGAS must approve any changes to the direct or indirect control of the entity; and
- The transfer of the PSC participating interest to non-affiliates is only allowable with BP MIGAS's approval and where the contractor retains majority interest and operatorship, or three years after the signing of the PSC (PwC, 2012). Note that BP MIGAS has since been handed over to SKKMIGAS.

Indonesia revised the terms of the domestic market obligation in 2009. Under Government Regulation No. 55/2009, the contractor must allocate 25% of its oil or gas share to the domestic market. In relation to the development of new gas reserves, the government advises the contractor, on request, of the domestic gas supply requirement about a year prior to production. The contractor and prospective domestic buyers negotiate directly on gas price and terms of supply. However, if there is no domestic demand for gas or if an agreement between the contractor and prospective buyers is not reached, the contractor may sell its entire share to the international market.

UPSTREAM

In 2013, the Directorate General of Oil and Gas, the Ministry of Energy and Mineral Resources signed 14 new PSCs. Apart from these, PSCs under the control of the upstream oil and gas implementing agency—BP MIGAS (before becoming SKKMIGAS)—numbered approximately 317 by the end of 2013. Of these 317 PSCs, 79 were for oil and gas at the exploitation stage and 238 related to the exploration stage. Of the 238 PSCs, 160 PSCs were for conventional oil and gas, 55 were for shale gas and 23 were terminated. (SKKMIGAS, 2013).

In order to increase production of oil and gas, SKKMIGAS has developed the economy's oil and gas in new fields through a number of major projects, namely (SKKMIGAS, 2013):

- Banyu Urip—Mobil Cepu Ltd;
- Indonesia Deepwater Development (IDD)—Chevron Indonesia Company;
- Abadi—INPEX Masela Ltd.;
- Jangkrik dan Jangkrik North East (JNE)—Eni Muara Bakau B.V.;
- Bukit Tua—PC Ketapang II Ltd.;
- Ande-Ande Lumut—AWE (north-west Natuna) Pte. Ltd.;
- North Duri Development 13 (NDD-13)—PT Chevron Pacific Indonesia;
- Corridor—ConocoPhillips Grissik Ltd.;
- Ruby—Pearl Oil (Sebuku) Ltd.;
- Kepodang—PC Muriah Ltd.;
- Donggi Senoro—JOB Pertamina-Medco Tomori; and
- Tangguh Train 3—BP Berau Ltd.

KEROSENE TO LIQUEFIED PETROLEUM GAS CONVERSION PROGRAM

In December 2009, Phase I of the government's kerosene-to-liquefied petroleum gas (LPG) conversion program was completed. The program distributed 23.8 million three-kilogram LPG cylinders to the densely populated provinces of Jakarta, Banten, West Java, Yogyakarta and South Sumatra. The program eliminated the need for Pertamina to supply 5.2 billion litres of heavily subsidised kerosene for household use in these provinces.

In an extension of the program, 4.7 million three-kilogram LPG canisters were distributed by 2010. In 2011 to 2012, some 5.1 million three-kilogram LPG cylinders were distributed. In 2013, the program expects to distribute 1.7 million cylinders with the same characteristics.

COAL-BED METHANE

Oil and gas laws and regulations also govern coal-bed methane. The Directorate General of Oil and Gas has oversight of business activities with regard to coal-bed methane gas development. The MEMR issues regulations, and establishes and offers coal-bed methane gas work areas. The Directorate General of Oil and Gas technically establishes and offers coal-bed methane work areas, with due consideration given to the opinion of BP MIGAS (which has now passed on its duties to SKKMIGAS).

Ministerial Regulation No. 36/2008 Regarding Business in Coal Methane Gas regulates coal-bed methane development. The regulation covers exclusive rights and business related to coal-bed methane gas; the method of determining and offering coal-bed gas methane work areas; the use of data, information, equipment and facilities; research, assessment and development of coal-bed gas methane; dispute resolution; rulings on coal-bed methane gas as an associated natural resource; and the utilisation of coal-bed methane for domestic needs.

MINERALS AND COAL MINING

Indonesia's Minerals and Coal Mining Law (Law No. 4/2009) replaced the COW and PKP2B systems with two forms of permit: specifically, mining business permits (Izin Usaha Pertambangan [IUPs]) and citizens mining permits (Izin Pertambangan Rakyat [IPRs]). The new law also introduced a contract called the mining business contract (Perjanjian Usaha Pertambangan [PUP]). The IUPs apply to large-scale mining. The PUP is a contract between the government and a private mining company whereby the government is represented by an implementing body, which is yet to be established.

Under the new law, the mining fiscal regime includes corporate tax under the prevailing taxation law, a surtax of 10% and a mining royalty that is determined according to the level of mining progress, the level of production and the prevailing price for the mineral. The law allows a transition period for current COW and PKP2B holders, some of which are large mining concessions for minerals and coal that will expire between 2021 and 2041. The law's explanation with regard to transition states that existing contracts will be upheld; however, the specific scheme for the transition of existing concessions is yet to be formulated.

PUBLIC PRIVATE PARTNERSHIP

In late 2011, project documents were signed which enable the Central Java ultra-supercritical coal power plant, consisting of two 1 000 MW units, to be the first project realised under the Public Private Partnership (PPP) program by Presidential Regulation No. 67 of the Year 2005 Regarding Government Partnership with Private Entities to Provide Infrastructure. The terms of the PPP include government investments and guarantees on PLN power purchases through a private guarantor established by Presidential Regulation No. 78 of Year 2010, Infrastructure Guarantees in Government Partnership Projects with Business Entities Executed through Private Infrastructure Guarantors.

Government guarantees for the PPP Central Java power plant project are an advanced step in infrastructure development in Indonesia because the approach taken is considered more transparent and accountable. The PPP scheme to be used for the Central Java power plant project is the Build-Own-Operate-Transfer (BOOT), which has a concession period of 25 years. Commercial operation is expected to commence at the end of 2018.

GEOTHERMAL

In order to promote geothermal development, the government has provided some fiscal incentives for income tax, value added tax, import duty and the withholding of income tax for imports under the taxation regulations (MoF, 2014). The details are as follows:

- A tax holiday with exemption from corporate income tax (from five to ten tax years). After the period of corporate income tax exemption has ended, the developers are given a 50% reduction of corporate income tax for two tax years.
- An investment allowance for geothermal energy. The allowance includes reduced net income tax of 30% of the total investment (5% a year for six years); accelerated depreciation; an income tax rate of 10% or lower based on a tax treaty with regard to dividends paid to non-resident taxpayers and compensation for losses in certain circumstances. However, the developers may only have either a tax holiday or an investment allowance.
- Exemption from value added tax for the importation of machinery and equipment, not including spare parts.
- Exemption from import duty for machinery, goods and materials for construction and development as long as the machinery, goods and materials have not been produced in the domestic area, have been produced in the domestic area but their specifications do not meet the criteria and have been produced in the domestic area but in insufficient quantities.
- Exemption from Withholding Income Tax Art. 22 for the importation of machinery and equipment, not including spare parts.

ENERGY EFFICIENCY

GOVERNMENT REGULATION ON ENERGY CONSERVATION

As called for by the Energy Law (Law No. 30/2007), on 16 November 2009 the government issued Government Regulation No. 70/2009 Regarding Energy Conservation. The regulation mandates the following:

- The formulation of a National Energy Conservation Master Plan (Rencana Induk Konservasi Energi Nasional, RIKEN), which will be updated every five years or annually, as required;
- The introduction of an energy manager, energy audits and an energy conservation program for final energy users of 6 000 toe or greater;
- The implementation of energy efficiency standards and energy labelling;
- Government incentives in the form of tax exemptions, fiscal incentives for the importation of energy-saving equipment and low-interest lending rates to encourage investments in energy conservation; and

- Government disincentives in the form of written notices to comply, public announcements of noncompliance, monetary fines and reduced energy supply for noncompliance.

In order to implement Government Regulation No. 70/2009 Regarding Energy Conservation throughout Indonesia, the government issued Ministerial Regulation No. 14/2012 on Energy Management.

The regulation states the following:

- Energy source users and energy users who use energy sources and/or energy of 6 000 toe per year or greater shall carry out energy management and have an obligation to establish an energy management team.
- Energy source users and energy users who use energy sources and/or energy of less than 6 000 toe per year shall carry out energy management and/or implement energy savings.
- Energy conservation programs shall consist of short-term programs (improvements in operating procedures, maintenance and installation of simple device controls), medium- to long-term programs (increasing efficiency of equipment and fuel switching) and continuous improvement of employee or operator awareness and knowledge of energy conservation techniques.
- An energy audit shall be conducted periodically on at least the main energy-consuming appliances and equipment at a minimum of once every three years.
- An annual report on energy management implementation shall be provided by energy source users and energy users to ministers, governors and regents or mayors within their respective jurisdictions.
- Incentives shall be given to energy source users and energy users who have succeeded in reducing their specific energy consumption by at least 2% per year during a three-year period. These incentives include eligibility for energy audit partnerships funded by the government and/or recommendation for priority access to energy supplies by ministers, governors and regents or mayors within their respective jurisdictions. Disincentives shall be imposed on energy source users and energy users who have not implemented energy conservation through energy management. These disincentives include written notices to comply, public announcements of non-compliance, monetary fines (calculated at 5% of the cost of energy used during the one-year reporting period) and/or reduced energy supply for non-compliance (maximum 5% of contract capacity for a period of one month, with an extension possible).

As part of the government commitment to increase energy efficiency and conservation, the MEMR has developed an energy conservation project as one of the Nationally Appropriate Mitigation Actions (NAMAs), namely the Smart Street Lighting Initiative (SSLI). The SSLI program aims to implement energy efficiency in street lighting by replacing conventional lighting technology with energy efficient technology, namely light emitting diodes (LEDs), in urban areas. The SSLI will be implemented in 22 cities in Indonesia in order to promote transformational changes in this particular sector. This program will then be implemented all over Indonesia. The SSLI has been registered with a NAMA of the United Nations Framework Convention on Climate Change (UNFCCC) since May 2014 in order to seek international support for implementation. Besides being proposed to the NAMA Facility, the project has been attracting support from several development partners, namely the Asian Development Bank, the United States Agency for International Development (USAID) and the French Development Agency (AFD).

Moreover, with regard to energy efficiency, Indonesia has also issued standards and regulations for energy efficiency in buildings, namely: National Standard (SNI) No. 03-6390-2011: Energy Conservation for Air Conditioning Systems in Buildings; SNI 03-6197-2011: Energy Conservation for Lighting Systems in Buildings; SNI 03-6389-2011: Energy Conservation for Building Envelopes; and SNI 03-6196-2011: Procedures for Energy Audits in Buildings. The implementation of the standards is carried out by local governments such as the City of Jakarta as part of the Governor's Regulations on Green Buildings in Jakarta. Each building, whether existing or new, must conform to the green building standard, which includes energy efficiency, in order to obtain or renew its building permit. Some buildings, new and existing, are also participating in the Greenship Program of the Green Building Council Indonesia. The Greenship Program has four criteria, which are:

- Sustainable building materials;
- Water and waste water management;
- Energy efficiency; and
- Waste management.

Currently, there are 41 new buildings and three existing buildings registered under this program.

BARRIER REMOVAL

Indonesia is participating in a United Nations Development Program-Global Environment Facility (UNDP-GEF) project, which involves six developing Asian economies. This project, Barrier Removal to the Cost Effective Development and Implementation of Energy Efficiency Standards and Labelling (BRESL), has five major programs promoting energy standards and labelling: policy making, capacity building, manufacturing support, regional cooperation and pilot projects. The BRESL project was finished in 2014 but the government has continued implementing the projects.

With regard to the promotion of the establishment of a legal and regulatory basis for the removal from the market of technologies that are less energy efficient and produce more emissions and the subsequent adoption of high-efficiency technologies, some of the achievements in 2015 were as follows (UNDP, 2014):

- The government has revised Ministerial Regulation No. 6/2011 on CFLs with Regulation No. 18/2014 and followed this with a Technical Guideline which has been signed and released by the Directorate General of New Renewable Energy and Energy Conservation (DGNREEC);
- Regulation No. 7/2015 on air conditioners has been issued by the Minister of Energy and Mineral Resources and followed by a Technical Guideline which has been signed and released by the DGNREEC;
- Drafts of a ministry regulation on refrigerator labels were submitted to the DGNREEC and will be the basis for the creation of technical guidelines for labels;
- Drafts of energy performance tests on rice cookers and electric fans were finalised and submitted to the DGNREEC and will be enacted as the Indonesian Standard for Energy Performance;
- A testing protocol for electronic ballast was submitted to DGNREEC to be evaluated and included as a Technical Guideline under a ministerial regulation; and
- A regional feasibility study on CFL was conducted based on Australian practices and updated for the standard harmonisation of CFL energy performance.

RENEWABLE ENERGY

On 17 October 2014, the government issued the new National Energy Policy under Government Regulation No. 79/2014 to replace the existing National Energy Policy, which was established by Presidential Regulation No. 5/2006. The aim of this policy is to:

- Achieve energy elasticity for GDP of less than one by 2025;
- Achieve a reduction of final energy intensity to 1% per year up to 2025; and
- Realise an optimum primary energy consumption mix where the share of new and renewable energy will be at least 23% by 2025 and at least 31% by 2050.

As part of the government commitment to mitigate climate change, the MEMR has developed a renewable energy project in the form of a NAMA, known specifically as the Debottlenecking Project Financing for Small-scale Renewable Energy (DEEP). The DEEP program aims to promote on-grid renewable energy, particularly bioenergy-based power plants, by increasing the institutional capacity of financial institutions and project developers. Its activities will include technical assistance as well as financial facilities for renewable energy developers. In addition to this project, Indonesia is currently developing another NAMA project, which focuses on small-scale renewable energy (mini/micro-hydro power plant).

BIOFUELS

In 2008, Indonesia passed Ministerial Regulation No. 32/2008 regarding the Supply, Use and Commerce of Biofuel as Other Fuel. This made biofuel consumption mandatory from 2009.

The regulation controls:

- The utilisation priority of biofuels;
- Biofuel categories;
- Standards and specifications of quality;
- Price setting;

- Biofuel commerce, as another fuel;
- Directives and oversight; and
- Sanctions.

In order to reduce fuel imports by accelerating the improvement and expansion of biofuels, the government revised Ministerial Regulation No. 32/2008 on 18 March 2015. This regulation sets mandatory targets for the percentage share of biofuels with regard to the share of total fossil consumption (biofuel blend), as shown in Table 4.

Table 4: Minimum obligations for biofuel use (% blend)

Sector	April 2015	Jan 2016	Jan 2020	Jan 2025
Biodiesel				
PSO transport	15	20	30	30
Non-PSO transport	15	20	30	30
Industrial and commercial	15	20	30	30
Electricity generation	25	30	30	30
Ethanol				
PSO transport	1	2	10	20
Non-PSO transport	2	5	10	20
Industrial and commercial	2	5	10	20
Straight vegetable oil fuel				
Industry	10	20	20	20
Marine	10	20	20	20
Aviation	–	2	3	5
Electricity generation	15	20	20	20

Note: PSO = public service obligation fuel means subsidised fuel.
Source: (ESDM, 2015).

Until the end of 2013, the realisation of biofuel (biodiesel and bioethanol) utilisation was 2.8 million kilolitre (kL), an increase of 27% from 2.2 million kL in 2012.

GEOTHERMAL

In 2013, Indonesia's total geothermal capacity was 1 344 MW, which is 4.7% of the total geothermal potential of 28 910 MW (EBTKE, 2014). Indonesia has identified 4 855 MW of geothermal power potential from existing geothermal plants, through capacity expansion of productive geothermal resources and from new geothermal projects at 51 sites. Specifically, the latter are anticipated to produce 2 585 MW in Sumatra at 18 sites, 1 920 MW in Java at 20 sites, 180 MW in Sulawesi at four sites, 105 MW in the Nusa Tenggara at six sites and 65 MW in the Maluku islands at three sites (ESDM, 2014b).

This geothermal power potential will be developed under the 10 000 MW Accelerated Development of Electricity Generation—Phase II program as well as a 35 000 MW program. It is expected that these projects will commence operations between 2014 and 2022. Under PLN's Electricity Power Supply Business Plan 2013–22 (*Rencana Usaha Penyediaan Tenaga Listrik,* or RUPTL), a further increase in geothermal capacity by 6 055 MW is expected between 2014 and 2022. Of the total capacity, 4 625 MW will be developed by IPPs, 230 MW by PLN and 1 200 MW by organisations with unallocated status (PLN, 2014).

HYDROPOWER

In 2013, Indonesia's total hydropower capacity was 4 338 MW (including 69 MW of micro- and mini-hydro). This was 5.8% of the total hydropower potential of 75 gigawatts (GW) (ESDM, 2014a). Under the 10 000 MW Accelerated Development of Electricity Generation—Phase II program over 2014–22, Indonesia is committed to developing additional hydropower with a total capacity of about 1 803 MW. Of this total capacity, 424 MW will be developed by IPPs and 1 379 MW by PLN.

PLN's RUPTL 2013–22 also includes the potential for an additional 12 352 MW of hydropower capacity during 2014–23 (including mini-hydro and pump-storage plants). Of this capacity, 339 MW would

be developed by PLN, 1 423 MW by IPPs and the rest of the project's 10 590 MW is not yet decided; however, private participation is still an option for the project. The additional hydropower capacity includes two pump-storage power plants in Java—specifically the Upper Cisokan (1 040 MW) in West Java and the Matenggeng (900 MW) at the border of West and Central Java. These pump-storage plants are considered important for the technical performance and stability of the Indonesian electricity grid.

These hydropower plants would increase Indonesia's total large hydropower capacity to 12 352 MW, or 13% of Indonesia's total hydropower potential. It is worth noting that Indonesia's large hydropower potential is located in the eastern part of Indonesia, far from the large demand centres.

SAVING ENERGY AND WATER

Presidential Instruction No. 13 of the Year 2011 Regarding Saving Energy and Water instructs Ministers of the Unity Indonesia II Cabinet, the Supreme Justice of the Republic of Indonesia, the Commander of the Armed Forces of Indonesia, the Head of State Police Republic of Indonesia, heads of non-ministerial government agencies, heads of state secretariat institutions, governors and regents or mayors to take measures and innovate in order to save energy and water within their institutional domains and/or in the domains of state-owned businesses and regional government-owned businesses within their jurisdiction.

The Presidential Instruction assigns an electricity savings target of 20% from the average electricity use over the six months prior to the Presidential Instruction; fuel savings targets of 10% through regulations to limit the use of subsidised fuels; and water savings targets of 10% from the average water use over the six months prior to the Presidential Instruction.

The Presidential Instruction calls for the creation of a National Team on Saving Energy and Water. The Coordinating Minister of Economic Affairs is the chair and a member of the National Team; the Minister of Energy and Mineral Resources is Executive Chief and a member of the National Team; 11 cabinet ministers are also members of the National Team. The National Team is supported by the Executive Team headed by the Secretary of the National Team.

NUCLEAR ENERGY

In 2007, the government of Indonesia established the Nuclear Power Development Preparatory Team, whose task it is to take the necessary preparatory measures and create the plans to build Indonesia's initial nuclear power plants; however, to date the team has not conducted any significant activities or performed relevant tasks. The legal basis of Indonesia's nuclear power development includes Law 17/2007 on Long Term Development, Years 2005–15 and Government Regulation 43/2006 on the Licensing of Nuclear Reactors.

Indonesia has developed an indigenous nuclear fuel cycle, although certain stages are still at the laboratory stage. The economy has a well-established nuclear research program, which spans nearly five decades. The National Nuclear Energy Agency (BATAN) currently operates three nuclear research reactors, specifically the GA Siwabessy 30 MW materials testing reactor (MTR) pool-type reactor in Serpong; the Kartini-PPNY 100 kilowatts (kW) Triga Mark-II reactor in Yogyakarta; and the Bandung 1 000 kW Triga Mark-II reactor in Bandung. A fourth 10 MW pool-type research reactor is planned for development in the near future.

Indonesia currently has two prospective uranium mines. The first is the Eko-Remaja prospect of the Remaja-Hitam Ore Body, a uranium vein in fine-grained metamorphous rock, estimated to contain between 5 000–10 000 tonnes of uranium with a grade ranging between 0.1–0.3. The second is the Rirang Tanah Merah Ore Body, a uranium vein, which may contain fewer than 5 000 tonnes of uranium of a grade ranging between 0.3–1.0. The uranium mines are located in West Kalimantan.

Despite the above developments, the Fukushima Daiichi nuclear accident in 2011 generated negative perceptions discouraging prospects for building nuclear power plants in Indonesia. At the same time, people have resisted development on candidate sites, thereby making development uncertain. Hence, the government has stated that nuclear power will be the last option used to achieve Indonesia's energy demand, which means prioritising renewable energy sources.

CLIMATE CHANGE

Indonesia strongly supports the objectives of the UNFCCC to prevent atmospheric concentrations of anthropogenic gases exceeding a level that would endanger the existence of life on Earth. In order to indicate its decisiveness and serious concern about global warming, Indonesia signed the convention on 5 June 1992. On 1 August 1994, the President of the Republic of Indonesia formalised this ratification by enacting Law No. 6/1994 Regarding Approval of the UNFCCC. Indonesia is legally included as a party to the convention, which implies that Indonesia is bound by the rights and obligations that it stipulates.

As a non-Annex 1 party in the Kyoto Protocol, Indonesia has no obligation to reduce greenhouse gas (GHG) emissions. However, the Indonesian Government is committed to participating in and cooperating with the global effort to combat climate change. This position was expressed by the President of the Republic of Indonesia at the G20 Finance Ministers meeting and Central Bank Governors Summit held in September 2009 in Pittsburgh, the United States. In addition, the government of Indonesia has pledged to reduce GHG emissions from forestry and the energy sector by 26% through domestic efforts, and by up to 41% through cooperation with other economies.

In response to this commitment and the challenges of climate change, the Indonesian government has set out a roadmap in order to integrate climate change issues into development planning. The climate change roadmap will integrate mitigation and adaptation into policy instruments, regulations, programs, projects, funding schemes and capacity building in all development sectors. Two initial phases of the roadmap are the integration of climate change into the Mid-Term Development Plan 2010–14 (Rencana Pembangunan Jangka Menengah 2010–14, RPJM) and the launch of the Indonesia Climate Change Trust Fund (ICCTF) on 14 September 2009.

The ICCTF is a financing mechanism for climate change mitigation and adaptation within Indonesia's policy framework. The ICCTF has two key objectives:

- Achieving Indonesia's goal of a low-carbon economy and greater resilience to climate change through the facilitation and acceleration of investment in renewable energy and energy efficiency; sustainable forest management and forest conservation; and the reduction of vulnerability in key sectors such as coastal zones, agriculture and water resources.
- Enabling the government of Indonesia to increase the effectiveness and impact of its leadership and management in addressing climate change by bridging the financial gap in order to address climate change mitigation and adaptation, and increasing the effectiveness and impact of external finance for climate change work in Indonesia.

Through the ICCTF, the government of Indonesia can utilise not only government budgets but also bilateral and multilateral financial agreements, public-private partnerships, mandatory and voluntary international carbon markets and the Global Environmental Fund and other funds in order to implement a policy framework for climate change.

The ICCTF consists of two funds: the Innovation Fund and the Transformation Fund. The Innovation Fund is a grants-based fund to finance demonstration and innovation projects, pilot projects and research and development. The Transformation Fund is used to finance low-emissions programs, projects and initiatives developed by private parties. The Transformation Fund is not a grants fund but a revolving fund; thus, projects are expected to generate returns on the fund's investments.

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY

ACCELERATED ELECTRICITY GENERATION PHASE I AND PHASE II

The accelerated power development program, 10 000 MW Phase I, had completed 7 895 MW of new generation capacity by the end of December 2014. With regard to project constraints, the MEMR has set a new final completion date of 2016 for the 10 GW Phase I of the program.

In 2010, the government mandated PLN to implement Phase II of the program. In this second phase, it is intended that PLN will add 11.1 GW of capacity based on 68% coal, 19% geothermal, 10% combined cycle gas and 3% hydropower. The two-phase accelerated power development program is expected to rapidly increase generating capacity, encourage renewable energy utilisation and at the same time eliminate oil-based power plants, except in regions where there are no other competitive alternative energy sources.

The composition of the generation capacity mix for Phase II of the 10 GW Accelerated Power Program is required to be updated to accommodate the current situation's conditions. In 2014, the MEMR established a new final energy mix for the 10 GW Phase II with a total capacity of 17 458 MW, 60% of which will be developed from coal, 28% from geothermal, 10% from hydropower and 2% from gas. The scheduled completion date for the 10 GW Phase II is 2022.

In order to provide a sufficient electricity supply for supporting economic growth as well as increasing the economy's electrification ratio, the government launched the 35 GW Electricity Program for Indonesia in May 2015. This project is expected to be completed in five years (2015–19). Taking into account 7.4 GW of power plants that are at construction stage, the total additional capacity of the power plants that will be

developed is 42.9 GW (7.4 GW plus 35.5 GW) up to 2019. In the 35 GW program, 56.5% of capacity comes from coal-fired power plants, 36.2% from combined cycle gas, 6.1% from hydropower and 1.2% from geothermal.

In order to realise such an ambitious program, a policy breakthrough has been prepared by the government. This involves initiatives such as land acquisition secured by the government according to the land law for projects of public interest; establishing a ceiling price for electricity purchase; shortening the procurement process in order to select developers and contractors through direct appointment and direct selection and conducting due diligence to assess the developer and contractor's performance; streamlining the permit process (the number of electricity permits has been reduced from 52 to 29); and establishing a one stop service for permits under the Investment Coordinating Board Agency (BKPM) (DJK, 2015b).

HYDROELECTRIC POWER

The project in West Java for the Upper Cisokan pumped storage hydroelectric power plant, with four 260 MW units, received loans from the World Bank/International Bank for Reconstruction and Development (IBRD) in late 2011. Completion of the project is expected in 2017. The Upper Cisokan plant will be the first of its kind in Indonesia.

PLN has also secured financing for construction of the Jati Gede hydroelectric power plant, with two 55 MW units, in West Java, the Baliem 50 MW hydroelectric power plant in the province of Papua, the Asahan III 174 MW hydroelectric power plant in the province of North Sumatera, and the Merangin hydroelectric power plant, with two 175 MW units, in the province of Jambi, Sumatra.

REGULATIONS

POWER PURCHASES FROM GEOTHERMAL POWER PLANTS AND GEOTHERMAL STEAM BY PLN

On 3 June 2014, the government introduced a ceiling price mechanism under Ministerial Regulation No. 17/2014 to replace the Feed-in Tariff (FiT) scheme, which was introduced in 2012 (Ministerial Regulation No. 22/2012). Under this new ceiling price mechanism, the government, through the MEMR, assigns PLN to purchase electricity from geothermal developers based on price auction results (a ceiling price has been set ranging from USD 11.8 cent/kWh to USD 29.6 cent/kWh depending on the commercial operation date of the project and the region where the project is located). Within six months after PLN has obtained the assignment to purchase electricity from the government, a power purchase agreement (PPA) must be signed by both parties.

If a delay in a PPA is caused by a disagreement over the geothermal price, an independent body must be appointed by both parties to recalculate the geothermal price, taking into account the developer's costs. The calculation of the geothermal price by the independent body will be the final price in the PPA. Moreover, under this regulation, there is an option to escalate the tariff after the developers carry out exploration and feasibility study phases.

POWER PURCHASES FROM HYDROPOWER PLANTS BY PLN

On 29 June 2015, the government established a FiT for hydropower plants with a capacity of up to 10 MW through Ministerial Regulation No. 19/2015. Under the new FiT mechanism, PLN is obliged to purchase electricity from hydropower plants with a capacity of up to 10 MW at a predetermined price. The FiT is set at approximately USD 12 cent/kWh to USD 14.4 cent/kWh for the first year to the eighth year depending on the location of the projects within Indonesia and the voltage connection points. The FiT will decreased to approximately USD 4.5 cent/kWh to USD 5 cent/kWh for the ninth year to the twentieth year depending on the location of the projects within Indonesia and the voltage connection points. Moreover, the FiT can be higher if the project is located in different location areas or islands since there is a regional factor (F) with ranges from 1.0 to 1.6.

POWER PURCHASES FROM BIOMASS AND BIOGAS-BASED POWER BY PLN

On 16 October 2014, the government established a Feed-in-Tariff (FiT) for biomass and biogas-based power through Ministerial Regulation No. 27/2014. Under the FiT mechanism, PLN is obliged to purchase biomass electricity and biogas electricity at a predetermined price (for biomass, from approximately USD 9.6 cent/kWh to USD 12.5 cent/kWh depending on the voltage connection point; and for biogas, from approximately USD 8.6 cent/kWh to USD 11.7 cent/kWh depending on the voltage connection point). Moreover, the FiT can be higher depending on the location of the projects since there is a regional factor (F) with ranges from 1.0 to 1.6. In addition, there is an incentive to encourage investor interest in biomass power plants and biogas-based power plants if they are operate as load followers.

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USEFUL LINKS

BPH MIGAS—www.bphmigas.go.id

Ministry of Energy and Mineral Resources (KESDM)—www.esdm.go.id

PT PLN (Persero)—www.pln.co.id

SKKMIGAS, Satuan Kerja Khusus Pelaksana Kegiatan Usaha Hulu Minyak dan Gas Bumi—www.skspmigas-esdm.go.id

Statistics Indonesia (Badan Pusat Statistik, BPS)—www.bps.go.id

UNDP Indonesia—www.id.undp.org

JAPAN

INTRODUCTION

Located in East Asia, Japan comprises several thousand islands, the largest of which are Honshu, Hokkaido, Kyushu and Shikoku. Most of its land area, approximately 377 800 square kilometres (km^2), is mountainous and thickly forested. Japan is the third-largest economy in the world and among the APEC economies, after the United States and China. Its real GDP in 2013 was approximately USD 4 448 billion (2010 USD purchasing power parity [PPP]). In 2013, Japan's population of 127.3 million people had a per capita income of USD 34 928. Japan's GDP increased by 1.6% in 2013 compared to 2012. Since indigenous energy resources are modest, Japan imports nearly all of its fossil fuels to sustain economic activity. As of the end of 2011, the proven energy reserves included approximately 44 million barrels of oil, 21 billion cubic metres (bcm) of natural gas and 350 million tonnes (Mt) of coal.

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b]	
Area (thousand km^2)	377.8	Oil (million barrels)	44
Population (million)	127.3	Gas (billion cubic metres)	21
GDP (2010 USD billion PPP)	4 448	Coal (million tonnes)	350
GDP (2010 USD PPP per capita)	34 928	Uranium (kilotonnes U)	–

Sources: a. EGEDA (2015); b. BP (2012).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2013, Japan's total primary energy supply was about 472 million tonnes of oil equivalent (Mtoe), 4.7% more than in 2012. By fuel type, oil contributed the largest share (48%), followed by coal (25%) and natural gas (23%). In 2013, the net imports of energy sources accounted for 90% of the total primary energy supply.

In 2013, Japan was the third-largest oil consumer of the world and APEC (4.5 million barrels per day (Mbbl/D)), after the United States and China (BP, 2014), and almost all of the oil was imported. The bulk of the imports (73% in 2013) were from economies in the Middle East such as Saudi Arabia; the United Arab Emirates; Qatar and Kuwait (BP, 2014). In 2013, the primary oil supply was 229 Mtoe, an increase of 7.8% from the previous year.

Japan is endowed with only limited coal reserves, 350 Mt, which is less than twice the annual consumption in 2013. It is the world's largest importer of coking coal for steel production and steam coal for power generation, and pulp, paper, and cement production. Japan's main steam coal suppliers are Australia; Indonesia and Russia, while those for coking coal are Australia; Indonesia and Canada.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 21 bcm, which is less than one-fifth of the annual consumption in 2013, and are located in the prefectures of Niigata, Chiba and Fukushima. In 2013, the domestic demand was met almost entirely by imports in the form of liquefied natural gas (LNG) (BP, 2014), from Australia (21%); Qatar (18%); Malaysia (17%); Russia (9.8%); Indonesia (7.2%); the United Arab Emirates (6.2%); Brunei Darussalam (5.8%); Oman (4.8%) and other economies. LNG imports to Japan comprised 37% of the total global LNG trade. Natural gas is mainly used for electricity generation, followed by reticulation as city gas and use as an industrial fuel. The primary natural gas supply was 105.9 Mtoe in 2013, an increase of 0.4% from the previous year.

Japan has 287 gigawatts (GW) (EGEDA, 2015) of installed generating capacity and generated 1 088 773 gigawatt-hours (GWh) of electricity in 2013. Electricity is generated from thermal fuels (coal, natural gas and oil—84.7%), hydro (7.8%) and nuclear (1.3%). Geothermal, solar and wind technologies produce the remainder (6.1%).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	23 534	Industry sector	134 837	Total power generation	1 088 773
Net imports and others	422 497	Transport sector	75 945	Thermal	922 158
Total primary energy supply	471 705	Other sectors	92 214	Hydro	85 160
Coal	117 673	Non-energy	3 532	Nuclear	14 603
Oil	228 505	Total final energy consumption	306 530	Others	66 851
Gas	105 918	Coal	34 854		
Others	19 609	Oil	155 400		
		Gas	29 611		
		Electricity and others	86 665		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

In 2013, the total final energy consumption in Japan was 306.5 Mtoe, 1.7% less than in the previous year. The industrial sector consumed 44% of the total, followed by the transportation sector at 25%. Final energy consumption in the industrial sector decreased by 0.2% compared to the previous year. Consumption in the transport and other sectors also decreased by 2.9% and 3%, respectively. By energy source, petroleum products accounted for 51% of the total final energy consumption, followed by electricity and others (28%), coal (11%) and gas (9.7%).

ENERGY INTENSITY ANALYSIS

Japan's energy intensity shows different trends between final energy consumption and primary energy supply. The energy intensity of the final energy consumption decreased by 3.2%, from 71 tonnes of oil equivalent per million USD (toe/million USD) in 2012 to 69 toe/million USD in 2013. Transportation and other sectors especially improve, by about 4.4 to 4.5%, among the sectors in Table 3. On the other hand, in terms of primary energy supply, Japan's energy intensity increased by 3.1%, from 103 toe/million USD in 2012 to 106 toe/million USD in 2013. The different trends are partly because of various factors in primary energy supply and energy conversion, including stock changes in crude oil and petroleum products, as well as efficiency changes in the total transformation sector.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	103	106	3.1
Total final energy consumption	71	69	–3.2
Industry	31	30	–1.4
Transportation	18	17	–4.4
Others	22	21	–4.5
Non-energy	0.88	0.79	-9.7

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Economy, Trade and Industry (METI) of Japan is responsible for designing the energy policy of the economy. Within METI, the Agency for Natural Resources and Energy is in charge of the

rational development of mineral resources, securing stable supplies of energy, promoting efficient energy use, and regulating electricity and other energy industries. Regarding nuclear safety, the Nuclear Regulation Authority (NRA), which is an independent commission affiliated to the Ministry of the Environment (MOE), is responsible for nuclear safety since September 2012.

Before the Great East Japan Earthquake in March 2011 and the subsequent Fukushima Daiichi Nuclear Power Plant Accident, the aim of the energy policy of Japan was to achieve the '3E' goals—energy security, economic efficiency and environment (for example, against global warming)—in an integrated manner. After these events, Japan aims to achieve the '3E+S' goals—the original 3E concept and safety.

The Basic Law on Energy Policy 2002 presents the core principles of Japan's energy policy (METI, 2008)—assurance of a stable supply, adaptation to the environment and use of market mechanisms. The Strategic Energy Plan was established in 2003.

In 2006, Japan launched the New National Energy Strategy in response to the global energy situation (METI, 2008). The strategy contains a program of action towards 2030, and significantly emphasises achieving energy security. Its five targets are energy efficiency improvements of at least 30%; increasing the share of electric power derived from nuclear energy to over 30% to 40%; reducing oil dependence in the transport sector to about 80%; raising Japan's investment in oil exploration and development projects; and reducing overall oil dependence to below 40%.

The Strategic Energy Plan based on the law was revised in 2007 (METI, 2008). It focused on developing an international framework for energy conservation and countermeasures to global warming; establishing a nuclear fuel cycle at an early stage; promoting new energy sources for electric power suppliers; ensuring a stable supply of oil and other fuels; promoting international cooperation in the energy and environmental fields; and developing an energy technology strategy.

The Strategic Energy Plan was revised again in 2010. It is required to be reviewed at least every three years and revised if needed. In this revision, two new principles—energy-based economic growth and reforming energy industrial structure—were added to the three existing principles of energy security, environmental suitability and economic efficiency (METI, 2010). The plan aims to fundamentally modify the energy supply and demand system by 2030, and has set ambitious targets for achieving this. For example, the plan targeted doubling the energy self-sufficiency ratio (18% in 2010) and raising the ratio of zero-emission power sources to about 70% (34% at that time), of which 53% is nuclear generation.

Following the Great East Japan Earthquake in March 2011 and the subsequent Fukushima Daiichi Nuclear Power Plant Accident, the DPJ (Democratic Party of Japan) Government decided to review its Strategic Energy Plan. In June 2012, the Energy and Environment Council of the Japanese Government announced 'Options for Energy and Environment'. The council showed three scenarios for the share of nuclear energy in the power generation mix in 2030: (1) a 0% scenario, (2) a 15% scenario, and (3) a 20% to 25% scenario (NPU, 2012).

However, Prime Minister Shinzo Abe, who was formally elected on 26 December 2012, has stated that the coalition of the Liberal Democratic Party and Komeito Party would reconsider the Democratic Party's nuclear energy policy. In April 2014, the Cabinet decided to approve the revised Strategic Energy Plan (METI, 2014). This fourth plan provides a direction to Japan's energy policies for medium/long-term (about the next 20 years). It reaffirms the importance of renewables as promising low carbon and domestic sources, coal as a stable and cost-effective base-load power source, and natural gas as a main flexible middle-load power source. The latest plan also reaffirms the importance of nuclear as a low carbon and quasi-domestic power source. However, it states that dependency on nuclear generation will be lowered to the extent possible by energy saving and introducing renewable energy, as well as by improving the efficiency of thermal power generation, and so on.

In July 2015, the Long-term Energy Supply and Demand Subcommittee of METI concluded the Long-term Energy Supply and Demand Outlook of Japan (METI, 2015a). The Subcommittee projected energy demand to 2030 using macroeconomic indicators, and calculated total energy savings with a bottom-up estimation about the sectorial savings potential. The Outlook indicates an electricity mix, primary energy demand and supply, and energy-related CO_2 emissions, and aims to ensure the '3E+S' policy where 'safety' is the foremost condition. It has three steps: 1) increase energy self-sufficiency (including nuclear as a quasi-domestic energy) to about 25% from about 6% in 2012; 2) reduce electricity costs from the current level; and 3) greenhouse gas (GHG) emission reduction comparable to the targets of Europe and the US. The government's outlook aims for a well-balanced power mix where nuclear accounts for 20% to 22% of the total generated electricity, renewables for 22% to 24%, LNG for 27%, coal for 26% and oil for 3%. Nuclear dependence is lower than before the earthquake (when it was around 30%). Within renewables, the two largest sources are hydro, accounting for 8.8% to 9.2%, and solar (7%).

ENERGY MARKETS

OIL

Japan aims to decrease its oil dependency, partly because of its experiences during the oil crises in 1973 and 1979. However, oil still dominates the total primary energy supply of the economy. The share of oil was about 40% in 2010, and increased to about half in 2013 partly due to the loss of nuclear generation and incremental oil-fired generation after the earthquake. Securing a stable supply of oil is one of the major energy policy issues of Japan.

The oil supply structure of the economy is vulnerable to disruption because it imports almost all of its crude oil. In preparation for possible supply disruptions, Japan has created emergency oil stockpiles and independently developed resources, and promoted cooperation with oil-producing economies to manage emergencies.

The Japan Oil, Gas and Metals National Corporation (JOGMEC) is responsible for the economy's stockpile business and also provides financial and technical assistance to Japanese oil industries for oil and natural gas exploration and development, both domestically and abroad. The oil stocks of Japan are well in excess of the International Energy Agency's 90-day net import requirements. As of December 2015, Japan held the equivalent of 213 days of net imports, including state-owned stocks, private sector stocks and joint oil storage programs with oil-producing countries (PAJ, 2015).

Competition continues in the domestic oil product market. The major Japanese petroleum companies are seeking to reduce their refining capacity to comply with the law on the Promotion of the Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Materials by Energy Suppliers, which requires that the heavy oil cracking unit capacity at petroleum companies is raised to 13% of the total distillation capacity.

The number of service stations in the economy decreased from 59 615 in 1996 to 34 706 in 2013 due to market liberalisation (NPA, 2014). The Provisional Measures Law on Importation of Specific Kinds of Refined Petroleum Products was abolished in March 2012. In this context, the Japanese Government aims to establish a fair and transparent market in terms of quality and prices, where oil product retailers are able to play an important role as the point of interaction with final consumers.

The number of oil refineries in Japan decreased from 40 in 1996 to 23 in October 2015, and the refining capacity from 5.3 Mbbl/D to 3.9 Mbbl/D (PAJ, 2015).

NATURAL GAS

Demand for natural gas has been increasing rapidly over the past two decades, at an annual rate of 3.2% between 1990 and 2013 (EGEDA, 2015). Natural gas is supplied almost entirely by imports in the form of LNG. Since Japan prioritises a stable and secure supply of LNG, Japanese LNG buyers have generally been paying a higher price than those in Europe or the US under long-term 'take or pay' contracts with rigid terms on volume and price. However, recently, Japanese gas and electric utilities seek to reduce their costs because of the deregulation of the gas and electricity markets. The utilities have been striving to secure LNG supply on flexible terms that enable them to quickly respond to changes in the market situation and supply gas at lower prices. Japan has also been seeking alternative gas supplies; for example, the economy promoted technological developments in the production and processing of methane hydrate, which is abundant in the ocean areas surrounding Japan, and is considered a future energy resource.

Japan will reform the domestic gas market. The Fourth Strategic Energy Plan states that the period from 2014 to 2018–20 is devoted to reforming the electricity and gas systems to build a more liberalised and competitive energy market. Accordingly, amendments to the Gas Business Act were enacted in June 2015 to fully liberalise the retail market by about 2017, and legally unbundle the gas pipes owned by three city gas utilities, Tokyo Gas, Osaka Gas and Toho Gas, by April 2022 (METI, 2015b).

COAL

In 2013, coal accounted for 25% of the total primary energy supply. Coal will continue to play an important role in Japan's energy sector, mainly for power generation and iron, steel, cement, and paper and pulp production. Japan is the second-largest coal importer in the world, after China, accounting for about 14% of the total global coal imports in 2013[4] (IEA, 2015).

[4] Note that in 2014, India's coal imports exceeded that of Japan, making the latter the third-largest coal importer in the world.

ELECTRICITY MARKET

Electricity was the second-largest contributor, after the petroleum industry, to the total final energy consumption in 2013. The increased use of electrical appliances in homes, widespread use of personal computers and related information technology in offices and a shift in the industry structure to more services-based sectors has driven the steady increase in electricity consumption in recent years.

Japan has been partially liberalised to ensure fair competition and transparency (METI, 2002). However, after the earthquake and the subsequent Fukushima Daiichi nuclear power accident, the Japanese electricity sector faces a mounting pressure to further deregulate the market for more competitive and transparent electricity supply. To reform the market, the Electricity Business Act was amended in 2013, 2014 and 2015 (METI, 2015b). This reform focuses mainly on three stages: 1) establishing the Organisation for Cross-regional Coordination of Transmission Operators (OCCTO) in April 2015; 2) full retail competition from April 2016; and 3) legal unbundling of the transmission/distribution sector from 2020 and transition to overall liberalisation of retail price after the unbundling. In order to avoid a monopoly situation after retail liberalisation in 2016, retail tariffs of designated utilities will be regulated as a transitional measure, and then gradually deregulated at the same time as or after the legal unbundling.

FISCAL REGIME AND INVESTMENT

The Japanese Government recognises the necessity of encouraging domestic petroleum companies to obtain upstream oil and gas equities overseas. JOGMEC offers technical support to domestic petroleum companies in areas such as geological structure studies and mining technologies. In addition, both JOGMEC and the Japan Bank for International Cooperation (JBIC) offer financial support to companies.

In the short term, the government intends to concentrate on financial support for existing upstream projects to assist with start-up and continuation. In the mid-term, the government will continue to appropriately support domestic petroleum companies by borrowing money in the market with government guarantees and building a flexible and effective finance system through JOGMEC, with the objective of reducing geopolitical and technical risks for future projects.

ENERGY EFFICIENCY

The Energy Conservation Law 1979, established after the oil crises, is the basis of all energy conservation policies in Japan. It requires improving the energy efficiency of the industrial, consumer (commercial and household), and transport sectors. Japan has improved its energy efficiency by approximately 40% after the crises. The Energy Conservation Law 1979 was partially amended in May 2013. The amendment includes the expansion of the top-runner program. In addition to energy consuming items, those that do not consume energy but rather contribute to high efficiency or energy conservation, such as building insulation materials, were added to this program.

In 2014, the revised Strategic Energy Plan set the following initiatives (METI, 2014):

- Enhancing Japan's energy efficiency (already at the highest level in the world) by introducing the most advanced technologies for replacing equipment in the industrial sector;
- Enhancing support and regulatory measures (including the top-runner program) to increase the adoption of highly efficient equipment in each sector. Expanding the coverage of the program; which now includes industrial refrigerators, printers, heat pumps, LED lamps as well as building insulation materials;
- Replacing 100% of the lighting with high-efficiency lamps (including LED and organic electro-luminescence [EL] lighting) on a flow basis by 2020 and stock basis by 2030;
- Achieving net zero energy with regard to a newly constructed public building by 2020, and all newly constructed buildings on average by 2030;
- Raising next-generation vehicles' share of new vehicle sales to 50% to 70% by 2030 while promoting comprehensive measures, including improving traffic flow such as introducing Intelligent Transportation Systems (ITS); and
- Facilitating introduction of the energy management system, such as BEMS (Building Energy Management System), and encouraging the acquisition of the certification of the ISO 50001 standard.

RENEWABLE ENERGY

Japan has a system of Feed-in Tariffs (FiT). In August 2011, the Act on Purchase of Renewable Energy-Sourced Electricity by Electric Utilities was passed by the Diet (the Japanese Parliament). This Act took

effect on 1 July 2012. It obliges electric utilities to purchase electricity generated from renewable energy sources (solar photovoltaic, wind power, small and medium-sized hydropower, geothermal and biomass) based on fixed-period contracts with fixed prices. Table 4 shows the prices for the FiT in fiscal year[5] (FY) 2015. Solar power prices were reduced from the FY 2014 levels (METI, 2015c).

Table 4: Prices for feed-in tariff in FY 2015

Renewable Energy		Prices (JPY per kWh)[a]	Years
Solar	Over 10 kW	31.3[b]/29.2[c]	20
	Less than 10 kW	33.0/35.0[d]	10
	Less than 10 kW (Double generation)	27.0/29.0[d]	10
Onshore wind	Over 20 kW	23.8	20
	Less than 23 kW	59.4	20
Offshore wind		38.9	20
Hydro	From 1 000 kW to 30 000 kW	25.9	20
	From 200 kW to 1 000 kW	31.3	20
	Less than 200 kW	36.7	20
Geothermal	Over 15 000 kW	28.1	15
	Less than 15 000 kW	43.2	15
Biomass	Methane fermentation gasification	42.1	20
	Unused woods	34.6	20
	General woods	26.0	20
	Waste (excluding woods)	18.4	20
	Recycled woods	14.0	20

Note: a. 8% tax is included; b. From April to June 2015; c. After July 2015; d. Solar PV, approved for grid connection in Hokkaido, Tohoku, Hokuriku, Chugoku, Shikoku, Kyusyu and Okinawa areas after April 2015, is obliged to be installed with suppression control system. Higher purchase prices are applied to this case.
Source: METI (2015c).

Costs incurred by the utilities in purchasing renewable energy-sourced electricity shall be transferred to all electricity customers, who will pay a surcharge for renewable energy at a rate proportional to their electricity usage. Surcharge for renewable energy is calculated as follows since May 2015 (METI, 2015c):

Surcharge for renewable energy=Monthly electricity consumption (kWh) ×1.58 JPY/kWh

FiT rates and contract periods are to be determined according to factors such as the type, form of installation and scale of renewable energy sources. Contract rates and periods shall be reviewed and set every year by METI, and are based on the recommendations of an independent committee in the ministry.

Table 5 shows the installed generation capacity for each renewable source of energy after the introduction of the FiT (METI, 2013; METI, 2015d). Three years after the introduction of the FiT, in total, 88 023 megawatts (MW) of renewable capacity have been authorised, while the accumulated renewable capacity by the end of June 2012, that is, before the introduction of the FiT, was 20 600 MW. This indicates that if all the authorised capacity is installed, the generation capacity based on renewable energy becomes more than five times since the introduction of the FiT. Non-residential solar PV shows a boom in Japan; its installed capacity and authorised capacity amounting to 17 453 MW and 78 527 MW, respectively, accounting for 81% of the newly installed capacity after the FiT introduction, and 89% of the authorised capacity. Start-up renewable capacity is 21 560 MW, only 24% of the authorised capacity.

[5] Fiscal year starts from April in Japan.

Table 5: Installed generation capacity by renewable energy after introduction of FiT (MW)

	Introduced and Start-up Capacity		Authorised Capacity
	Before FiT	After FiT	After FiT
	Accumulated capacity by the end of June 2012	July 2012–June 2015	July 2012–June 2015
Solar (Residence)	4 700	3 324	3 952
Solar (Non-residence. More than 10 kW)	900	17 453	78 527
Wind	2 600	347	2 344
Medium hydro	9 600	106	662
Biomass	2 300	321	2 465
Geothermal	500	9	71
Total	20 600	21 560	88 023

Sources: METI (2013, 2015d).

NUCLEAR ENERGY

There were 54 nuclear reactors in Japan in 2010, the most recent year before the Fukushima Daiichi Nuclear Power Plant Accident. As of November 2015, the number of reactors decreased to 43 due to decommission of the Fukushima Daiichi Nuclear Power Station[6] and other five reactors[7]: Tsuruga unit 1, Mihama units 1 and 2, Shimane unit 1 and Genkai unit 1. Owners of the five reactors decided the retirements due to the aging of the facilities and the large amount of additional costs to meet the new safety regulations enforced in June 2013.

The year 2014 was the first year without nuclear generation since 1966, when commercial nuclear operations started. After the Ohi units 3 and 4 ceased operations for periodic inspections in September 2013, no nuclear reactors were restarted until August 2015. The Sendai nuclear power plant became the first reactor to restart under the new regulatory scheme. Units 1 and 2 started operations in August and October 2015, respectively. As of December 2015, the NRA has given the final safety approval to Takahama units 3 and 4 and Ikata unit 3.

CLIMATE CHANGE

According to the Kyoto Protocol, Japan was obliged to reduce GHG emissions by 6% on average between 2008 and 2012 from the 1990 level, and the economy has achieved the commitment by reducing 8.4%. In fact, average GHG emissions in Japan during the commitment period increased by 1.4%, from 1 261 million tonnes of CO_2 equivalent to 1 278 million tonnes of CO_2 equivalent, partly due to additional fossil fuel consumption after the earthquake and the subsequent nuclear plant shutdown. However, the carbon sink by forest ecosystems (equivalent to a 3.9% reduction) and the Kyoto Mechanism Credit (equivalent to a 5.9% reduction) contributed to achieving the commitment level (MOE, 2014).

For further emission reductions, Japan introduced the Tax for Climate Change Mitigation since October 2012 (MOE, 2012). This tax is levied on crude oil/oil products, gas and coal. The tax has to be raised in phases; already accomplished in April 2014, and due in April 2016 (Table 5); the tax value will be JPY 289 per tonne-CO_2 for each kind of product from April 2016. Revenue from this tax is used for implementing various measures to promote energy efficiency and renewable energy, as well as the use of clean fossil fuels.

[6] Total six reactors. The reactor owner (Tokyo Electric Power Company) decided to decommission units 1 to 4 in April 2012 and units 5 to 6 in January 2014.
[7] Reactor owners announced in March 2015.

Table 5 Tax for promotion of global warming countermeasures

	October 2012	April 2014	April 2016
Crude Oil/Oil Product (JPY/KL)	250	500	760
Gas (JPY/tonne)	260	520	780
Coal (JPY/tonne)	220	440	670

Source: MOE (2012).

In July 2015, Japan submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC, 2015). The economy decided its emission reduction level based on the government's Long-term Energy Supply and Demand Outlook. Japan's INDC towards post-2020 GHG is at the level of a reduction of 26% by FY 2030 compared to FY 2013 (25.4% reduction compared to FY 2005), equivalent to 1 042 million tonnes of CO_2 in 2030.

NOTABLE ENERGY DEVELOPMENTS

LONG-TERM ENERGY SUPPLY AND DEMAND OUTLOOK AND SUBMISSION OF INDC

As mentioned in the 'Energy Policy Framework' section, in July 2015, the economy concluded its future energy mix in a quantitative manner. The government's outlook aims to ensure the '3E+S' policy where 'Safety' is the foremost condition, and shows a well-balanced power mix. Based on the energy mix, Japan decided its INDC and submitted to UNFCCC (see the 'Climate Change' section).

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USEFUL LINKS

Agency for Natural Resources and Energy—www.enecho.meti.go.jp/en/

Institute of Energy Economics, Japan—eneken.ieej.or.jp

Ministry of Economy, Trade and Industry—www.meti.go.jp/english/index.html

Ministry of the Environment—www.env.go.jp/en/index.html

REPUBLIC OF KOREA

INTRODUCTION

The Republic of Korea is located in north-east Asia between China and Japan. It has an area of 99 538 square kilometres (km²) and a population of 50 million people as of 2013. Korea's population density is very high, with an average of more than 500 people per km². Around 20% of the population lives in Seoul, Korea's capital and its largest city. The economy's geography is largely made up of hills and mountains, with wide coastal plains in the west and the south. The climate is relatively moderate with four distinct seasons. Air conditioning is commonly necessary during the tropical hot summers and buildings need to be heated during the bitterly cold winters.

During the last few decades, Korea has been one of Asia's fastest-growing and most dynamic economies. Gross domestic product (GDP) increased at a rate of 6.5% per year from 1980 to 2013, reaching USD 1 643 billion (2010 USD purchasing power parity [PPP]) in 2013. GDP per capita (2010 USD PPP) income in 2013 was USD 32 711, almost six times higher than in 1980. Korea's major industries include the semiconductor, shipbuilding, automobile, petrochemical, digital electronic, steel, machinery and parts and materials industries.

Korea has few indigenous energy resources. It has no oil resources except a small amount of condensate, only 320 million tonnes of recoverable coal reserves and 5.7 billion cubic metres of natural gas. Thus, in order to sustain its high level of economic growth, Korea imports large quantities of energy products. Korea imported about 84% of its primary energy supply in 2013. In the same year, it was the world's fifth-largest importer of both oil and liquefied natural gas (LNG) and the world's third-largest importer of coal.

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b, c]	
Area (km²)	99 538	Oil (million barrels)	–
Population (million)	50	Gas (billion cubic metres)	5.7
GDP (2010 USD billion PPP)	1 643	Coal (million tonnes)	320
GDP (2010 USD PPP per capita)	32 711	Uranium (kilotonnes U)	–

Sources: a. EGEDA (2015); b. EIA (2015); c. KEEI (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased almost seven-fold between 1980 and 2013 from 38 million tonnes of oil equivalent (Mtoe) in 1980 to 263 Mtoe in 2013. In particular, from 1990 to 2000, energy supply increased at an annual average rate of 7.3%, far exceeding the economic growth rate of 6.5% for the same period. Likewise, per capita primary energy supply grew from 1 tonne of oil equivalent (toe) in 1980 to 5.2 toe in 2013. This increase was similar to that of Japan and most European economies.

In 2013, Korea's total primary energy supply was 263 Mtoe, a 0.1% increase from the prior year. In terms of energy source, oil represented the largest share (37%), followed by coal (29%) and gas (18%). The remaining 16% of the primary energy supply came from nuclear and hydro energy sources. Energy imports accounted for about one-third of Korea's total import value in 2013.

The oil supply in 2013 was 97 Mtoe, a 0.7% decrease from the prior year. In 2013, the economy imported more than 80% of its crude oil from the Middle East. With regard to coal, the supply in 2013 totalled 77 Mtoe, a 1% increase from the prior year. Korea has modest reserves of low-quality, high-ash anthracite coal, which are insufficient to meet its domestic demand. Thus, almost all of Korea's coal demand is met by imports. Korea is the world's fourth-largest importer of steam coal and third-largest importer of coking coal after Japan. The main coal imports come from Australia, Canada, China, Indonesia, Russia and the United States.

Since the introduction of LNG in 1986, natural gas use in Korea has grown rapidly. Gas supply reached 48 Mtoe in 2013. Its share of the primary energy supply was 18% in the same year. Most of Korea's LNG imports come from Qatar, Indonesia, Oman, Malaysia, Brunei Darussalam and Australia. Korea began

producing natural gas domestically in November 2004 after a small quantity of natural gas was discovered in the Donghae-1 offshore field in the south-east.

Korea's electricity generation in 2013 was 538 terawatt-hours (TWh), a 1.3% increase from 2012. Generation by thermal sources, including coal, oil and natural gas, accounted for 72% of the total electricity generated, followed by nuclear at 26% and hydro and others at 1.9%.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	43 423	Industrial sector	45 957	Total power generation	537 891
Net imports and others	233 575	Transport sector	31 343	Thermal	389 095
Total primary energy supply	263 103	Other sectors	44 978	Hydro	4 289
Coal	77 320	Non-energy	43 787	Nuclear	138 784
Oil	96 570	Total final energy consumption	166 065	Others	5 723
Gas	47 618	Coal	7 718		
Others	41 595	Oil	84 923		
		Gas	24 140		
		Electricity and others	49 283		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2013 was 166 Mtoe, which is the same level as the prior year. The industrial sector accounted for the largest share at 28%, while the transport sector accounted for 19%. The remainder (53%) was used in the residential and commercial sector and as non-energy consumption by agriculture and industry, such as for petrochemical feedstock. In general, demand in the industrial sector has weakened since the late 1990s, and demand in the transport and commercial sectors has increased.

By energy source, petroleum products accounted for 51% of total energy consumption, followed by electricity and other (30%), natural gas (15%) and coal (4.7%). Natural gas consumption has increased significantly because of the economy's policy measures.

ENERGY INTENSITY ANALYSIS

The 2.9% growth of Korean GDP in 2013 resulted in a 2.7% decrease in the energy intensity of the economy's total primary energy supply. This is an economy-wide energy intensity level decrease of 4.4 tonnes of oil equivalent per million USD. With regard to final energy demand, the energy intensity level decreased by 2.8% from the 2012 level of 104 tonnes of oil equivalent per million USD to 101 tonnes of oil equivalent per million USD in 2013. Using a per sector analysis, the industrial sector registered the largest reduction in energy use per USD million of GDP from a level of 29 tonnes of oil equivalent per million USD in 2012 to 28 tonnes of oil equivalent per million USD in 2013, a fall of 5%. The transport sector in 2013 had a lower intensity at 19 tonnes of oil equivalent per million USD, an increase of 0.7% from its prior year's level. The energy intensities of the other sectors and for non-energy fell by 3.7% and 2.0% respectively from the 2012 levels.

Table 3: Energy intensity, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	165	160	–2.7
Total final energy consumption	104	101	–2.8
Industry	29	28	–5.0
Transportation	18.9	19.1	0.7
Others	28	27	–3.7
Non-energy	27.1	26.7	–2.0

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In the past, Korea's energy policy has focused on ensuring a stable energy supply in order to sustain economic growth. The government is now seeking a new direction in energy policy with the aim of supporting sustainable development that fully considers the 3Es (energy, economy and environment).

The responsibility for energy policy development and implementation is divided among a number of government institutions. The Ministry of Trade, Industry and Energy (MOTIE), which succeeded the Ministry of Knowledge Economy (MKE) in 2013, is the primary government body for energy policy.

In 2006, the Korean Government established the National Energy Committee, which is chaired by the president and includes governmental and non-governmental experts. The committee's role is to deliberate upon and mediate among major energy policies and plans. In addition, it discusses the National Basic Plan for Energy, emergency preparedness, foreign energy resource development, nuclear energy policy, the coordination of energy policies and projects, the prevention and settlement of social conflict related to energy issues, the transportation of energy and the physical distribution plan, the effective execution of the energy budget and energy issues within the United Nations Framework Convention on Climate Change (UNFCCC).

As part of its liberalisation efforts in the energy sector, in 2001 the government established the Electricity Regulatory Commission to take charge of regulations in the electric power sector and to manage technical and professional competition policy. There is no regulatory commission for the gas industry. The Fair Trade Commission is Korea's anti-trust agency and monitors monopoly problems and unfair business practices in the energy sector.

The Korea Energy Economics Institute (KEEI) develops energy policies related to the production of energy statistics. It also considers policies with regard to demand and supply overviews, energy conservation and climate change, the petroleum industry, the gas industry, the electricity industry, and the new and renewable energy industry among others. It is financed directly by the government.

The Korea Institute of Energy Technology Evaluation and Planning (KETEP), funded by the government, is Korea's major energy technology research institute. Its mission is to contribute to growth across the economy by developing industrial core energy technologies and deploying outcomes.

The Korea Energy Agency (KEA) plays a key role in achieving Korea's research and development (R&D) policy goals for energy efficiency, energy conservation, clean energy, and new and renewable energy technologies. It also administers R&D planning, financial support and management.

In August 2008, faced with high energy prices and rising concerns over climate change, Korea announced a long-term strategy, which will determine the direction of its energy policy until 2030.

On 14 January 2014, Korea launched the Second Energy Basic Plan, which is the main official plan in the energy sector with a timeframe up to 2035 (MOTIE, 2014a). According to the Second Energy Basic Plan, total primary energy demand is projected to grow at an annual average rate of 1.3% between 2011 and 2035. Final energy demand will grow at 0.9% per year. Energy intensity is expected to drop from 0.26 toe per million KRW (toe/million KRW) in 2011 to 0.18 toe/million KRW in 2035 with an improvement of

1.4% per year, resulting in a 30% improvement of energy intensity, which is equivalent to a 13% reduction in final energy consumption.

The government proposes six major policy strategies as follows:

- A move to an energy management-oriented policy;
- Building a power generation system based on distributed generations (DGs);
- Pursuit of harmonisation between the environment and safety;
- Strengthening the energy security;
- Building a stable energy supply according to source; and
- Pursuing an energy policy together with the public.

Heavy dependence on the Middle East for its crude oil supply has led the economy to a policy of diversifying its oil supply during the outlook period. The state-owned Korea National Oil Corporation (KNOC) will continue to be responsible for the economy's preparedness for an oil emergency situation by operating oil stockpiling facilities and pursuing stakes in oil projects around the world.

In the natural gas industry, the state-owned monopoly Korea Gas Corporation (KOGAS) will continue to be responsible for managing the import, storage, transmission and wholesale distribution of LNG. The electricity industry will continue to be dominated by the state-owned Korea Electric Power Corporation (KEPCO). It is possible that there may be stages of restructuring and liberalisation during the outlook period, allowing more private participation in the oil, gas and electricity industries.

ENERGY MARKETS

MARKET REFORM

Korea has been restructuring its energy sector since the late 1990s when it introduced the principle of free competition in industries traditionally considered natural monopolies, such as electricity and natural gas. In January 1999, in a move to phase in competition in the electricity industry, the government announced the Basic Plan for Restructuring the Electricity Industry. The plan included the unbundling and privatisation of Korea's state-owned electricity monopoly, KEPCO.

Part of the plan has been implemented, including the establishment of the Korea Power Exchange and the Korea Power Commission in April 2001. The power generation part of KEPCO was split into six wholly owned companies—five thermal generation companies and the Korea Hydro & Nuclear Power Company Limited. The five thermal generation companies were to be privatised in stages. However, in July 2008, the government announced there would be no further privatisation of KEPCO and its five subsidiaries. At the end of 2015, 51% of KEPCO, as a holding company, was owned by the Korean Government. KEPCO is still a dominant player in the electricity sector, controlling 87% of total power generation and 100% of transmission and distribution in Korea (KEEI, 2014).

The Korean Government has also made moves to restructure the gas industry. In November 1999, the government sold 43% of its equity in KOGAS and developed the Basic Plan for Restructuring the Gas Industry to promote further competition in the industry. The plan outlines a scheme to introduce competition into the import and wholesale gas businesses, promote the development of the gas industry and enhance consumer choice and service quality. A detailed implementation plan was announced in October 2001. The plan covers ways in which to achieve the smooth succession of the existing import and transportation contracts, the privatisation of import and wholesale businesses, the stabilisation of prices and the balance of supply and demand, and the revision of related legislation and enforcement (KEEI, 2002).

With regard to competition in the import and wholesale sectors of KOGAS, a final decision on whether to split the sectors from KOGAS or to introduce new companies will be made following discussions among stakeholders. Given the strong public interest in this sector, the existing public utility system is expected to be maintained. Competition in the retail sector, which is currently operated under a monopoly system within each region, will be introduced in stages, in conjunction with the progress made in the wholesale sector. As of the end of 2011, no decision on the liberalisation of the gas market had been made.

OIL, GAS AND ELECTRICITY MARKETS

OIL

Because of Korea's dependence on oil imports, the government has been trying to secure supplies for the short and long terms. To ease short-term supply disruptions and to meet International Energy Agency (IEA)

obligations, the Korean Government has been increasing its oil stockpile since 1980. At the end of 2013, Korea held 187 million barrels in strategic reserves. This economy-wide stockpile capacity substantially exceeds the IEA's 90-day requirement.

The state-controlled KNOC has been actively exploring and developing oil and gas, both locally and abroad, in order to improve energy security. As of the end of February 2011, it was conducting 191 projects in 25 countries. Private companies (including SK, GS Caltex, S-Oil and Hyundai Oil Bank) are also active in the oil and gas sector, as well as the downstream market and wholesale import areas.

In order to encourage private companies to invest in development projects overseas, the Korean Government has expanded its policy of supplying long-term, low-interest loans through the Special Account of Energy and Resources.

Korea has also been trying to diversify its crude oil supply sources. The number of source countries increased from nine in 1980 to 29 in 2004; however, the economy's dependency on oil imports from the Middle East remains high (86% in 2013). Korea is also actively strengthening its bilateral relations with oil-producing economies as well as its multilateral cooperation through the IEA, the Asia-Pacific Economic Cooperation (APEC) forum, the Association of South-East Asian Nations (ASEAN)+3, the International Energy Forum and the Energy Charter in order to enhance its crisis management capabilities. In particular, the government plans to play a leading role in energy resource development and trade in north-east Asia by creating a collaborative framework on energy cooperation.

NATURAL GAS

In order to reduce the economy's dependence on imported oil, Korea introduced natural gas-based city gas to the residential sector in the 1980s. Since then, gas use has grown rapidly and has replaced coal and oil in the residential sector. KOGAS has a monopoly over Korea's natural gas industry, including the gas import, storage, transport and wholesale businesses. Thirty-two city gas companies operate in the gas retail business in each region of the economy. Not only is KOGAS the world's largest LNG buyer, it also promotes the development of natural gas resources abroad in such countries as Australia, Canada and Iraq.

The Twelfth Plan for Long-Term Natural Gas Demand and Supply, finalised by MOTIE in December 2015, projected natural gas demand would decrease by 0.34% per year from 2014–29 (MOTIE, 2015b). By sector, the city gas sector's demand for natural gas is projected to increase by 2.1% per year, while the demand for gas for power generation is projected to decrease by 4.2% per year.

The Korean Government is considering new regulatory reforms on sales restrictions for private LNG importers and on using storage facilities in the duty-free zone in order to facilitate international trading businesses.

ELECTRICITY

Because of Korea's economic growth, electricity consumption has risen substantially over the past few decades. Throughout the 1990s, the average annual growth rate was 9.5%. Then, between 1990 and 2013, installed capacity increased by more than four from 21 gigawatts (GW) in 1990 to 87 GW in 2013.

The Seventh Electricity Demand and Supply Basic Plan (2015–29), finalised by MOTIE in July 2015, projects that electricity demand will grow by 2.1% per year from 2015 to 2029 and that additional capacity of 49 GW will be required by 2029 (MOTIE, 2015a). When decommissioning is taken into account, this translates to about 137 GW of total generation capacity for this period.

Korea's electricity industry is dominated by KEPCO. KEPCO was separated into six power generation subsidiaries in April 2001: Korea Hydro & Nuclear Power, which owns the economy's nuclear-energy power plants and large hydroelectric dams, and five state-owned generating companies, which took over ownership of the economy's thermal power plants. KEPCO retained the economy-wide transmission and distribution grids.

In order to rectify an energy supply and demand structure that is overly dependent on oil, the construction of oil-fired power plants has been strictly controlled and the development of nuclear, coal and natural gas electricity generation units has been promoted. Gas-fired power plants were first introduced in 1986. During the period of the Seventh Basic Plan, 13 nuclear-energy power plants, 20 coal-fired power plants and 14 gas-fired power plants are planned for construction. Korea has been building nuclear-energy power plants since the 1970s because nuclear energy is a strategic priority for the government. The share of total electricity production capacity in terms of nuclear-energy power plants is projected to increase to 24% in 2029.

FISCAL REGIME AND INVESTMENT

In December 2009, the Korean Government approved tax reforms in order to foster a business-friendly environment and to promote investment. The tax changes included a reduction in corporate tax rates and an increase in tax benefits for R&D.

In 2009, the corporate tax rate was 22% on taxable income over KRW 200 million and 13% on taxable income below that amount. Under the tax reforms, these rates were scheduled to be reduced further from 22% in 2009 to 20% in 2010, and from 11% to 10% for the same period respectively. The tax reduction for the lower bracket was implemented as scheduled, while the implementation for the higher bracket was delayed. Since 2012, the corporate tax rate has been 22% on taxable income over KRW 20 billion, 20% on between KRW 200 million and KRW 20 billion, and 10% on taxable income below that KRW 200 million.

In order to promote investment in R&D, which will boost economic growth, the government has increased its tax assistance for R&D. The measures include an R&D reserve fund, an increase in investment tax credits for R&D facilities and an increase in the deduction for R&D grants paid by corporations to universities from 50% to 100%.

ENERGY EFFICIENCY

The Korean Government has introduced various policy measures in order to improve energy efficiency, including energy-demand management schemes for end users, adjustment of the energy pricing system and the provision of incentives for companies to invest in energy efficiency. These policy measures aim to improve energy efficiency by 8.7% by 2017 compared with 2012 and to save 9.3 Mtoe in 2017. Announced in December 2014, the measures are part of Korea's long-term energy plan, which aims to achieve a 1.4% annual energy efficiency improvement by 2035, compared with 2011.

RENEWABLE ENERGY

In September 2014, the Korean Government announced the Fourth National Basic Plan for New and Renewable Energy (MOTIE, 2014c). According to the plan, the Korean government plans to provide 11% of total primary energy supply with new and renewable energy (NRE) by 2035. The development of solar and wind power as main energy sources will also enable 13% of total electric energy in Korea to be supplied by NRE by 2035.

CLIMATE CHANGE

On 15 August 2008, a new Low Carbon, Green Growth vision for Korea was announced. The vision aimed to shift the traditional development model of fossil fuel-dependent growth to an environmentally friendly model.

In order to realise this vision, the Presidential Commission on Green Growth was established in February 2009. The Basic Act on Low Carbon and Green Growth was subsequently submitted and took effect in April 2010. This legislation provided the legal and institutional basis for green growth. In order to implement the vision of green growth more effectively, the National Strategy for Green Growth was adopted in June 2009 together with the Five-Year Plan for Green Growth in June 2014.

The National Strategy for Green Growth calls for the construction of a comprehensive, long-term (2009–50) master plan in order to address the challenges caused by climate change and resource depletion. The strategy consists of three main objectives and ten policy directions:

- Mitigation of climate change and achievement of energy independence
  - Effective reduction of greenhouse gas emissions (MKE, 2009)
  - Reduction in fossil fuel use and the enhancement of energy independence
  - Strengthening the capacity to adapt to climate change.
- Creation of new engines for economic growth
  - Development of green technologies (KEEI, 2010a)
  - Greening of existing industries and the promotion of green industries
  - Advancement of industrial structure
  - Engineering a structural basis for the green economy (KEEI, 2010b).
- Improvement in the quality of life and enhanced international standing
  - Greening the land and water, and building a green transportation infrastructure

- Building the green revolution into people's daily lives
- Becoming a role model for the international community as a green growth leader.

NOTABLE ENERGY DEVELOPMENTS

CLEAN ENERGY/ENERGY EFFICIENCY

NEW BUSINESS MODELS IN ORDER TO RESPOND TO CLIMATE CHANGE

In July 2014, MOTIE introduced six new energy-related businesses, based on emerging business models, in order to reduce CO_2 emissions and increase energy efficiency (MOTIE, 2014b). MOTIE also established the Energy Efficiency and Climate Change Bureau for more efficient policy support. Plans for R&D in related technology and regulation reforms were announced in December 2014 and April 2015 (Government of Korea, 2014 and 2015).

The six business models are:

1. A demand management service, which collects electricity saved from buildings and factories using electricity-saving devices and sells it to the electricity trading market.
2. An integrated energy management service, which connects finance, insurance and an energy management system (EMS) and also provides system maintenance for companies.
3. An independent micro-grid, which replaces diesel generators with NRE generators and an electricity storage system (ESS).
4. Photovoltaic equipment rental, which lends photovoltaic equipment to households and receives payment through electricity gains.
5. A recharging service for electric vehicles, which provides paid recharging.
6. Used-heat recycling from thermal power plants, which utilises used heat in diversified farming.

These business models focus on reducing the demand for fossil-fuel electricity and on increasing R&D investment in order to develop related technologies such as carbon capture and storage (CCS), ESSs and EMSs.

KOREA'S MITIGATION TARGET AND ITS AMBITION

In June 2015, the Korean Government announced its Intended Nationally Determined Contribution (INDC) towards achieving the objective of Article 2 of the UNFCCC. Korea plans to reduce its greenhouse gas (GHG) emissions by 37% from the business-as-usual (BAU 850.6 $MtCO_2$ eq.) level by 2030 across all economic sectors, based on the BAU projection of the Korea Energy Economics Institute and Energy and GHG Modelling System (KEEI-EGMS).

Korea accounts for approximately 1.4% of global GHG emissions, including land use, land-use change and forestry (LULUCF), according to CAIT of the World Resources Institute (WRI). Korea's mitigation potential is limited because of its industrial structure, which comprises a large share of manufacturing (32% as of 2012), and the high-energy efficiency of its major industries. Further, given the decreased level of public acceptance following the Fukushima accident, there are now limits to the extent that Korea can make use of nuclear energy, one of the major mitigation measures available to it.

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USEFUL LINKS

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Korea Energy Economics Institute—www.keei.re.kr

Korea Energy Agency—www.energy.or.kr

Korea Gas Corporation—www.kogas.or.kr

Korea National Oil Corporation—www.knoc.co.kr

Ministry of Trade, Industry and Energy—http://english.motie.go.kr

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World Resources Institute (CAIT Climate Data Explorer)—http://cait.wri.org

MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia. It has a total territory of approximately 330 803 square kilometres (km^2), covering the states in the Peninsular Malaysia, Sabah and Sarawak on the island of Borneo, and the Federal Territories of Kuala Lumpur, Putrajaya and Labuan. Kuala Lumpur is the capital of Malaysia, while Putrajaya is the seat of the federal government (EPU, 2013). In 2013, Malaysia's population stood at 29.5 million, an increase of 1.5% from the 2012 level of 29.2 million (EGEDA, 2015).

Malaysia's gross domestic product (GDP) reached USD 658 billion (2010 USD purchasing power parity [PPP]) in 2013, an improvement of 4.7% from USD 628 billion in 2012. This represented a 3.2% improvement in GDP per capita from USD 21 638 in 2012 to USD 22 321 (EGEDA, 2015). The largest contributions to GDP were from services (55%) and manufacturing (25%) (MOF, 2015). In 2014, the main export products were electrical and electronic (E&E) products (approximately 33% of total exports), petroleum products (9.2%) and liquefied natural gas (LNG) (8.4%) (MATRADE, 2015).

When compared with other large economies in the Asia-Pacific Economic Cooperation (APEC), Malaysia's energy resources can be considered moderate in absolute terms. A 2013 survey shows that the East Malaysian states hold nearly two-thirds of Malaysia's energy reserves; the rest are located in Peninsular Malaysia. The economy's oil reserves (including condensate) were 5.9 billion barrels, 40% of which is found in Peninsular Malaysia (the Malay basin). The abundant natural gas reserves of the economy are estimated at approximately 98 trillion cubic feet (Tcf), with nearly half found in the Sarawak basin. The coal reserves, assessed at 1.9 billion tonnes, are located mostly in Sarawak and Sabah (EC, 2014a).

Located near the equator, where sunshine is abundant, Malaysia has huge potential to develop solar power albeit the cloudy appearance that constantly manifest the region. It also has huge potential for biomass although the logistical network connectivity has been far from perfect. As of 2013, Malaysia accounts for 39% of world palm oil production and 44% of world palm oil exports (MPOC, 2015). The production creates abundant agricultural residue, particularly empty fruit bunches.[8]

Table 1: Key data and economic profile, 2013

Key data[a, b]		Energy reserves[c]	
Area (km^2)	330 803	Oil (billion barrels)	5.9
Population (million)	29.5	Gas (trillion cubic metres)	2.8
GDP (2010 USD billion PPP)	658	Coal (million tonnes)	1 938
GDP (2010 USD PPP per capita)	22 321	Uranium (million tonnes)	–

Sources: a. EPU (2013); b. EGEDA (2015); c. EC (2014a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 81 100 kilotonnes of oil equivalent (ktoe) in 2013, an increase of 5.9% from the 2012 level of 76 621 ktoe. Natural gas contributed the largest share at approximately 41% (33 223 ktoe), followed by oil with 39% share (31 648 ktoe) and coal with a 19% share (15 290 ktoe). Other resources include hydro, which in 2013 provided a minimal share of approximately 1% (939 ktoe) to the primary energy supply (EGEDA, 2015).

Among the primary energy sources, coal demand decreased by more than 3% over 2012–13. Gas demand increased by more than 3% and oil showed significant growth of more than 16%. The completion of several oil storage facilities, which began operations in 2013, is responsible for the large growth in the demand for oil. Oil storage is part of a government initiative to improve Malaysia's position as an oil-trading

[8] The process of palm oil production generates large amounts of residue, such as empty fruit bunches (EFBs) of palm. EFBs are a type of woody biomass with a calorific value of 4 400 kilocalories per dry kilogram (kcal/kg-dry); they are regarded as a safe and promising biofuel resource because they have a very low chlorine content (Asia Biomass, 2009).

hub and to increase the level of energy security. It is expected that Malaysia will have cumulative oil storage capacity of approximately 10 million cubic metres by 2020 (EC, 2014a).

Traditionally, Malaysia has been an energy exporter of mainly crude oil, LNG and natural gas. Malaysia registered total energy exports of 27 323 ktoe in 2013, a decrease of 0.8% from the 2012 level of 27 541 ktoe. Over the same period, total energy imports increased by nearly 30% from 20 493 ktoe to 26 601 ktoe (EC, 2014a). Most of the increase occurred in the oil sector, probably because of the new oil storage facilities, which were completed in 2013. Malaysia is the second-largest exporter of LNG in the world and the second-largest producer of crude oil and natural gas in South-East Asia (EIA, 2014).

OIL

Malaysia's oil reserves are the fourth largest in the Asia-Pacific region and are mostly in offshore fields. Malaysia's continental shelf is divided into three producing basins, namely the offshore Malay basin in Peninsular Malaysia in the west and the Sarawak and Sabah basins in the east. The bulk of the oil reserves are located in the Malay basin, which produces light and sweet crude oil (EIA, 2014). Malaysia's average daily oil production was 575 thousand barrels per day in 2013, approximately 80% of which were crude oil while the rest were condensates. In 2013, the Malay basin yielded almost 43% of total oil production, followed by Sarawak with 32% and Sabah with approximately 25% (EC, 2014a).

Malaysia has five oil refineries with a combined capacity of 566 million barrels per day (Mbbl/D) (including condensate splitter capacity). Petroliam Nasional Berhad (PETRONAS), the state-owned national oil company, has three refinery facilities that provide more than 50% of total daily refinery production. Petrol and diesel accounted for approximately 80% of total domestic sales of petroleum products in 2013. In the same year, Malaysia imported a total of 19 383 ktoe of petroleum products, an increase of approximately 39% from the 2012 level, in order to meet the growing domestic requirement (EC, 2014a).

As aforementioned, the Malaysian Government, arising from the Economic Transformation Programme, embarked on a large scale oil and gas project in the southern Peninsular Malaysia which is called as Pengerang Integrated Petroleum Complex (PIPC). PIPC is divided into two mega-projects - Pengerang Independent Deepwater Petroleum Terminal (PIDPT) undertaken by private companies and Refinery and Petrochemical Integrated Development (RAPID) Project that involves PETRONAS as the major developer. Because of the size of the project, Platts, a provider of energy information that produced the Free on Board (FOB) Singapore oil benchmark price for the oil trade, will expand the price benchmarking scope to include oil storage terminals from Malaysia and rename it FOB Straits (Platts, 2015a).

NATURAL GAS

Most of the gas reserves of Malaysia are offshore in Peninsular Malaysia in the eastern areas, Sarawak and Sabah. Most of the gas reserves are non-associated (83%), while the remaining reserves are associated with oil basins (17%). Sarawak hosts slightly more than half of the total reserves, followed by Peninsular Malaysia with 36% and Sabah with 13%. In 2013, the average daily natural gas production was 6 730 million standard cubic feet per day (MMscf/D), an increase of approximately 3.2% from the 2012 level of 6 521 MMscf/D (EC, 2014a). Most of the production came from Sarawak with a 63%. Peninsular Malaysia had a 31% share and Sabah had a 6.3% share. In order to meet local demand, Malaysia imported gas via pipelines from the Malaysia-Thailand Joint Development Area (MT-JDA) and Indonesia (EC, 2013). Year of 2013 marked an historical year for Malaysia for the importation of LNG. Although Malaysia is one of the world's largest LNG exporters, a geographical mismatch between where the gas is produced (Sabah and Sarawak) and the regions of highest demand (Peninsular Malaysia) prompted Malaysia to build a regasification terminal (RGT) to facilitate the importation of LNG. In 2013, Malaysia imported approximately 1 450 ktoe of LNG (EC, 2014a).

Malaysia has an extensive gas pipeline network running through Peninsular Malaysia with pipelines connected to offshore fields on the east coast of Peninsular Malaysia. The Peninsular Gas Utilisation (PGU) network, which started in 1984, covers more than 2 500 km of pipelines composed of main pipelines, supply pipelines and laterals, which link most cities in Peninsular Malaysia. The pipelines also have cross-border interconnections to Singapore and Songkhla, Thailand. The PGU network comprises of six gas-processing plants with a combined capacity of 56 million cubic metres per day (mcm/d) (2 000 MMscf), producing methane, ethane, butane and condensate (Gas Malaysia, 2015a).

Malaysia has extensive LNG export facilities and contributed approximately 10% of the world's LNG exports, equivalent to 25 Mt per year. In 2013, Japan remained the largest importer of Malaysia's LNG with approximately a 61% share, followed by Korea, Chinese Taipei and China with export shares of 16%, 12% and 11% respectively (IGU, 2015).

In order to boost the oil and gas reserves, PETRONAS is intensifying efforts in deepwater exploration. According to Bank Pembangunan Malaysia Berhad, Malaysia has approximately 615 100 km² of acreage available for oil and gas exploration. In 2011, production-sharing contracts (PSCs) covered 36% of the total acreage, leaving almost two-thirds of the area available for exploration (BPMB, 2012). This indicates the potential for PETRONAS to expand existing proven hydrocarbon reserves. This was demonstrated in April 2015 with an oil discovery at the Bestari-1 exploration well in Deepwater Block R in Sabah (INPEX, 2015).

COAL

Malaysia's coal resources mostly consist of bituminous and sub-bituminous coal. Estimated reserves are approximately 1 938 Mt, which are found in Sabah and Sarawak. Even with substantial coal resources, domestic coal production has not been that aggressive because most of the coal deposits are far inland, which makes extraction costs high. Likewise, some areas have been declared protected areas, such as the Maliau Basin in Sabah, thereby prohibiting coal-mining activities. Only Sarawak has coal-mining activity. The areas are Kapit (the largest producing coal basin) with 2 006 765 metric tonnes of production in 2013, Sri Aman with 776 586 metric tonnes and Mukah with 110 611 metric tonnes (EC, 2014a).

Of total coal consumption, approximately 90% was consumed by the power generation sector, while the remainder was consumed by the iron, steel and cement industries. Malaysia imports coal from Australia, Indonesia, South Africa and, recent years, Russia in order to meet its growing requirements. (EC, 2013).

According to IEA Energy Statistics 2014, Malaysia ranked as the ninth-largest coal importer in the world in 2013 with coal consumption reaching more than 20 Mt (IEA, 2014). This reflects a rapid expansion of coal generation capacity, especially during 2000–13 when coal consumption in the power sector increased from 1.5 million tonnes of oil equivalent (Mtoe) to 14 Mtoe. Coal generation capacity expanded in order to meet increasing electricity demand and reduce dependence on natural gas, which previously dominated generation with a share as high as 70% in the 1990s (EC, 2014a). Although Malaysia has 1.9 billion tonnes of proven coal reserves, most deposits are of poor quality (high ash content etc.) and located in protected areas such as national parks in Sabah and Sarawak. With limited options to extract sufficient domestic coal in order to meet demand, Malaysia has become highly dependent on coal imports.

ELECTRICITY

There are three major electricity grids in Malaysia. The national grid in Peninsular Malaysia and the Sabah grid are both regulated by the federal government; the Sarawak grid is under the responsibility of state government. The national grid is connected to Thailand's grid to the north (with the capacity for power transfer of 380 megawatts (MW)) and to Singapore's main grid to the south (with the capacity for power transfer of 450 MW) (HAPUA, 2015). The Sarawak grid is connected to the Kalimantan grid in Indonesia. Capacity is expected to reach 50 MW by the end of 2015 (SEB, 2015).

Malaysia's total installed power generation capacity in 2013 was recorded at 29 748 MW, an increase of approximately 2% from the 2012 level of 29 143 MW. Such an increase in installed capacity was attributed to the additional capacity of 600 MW from the Bakun hydro project in Sarawak (Bakun hydro project total installed capacity is 2 400 MW). Approximately 60% of total installed capacity was owned by the independent power producers (IPPs) and the rest by government-linked utilities, self-generation facilities and cogeneration facilities (EC, 2015a).

In the same year, total electricity generation was 138 330 gigawatt-hours (GWh), an increase of approximately 3% from the 2012 level. Thermal generation, mostly from natural gas and coal, accounted for 91% of total power generation, while hydropower accounted for the remainder (EGEDA, 2015).

FINAL ENERGY CONSUMPTION

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	91 528	Industry sector	13 638	Total power generation	138 330
Net imports and others	–6 387	Transport sector	19 751	Thermal	126 472
Total primary energy supply	81 100	Other sectors	8 450	Hydro	10 586
Coal	15 290	Non-energy	6 945	Nuclear	–
Oil	31 648	Total final energy consumption	48 784	Others	1 272
Gas	33 223	Coal	1 538		
Others	939	Oil	26 775		
		Gas	9 886		
		Electricity and others	10 585		

Note: For full details of the energy balance table, see www.ieej.or.jp/egeda/database/database-top.html.
Source: EGEDA (2015).

In 2013, Malaysia's final energy consumption reached 48 784 ktoe, an increase of 9.3% from the 2012 level. The transport sector was the biggest energy consumer, overtaking the industrial sector and accounting for a 41% share of the total final energy consumption or approximately 19 751 ktoe. It was followed by the industry sector with a 28% share or 13 638 ktoe, the non-energy sector with a 14% share or 6 945 ktoe, and other sectors with a share of 17% or 8 450 ktoe (EGEDA, 2015).

In 2013, in terms of fuel type, oil was still the most consumed fuel, particularly for the transport sector, accounting for approximately 55% of total energy demand. This was followed by gas with a 20% share, electricity with a 22% share and coal with a 3% share. Oil consumption increased by nearly 18% to 26 775 toe in 2013 from 22 716 toe in 2012. However, natural gas and coal consumption decreased by 2.5% and 12% respectively (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

Because the primary energy supply growth rate stood at 5.9% while the economy's real GDP growth (2010 USD PPP) was 4.7% in 2013, primary energy intensity in Malaysia increased by 1.1% from 122 tonnes of oil equivalent per million USD (toe/million USD) in 2012 to 123 toe/million USD in 2013. Final energy demand intensity increased 4.4% from 71 toe/million USD in 2012 to 74 toe/million USD in 2013 (EGEDA, 2015).

The transportation sector showed a large increase of nearly 25% from 24 toe/million USD in 2012 to 30 toe/million USD in 2013. At the same time, a large reduction of nearly 15% in final energy intensity can be seen in the industry sector (EGEDA, 2015). One of the reasons behind the unusual high growth rate of final energy intensity in the transportation sector is because the data collected from the oil companies were based on sales, which may include sales for oil storage purposes.[9]

However, based on Malaysia's National Energy Balance 2013, final energy consumption reached 51 583 ktoe, an increase of 10.4% from 2012 (46 711 ktoe). This led to a decrease in final energy consumption intensity by 0.08% from 76.9 toe/million USD in 2012 to 76.8 toe/million USD in 2013 (EC, 2014a).

[9] Data from the Malaysian Automotive Association shows that total vehicle sales in 2013 increased by 4.5% from 2012, while in 2012, total vehicle sales increased at a slightly higher rate of 4.6% from the 2011 level. A further check with Malaysian officials confirmed that the data for final energy in the transport sector need to be readjusted in the future.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	122	123	1.1
Total final energy consumption	71	74	4.4
Industry	24	21	–15
Transportation	24	30	25
Others	12.9	12.8	–0.6
Non-energy	9.6	10.6	9.7

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Malaysia's National Energy Policy, which was first formulated in 1979, serves as the overall framework for the development of the energy sector. It consists of the following three principal objectives.

- The supply objective: To ensure the provision of an adequate, secure and cost-effective supply of energy through the development of indigenous energy resources and the diversification of energy supply from domestic and international sources.
- The utilisation objective: To promote the efficient utilisation of energy and discourage wasteful and non-productive patterns of energy consumption.
- The environmental objective: To minimise the negative impacts of energy production, transportation, conversion, utilisation and consumption on the environment (KeTTHA, 2015).

This policy has been instrumental in the development of Malaysia's energy sector. Subsequent policies are designed to support these objectives and their implementation.

In 1980, the National Depletion Policy was enacted in order to safeguard and preserve Malaysia's energy resources, particularly its oil and gas resources. Under this policy, the total annual production of crude oil should not exceed 3% of 'oil initially in place'. In effect, this limits the production of crude oil to 650 thousand barrels per day. The policy also extended to the production of natural gas, imposing a limit of 2 000 MMscf/D in Peninsular Malaysia (UNPAN, 1999).

A year later, Malaysia introduced the Four-Fuel Diversification Policy in order to expand the fuel mix for power generation. Initially, the focus of the policy was to reduce the economy's dependence on oil as the dominant energy source. The scope of the Four-Fuel Diversification Policy was further expanded in 2001 through the implementation of the Five-Fuel Diversification Policy, which incorporated renewable energy (RE) (e.g. biomass, solar and mini-hydro) as the fifth fuel (KeTTHA, 2015).

In support of the Five-Fuel Diversification Policy, the National Biofuel Policy was launched in 2006 and the National Renewable Energy Policy and Action Plan (NREPAP) was introduced in 2010 as the policy framework to advance the development of indigenous RE and expand its contribution to the power generation mix. The NREPAP provides long-term goals and a holistic approach for the sustainable development of RE. (SEDA, 2011)

The RE power capacity is expected to increase to 2 080 MW (11 GWh) by 2020 contributing 7.8% to the total power generation mix (EPU, 2015).

In May 2015, the government launched the Eleventh Malaysia Plan 2016–20 as the final stage in the journey towards realising Vision 2020, a long-term development plan launched in 1991 that envisions Malaysia as a fully developed economy, across all dimensions, by 2020.[3] Six strategies are outlined in the Eleventh Malaysia Plan. These include pursuing green growth for sustainability and resilience, and strengthening the infrastructure in order to support economic expansion, both of which have implications for energy initiatives (EPU, 2015).

In the past, the focus for economic growth was on quantity over quality. The Eleventh Malaysia Plan places greater emphasis on quality growth, taking into consideration the economy's natural resources and the impacts of their use on the environment. The Eleventh Malaysia Plan covers almost the entire spectrum of energy.

ENERGY SECTOR STRUCTURE

PETRONAS is Malaysia's national petroleum corporation, wholly-owned by the Malaysian Government, created under the Petroleum Development Act of 1974. PETRONAS is vested with the exclusive rights for the exploration and production of petroleum whether onshore or offshore of Malaysia. It also has responsibility for the planning, investment and regulation of the upstream sector. Any foreign and private companies desired to explore and produce petroleum in Malaysia have to enter into a Production Sharing Contracts ("PSC") with PETRONAS.

However, Malaysia's power industry is dominated by three vertically integrated utilities, namely Tenaga Nasional Berhad (TNB) serving Peninsular Malaysia, Sabah Electricity Sendirian Berhad (SESB) in Sabah state and Sarawak Energy Berhad (SEB) in Sarawak state. These utilities undertake electricity generation, transmission, distribution and supply activities in their respective areas. TNB is the largest power utility in Malaysia and is a publicly listed company. SESB is a subsidiary of TNB with 80% owned by TNB and the remaining 20% by the state government of Sabah. SEB is wholly owned by the state government of Sarawak (HAPUA, 2013). Various independent power producers (IPPs), dedicated power producers and co-generators complement the three utilities. The key ministries and government agencies for the Malaysian energy sector are as follows:

- The Economic Planning Unit (EPU) sets the general direction and strategies for Malaysia's energy policies, through the formulation and implementation of the national policy on energy, and the development of the oil and gas industry.
- The Ministry of Energy, Green Technology and Water (KeTTHA) is responsible for strengthening energy resources to ensure electricity supply is of quality, reliable and cost effective. KeTTHA formulates and implements the national policy on renewable energy and energy efficiency. In this regard, KeTTHA plays a pivotal role in driving the development of renewable energy and the promotion of energy efficiency programs. This is in line with the Ministerial Functions Act 1969; Ministers of the Federal Government (No 2) (Amendment) (No 2), Order 2015.
- The Energy Commission (EC) is a statutory body established in 2001 to serve as a regulator for electricity and piped gas supply industries in Peninsular Malaysia and Sabah. The commission's main functions are to provide technical and performance regulations for the electricity and piped gas supply industries; act as the safety regulator; and protect consumers by ensuring the quality of services, the supply of electricity and piped gas, and the maintenance of reasonable prices.

ENERGY SECURITY

The Tenth Malaysia Plan, launched in 2010, outlines the strategic approaches that are designed to improve energy supply security. One of the measures identified is the diversification of energy resources, specifically, an increase in the contribution of RE to the primary energy and power generation mix. Nuclear energy has also been considered as a possible energy supply option for Malaysia in the future (EC, 2014b).

During the Eleventh Malaysia Plan, energy security and RE will continue to be considered, while demand-side management (DSM), a major paradigm shift, which incorporates energy efficiency and conservation measures, will be implemented in order to ensure the sustainable management of energy resources. Several notable strategies, initiatives and targets to improve energy security in Malaysia under the Eleventh Malaysia Plan can be simplified, as in Table 4.

Table 4: Energy security measures and targets under the Eleventh Malaysia Plan

Security measures	Target
Strengthening gas supply security and connectivity for:	
Peninsular Malaysia	• Supply a total of 2 500 MMscf/D • Operationalise RGT-2 by 2017 • Provide additional buffer from: 10% supply from swing field; 15% supply storage in RGT-1
Sabah	• Link Sabah-Sarawak Gas Pipeline (SSGP) to Federal Territory of Labuan • Provide alternative bypass between platforms
Installed capacity and reserve margin for:	
Peninsular Malaysia	24 943 MW with reserve margin of 20%
Sabah	1 782 MW with reserve margin of 34%
Sarawak	5 103 MW with reserve margin of 19%
SAIDI[10] for generation, transmission and distribution	
Peninsular Malaysia	50 minutes/customer/year
Sabah	100 minutes/customer/year
Sarawak	157 minutes/customer/year
Increase generation capacity in Peninsular Malaysia	7 626 MW from new generation capacity and 2 253 MW by extending retiring units
Apply a fuel diversity index, the Hirchmann–Herfindahl Index (HHI),[11] for the power sector	Achieve below 0.5
Strengthen the Sabah electricity grid for reliability	Transmission and distribution networks reinforcement
Subsidy rationalisation for electricity tariff	Tariff review in order to achieve market price

Source: EPU (2015).

Another measure to improve energy security is by diversifying LNG supply importation. The economy is confronting the issue of the geographic disparity of the natural gas supply and demand among its regions. The west of the Peninsular Malaysia requires a greater natural gas supply for power and industrial use, while Sarawak and Sabah produce natural gas but lack local demand. In order to address these concerns, LNG RGTs are being constructed in order to increase supply security through imports of LNG from the global gas market (EIA, 2014). Malaysia has completed its first RGT in Malacca (Melaka), which commenced operation in May 2013 with a capacity of 2 × 130 000 cubic metres and an annual storage volume of 3.8 million Mt (PETRONAS, 2012). The RGT will improve the security of the natural gas supply in Peninsular Malaysia and can accommodate LNG importation. The building of a second RGT is planned for Johor in the Peninsular Malaysia as part of the Pengerang Integrated Petroleum Complex (PIPC). The PIPC is seen to be the next regional downstream oil and gas industrial hub in the Asian region (PETRONAS, 2014a).

Regional energy cooperation under the Association of Southeast Asian Nations (ASEAN) framework also addresses energy security. Among the agreements reached on energy security, is the ASEAN Petroleum Security Agreement (APSA) signed in 1986 and updated in 2009. Its purpose is to enhance petroleum security

[10] The system average interruption duration index. This is commonly used as a reliability indicator by electric power utilities. It measures the average outage duration for each customer served and is calculated as minutes/customer/year or simply minutes of interruption.

[11] The Herfindahl-Hirschman Index (HHI) is an economic concept which is widely applied in competition law and from which an assessment about market share can be derived.

in the ASEAN region. ASEAN members, through the Trans-ASEAN Gas Pipeline project (TAGP) and the ASEAN Power Grid project (APG), have entered into interconnection cooperation agreements on power and natural gas. The TAGP will provide the region with a secure supply of natural gas through the interconnection of gas pipelines and associated infrastructure. Malaysia may serve as a hub in the TAGP given its location and extensive natural gas infrastructure (EIA, 2014). The APG will integrate the power grids of ASEAN members in order to enable regional sales of electricity. The APG will also optimise the development of energy resources in the region.

GREEN TECHNOLOGY POLICY

In its pursuit of a low-carbon economy, the Malaysian Government launched the National Green Technology Policy in July 2009. This serves as the basis for all Malaysians to enjoy an improved quality of life by ensuring that the objectives of the national development policies continue to be balanced with environmental considerations. The policy is built on four pillars as follows.

- Energy: seek to attain energy independence and promote efficient utilisation.
- Environment: conserve and minimise the impact on the environment.
- Economy: enhance the national economic development through the use of technology.
- Society: improve the quality of life for all.

Four sectors have been identified as the primary focus of the policy as follows.

- Energy. The application of green technology in power generation and in energy supply-side management, including cogeneration by the industrial and commercial sectors, in all energy-consuming sectors and in DSM programs.
- Buildings. The adoption of green technology in the construction, management, maintenance and demolition of buildings.
- Water and waste management. The use of green technology in the management and use of water resources, wastewater treatment, solid waste and sanitary landfill.
- Transport. The incorporation of green technology into the transportation infrastructure and vehicles, relating in particular to biofuels and public road transport (KeTTHA, 2011).

Among the policy's long-term goals is the intention to infuse green technology and a significant reduction of energy consumption into Malaysian culture. Malaysia has joined the global endeavour by earmarking the promotion of green technology through the establishment of the Ministry of Energy, Green Technology and Water in April 2009. This replaced the Ministry of Energy, Water and Communication. In addition, the Malaysian Energy Centre was restructured into the Malaysian Green Technology Corporation and has become the lead agency of the Ministry for the promotion, development and implementation of green technology.

The Green Technology Master Plan is being formulated to provide strategic directions for the implementation of the green technology policy and to realise its aspirations and goals. The Green Technology Master Plan also serves as guidance for the development of action plans, programs and projects for the Eleventh and Twelfth Malaysia Plans.

The Green Technology Financing Scheme (GTFS) was established in 2010 in order to accelerate the expansion of the green technology industry with an allocated government fund of MYR 3.5 billion (USD 825 million) until 2017. The objective of establishing the fund is to provide a special financing scheme for soft loans to companies that produce and utilise green technology. As of the end of February 2016, 227 projects had been approved for loan under the GTFS amounting to MYR 2.07 billion (GreenTechMalaysia, 2016).

The introduction of the MyHIJAU Labelling Program is intended to ensure the availability of green products and services in accordance with international standards and regulations. Currently, there are three agencies in Malaysia that have been recognised to provide environmentally friendly certification schemes. They are:

(i) SIRIM Eco Labelling by SIRIM Berhad for certifying the environmental attributes of green products and services;

(ii) Energy Efficiency Labelling by the Energy Commission for energy-efficiency labelling of electrical appliances; and

(iii) Water-Efficient Products Labelling by the National Water Services Commission or SPAN.

The Green Building Index (GBI) has been developed as a rating tool in order to promote green technology in the building sector. It also intends to raise awareness among developers and building owners about the design and construction of green and sustainable buildings. A GBI certificate is granted to developers and building owners who have satisfied the standards in six areas: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency and innovation.

In order to encourage the adoption of green building design, the government intends to establish itself as the market leader. All new government buildings will have to adopt green features and designs, while existing government buildings will be gradually retrofitted. Under the Tenth Malaysia Plan, two government buildings were chosen as pilot projects for retrofitting through the energy performance contracting (EPC) concept. Data collected through these projects are promising: energy consumption in both buildings was reduced to the required level with payback periods of 1.6 years and 4.7 years. Under the Eleventh Malaysia Plan, the government aims to retrofit 100 government buildings (EPU, 2015). Other initiatives that are being implemented are the Government Green Procurement (GGP) and Green Township projects. The GGP integrates environmental considerations into the public sector procurement process in order to protect the natural environment, conserve resources and lessen the harmful effects of human activities. By 2020, the GGP will be implemented in all government offices and will ensure that 20% of the public sector's purchases of products and services are green-labelled. The Green Township project advocates the adoption of a Low Carbon Cities Framework and Assessment System (LCCF) by city councils, developers and town planners. The project provides a systematic process and strategies for reducing carbon emissions in urban developments in accordance with the government flagship and on-going projects.

ENERGY MARKETS

MARKET REFORM

Malaysia's energy market is regulated. Further, the government provides subsidies to energy consumers. However, Malaysia intends to embark on the implementation of energy market reforms, as suggested in the Eleventh Malaysia Plan, through the gradual removal of energy subsidies. As a strategy to rationalise subsidies, the plan states that gas prices for power and non-power sectors will be revised every six months in order to gradually reflect market-based prices. The intention of this approach is to unbundle energy bills in order to itemise subsidy values. This will eventually delink subsidies from energy use.

The first round of subsidy reductions for the power sector's natural gas prices has been in place since 1 June 2011. As a social safety net, government assistance in different forms is extended to low-income households and other groups. In order to institutionalise greater market discipline, other measures will also be pursued. These include separate accounting for generation, transmission and distribution activities; performance-based regulations; and the review and renegotiation of power purchase agreements (EPU, 2015).

As part of the market reform initiative, and in order to move towards better regulation, the Energy Commission imposed Incentive-Based Regulation (IBR) on the utility companies in 2013. The implementation of IBR will continue in order to ensure that utility companies provide efficient services. The IBR framework is designed to incentivise utility companies to reduce costs and improve service levels. The separation of generation, transmission and distribution tariffs with automatic adjustments will take into account changes in fuel prices in order to increase the transparency and efficiency of electricity supply. New power plants and extensions of existing power plants will continue to be undertaken through competitive bidding in order to ensure greater transparency. This will create healthy competition among industry players, resulting in more competitive tariffs and in turn benefitting end-consumers (EPU, 2015).

Besides IBR, the Eleventh Malaysia Plan states that the Gas Supply Act 1993 (Act 501), which regulates the supply of gas to consumers through pipelines, will be amended in order to create a level playing field for third party gas players. Such players can then utilise the natural gas supply infrastructure, which is the Peninsular Gas Utilisation (PGU) pipeline and the RGT, at fair and transparent fees. The amended Act will come into force in 2016 through the Energy Commission covering the economic regulation of the domestic natural gas market. This will include the RGT, the PGU pipeline and the distribution pipeline infrastructure. The aim is to unlock additional revenue from the gas industry valued at an estimated MYR 2.9 billion (USD 684 million) per year (EPU, 2015).

UPSTREAM ENERGY DEVELOPMENT

Because Malaysia's oil and gas basins are becoming mature fields, the government, through PETRONAS, has intensified exploration efforts in the more challenging areas of underexplored deepwater; ultra-deepwater; high pressure, high temperature (HPHT); and high CO_2 fields. In 2013, 100 active PSCs were in

operation as a result of a favourable upstream investment environment. This environment comprised a stable fiscal environment, commercial and tax incentives, infrastructure support and the availability of locally based service companies that supported upstream activities. A PSC is a form of public-private partnership model in which PETRONAS has public responsibility and the contractors represent the private interest (PETRONAS, 2013a).

Under the Eleventh Malaysia Plan, with an average overall resource replenishment ratio (ORRR) of 1.9 achieved from 2011 to 2013, the government is cautiously optimistic that the lifespan of the reserves can be prolonged.[12] This 'healthy' ORRR is attributed to continuous investment by PETRONAS (EPU, 2015).

In order to encourage players aggressively explore and develop marginal fields, PETRONAS introduced a variation of the PSC in 2011 known as the risk service contract (RSC). An RSC shares risk among PETRONAS, the project owner and the contractor. Under this service contract model, the contractor provides the upfront capital expenditure (capex); however, the capex is reimbursed upon first commercial production. The contractor is also entitled to a remuneration fee per barrel based on a pre-determined percentage of the field revenue. There are already three active RSCs. The first (the Berantai Field) commenced gas production in 2012. The other two RCSs are the Balai Cluster, which was awarded a contract in 2011 and achieved its first oil production in November 2013 (PETRONAS 2013b), and the Kapal, Banang and Meranti fields cluster, which was awarded a contract in 2012 and achieved its first oil production in December 2013 (PETRONAS, 2014b). However, based on the feedback from EPU, RSCs initiative are currently underwent reviews due to current low oil prices environment.

ELECTRICITY AND GAS MARKETS

Malaysia's electricity supply industry is monopolistic. It is vertically integrated whereby each of the utility companies (TNB, SESB and SEB) undertakes the generation, transmission and distribution of electricity in its respective region. However, IPPs provide nearly half of the electricity generation supply to the utility companies. All electricity utilities have a government stake as either a government-owned entity or a main shareholder. The industry is highly regulated and governed by several institutions (EPU, KeTTHA and EC), each of which has specific functions and jurisdiction.

In view of the volatility of global energy prices and declining domestic gas production, Malaysia intends to continue its efforts to ensure greater electricity supply and a sustainable electricity supply system as adopted under the Eleventh Malaysia Plan. Further, the Eleventh Malaysia Plan espouses the importance of enhancing the productivity and efficiency of utility providers. The strategies that the plan has identified for a reliable and stable electricity supply industry include increasing and diversifying generation capacity, strengthening the transmission and distribution networks, restructuring the electricity supply industry, and improving customer service delivery.

In order to increase and diversify its generation capacity, Malaysia intends to develop aggressively alternative sources of energy, specifically hydro, and increase coal and LNG importation. There are plans to expand the generating capacity of coal-fired power plants in Peninsular Malaysia and Sarawak using more efficient coal technology, which includes supercritical or ultra-supercritical technology. This new technology will reduce CO_2 emissions from coal-fired power plants (EPU, 2010). Nuclear energy will also be explored as a long-term option for electricity generation. Prior to the Fukushima incident in Japan, the economy considered building nuclear power facilities by 2023 (EPU, 2015).

In order to lower the cost of energy subsidies and reduce market distortions, the Malaysian Government intends to continue to institute market-based energy pricing. In December 2014, for example, the government abolished petroleum product subsidies. Under the Eleventh Malaysia Plan, the government's plan is to remove the Special Industrial Tariff (SIT) for the power sector. This tariff was introduced during the Asian financial crisis in 1997–98 in order to help manufacturers to stay competitive. Although launched as a temporary measure, the SIT has remained in place. The SIT will be abolished in stages and fully by 2020. Its removal should encourage industry to be more energy efficient in the future. Similar electricity subsidy rationalisation is also expected to occur during the period of 2016–20 (EPU, 2015).

However, transmission and distribution systems will be expanded and improved in order to minimise losses. The SAIDI, used as a progress indicator in the Eleventh Malaysia Plan, has been given target reductions of 50 minutes for Peninsular Malaysia (60.5 minutes in 2012), 100 minutes for Sabah (424 minutes in 2013) and 157 minutes for Sarawak (168 minutes in 2013) by 2020.

It is intended that the gradual reduction of the subsidy for gas will eventually enable the adoption of a market price level for gas. This is expected to have a significant effect on the electricity supply industry.

[12] ORRR is an indicator to measure discovered reserves versus production. A ratio of one and above is considered 'healthy'.

Currently, gas for power generation supplied by the Peninsular Gas Utilisation (PGU) pipeline system is heavily subsidised by the government. Other reforms will also be implemented, such as the introduction of performance-based regulation, the renegotiation of power purchase agreements, and separate accounting (unbundling) for the generation, transmission and distribution activities. In order to achieve these goals, the Malaysian Government plans to introduce IBR as an instrument to regulate the gas supply industry so that it will be more efficient and competitive.

In addition, access to electricity supply in rural areas will be extended through grid expansion and alternative systems, such as mini hydro and solar hybrid. Under the Eleventh Malaysia Plan, the coverage of the electricity supply, on a household basis, is targeted to be nearly 100% in Peninsular Malaysia and 99% in Sabah and Sarawak by 2020 (EPU, 2015).

ENERGY EFFICIENCY

A lack of holistic and long-term policy for DSM has been identified as one of the main barriers in implementing energy efficiency initiatives in Malaysia, even though energy efficiency is considered an important element in Malaysia's energy plan and policy. Energy efficiency initiatives are set to receive renewed attention under the Eleventh Malaysia Plan through a reinvigoration of DSM. It is intended that this will be achieved by formulating a comprehensive DSM master plan. EPU will initiate a study on DSM, which covers the whole spectrum of the energy sector (EPU, 2015).

Table 5: Energy efficiency targets under the Eleventh Malaysia Plan

Item	Target
Comprehensive long-term DSM master plan	Formulating policy and action plan covering the entire spectrum of the energy sector including electrical, thermal, and usage in the transport sector
Buildings	• Achieve a target of 700 registered electrical energy managers (REEMs)
	• Extend EPC to other government buildings
	• All new government buildings to adopt energy efficient design
	• Retrofit 100 government buildings
	• Register 70 energy service companies (ESCOs)
	• Target 100 companies to implement ISO 50001[13]
Industries	• Introduce enhanced time of use (EToU) with three different time zones
	• Abolish the Special Industrial Tariff (SIT)
	• Install 4 million smart meters
	• Increase on-grid cogeneration capacity of 100 MW or more by reviewing utility standby charges
Households	Additional appliances with minimum energy performance standards (MEPSs) and labelling program

Source: EPU (2015)

A notable highlight in the Eleventh Malaysia Plan is the initiative to retrofit government buildings. The pilot programs in EPU and Ministry of Finance buildings has reduced electricity use ranging from 16% to 19%, equivalent around USD 5 200 (RM21 000) to USD 32 000 (RM130 000) monthly savings. In addition, the Malaysian Government intends to implement smart grid systems for the electricity industry by introducing smart meters. This move will help customers to manage their electricity supply more effectively. By 2020, a total of 4 million smart meters will be installed by the utility companies at an estimated cost of RM 4 billion. The smart grid is expected to benefit customers by enabling them to obtain information on their electricity usage.

[13] ISO 50001 is a voluntary international standard to provide organisations with a recognised framework in order to manage and improve their energy performance.

RENEWABLE ENERGY

Malaysia's Five-Fuel Policy in 2001 recognised the importance of RE and adopted it as the fifth fuel in the energy supply mix alongside natural gas, oil, hydro and coal. During the Tenth Malaysia Plan period (2010–15), focus was given to implementing greenhouse gas (GHG) mitigation measures. Among the measures undertaken was the introduction of the RE Act in 2011, and the implementation of the feed-in tariff (FiT) mechanism. Sustainable Energy Development Authority (SEDA), an organisation established by the government in order to promote RE, set a target of 415.5 MW of additional RE capacity by 2015. However, the total installed capacity of RE was 332.76 MW in 2015 (EPU, 2015). As at the end of 2015, cumulative RE installed capacities under the FiT that achieved commercial operation was 332.76 MW, of which biomass was 74.9 MW, biogas 18.23 MW, small hydro 18.3 MW and solar PV 221.33 MW (SEDA, 2015)

The government identified challenges which have affected the growth of RE in Malaysia. Among these are issues that affect the reliability of RE plants, and problems in securing adequate feedstock for long-term supply, particularly for biomass. Other challenges are the lack of experts in the sector, including RE project developers, financial personnel and service providers. There are also difficulties in securing financing in order to develop RE installations. Current RE sources focus on biomass, biogas, mini hydro and solar photovoltaic (PV), while new RE sources have not been explored extensively.

Under the Eleventh Malaysia Plan, the government has set a target for RE capacity to reach 2 080 MW, thereby contributing 7.8% of total installed capacity in Peninsular Malaysia and Sabah. Strategies have also been identified to boost RE capacity. For example, studies will be conducted to identify new RE sources such as wind, geothermal and ocean energy in order to diversify the power generation mix. Currently, the national wind mapping exercise is underway and is expected to be completed by 2016. The exercise will provide data for a study on the feasibility of developing wind energy. Geothermal potential will also be explored following the discovery of a 12 km^2 geothermal field in Sabah. Further, the viability of ocean energy will be considered in order to take advantage of the sea, which surrounds Malaysia.

In order to complement the current FiT mechanism, a new instrument termed net energy metering (NEM) will be implemented in the Eleventh Malaysia Plan. The objective of NEM is to promote and encourage more RE generation by prioritising internal consumption before any excess electricity generated is fed to the grid. NEM is anticipated to encourage manufacturing facilities and the public to generate electricity without any restriction on their generation capacity. This will further assist the government's effort to increase the contribution of RE in the generation mix.

CLIMATE CHANGE

Malaysia is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and ratified the treaty on 17 July 1994. Subsequently, the National Climate Committee was established in 1995. This is composed of various government agencies and stakeholders from business and civil society groups. Its purpose is to guide national responses to climate change mitigation and adaption.

At the 2015 United Nations Climate Change Conference in Paris, Malaysia's prime minister made a pledge to reduce by 45% the GHG emissions intensity of the economy's GDP by 2030 relative to the emissions intensity of GDP in 2005. The 45% figure consists of 35% on an unconditional basis and a further 10% conditional upon receipt of climate finance, technology transfer and capacity building from developed countries (UNFCCC, 2015). The sectors which will be covered under this emission intensity reduction target are energy; industrial processes; waste; agriculture; and land use, land use change and forestry (LULUCF).

There are two significant policies approved in 2009 that support this goal: the National Green Technology Policy and the National Climate Change Policy. These policies strengthen the national agenda on environmental protection and conservation. The National Climate Change Policy has three main objectives. First, to mainstream measures to address climate change through the efficient management of resources and enhanced environmental conservation, resulting in strengthened economic competitiveness and improved quality of life. Second, the integration of responses into national policies, plans and programs in order to strengthen the resilience of development from arising and potential impacts of climate change. Third, strengthening institutional and implementation capacity in order to harness opportunities to reduce the negative impacts of climate change more effectively (NRE, 2009).

The Eleventh Malaysia Plan also stressed the effort needed to address the challenges of climate change by developing a roadmap for climate resilient growth, which covers adaptation and mitigation approaches. In order to reduce the economy's carbon footprint, development work will focus on creating green markets, increasing the share of renewables in the energy mix, enhancing DSM, encouraging low-carbon mobility and managing waste holistically (EPU, 2015).

NOTABLE ENERGY DEVELOPMENTS

NEW ENHANCED DISPATCH ARRANGEMENT (NEDA) LAUNCHED TO ENCOURAGE HEALTHY COMPETITION IN THE POWER SECTOR

The Energy Commission, the power sector's regulator for Peninsular Malaysia and Sabah, launched the new enhanced dispatch arrangement (NEDA) mechanism in order to create healthy competition among IPPs. The mechanism, which came into effect in October 2015, is expected to result in savings in electricity production costs, which is intended to benefit consumers in the long run. Under the new mechanism, IPPs whose power purchase agreements (PPAs) have expired or will be expiring can apply for an operating licence to enable them to continue generating electricity for sale to utility companies. The NEDA will allow these IPPs to bid on the basis of their variable costs (fuel cost and operation and maintenance costs) rather than those stated in the PPAs. This can help enable Malaysia to embark on an open and competitive power market. The mechanism is planned to be fully implemented by the first quarter of 2016 (EC, 2015b).

INTRODUCTION OF INCENTIVE-BASED REGULATION IN THE GAS SUPPLY SECTOR

Incentive-based regulation (IBR) is a form of economic regulation aimed at incentivising utility companies in order to improve operational and financial performance, while simultaneously regulating the natural gas tariff. IBR supports the liberalisation of the natural gas industry, which is gradually aligning current piped gas towards market prices. In this regard, the introduction of IBR promotes the efficient allocation and usage of resources, and sustainable financial performance. There will be a trial period for IBR in 2016, following which the first regulatory period will run from 2017 until 2019. IBR is expected to promote a cost-efficient tariff structure for customers (Gas Malaysia, 2015b)

PENGERANG INTEGRATED PETROLEUM COMPLEX (PIPC)

The PIPC was declared a National Project of Strategic Importance during the Economic Council Meeting in February 2012 and was chaired by the Malaysian prime minister. The PIPC is being developed as part of the Economic Transformation Program in order to establish a dynamic oil and gas downstream industry. The project is located on a single plot of land (approximately 8 100 hectares) in Pengerang, Johor at the south-eastern tip of Peninsular Malaysia. This is strategically accessible to major international shipping lanes. In order to manage and administer efficiently the different projects within the PIPC, a new federal government agency has been created—the Johor Petroleum Development Corporation (JPDC).

The PIPC will house oil refineries, naphtha crackers, petrochemical plants, and LNG regasification terminal. As of January 2013, two projects have been committed to the PIPC area. The first is the Pengerang Independent Deepwater Petroleum Terminal (PIDPT), a deepwater oil terminal that is expected to be completed by 2020 with planned total storage capacity of 5 million cubic metres. Oil refineries in PIPC will be value added in order to import crude oil through PIDPT. Another project is PETRONAS's Refinery and Petrochemical Integrated Development (RAPID), which will include a 300 000 barrels per day crude oil refinery that will provide feedstock for RAPID's petrochemical complex and produce petrol and diesel which meets European specifications (MPRC, 2013)

In April 2014, as part of the final investment decision (FID), PETRONAS announced the development of the PIPC with a total investment of USD 27 billion inclusive of RAPID's development and other facilities (PETRONAS, 2014a).

Despite the low oil price, the RAPID project is on track for phase 2 of the site preparation. The refinery and cracker construction is progressing on schedule. It is intended that the project will be completed in Q1 2019 and that commercial operations will begin in Q2 (Platts, 2015b).

ELEVENTH MALAYSIA PLAN (2016–20)

As aforementioned, in May 2015, the government launched the Eleventh Malaysia Plan 2016–20 as the final stage in Malaysia's journey towards realising Vision 2020, a long-term development plan launched in 1991, which envisions Malaysia to be a fully developed economy, across all dimensions, by 2020. Six strategies are outlined in the Eleventh Malaysia Plan. These include pursuing green growth for sustainability and resilience, and strengthening the infrastructure in order to support economic expansion, both of which have implications for energy initiatives. The Eleventh Malaysia Plan is a mid-term (five-year) national development plan that supports the long-term (20 years) plan. The First Malaysia Plan started in 1966 and the Eleventh Malaysia Plan will take effect in 2016 (EPU, 2015).

Under the Eleventh Malaysia Plan, two strategy papers, Climate Resilience Development and Energy, were introduced. Among the ways forward which are outlined under the Climate Resilience Development strategy paper are strengthening and enabling the environment, strengthening resilience against climate change and natural disasters, and harnessing economic value through sustainable consumption and

production practices. Two energy sectors are affected by this strategy paper. They are DSM and RE. With regard to the Energy strategy paper, the way forward is divided into four categories, namely the overall energy sector, the oil and gas subsector, the electricity subsector and DSM (EPU, 2015).

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USEFUL LINKS

Prime Minister's Office—www.pmo.gov.my

Economic Planning Unit, Prime Minister's Department—www.epu.gov.my

Energy Commission—www.st.gov.my

Ministry of Energy, Green Technology and Water—www.kettha.gov.my

Ministry of Finance—www.treasury.gov.my

Ministry of National Resources and Environment—www.nre.gov.my

PETRONAS—www.petronas.com.my

Sabah Electricity Sdn.Bhd.—www.sesb.com.my

Sarawak Energy Berhad—www.sarawakenergy.com.my

Tenaga Nasional Berhad—www.tnb.com.my

MEXICO

INTRODUCTION

Mexico, officially known as the United Mexican States (*Estados Unidos Mexicanos* in Spanish), is a North American federal republic bordered by the United States to the north, Belize and Guatemala to the south, and the Atlantic and Pacific Oceans on the east and west, respectively. For cultural and historic reasons, Mexico has been commonly regarded a Latin American economy, although its geographical location and economic integration are in North America.

Mexico is rich in biodiversity, with abundant fossil and renewable energy resources across its land area of approximately 2 million square kilometres (km^2). There are diverse climatic conditions across the Mexican territory that range from very dry with high temperatures in the north, to very humid with high temperatures in the south, mild temperatures in the centre and a warm coast. The total population of Mexico by mid-2014 was more than 125 million (World Bank, 2015). Mexico City is the political capital of the economy and is considered one of the largest urban centres in the world. It is home to more than 20 million people, with nine million living in Mexico's federal district and more than 11 million in the 60 surrounding municipalities in the states of Mexico and Hidalgo (INEGI, 2013). After Mexico City, the other most important cities of the economy are Guadalajara and Monterrey, which are located in the west-central and north-eastern sides of the territory, respectively.

Several major reforms and free trade agreements introduced since the 1990s have resulted in macroeconomic stability and increased flows of foreign direct investment into Mexico, making it one of the largest developing economies with a robust manufacturing industry. Despite these milestones, the growth of the Mexican economy between 2000 and 2013 has been modest, rising little more than 2% annually, with the real GDP in 2013 reaching USD 1 900 billion (2010 USD purchasing power parity [PPP]) (EGEDA, 2015). The accomplishment of significant political, economic and energy reforms, was expected to underpin a more robust economy, but partly due to the prevalent environment of low oil prices since 2014, the GDP grew only 1.4% from 2012 to 2013. Despite the expectations and efforts in the last decade to create a stronger economy, the growth of Mexico's GDP on a per capita basis is meagre, with an annual rate lower than 0.7% from 2000 to 2013 and nearly zero from 2012 to 2013 (EGEDA, 2015). In addition, by the end of 2014, around 46% of the Mexican population was deemed to live under poverty conditions, with this share being roughly the same as in 2010 and 2012 (CONEVAL, 2015).

Energy, particularly oil, is a central component of the Mexican economy, and is poised to become more relevant through the structural changes approved in 2013. In 2014, the value of crude oil exports represented 13% of Mexico's total exports in the same year, yet they provided 31% of the government's total revenue, from which social development is funded (Banxico, 2015).

Table 1: Key data and economic profile, 2013

Key data[a, b]		**Energy reserves**[c, d]	
Area (million km^2)	2.0	Oil (billion barrels)	11
Population (million)	125	Gas (billion cubic metres)	348
GDP (2010 USD billion PPP)	1 900	Coal (billion tonnes)	1.2
GDP (2010 USD PPP per capita)	15 355	Uranium (kilotonnes U)	2.9

Sources: a. World Bank (2015); b. EGEDA (2015); c. BP (2015); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

By the end of 2013, the net primary energy supply of Mexico amounted to more than 193 500 kilotonnes of oil equivalent (ktoe), an increase of 2.3% over 2012. Fossil fuels constituted 90% of the primary energy supply of the economy, with other non-fossil sources such as nuclear and renewable energy constituting the remaining 10% (EGEDA, 2015). An economy endowed with abundant fossil and renewable energy resources, by the end of 2014, Mexico held proven reserves of fossil fuels amounting to 11 billion barrels of crude oil, 348 billion cubic meters (bcm) of natural gas and 1.2 billion tonnes of coal. In terms of the size of the crude oil, natural gas and coal reserves, Mexico was ranked eighteenth, thirty-third and twenty-first in the world, respectively, as well as the fifth, tenth and eighth in APEC, respectively (BP, 2015).

Mexico is a major oil producer, and by the end of 2014, it produced 2.4 million barrels per day (Mbbl/D) of crude oil, mostly the heavy type. This volume was 3.7% lower than that of the previous year, mostly due to the decline in several major fields. In particular, Mexico faces the challenge of replacing the output from its once largest oil asset Cantarell, a supergiant field, which, at its peak in 2004 produced 2.1 Mbbl/D, constituting more than 60% of the total crude oil production in Mexico. However, its productivity has been decreasing rapidly since then. By the end of 2014, Cantarell produced less than 0.4 million barrels, representing only 15% of the economy-wide production (PEMEX, 2014). Consequently, in the last few years, the biggest oil company in Mexico, Petróleos Mexicanos (PEMEX), has focused its strategy on the discovery and development of new oil fields that can offset the natural decline of its major assets. Mexico is a net crude oil exporter with around half of its total indigenous crude oil production being exported, especially to the US, making Mexico the third-largest oil supplier to that economy in 2014, after Canada and Saudi Arabia (EIA, 2015). Despite its robust production of crude oil and a domestic distillation capacity of 1.7 Mbbl/D in six refineries located across its territory, Mexico is a net importer of oil-based products, especially gasoline.

As shown in Table 1, the proven natural gas reserves of the economy at the end of 2014 totalled 348 bcm, with production in the same year reaching 0.2 billion cubic metres per day (bcm/d), of which almost three-quarters were associated with the production of crude oil. As a net natural gas importer, Mexico has looked forward to boosting its domestic gas resources, including the development of its unconventional resources such as shale gas. Nevertheless, the challenges in the early shale gas development in Mexico along with a rapidly growing demand in the industry due to the availability of cost-competitive natural gas flows from the US have favoured a rising volume of imports and have prevented a more accelerated domestic gas production.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	218 104	Industry sector	34 724	Total	297 079
Net imports and others	-21 228	Transport sector	51 125	Thermal	245 594
Total primary energy supply	193 635	Other sectors	26 692	Hydro	28 002
Coal	12 682	Non-energy	5 640	Nuclear	11 800
Oil	98 863	Total final energy consumption	118 181		
Gas	61 794	Coal	5 173	Others	11 683
Others	20 297	Oil	72 350		
		Gas	12 131		
		Electricity and others	28 527		

Source: EGEDA (2015).

By the end of 2014, the contribution of domestic gas production to the natural gas supply in Mexico amounted to 63%, much lower than the 2007 level at 81%. Out of the 37% of the natural gas supply provided by imports by the end of 2014, approximately 25% was from pipeline imports and 12% from LNG. As a reference, in 2007, these sources represented 15% and 5% of the economy-wide natural gas supply, respectively (CRE, 2015; SIE, 2015). Mexico has three LNG regasification terminals, two in its Pacific Coast in Ensenada (in Baja California State) and one in Manzanillo (in Colima State). Another terminal is located in Altamira (the State of Tamaulipas) in its Atlantic Coast, facing the Gulf of Mexico.

COAL

In comparison to most other economies, coal is not as widely used in the primary energy supply of the economy, as it represented less than 7% of the total supply in 2013, equivalent to 12 682 ktoe (EGEDA, 2015). Most of Mexico's recoverable coal reserves of 1.2 billion tonnes are located in the Coahuila State in the north-eastern part of its territory, with some significant additional resources in the states of Chihuahua and Sonora in the north-west, and Oaxaca in the south.

ELECTRICITY

Electricity generation in Mexico amounted to more than 300 Gigawatt-hour (GWh) in 2013, mostly derived from thermal power plants (EGEDA, 2015) largely fuelled by natural gas. Mexico's electricity system is well developed and comprises a main grid spread across most of its territory as well as two other grids in the north and south of its Baja California Peninsula. The interconnection between the main and north Baja California grids is planned to be functional by 2018. It is expected to underpin the optimisation of infrastructure and energy sources across the Mexican territory (CFE, 2014), and could have deeper effects on the entire system's configuration in the long term.

In 2014, the total installed power capacity was above 65 300 megawatts (MW), of which 54 375 MW were used for public service. This installed capacity represented an increase of 936 MW over the 2013 level. The bulk of the electricity generation infrastructure has been developed by the Comisión Federal de Electricidad (CFE), Mexico's state-owned and largest utility, although the number of private generators has also grown over the last two decades. Both for public service sales and different self uses, the capacity held by the private sector represented approximately 37% of the economy-wide installed electricity generation capacity in 2014 (SENER, 2015f). CFE and private generators alike predominantly rely on combined cycle technologies fuelled by natural gas, although the use of renewable energy, particularly wind energy, has grown robustly in recent years.

FINAL ENERGY CONSUMPTION

In 2013, total final energy consumption in Mexico reached 118 181 ktoe, a slight increase of 1% from 2012. By energy source, oil-based products accounted for 61%; electricity and others 24%; natural gas 10% and coal 1.5% (EGEDA, 2015). This structure remained very similar to that of the previous year. By use, the bulk of the final energy consumption in 2012 was in the transport sector (43%), industry sector (29%), and the residential, commercial and agriculture sectors together (23%).

ENERGY INTENSITY ANALYSIS

In the last decades, Mexico has undertaken several initiatives to improve its energy efficiency, with a cumulative positive effect on its energy intensity levels. As shown in Table 3, from 2012 to 2013, the energy intensity worsened by less than 1% when assessed by the economy-wide primary energy demand; although from a final energy basis it made a slight improvement. All final energy sectors reported improvements in their respective energy intensities, with the exception of the industry sector, which has experienced an unprecedented energy demand surge due to the availability of inexpensive gas imported from the US. Consistent with the aspirations of APEC on energy intensity, the advance of the 2013 figures over those of 2005 amounted to improvements of 6.1% on a primary energy supply basis and 7% for the final energy demand, which confirm Mexico's decreasing energy intensity trend.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	101	102	0.9
Total final energy consumption	62.4	62.2	–0.4
Industry	16	18	13
Transportation	28	27	–3.8
Other sectors	14.3	14.0	–1.9
Non-energy	4	3	–26

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Mexico's energy policy is led by the Ministry of Energy (Secretaría de Energía, or SENER), which is required by law to develop an Energy Sector Program with the main energy goals and strategies to be enforced at the beginning of every six-year presidential term. The current Energy Sector Program, in force until 2018, set several short and medium-term actions to remove the hurdles towards ensuring a more vigorous energy supply, to promote the development of energy infrastructure, and foster the efficiency and modernisation of regulatory institutions and state-owned companies. In alignment with these objectives, the milestone reform passed in 2013 introduced a new structure and institutional arrangement for the Mexican energy sector.

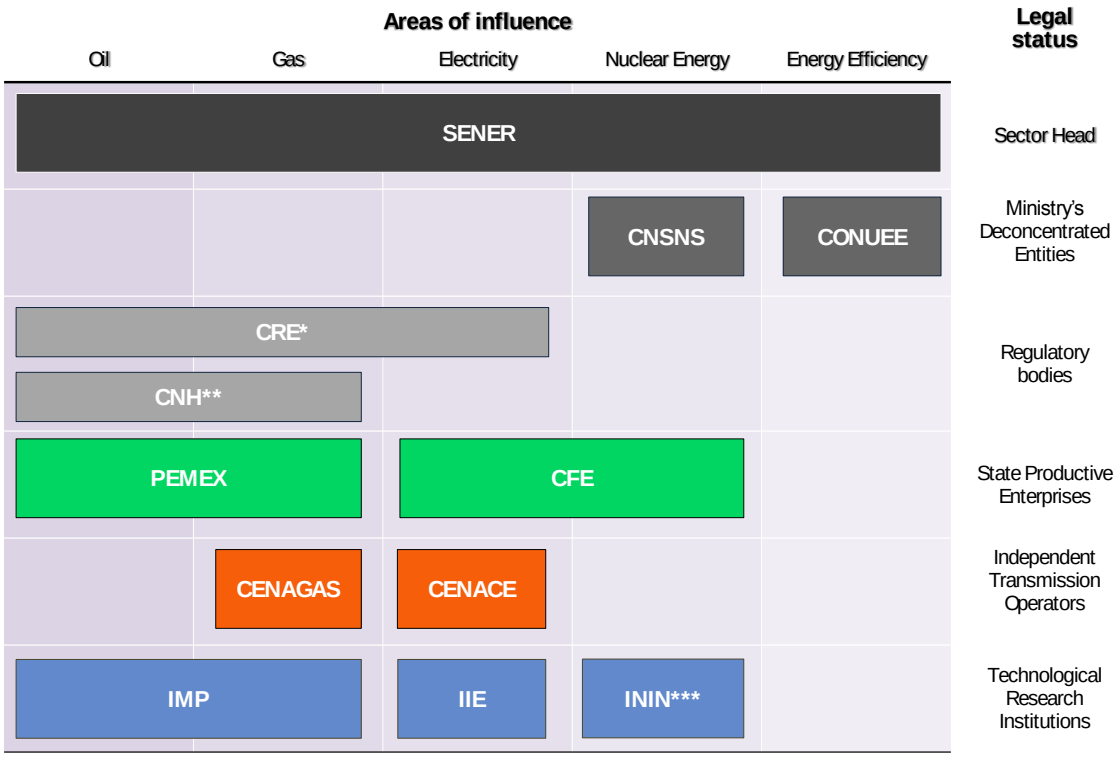
SENER is strengthened as the strategist of the economy-wide policies on the subject. In the oil and gas industry, it adjudicates oil assignments to PEMEX and awards permits related to oil and natural gas processing. Regarding exploration and production activities, SENER selects the areas to tender and designs the technical guidelines to observe. The Ministry of Finance determines the fiscal and economic terms for oil and gas exploration and production contracts, while the National Hydrocarbons Commission (CNH) awards these contracts and authorises the working plans originating from them.

The reform reaffirmed the state ownership of all hydrocarbons in the subsoil while introducing more competition in the energy sector. To that end, and to foster larger investment inflows into the sector, in addition to the status given to the state-owned companies as state productive enterprises to become more competitive, private companies are now allowed to participate across the entire value chain of the oil and gas industry. In the electricity industry, with the exception of nuclear energy, private parties can participate in electricity generation and marketing activities under state regulation. Concerning transmission and distribution, private parties may participate under contract with the Federal Electricity Commission, which will be restructured with more transparent rules.

To strengthen the regulation of the energy sector, regulators had their mandates expanded in order to address the upcoming industry challenges more effectively. The CNH and the Energy Regulatory Commission (CRE) became coordinated regulatory organisations with their own legal personality, technical and management autonomy, and budgetary self-sufficiency. To ensure that assignments and contracts granted to public and private enterprises contribute to the economy-wide industry, legislation will be required to establish minimal percentages of domestic content. Private investment must promote the inclusion and development of domestic and local suppliers in the value chain of the entire industry.

To enhance transparency, several mechanisms include external audits and citizens' participation with the aim of verifying the payments made to companies. To facilitate the understanding of the new institutional arrangement of Mexico's public energy sector, and its areas of influence, a schematic representation is shown in Figure 1.

Figure 1: Current institutional arrangement of Mexico's public energy sector



* In the oil and gas industry, the regulations are applicable only to the midstream and downstream segments.

** In the oil and gas industry, the regulations are applicable only to the upstream segment.

*** Stemmed from the Energy Transition Law, ININ has six months starting from December 2015 to transform into the National Institute for Electricity and Clean Energy.

SENER: Ministry of Energy; CNSNS: National Commission for Nuclear Safety and Safeguards; CONUEE: National Commission for the Efficient Use of Energy; CRE: Energy Regulatory Commission; CNH: National Hydrocarbons Commission; PEMEX: Petróleos Mexicanos; CFE: Federal Electricity Commission (utility); CENACE: National Centre for Energy Control; CENAGAS: National Centre for Natural Gas Control; IMP: Mexican Petroleum Institute; IIE: Electricity Research Institute; ININ: National Institute for Nuclear Research.

Source: APERC analysis.

OIL AND GAS

With the reform enacted, Mexico can conduct hydrocarbon exploration and extraction activities through assignments and contracts with PEMEX, private operators or both parties in association. Four types of combinable contracts for hydrocarbons are established: services, profit sharing, production sharing and licenses. In particular, the last three will allow the transfer of the geological and financial risks involved in the exploration and extraction activities, to contractors. To preserve PEMEX's assets and value creation in this new institutional arrangement, it was provided with a Round Zero, a new tax regime and best corporate governance practices.

In terms of regulation, with its new capacities, the CNH aims to perform public biddings on hydrocarbons, determine winners and administer the incumbent contracts. The CNH is also responsible for the quantification of Mexico's oil and gas potential and geological records; for the announcement, tendering and signing of exploration and production contracts, and overseeing the technical issues related to all the permits awarded to maximise the economy's rent perceived for its hydrocarbons. Consistent with the competition introduced, a National Centre for Natural Gas Control (CENAGAS) was created to administer, coordinate and manage the pipeline grid and the storage of natural gas efficiently and independently. CENAGAS is intended to act as an independent transmission operator.

The Mexican Fund of Petroleum for Stabilisation and Development is responsible for safeguarding, managing and distributing the revenues derived from hydrocarbons-related assignments and contracts, with the exception of taxes. The Fund is constituted as a trust within Mexico's Central Bank, with a technical committee comprising four independent board members and three members from the state.

ELECTRICITY

Since 1992, the private sector has participated in the electricity generation in Mexico, due to the industry's partial liberalisation at the time that allowed private companies to generate electricity, provided that their power was either sold to CFE or used for own purposes (self-supply). However, the 2013 Energy Reform stresses the need to expand generation and retail segments so that CFE becomes more competitive and is able to regain major customers. Therefore, private generators will eventually participate along with CFE to serve medium-sized customers under a more competitive market.

As this Energy Reform retains state control over transmission and distribution activities, it is expected that CFE's efforts to undertake the expansion and operation of Mexico's transmission and distribution lines will be strengthened with the aid of private companies that will enhance investment flows and market technologies. The CRE now has its own legal personality, as well as technical and management autonomy, and budgetary self-sufficiency to carry out its duties more effectively. These duties span the regulation of the electricity industry, as well as the storage, transport and distribution of oil products through pipelines. Finally, the National Centre for Energy Control (CENACE) has been withdrawn from CFE to become a public decentralised entity responsible for operating the government's power system and the wholesale power market to ensure open and non-discriminatory access to the government's transmission and distribution grids.

NUCLEAR ENERGY

Mexico is experienced in the development of nuclear energy to generate electricity, with the only plant with two nuclear reactors (Laguna Verde) being operated by CFE since 1990. Mexico has not explicitly ruled out any nuclear development plans, but neither has its government clearly signalled any possible expansion of the current capacity. Furthermore, even with the changes introduced to promote the participation of private generators, nuclear energy development remained reserved to the Mexican State, most likely through CFE.

ENERGY EFFICIENCY

Mexico has organised energy efficiency programs since 1989. The institution in charge of promoting these programs and providing technical advice is the National Commission for Efficient Energy Use (CONUEE). Energy efficiency actions are framed by the National Programme on the Sustainable Use of Energy 2014–18. The Programme was jointly created by SENER and CONUEE, with several objectives that include the design of programs and actions conducive to an optimal energy use across the energy sector; an effective regulation of energy-based equipment and devices made and/or marketed in Mexico; and a strengthened governance of energy efficiency systems at the federal, state and municipal levels including public, social, private and academic entities.

RENEWABLE ENERGY

To achieve the goal of reducing the dependency on fossil fuels while integrating sustainability principles into the energy policy framework, a legal reform in 2008 allowed the development of new policy and regulatory instruments that would promote the introduction and growth of renewable energy, biofuels and research activities.

In 2008, the Mexican Government passed its Law for the Use of Renewable Energy and Financing of Energy Transition to reduce the dominance of fossil fuels in the economy-wide electricity mix through renewable and environmentally sustainable energy solutions. To that end, the Law mandated the maximum share of fossil energy in Mexico's total electricity generation at 65% by 2024, 60% by 2035 and 50% by 2050. This Law was overridden by the Law for Energy Transition passed in December 2015. Nevertheless, the goals were largely preserved, mandating the minimum share of economy-wide electricity generation based on clean energy (renewables and nuclear) constituting 25% by 2018, 30% by 2021 and 35% by 2024.

These goals are also aligned with the guidelines of Mexico's Law for Climate, which establishes an aspirational goal of at least 35% of the economy-wide electricity generation based on sources other than fossil fuels and nuclear energy by 2024.

ENVIRONMENTAL SUSTAINABILITY

Mexico made significant efforts to decrease the carbon intensity of its economic development, despite its emissions representing only 1.4% of the worldwide total (UNFCC, 2015). Mexico is one of the economies most devoted to address climate change, having issued its first specific strategy in 2000 and becoming the first developing economy to have a law dedicated exclusively to this subject, issued in 2012. Since then, numerous other policies on emissions mitigation and adaptation to climate change have been implemented, with several focusing on the energy sector and its most energy-intensive industrial processes. The energy sector is the largest source of emissions, and according to the most recent official records, it accounts for

82% of the CO_2 and 67% of the greenhouse gases (GHGs) emitted in Mexico during 2010 (SEMARNAT, 2013).

With the structural changes achieved, the Mexican State promotes actions that protect the environment through lower carbon intensity in its domestic energy demand and supply, as well as the reduction of polluting emissions from the electricity industry. Consistent with Mexico's cross-sectorial public policies, environmental sustainability is a major component of the economy's energy planning.

In agreement with the energy reform and its precepts to minimise the negative impact on the environment, SENER coordinated a cross-institutional effort towards the development of the Special Program for Climate Change 2014–18. The Program contains 38 action lines oriented to the adaptation and mitigation of climate change, from which eight have specific goals. According to the Program, the energy sector's impact on climate change is considerable, as it accounts for 61% of the mitigation commitments established.

Additionally, the energy reform mandate to establish an agency responsible for industrial safety and environmental protection in the oil and gas industry resulted in the Agency of Security, Energy and Environment (ASEA), an organisation with technical and management autonomy, attached to the Federal Ministry of Environment. ASEA oversees and sanctions operators across the oil and gas value chain (upstream, midstream and downstream) in their compliance to industrial and operational safety measures; plugging and abandonment of wells and facilities; and control of polluting emissions and waste. In doing so, the Agency looks forward to complying with domestic and international technical standards.

RESEARCH AND DEVELOPMENT

SENER, through its Vice-Ministry for Energy Planning and Transition, is responsible for fostering research and development (R&D) policies, which are predominantly carried out by three public research bodies, as explained in Figure 1. The Mexican Petroleum Institute supports the hydrocarbons sector; the Electricity Research Institute supports electric power and the National Institute for Nuclear Research supports nuclear-based applications for electricity generation and other peaceful purposes.

Energy-related R&D in strategic areas has been enhanced by the creation of two trust funds managed jointly by SENER and the National Technology Council (Conacyt): the Trust Fund for Hydrocarbons and the Trust Fund for Energy Sustainability. These trust funds are financed by fee payments collected from PEMEX Exploration and Production as required by the National Income Law. Further, they are oriented to fund scientific and applied research projects, as well as supporting the adoption, innovation, assimilation of technological development and training of specialised human resources.

While the Trust Fund for Hydrocarbons is oriented towards upstream and downstream hydrocarbon activities, including basic petrochemicals, the Trust Fund for Energy Sustainability supports clean technologies, diversification of energy sources, renewable energy sources and energy efficiency. The objectives and budgetary resources of these Trust Funds have supported the creation of several centres to enhance Mexico's research and training on their respective areas of influence. The Centre for Training in Development Processes and the Centre for Deep Water Technologies stem from the Trust Fund for Hydrocarbons, while five Mexican Centres for Innovation stem from the Trust Fund for Energy Sustainability. Each of these fives centres is specialised in bioenergy, wind energy, geothermal energy, wave energy and solar energy.

In addition, the Trust Fund for Energy Transition and Sustainable Use, which is financed through the federal budget, aims to promote the use of renewable energy and energy efficiency. To that end, this Trust Fund supports public research projects oriented towards the diversification of primary energy use and energy savings in industrial and domestic activities.

NOTABLE ENERGY DEVELOPMENTS

OIL AND GAS

As part of the energy reform, a 'Round Zero' mechanism was included, whereby PEMEX requested to retain certain strategic oil and gas assets prior to any public tenders for private competitors. The aim of this mechanism was to provide PEMEX a competitive advantage in the face of the increased competition. The Round Zero resulted in PEMEX retaining 83% of the proven and probable reserves in Mexico and 21% of the prospective oil and gas resources.

A subsequent 'Round One' followed Round Zero, to offer the oil and gas resources to private companies in a series of consecutive tenders (Ronda Uno, 2015).

- By December 2014, SENER announced the first tender (Licitación 1—Aguas Someras—Exploración) for the exploration of several blocks in shallow waters in front of the Mexican states of Veracruz, Tabasco and Campeche under a regime of production sharing contracts.
- By February 2015, a second tender was opened for the development of hydrocarbons in five blocks of shallow waters in the states of Tabasco and Campeche (Licitación 2—Aguas Someras—Extracción), again under a regime of production sharing contracts.
- The third tender for 2015 was opened in May, targeting the development of hydrocarbons in 25 onshore blocks bordering the Gulf of Mexico (Licitación 3—Terrestre—Extracción), this time under a licence regime.

Shortly after these tenders were announced, SENER released its five-year plan for the exploration and production of hydrocarbons. According to this plan, up to 2019, the Mexican Government expects to tender 379 blocks for the exploration of conventional hydrocarbons, 291 for the exploration of unconventional hydrocarbons, and 244 for production. The amount of oil and gas for each of these activities was estimated at 15, 25 and 68 billion barrels of oil equivalent, respectively (SENER, 2015e).

- The results of the oil and gas tenders were announced during the second half of 2015.
  - In the first tender, out of the 14 blocks tendered, only two were awarded.
  - In the second tender, three out of five blocks were awarded.
  - The results for the third tender were announced in December 2015, with all 25 blocks awarded.

In the midst of a continued environment of low crude oil prices that posed major financial and operational challenges, by December 2015, PEMEX announced that during that year, it had completed 30 exploratory wells with a commercial success of 45%, which resulted in several discoveries adding 1 billion barrels of oil equivalent of possible (3P) reserves. Approximately 57% of these reserves are light crude oil and condensate, 20% heavy oil and 23% non-associated gas (PEMEX, 2015).

In order to guide the private investments in the downstream segment, SENER released the Five-year Plan on Natural Gas Pipelines in October 2015. The plan considers the development of 13 projects spanning 12 pipeline systems and 1 compression station. These projects involve 5 000 km of additional gas pipelines, with investments estimated at USD 10 billion (SENER, 2015c).

ELECTRICITY

Up to the first half of 2015, multiple projects were finished or commissioned to keep up with the rising electricity demand in Mexico. Three power plants (Los Azufres III Phase I Geothermal, CC and Cogeneration Salamanca Phase I, and Sureste Wind Energy Phase II) were built, adding a capacity of 529 MW with capital investments worth USD 514 million. Other major electricity projects for public service were either completed or were in progress under different financing mechanisms. These included the upgrade and maintenance of three power plants for USD 839 million as well as several substations and transmission lines projects (SENER, 2015f).

It is also worth noting that the electricity sector has been the major driver for natural gas demand in Mexico, and as this trend continues, several gas pipeline systems were finished or commissioned to strengthen the transmission and supply of natural gas for electricity generation plants across the Mexican territory, particularly its northern and central parts. In June 2015, SENER and CFE announced the tender of 24 projects for electricity and gas infrastructure. These projects are expected to add more than 2 300 km to the economy-wide gas pipeline system and more than 3 000 circuit-kilometres, and involve investments of around USD 9.8 million (SENER, 2015a).

In September 2015, SENER released the Electricity Market Guidelines (Bases del Mercado Eléctrico) for explaining and disseminating the premises for the design and operation of the electricity industry under the changes brought about with the 2013 reform. This instrument recognises the wholesale market figures, which include generators, marketers, transmission and distribution operators, retailers and final consumers. It also establishes the tradability of several products beyond electricity, such as effective capacity, clean energy certificates, auxiliary services and financial rights on transmission.

ENERGY EFFICIENCY

Mexico was able to save more than 5 700 GWh of energy during the first half of 2015 due to several efficiency programs, with many of them being implemented since a long time, including norms and standards in the energy end-use sectors (industrial, residential and commercial), savings on facilities owned by the federal government, public lighting and daylight savings (Horario de Verano) (SENER, 2015f).

In January 2015, the Mexican Government issued the Energy Efficiency Guidelines for the Federal Administration, and in March, CONUEE published specific administrative directions aiming to foster a permanent process of energy efficiency improvement in the buildings, vehicle fleets and industrial facilities of the federal government. These instruments clarify the energy savings criteria applicable to the projects, acquisitions, works and services used or contracted by the federal government. During 2015, the federal government continued implementing initiatives and programs related to the dissemination and training on energy savings and efficiency measures at the federal, state and local levels, and across the end-use economic sectors, mostly through CONUEE.

RENEWABLE ENERGY

Due to its favourable geophysical conditions, Mexico has a promising potential for renewable energy development. The economy has promoted more intensively the development of renewable technologies for power generation, cogeneration and biofuels. By the end of 2014, Mexico's proven annual potential of renewable energy amounted to 1 932 GWh of geothermal, 4 457 GWh of hydro, 15 307 GWh of wind, 8 171 GWh of solar and 728 GWh of biomass (SENER, 2015b). This combined potential is 60% higher than Mexico's current electricity generated from renewable energy.

In June 2015, SENER granted 13 geothermal exploration permits to CFE to support a more advanced use of this energy source in the economy's electricity mix, and in November, the first concession was awarded to a private company. This concession is expected to add between 25 to 50 MW of installed capacity and significant capital investments. In order to provide electricity to 33 rural communities in several states through a microgrid of solar photovoltaic panels, the Integral Energy Services Project under the guidance of CFE continued to benefit 7 400 people. The project ceased operations in October 2015.

Regarding biofuels, in October 2015, a tender was announced for acquiring ethanol for a maximum volume of 2.2 billion litres over 10 years, which is expected to create a relevant opportunity for the production of this additive at a large scale from biomass sources. Up to June 2015, there were 20 permits for its commercialisation and 18 special permits for its small-scale production and storage.

ENVIRONMENTAL SUSTAINABILITY

SENER issued the requirements for acquiring clean energy certificates up to 2018, which fundamentally mandates those users with an intensive use of electric power to prove that at least 5% of their demand comes from clean energy sources, starting from 2018. In March 2015, Mexico submitted its Intended Nationally Determined Contribution (INDC), committing for an unconditional reduction of 22% of its GHG emissions by 2030 in comparison with its Business-as-Usual Scenario 2013 baseline. On a conditional basis, this share might increase to 36% if certain global measures to address climate change are in place (UNFCC, 2015).

In October 2015, PEMEX, along with other nine major oil companies, participated in the Oil and Gas Climate Initiative and in preparation for the COP21 in Paris to discuss global actions on climate change. They declared their collective commitment to support an effective climate change agreement by contributing to decrease the environmental footprint in their operations. In the midst of the COP21, the Mexican Congress hastened the work towards the approval of the long-delayed Law of Energy Transition. Once approved, this law will pave the way towards a more effective energy transition in Mexico, by streamlining and enforcing several mechanisms to make operational the targets to promote a cleaner electricity generation. Combining prior legal instruments, the Law establishes a rapid decoupling from the use of fossil fuels, as it mandates a minimum goal of clean energy in Mexico's total electricity generation at 25% by 2018, 30% by 2021 and 35% by 2024.

INTERNATIONAL COOPERATION

Given the momentum instilled by its energy reform, Mexico was particularly active during 2015 in several international energy events other than APEC.

In compliance with the international policy established by its Ministry of Foreign Affairs, during 2015 SENER promoted bilateral strategic cooperation initiatives with several economies, across diverse energy topics. These economies were Belize, Cuba, the Dominican Republic, Guatemala, the US and Venezuela in the Americas; Denmark, Germany, the Netherlands and Norway in Europe; India and Japan in Asia; and Qatar and South Africa.

On a multilateral level, Mexico participated in and led several dialogues, mainly through SENER. This collaboration included several multilateral organisations, including the United Nations, the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA), the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the International Energy Forum, the Energy and Climate Partnership of the Americas, the Clean Energy Ministerial, the G20 and the Extractive

Industries Transparency Initiative being among the most important. The following are the other major accomplishments during 2015 (SENER, 2015d):

- In late May, Mexico hosted several major energy events in its southern city of Mérida, in the State of Yucatán.
    - Mexico hosted the Second Ministerial Meeting of the Energy Climate and Partnership of the Americas (ECPA). During the event, the Energy Ministers of Chile, Colombia, Costa Rica, Mexico, Peru, Panama and the US announced the creation of a new initiative of the Western Hemisphere to promote clean energy.
        - Within this event, the Energy Ministers of Canada, Mexico and the US also established a trilateral Working Group on Energy and Climate, which supports the implementation of the clean energy and climate change goals of these three economies, in terms of the dialogues in the North American Leaders 2014 Summit, which called for clean and reliable energy supplies to foster economic growth with a low-carbon intensity.
    - Mexico also hosted the Sixth Clean Energy Ministerial Meeting (CEM6), which contributed to reach international agreements to implement energy saving measures in electricity systems and strengthen the cooperation towards a more accelerated energy transition and use of clean energy sources.
    - Within these events in the city of Mérida, the Mexican Federal Government and the IRENA released the report 'Renewable Energy Prospects', which analyses the economy's renewable energy potential and its role to promote an energy mix less concentrated on the use of fossil fuels. The report highlights that under a Business-As-Usual (BAU) scenario, the share of renewable energy in Mexico's final energy consumption would barely amount to 10% by 2030 (IRENA, 2015).
- Consistent with the precepts of the energy reform to bolster the transparency and accountability in the energy sector, particularly under the current institutional arrangement in which both private and public investments are allowed, in June 2015, the Mexican Government formed an inter-ministerial working group responsible for advancing the economy's adherence to the Extractive Industries Governance Initiative (EITI).
- In November, the Mexican Government submitted a request to become a member of the IEA. If accepted, Mexico would be the first Latin American economy to join this organisation.

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Centro Nacional de Control del Gas Natural (CENAGAS)—www.cenagas.gob.mx

Comisión Federal de Electricidad (CFE)—www.cfe.gob.mx

Comisión Nacional para el Uso Eficiente de la Energía (CONUEE)—www.conuee.gob.mx

Comisión Nacional de Hidrocarburos (CNH)—www.cnh.gob.mx

Comisión Regulatoria de Energía (CRE)—www.cre.gob.mx

Comisión Nacional de Seguridad Nuclear y Salvaguardias—www.cnsns.gob.mx

Instituto Mexicano del Petróleo (IMP)—www.imp.mx

Instituto de Investigaciones Eléctricas (IIE)—www.iie.org.mx

Instituto Nacional de Investigaciones Nucleares—www.inin.gob.mx

Instituto Nacional de Estadística y Geografía (INEGI)—www.inegi.org.mx

Petróleos Mexicanos (PEMEX)—www.pemex.com

Presidencia de la República—www.gob.mx/presidencia

Ronda Uno—http://ronda1.gob.mx

Secretaría de Energía (SENER)—www.gob.mx/sener

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Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT)—www. gob.mx/semarnat

Sistema de Información Energética (SIE)—http://sie.energia.gob.mx

NEW ZEALAND

INTRODUCTION

New Zealand is an island economy in the South Pacific, comprising the North Island, South Island and numerous outer islands. While its land area is between that of Japan and the United Kingdom, its low population of about 4.4 million is comparable to a medium-sized Asian city. Due to its remote location, New Zealand has no electricity or pipeline connections to other economies. New Zealand has a mature economy with a per capita gross domestic product (GDP) of about USD 32 526 (2010 USD purchasing power parity [PPP]) in 2013.

New Zealand is self-sufficient in all energy forms except oil. It has a vast renewable energy potential, which in 2013 accounted for 74% of electricity generation, largely from hydro, geothermal and wind. For fossil energy resources, the proven and probable (2P) reserves are more modest, including: 128 million barrels (Mbbl) of oil and liquefied petroleum gas (LPG), 56 billion cubic meters (bcm) of natural gas and 571 million tonnes of coal at the end of 2014 (BP, 2013; MBIE, 2015).

Table 1: Key data and economic profile, 2013

Key data[a, b]		Energy reserves[b, c, d]	
Area (km^2)	269 652	Oil (million barrels)	128
Population (million)	4.4	Gas (billion cubic metres)	56
GDP (2010 USD billion PPP)	144	Coal (million tonnes)	571
GDP (2010 USD PPP per capita)	32 526	Uranium (kilotonnes U)	–

Sources: a. Statistics New Zealand (2014); b. EGEDA (2015); c. MBIE (2015); d. BP (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2013, New Zealand's total primary energy supply (TPES) was 19 178 kilotonnes of oil equivalent (ktoe). Oil was the major contributor (33%), followed by geothermal, wind, solar and others (21%); gas (21%); hydro (10%); coal (8%) and biomass, biogas, waste heat, and others providing the remaining (7%). It is worth noting that geothermal electricity generation has an efficiency of 13% in New Zealand (MBIE, 2015). As such, the geothermal share of the total final energy demand (TFED) is significantly smaller than its primary energy supply share. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2013 was 83%, same as that in 2012, but significantly lower than in 2011 (88%), due to the waning of oil production in recent years. Since 2000, growth in New Zealand's primary energy supply has been modest, increasing at an average annual rate of 1% (EGEDA, 2015).

Coal is New Zealand's most abundant fossil energy resource, predominantly available in the form of lower value lignite. However, almost all coal production comprises sub-bituminous and bituminous coals. In 2013, coal production decreased by 5% on an energy-equivalent basis compared with 2012 as domestic producers competed with cheap imports from Asia (EGEDA, 2015).

Oil is sourced from 19 fields in the Taranaki region in the North Island (MBIE, 2015). The production of crude oil, natural gas liquids and condensate was down by 13% on an energy-equivalent basis in 2013 compared with 2012. Oil production peaked in 2008 underpinned by the coming on-stream of the newest fields Pohokura, Kupe, Tui and Maari, and from the onshore fields such as Cheal and Sidewinder (MBIE, 2015). Most of New Zealand's oil is exported due to its high quality (it is 'sweet' and 'light'). The vast majority of domestic oil demand is met by importing heavier crudes and refining it at New Zealand's only refinery at Marsden Point and importing refined oil products. New Zealand is a net importer of oil, with indigenous production accounting for around 30% of the domestic oil demand in 2013.

Natural gas is sourced from 18 fields currently in production (MBIE, 2013). In 2013, natural gas production increased by 6% compared with 2012 (EGEDA, 2015). The largest uses for gas are industrial heat, electricity generation and in methanol and urea production. All the gas produced in New Zealand is

domestically consumed since there are no liquefied natural gas (LNG) terminals. In 2013, there was a significant increase in gas and LPG remaining reserves (by 31%), with the reassessment of the reserves in the Pohokura, Maui and Mangahewa fields contributing most of to this increase. In 2012, Methanex, which produces methanol with natural gas as feedstock, signed a 10-year gas supply agreement with the Mangahewa field operator.

New Zealand has a large renewable energy potential primarily in the form of hydro, geothermal and wind primarily. Currently the use of this potential is restricted to electricity generation (as explained below). However, geothermal heat is used directly in industry and biomass is used in the residential and industrial sectors as a source of heat. The biomass potential for advanced biofuels production is being examined as this technology advances. Finally, solar is also an area of future development as technology advances and becomes cheaper for deployment and grid integration.

In 2013, New Zealand generated 43 256 gigawatt-hours (GWh) of electricity, a slight decrease from 2012 (EGEDA, 2015). Hydro is the major source of electricity generation, accounting for 54% of total generation in 2013. Hydro production is affected by climatic conditions that influence the amount of rainfall to supply the hydro dams. Geothermal generation accounted for 14% (MBIE, 2015). More than two-thirds of New Zealand's hydroelectricity is generated in the South Island, while all the geothermal electricity is generated in the North Island. It is worth noting that while most hydro generation is in the south island, the main sources of load are in the North Island, requiring significant investment in the inter-island link.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		**Final energy consumption (ktoe)**		**Power generation (GWh)**	
Indigenous production	15 870	Industry sector	4 095	Total	43 256
Net imports and others	4 619	Transport sector	4 584	Thermal	11 101
Total primary energy supply	19 178	Other sectors	3 375	Hydro	23 044
Coal	1 558	Non-energy	1 174	Nuclear	–
Oil	6 387	Total final energy consumption	13 228	Others	9 111
Gas	3 980	Coal	620		
Others	7 253	Oil	5 930		
		Gas	2 160		
		Electricity and others	4 517		

Source: (EGEDA, 2015).

FINAL ENERGY CONSUMPTION

In 2013, New Zealand's total final energy consumption was 13 228 ktoe, just over 2% higher than in 2012. The transport sector consumed 35% of the final energy, while the industry sector consumed 31% the other sector 26% (which includes residential, commercial and agriculture), and the remaining 8.9% was used for non-energy purposes. The final energy consumption was dominated by oil, accounting for 5 930 ktoe (45%), followed by electricity and others (mainly biomass) at 4 517 ktoe (34%), gas at 2 160 ktoe (16%) and coal at 620 ktoe (5%) (EGEDA, 2015).

Industrial energy demand has been relatively flat in recent years at or near 4 000 ktoe for over 10 years, as industry demand is dominated by a small number of large consumers, including: one aluminium smelting plant, one steel mill, one oil refinery, two methanol plants, two cement plants, several pulp and paper mills, and a very large dairy company with several plants. Each of these consumers has a unique consumption profile, for example, the aluminium smelter uses around 15% of electricity demand, the methanol plants consume 29% of natural gas supply as a feedstock, and the pulp and paper industry meets up to half of its energy needs from wood and wood waste.

Transport energy demand has also remained relatively flat and is dominated by road transport in the form of the light passenger vehicle fleet with significant contributions from heavy freight transport, and air transport, while rail and water transport have relatively small shares of consumption. As the fleet gradually improves its efficiency, the savings are offset by an increase in vehicle numbers resulting in stable demand.

The transport sector is the main consumer of petroleum products, accounting for 77% of domestic oil consumption in 2013. Consumption of oil products in the other sectors was shared between industry (13%) and residential, commercial, and agricultural (10%), (EGEDA, 2015).

Energy demand in the others sector is also flat since 2000. In this case, a slowly decreasing population coupled with improving efficiency counteract each other resulting in a flat demand.

ENERGY INTENSITY ANALYSIS

New Zealand's energy intensity of primary energy in 2013 was 133 tonnes of oil equivalent per million USD (toe/million USD), a decrease of 2.5% from 136 toe/million USD in 2012. This is partly due to a stable demand in the previous year while GDP grew by nearly 2.5%. Final energy consumption intensity remained flat at 92 toe/million USD. The energy intensity of the industry sector increased by 0.6%, while that of the transport and other sectors, which includes the commercial and residential sectors, decreased by 1.5% and 3.9%, respectively.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	136	133	–2.5
Total final energy consumption	91.8	91.6	–0.2
Industry	28.2	28.3	0.6
Transportation	32.2	31.7	–1.5
Others sector	24	23	–3.9
Non-energy	7.1	8.1	15

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Business Innovation and Employment (MBIE) was established in July 2012 through the merger of four government ministries: the Ministry of Science and Innovation, the Ministry of Economic Development (formerly responsible for energy policy), the Department of Labour and the Department of Building and Housing. The merger was part of a broader effort to simplify government departments, enhance performance and reduce government spending. MBIE is responsible for developing New Zealand's energy policies and strategies with assistance from several agencies, and it reports to the Minister of Energy and Resources.

New Zealand's oil and gas exploration and production activities are privately owned and open to competition. It welcomes investment in oil and gas exploration by foreign firms. Oil and gas development shows a mixed international ownership including New Zealand companies, major international oil companies and Japanese industrial/energy concerns.

Electricity generation and retailing is also open to competition, although three of the five companies that dominate the market are state-owned. During 2013 and 2014, the government privatised 49% of the three remaining state-owned electricity generators, themselves retaining a controlling stake while enabling private investment in the sector. Transpower is the transmission grid owner and operator, a state-owned enterprise. The New Zealand Electricity Authority oversees the conduct of the electricity market, but does not regulate electricity prices.

The coal mining industry in New Zealand is dominated by Solid Energy, a state-owned firm, with over 80% production in 2014 (MBIE, 2015). Several smaller private operators make up the remaining coal mining industry.

In August 2011, the government released New Zealand's current overarching energy policy framework, the New Zealand Energy Strategy 2011–21: Developing Our Energy Potential (the Energy Strategy) (MBIE, 2012) to replace the 2007 New Zealand Energy Strategy. The new strategy focuses on four priorities: diverse

resource development; environmental responsibility; efficient use of energy; and secure and affordable energy. The Energy Strategy includes the New Zealand Energy Efficiency and Conservation Strategy 2011–16 (NZEECS), which replaces the 2007 version.

ENERGY MARKETS

New Zealand's energy sector has been subject to major reforms since the mid-1980s, coinciding with the introduction of broader economic reforms. The broader reforms aimed to improve economic growth through improved economic efficiency, driven by clear price signals, and where possible, competitive markets. The greatest change occurred in the electricity and gas markets where the vertically integrated utilities were dismantled by separating the natural monopoly and competitive elements; the former government-owned and operated electricity and gas monopolies were either corporatized or privatised; and the electricity market was deregulated.

In April 2009, responding to concerns about rising electricity prices, especially for residential customers and governance arrangements in the electricity sector, the government initiated a Ministerial Review. The review made several recommendations that were included in the Electricity Industry Act 2010 (MED, 2009) and resulted in important changes in the market. A key change resulting from this Act was replacing the Electricity Commission with the Electricity Authority, which has more independence from government and streamlining its activities to focus on developing a healthy competitive market. Responsibilities of the Electricity Commission that overlapped with those of other agencies were transferred to these agencies, for example the promotion of electricity-related energy efficiency, approval of grid upgrades and the management of supply emergencies.

The Electricity Industry Act 2010 has several provisions to promote competition. These include provisions for swapping assets between the three state-owned electricity-generating companies to better align the generation assets of each firm with their market presence, a fund to encourage customers to switch electricity providers and better electricity market hedging arrangements. The Act also has provisions to improve the security of supply. These include rule changes to ensure that electricity retailers do not profit from supply emergencies, and the requirement that a state-owned reserve power station, criticised for distorting market incentives, be privatized so that it could be operated on a commercial basis (NZG, 2010a). This plant was sold to Contact Energy in 2011.

Since 2004, New Zealand's gas sector has been co-regulated by the government and the Gas Industry Company, an industry body established under the Gas Act 1992. The Gas Industry Company pursues the government's objectives and outcomes as outlined in the Gas Act 1992 and the Government Policy Statement on Gas Governance. Its work is driven by ministerial requests and its own engagement with the gas sector (MED, 2014).

FISCAL REGIME AND INVESTMENT

In New Zealand, the ownership of all petroleum resources, including natural gas, rests with the Crown, regardless of the ownership of the land. However, some coal resources are privately owned (Harris, 2004). The New Zealand Petroleum & Minerals (NZP&M) business unit within the MBIE manages the New Zealand Government's oil, gas, mineral and coal resources, known as the Crown Mineral Estate. NZP&M was formed in May 2011 to maximise the gains to New Zealand from the development of its oil, gas, coal and mineral resources, consistent with the government's objectives for energy and economic growth. Its role is to efficiently allocate rights to prospect for, explore for and mine Crown-owned minerals, effective management and regulation of these rights and ensuring a fair financial return to the Crown for its minerals. NZP&M is also instrumental in promoting investment in the mineral estate. It replaces the former Crown Minerals Group. The Resource Markets Policy team of the Resources, Energy and Communication Branch of MBIE, advises the New Zealand Government on policy and operational regulation in the mineral estate.

Corporations earning income in New Zealand were previously taxed at a flat rate of 30% (Inland Revenue, 2012). The tax rate has dropped to 28%, effective from 1 April 2011 (Inland Revenue, 2012). Corporations are also required to pay other indirect taxes such as payroll tax and fringe benefits tax.

For petroleum production, companies must pay an ad valorem royalty of 5% (i.e. 5% of the net revenues obtained from the sale of petroleum) or an accounting profits royalty of 20% (i.e. 20% of the accounting profit of petroleum production), whichever is greater in any given year. For discoveries made between 30 June 2004 and 31 December 2009, an ad valorem royalty of 1% is applied to natural gas, or an

accounting profits royalty of 15% on the first NZD 750 million for offshore projects, or 15% on the first ANZD 250 million for onshore projects (NZP&M, 2014).

For the production of Crown-owned coal, the royalty payable will depend on when the initial permit was awarded. For initial permits awarded between 1991 and 2008, an ad valorem royalty of 1% of the net sales revenue is payable on the net sales revenue between NZD 100 000 and NZD one million. For producers with net sales revenues exceeding NZD one million, the royalty payable is either 1% of the net sales revenue or 5% of accounting profits, whichever is higher (NZP&M, 2014). For initial permits awarded between 1 February 2008 and 23 May 2014, a unit-based royalty of NZD 1.4 per tonne is payable for hard and semi-hard coking coal, NZD 0.8 per tonne for thermal and semi-soft coking coal, and NZD 0.3 per tonne for lignite. For initial permits awarded since 24 May 2014, an ad valorem royalty of 2% of the net sales revenue or 10% of the accounting profits is payable, whichever is higher.

New Zealand has good oil and gas resources potential, but is considered underexplored (Samuelson 2008, Section 5.3). Responding to this challenge, the government has developed an action plan for realising the potential of New Zealand's petroleum resources. The Action Plan for the Development of Petroleum Resources, released in November 2009, aims to ensure that New Zealand is considered an attractive destination for investment in petroleum exploration and production. The plan is based on several work streams, including:

- Reviewing the fiscal and royalty framework to ensure the government receives a fair return from petroleum resources while providing sufficient incentives for investors;
- Investing in data acquisition to improve resource knowledge and foster more investment, particularly in frontier resources;
- Developing a fit-for-purpose legislative framework for the petroleum sector (MBIE, 2012; NZG, 2010b).
- In August 2011, the government announced a new approach for allocating petroleum exploration rights. Previously, New Zealand primarily used a 'first-in, first-served' priority-in-time allocation scheme. Under the new scheme, the government will announce 'block offers' for specific acreage and invite competitive bids to develop them. The goal of this change is to attract significant additional investment to New Zealand while providing the government with more control over where, when, and to whom exploration rights are granted (NZP&M, 2014).

New Zealand's environmental permitting process, known as 'resource consent', is governed by the Resource Management Act 1991 (RMA) and its subsequent amendments. A resource consent is required for any project that might affect the environment, which includes essentially all energy development projects. Resource consents are generally obtained from regional, district or city councils, depending on the nature of the resources affected. The RMA specifies that the guiding principle of decision-making is sustainable management (MFE, 2014).

In December 2008, in response to concerns about the slow and costly consenting process under the RMA, the government reviewed the RMA process. A major criticism of the RMA had been that decision-making was generally delegated to local governments, where local interests can take precedence over economy-wide interests, or where insufficient expertise and resources are available, especially for major, complex projects. The RMA amendment in 2009 addressed this criticism by establishing an Environmental Protection Authority (EPA) to receive resource consent applications for proposals of national significance and to support the boards of inquiry (or the Environment Court) in making decisions regarding these proposals (MFE, 2014).

The Resource Management (Simplification and Streamlining) Amendment Act 2009 also includes provisions to streamline the consenting process. These provisions make it more difficult for competitors to challenge a resource consent application, impose stricter deadlines for decisions by local governments and make procedural changes.

There are also provisions for more effective enforcement and tougher penalties for non-compliance (MFE, 2014). An ongoing Phase 2 Review of the RMA takes on the more complex tasks of better aligning the RMA with other environmental laws and exploring better approaches to urban planning and water management (MFE, 2014).

Further changes to the RMA have been proposed that will build on previous amendments, but may also include more widespread changes primarily designed to address housing affordability concerns.

- In response to the Deepwater Horizon massive oil spill incident in the Gulf of Mexico in June 2010, the government initiated a review of offshore petroleum health, safety and environmental (HSE) legislation. Consequently, in December of that year, the Comparative Review of Health, Safety and Environmental Legislation for Offshore Petroleum Operations Report was released. The report concluded that New Zealand's HSE arrangements for offshore petroleum operations in New Zealand do incorporate several key characteristics of international best practices but there are areas for improvement in the regulatory framework (MED, 2010).

- Responding to the recommendations of the review, in 2012 the government passed the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012. Currently, the RMA regulates operations in New Zealand's Exclusive Economic Zone (EEZ) up to 12 miles at sea, but beyond 12 miles many activities have historically been unregulated. This legislation makes the EPA responsible for the consenting, monitoring and enforcement of activities in the EEZ that have an impact on the environment, including petroleum exploration and marine energy development (NZG, 2011a).

- Since the EEZ Act came into force on 28 June 2013, the EPA has received six marine consent applications: four for discretionary activities (seabed mining and petroleum development drilling) and two for non-notified discretionary activities (petroleum exploration drilling).

- Some stakeholders have raised concerns about these early experiences, particularly about whether the consenting regime allows for an appropriate balance between managing environmental effects in the EEZ and maximising economic opportunities. The government is currently considering these concerns.

ENERGY EFFICIENCY

New Zealand has been promoting energy efficiency for over 20 years and in 2000 it passed the Energy Efficiency and Conservation Act 2000, which led to the economy's first energy efficiency strategy and the establishment of the Energy Efficiency and Conservation Authority (EECA) to spearhead the strategy's implementation (EECA, 2012a).

In August 2011, the government released the New Zealand Energy Efficiency and Conservation Strategy 2011–16 (NZEECS) to replace the 2007 strategy. The overall goal of the new strategy is for New Zealand to continue to improve its energy intensity (energy used per unit of GDP) by 1.3% per year to 2016. In addition, New Zealand is part of the voluntary APEC-wide target to reduce energy intensity by 45% from its 2005 levels, by 2035 (APEC, 2012).

Some of New Zealand's major policies for promoting energy efficiency are as follows.

- In transport, the key policy is fuel efficiency labelling for light vehicles but there is also a program for driver education in the heavy transport sector, and a general support for the electrification of transport. In 2014, New Zealand also launched a tyre-labelling program to promote low rolling resistance tyres, which increase vehicle fuel economy.

- There is no blanket policy for businesses, rather an individual approach is prevalent to support innovative and replicable projects that demonstrate efficiency opportunities, support energy auditing in larger business and promote awareness of energy efficiency in business by recognising energy efficiency excellence through a highly publicised awards event.

- In buildings, a subsidy program to insulate approximately 188 500 homes (over 10% of the housing stock) concluded in 2013 and a follow-up smaller program targeting at-risk households began in 2014. New residential buildings must meet tougher insulation standards last updated in 2007. In commercial buildings in 2014, a rating tool for the buildings' energy and water efficiency was launched to promote efficiency.

- For appliances and equipment, New Zealand has in place an extensive Minimum Energy Performance Standards (MEPS) and labelling program. This initiative is coordinated with Australia (MBIE, 2012).

RENEWABLE ENERGY

New Zealand is well endowed with hydro, geothermal, wind, biomass and, potentially, ocean energy. So much so that all current wind and geothermal capacity was developed without subsidies. Although the state-owned electricity generating companies have played a major role in the development of these resources, they are required to operate as commercial businesses and must compete with private generators (The Treasury, 2011). As part of the Energy Strategy, the New Zealand Government set a target of generating 90% of its electricity from renewable sources by 2025, provided security of supply is maintained. The major instrument to achieve this goal is the Emissions Trading Scheme, discussed in Climate Change (MBIE, 2012).

Hydro has historically been New Zealand's major source of renewable energy. However, the majority of favourable hydro sites have already been developed, and there is a strong social opposition to further hydro developments, thus New Zealand has been focusing on geothermal and wind. Several major renewable generation capacity projects have been consented in recent years but have not been developed due to lower than expected electricity demand. In effect, the next 20 years of the new demand have already been consented and is mostly wind and geothermal electricity.

Another tool employed by the government was the issuing of a National Policy Statement for Renewable Electricity Generation in April 2011. This policy statement requires decision-makers at all levels of government, especially the local level, to recognise the economy-wide significance and make provisions for renewable electricity generation in their plans and policy statements (MFE, 2011).

In the transport sector, a grant of up to 42.5 cents per litre for biodiesel producers ended on 30 June 2012 with very low uptake during its three-year period (EECA, 2012b). In order to promote biofuels, the government is now supporting research, development and demonstration for advanced biofuels projects (i.e. from woody biomass).

Electric and plug-in hybrid electric light vehicles (EVs and PHEVs) are also considered an option to increase renewables in transport, not just as a form of demand but also as a source of storage for intermittent renewable electricity generation. In order to stimulate EVs and PHEVs, they have been exempted from road user taxes until 2020, which for the average user equates to a saving of around NZD 700 per year (NZG, 2011b; MT, 2015). For more information, see the Energy Wise website: www.energywise.govt.nz/your-vehicle/electric-vehicles/regulations.

NUCLEAR ENERGY

Nuclear energy is not legal in New Zealand and there are no plans to revisit this stance in the foreseeable future.

CLIMATE CHANGE

The New Zealand Government supports climate change action and has several policies and initiatives to this effect. The government has adopted a domestic economy-wide target for a 50% emissions reduction in New Zealand's carbon-equivalent net emissions, compared with the 1990 levels, by 2050. Further, for the latest Intended Nationally Determined Contribution (INDC), New Zealand adopted a 30% emissions reduction compared to 2005.

The key climate change intervention is the Climate Change Response (Emissions Trading) Amendment Act of 2008 that established New Zealand's emissions trading scheme. The scheme places a price on greenhouse gas emissions to provide an incentive to reduce the volume of overall emissions. The scheme includes all sectors of the economy and the six gases covered under the Kyoto Protocol under the scheme—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (CCINZ, 2012). However, the entry of the agriculture sector has been delayed indefinitely until there are realistic options for the sector to curb its emissions (Table 4).

The scheme has been in effect since 2008 and was amended in 2009 and 2011. After the amendment, generous free emissions permits were allocated to export-exposed industries in order to preserve international competitiveness. However, the generous grandfathering, the lack of an overall cap, and a two-for-one permit surrendering deal put a downward pressure on the price of carbon, which remained under NZD 5 during 2013, limiting its impact on emission.

For energy, the point of obligation under the scheme generally lies with energy suppliers, not with the end-users. This means that only energy suppliers and a few large industrial facilities are directly involved in

the scheme. The government is providing free units to energy-intensive trade-exposed industries to protect them from international competition that does not face a carbon cost (FL, 2012).

Table 4: Timeframe for entry into the emissions trading scheme

Sector	Voluntary Reporting	Mandatory Reporting	Full Obligations
Forestry			1 January 2008
Liquid fuels (including transport)		1 January 2010	1 July 2010
Stationary energy (including electricity, coal, gas, geothermal)		1 January 2010	1 July 2010
Industrial processes		1 January 2010	1 July 2010
Synthetic gases	1 January 2011	1 January 2012	1 January 2013
Waste	1 January 2011	1 January 2012	1 January 2013
Agriculture	1 January 2011	1 January 2012	No date set

Source: CCINZ (2013).

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY MARKET

In 2014, the New Zealand Government completed the partial privatisation of the three large state-owned energy utilities by selling 49% of each company. This process is expected to raise as much as NZD six to seven billion, which has been reserved for reinvestment in education and infrastructure (FT, 2013).

The electricity sector is grappling with uncertainty in both the demand side from large industrial electric consumers and the supply side through the possible closure of Huntly power station (the only coal plant) and the recent unexpected closure of gas generation. New Zealand's second-largest electricity consumer, a paper mill, reduced output by half and there are concerns about the profitability of the Tiwai Point Aluminium Smelter (TPAS), which accounts for about 14% of New Zealand's total electricity demand. The New Zealand Government supplied a short-term NZD 30 million one-off subsidy to ensure the plant continues to operate for the next few years (NZAS, 2013). However, its long-term future is uncertain as is the capacity at which TPAS will be able to operate over the medium term.

In the supply side, the recent closure of nearly 600 MW of natural gas generation due to a stagnant market and the slated retirement of 500 MW of coal generation by 2018 are pressurising the grid and market operators to ensure security of supply during dry climate periods when hydro generation will be constrained (NBR, 2015). This may spur the development of some of the currently shelved projects, but currently the major players want more security before investing. These closures are partly covered by the completion of the Te Mihi geothermal plant of 166 MW and the Mill Creek wind farm of 60 MW, which were both completed in 2014.

Another development includes the deployment of smart metering devices throughout the market. To date, approximately 1.2 million meters have been replaced out of around 2.1 million (EA, 2015). The key driver resides in operational savings for electricity retailers in terms of not having to employ meter readers and control of certain processes remotely. The newly formed Smart Grid Forum, however, believes that there is potential to expand benefits into streamlining the market, energy efficiency technologies adoption, and greater adoption of renewables, among others (MBIE, 2014b).

NEW PROJECTS

In 2015, no new generation projects were under construction. There are, however, several large-scale wind, geothermal and hydro projects that have regulatory and environmental consent to proceed. However, all the large utility companies have stated that they are unlikely to develop any new large-scale projects for the next several years owing to the current market's oversupply of capacity and tepid electricity demand growth. With continued improvement in the energy intensity demand, growth may be much slower in the medium to long term than seen historically.

The New Zealand grid system operator Transpower, in the past few years, completed several essential major upgrade projects to maintain grid security and keep up with the demand. These include: the NZD 417 million North Auckland and Northland Grid Upgrade Project (completed in 2013); the North Island grid upgrade project (completed in 2012); the NZD 100–300 million Wairakei to Whakamaru Replacement Transmission Line Project, completed in 2013 and the NZD 672 million high voltage direct current (HVDC) Inter-island Link Project, completed in 2014 (Transpower, 2015). Other grid maintenance and upgrade projects worth around NZD 400 million are currently underway. Transpower is also managing a demand response project aiming to develop a market within the New Zealand electricity system.

In the oil and gas industry, the government continues to offer blocks for exploration and the industry is spending around NZD 300 million in multiple sites to explore further resources. However, at present, no significant funds are being developed for production.

In transport, Z Energy is currently building New Zealand's largest biofuel plant with a capacity of 20 million litres per year. It is expected to be operational in early 2016 (Z Energy, 2015). In addition, a consortium led by Z Energy and partly funded by the government is investigating the large-scale production of next-generation biofuels from domestically grown timber.

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USEFUL LINKS

Climate Change Information, Ministry for the Environment—www.climatechange.govt.nz

Electricity Authority—www.ea.govt.nz/

Energy Efficiency and Conservation Authority (EECA)—www.eeca.govt.nz

Environmental Protection Authority—www.epa.govt.nz/Pages/default.aspx

Ministry of Business Innovation and Employment (MBIE)—www.med.govt.nz

New Zealand Government (portal for access to New Zealand government agencies and government-funded websites)—www.newzealand.govt.nz

New Zealand Government (news and speeches from government ministers)—www.beehive.govt.nz

New Zealand Parliament—www.parliament.govt.nz

New Zealand Petroleum & Minerals (formerly Crown Minerals)—www.nzpam.govt.nz/cms

Transpower—www.transpower.co.nz

PAPUA NEW GUINEA

INTRODUCTION

Papua New Guinea (PNG) is located in the south-west part of the Pacific Ocean, just south of the equator. It comprises more than 600 islands, including the eastern half of New Guinea—the world's second-largest island—as well as the Bismarck Archipelago, D'Entrecasteaux island group and the three islands of the Louisiade Archipelago. The mainland and the larger islands are mountainous and rugged, with a string of active volcanoes dotting the northern part of the mainland and continuing to the island of New Britain. PNG has a population of more than seven million, spread across a total area of 462 840 square kilometres (km^2). The natural resource extraction industry, which includes minerals, oil and gas, contributes to approximately 80% of PNG's export income (MRA, 2012).

In 2013, PNG's real gross domestic product (GDP) was estimated at USD 18.4 billion (2010 USD purchasing power parity [PPP]), an increase of 5.5% from 2012.

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b]	
Area (thousand km^2)	463	Oil (million barrels)	175
Population (million)	7.3	Gas (billion cubic metres)	155
GDP (2010 USD billion PPP)	18.4	Coal (million tonnes)	—
GDP (2010 USD PPP per capita)	2 511	Uranium (kilotonnes U)	—

Sources: a. EGEDA (2015); b. CIA (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2013, PNG's net primary energy supply was 2 321 kilotonnes oil equivalent (ktoe), an increase of 6.6% over the value in 2012. Of the total supply, light crude oil and petroleum products accounted for the largest share (75%), followed by gas (5%) and hydro and other renewables contributed the remaining (19%) (EGEDA, 2015).

Production of crude oil in PNG started in 1992 and peaked at over 150 000 barrels per day (bbl/d) the following year. Since then, production has declined to 34 000 bbl/d in 2014 (CIA, 2015), despite exploration activities that resulted in the development of additional oilfields. At this rate, crude oil reserves are expected to be depleted by 2026. Crude oil has been refined locally since the first refinery plant was commissioned in 2004 (Napanapa Oil Refinery, owned by InterOil), which has a refining capacity of 33 000 bbl/d.

PNG remains underexplored and until recently, the natural gas resources have been undeveloped, except for the Hides gas field, which provides 145–155 million cubic metres per year for power generation to supply the Porgera Gold Mine in the central highlands of PNG. However, the PNG liquefied natural gas (LNG) project development was initiated in 2009 to develop these resources.

The PNG LNG Project is operated by Esso Highlands Limited (Company), a subsidiary of Exxonmobil, and is a joint venture between Esso Highlands Limited and Oil Search Limited, Santos, AGL, JX Nippon Oil & Gas Exploration, Minerals Resources Development Company and Petromin PNG Holdings Limited, as well as local landowners. It is a 6.9 million tonnes per annum integrated LNG project sourced from the Hides, Angore and Juha fields, and from associated gas in the Kutubu, Agogo, Moran and Gobe Main oil fields. The PNG LNG Project commenced production in April 2014 and the first LNG deliveries began in May 2014 to Asian customers (PNG LNG, 2014).

In 2013, PNG generated 3 965 gigawatt-hours (GWh) of electricity, a 5.3% increase from 2012. Thermal generation contributed the largest share (64%), followed by hydro (25%) and geothermal (11%) (EGEDA, 2015). The electricity system of PNG is characterised by numerous smaller regional or town-sized generation and distribution network systems without a central transmission network connecting generation and demand. The majority of these are small thermal generation systems, except three hydro locations and two hybrid micro-hydro and diesel systems. Most thermal and hydro power stations are owned and operated by PNG Power Limited (PPL), formerly the PNG Electricity Commission.

PNG also has significant geothermal resources and the first plant was commissioned in April 2003. By 2007, the installed geothermal capacity was 56 megawatts (MW). The Geothermal Energy Association (GEA) estimated a potential 3 to 4 GW of geothermal potential which could, in theory, meet all its electricity needs well into the future from geothermal sources alone (GEA, 2010).

In 2010, the International Renewable Energy Agency (IRENA) estimated that traditional biomass accounted for over half of PNG's energy consumption (IRENA, 2013). However, since there are no recent surveys to track its use and it is not commercial in nature, its use is largely undocumented and therefore not included in the statistics below.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		**Final energy consumption (ktoe)**		**Power generation (GWh)**	
Indigenous production	1 394	Industry sector	640	Total power generation	3 965
Net imports and others	879	Transport sector	538	Thermal	2 546
Total primary energy supply	2 321	Other sectors	257	Hydro	996
Coal	—	Non-energy	—	Nuclear	—
Oil	1 746	Total final energy consumption	1 434	Others	422
Gas	127	Coal	—		
Others	449	Oil	1 133		
		Gas	—		
		Electricity and others	302		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

In 2013, total final energy consumption (TFEC) in PNG was 1 434 ktoe, an increase of 5.7% from 2012. The industrial sector's consumption witnessed an increase of 6.2% from 2012, and it was the largest end user, accounting for 45% of the total, followed by the transport sector with 37%. The other sectors, including agriculture and residential/commercial, constituted 18%. By energy source, petroleum products accounted for 79% of the total consumption, while electricity and other sources accounted for 21%.

In PNG, although around 85% of the population lives in rural areas, electrification remains limited to the main urban areas relying largely on traditional biomass to meet their energy needs. As such, the levels of ownership of electric domestic appliances is low (ADB, 2012) and likely to remain low until the wealth from the resource sector is translated into improved incomes for the population and infrastructure development.

In the 2014 Fifteen-Year Power Development Plan 2014–28, PPL highlights the government key target to extend electricity access to 70% of the population by 2030 by extending generation capacity and developing their transmission and distribution networks (PPL, 2014a). Electricity consumption will increase significantly as these projects develop.

The transport sector faces a similar infrastructure challenge with road services generally limited to the main centres while intercity roads are few and in a state of disrepair. Many locations can only be accessed through coastal or river barges. As such, transport fuel demand will be hampered once road saturation levels are reached. In 2013, transport demand grew by 6% from 2012 to a total of 538 ktoe.

Petroleum products such as diesel, petrol and heavy fuel oil are used in the transport and electricity generation sectors. PPL and the PNG Government, with the assistance of the World Bank, are continuously extending their rural distribution networks throughout the economy, especially within the outskirts of urban areas. PNG aims to increase electricity access to 41% of the population by 2020 and to 70% by 2030 (IRENA, 2013).

The industry sector is expected to show a high growth in consumption as the PNG LNG project develops and commences operations. Given the scale of PNG's economy and energy consumption, this project on its own will impact national level statistics. The remainder of the resource industry is currently under pressure due to the low international prices for oil and minerals (ADB, 2015).

ENERGY INTENSITY ANALYSIS

Given the small size of PNG's economy, intensity patterns can be affected significantly by individual events or trends, and can be volatile. Primary energy intensity in 2013, however, was 127 tonnes of oil equivalent

per million USD (toe/million USD), a slight increase of 1% from 125 toe/million USD in 2012. The increase is potentially due to the increased energy consumption in the industry sector from the LNG development.

The energy intensity of final energy demand was 78.2 toe/million USD in 2013. The energy intensity of the industry and transport sectors remained flat at 34.9 and 29.3 toe/million USD respectively. Regarding the others sector, which includes commercial, residential and agriculture, the value decreased from 2012 by 1.8% to 14.0 toe/million USD.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/ million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	125	127	1.0
Total final energy consumption	78.1	78.2	0.1
Industry	34.7	34.9	0.6
Transportation	29.2	29.3	0.5
Other sectors	14.2	14.0	–1.8

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Papua New Guinea, or the Independent State of Papua New Guinea, is a constitutional, parliamentary democracy and a Commonwealth realm. Jurisdiction over energy matters is the responsibility of the PNG Government's Energy Division within the Department of Petroleum and Energy (DPE).

In 2010, the PNG Government initiated The National Strategic Plan 2010–50, also known as the PNG Vision 2050 (PNG Government, 2010), their overarching development document. The plan has seven pillars encompassing all areas of development with energy under the Environmental Sustainability and Climate Change pillar. The Wealth Creation, Natural Resources and Growth Nodes may also influence energy development as infrastructure develops and demand grows. The key energy-related objectives included:

- Provide 100% electricity generation from renewable sources
- Reduce greenhouse gas (GHG) emissions by 90% from 1990 levels

In March 2010, the PNG Government announced the Development Strategic Plan (DSP) 2010–30 in response to the vision. The DSP 2010–30 also set this goal: All households should have access to a reliable and affordable energy supply, and sufficient power should be generated and distributed to meet future energy requirements and demands (12% of households had access to electricity in 2010).

Since 2011, the Energy Division has authored several draft energy policies pursuant to the strategies and objectives mentioned above. The key draft policies included the National Energy Policy, National Energy Plan, Rural Electrification Policy and Strategy, Geothermal Policy, Renewable Energy Policy and the Electricity Industry Policy (IRENA, 2013). However, not all of them have been finalised and passed by the government. The exploration and development of petroleum resources has also been authorised and administered by the DPE.

In October 2010, the PNG Government announced its Medium-Term Development Plan (MTDP) 2011–15. The MTDP 2011–15 will focus on increasing access to electricity for all households in the member economy government. New investments from the private sector in solar technology are also expected during the period of the first MTDP. A comprehensive analysis will be necessary to analyse the cost effectiveness of the various alternative sources of power.

In 2014, PPL published its Fifteen-Year Power Development Plan 2014–28 with projected areas of growth. It is worth noting that according to this report, in order to achieve the targets indicated in the strategy documents, the government will need a coordinated effort with private sector to develop the infrastructure and generate demand, and source funding.

ENERGY MARKETS

PNG's power authority, PPL, is responsible for generating, transmitting, distributing and retailing electricity throughout PNG. Sections 21 and 23 of the Electricity Industry Act 2000 outline the functions and powers of PPL. Under the Act, PPL's function is to plan and coordinate the supply of electricity throughout the economy, especially in urban areas.

The Act also authorised the Independent Consumer and Competition Commission (ICCC) as the technical regulator of the electricity and petroleum sector, determining standards, carrying out inspections and controlling applications for all matters relating to the operations of electricity supply. The ICCC was established in 2002 to oversee and regulate price and service standard issues relating to utilities such as PPL and selected corporatized government statutory entities. This made it responsible for setting prices or tariffs for electricity and petroleum products. PPL was also corporatised under the Electricity Commission (Privatisation) Act 2002.

Due to the lack of technical capacity to perform this regulatory role, the ICCC outsourced this role to PPL on a contractual basis for an initial period of two years ending in 2005. PPL has an exclusive licence until 31 December 2017 to sell electricity under this contract (PPL, 2014b). PPL sold 1 023 GWh in 2014.

In the latest power development plan (PPL, 2014a), there are provisions for independent power producers (IPPs) to enter the market and develop more competition.

FISCAL REGIME AND INVESTMENT

In September 2003, the PNG Government introduced special fiscal terms to provide incentives for oil and gas exploration in the economy. This was in response to a decline in investments in exploration, as well as the prospect of declining oil production from the Kutubu, Gobe and Moran oilfields between 2003 and 2010.

The special terms are known as 'incentive rate petroleum operations'. They offer a revised income tax rate of 30% of the taxable income, which is lower than the tax rate for income from petroleum projects established before 1 January 2001 (50%), and that for projects established after that date (45%). The new 30% fiscal rate is available for petroleum operations that have a petroleum development licence granted on or before 31 December 2017, and a petroleum prospecting licence granted within the period of 1 January 2003 to 31 December 2007.

PNG has arguably the most competitive terms for oil and gas investment in the region. There is no capital gains tax, and a full (100%) tax deduction is available for exploration expenditure. The PNG Government's equity is set at 20.5% and that of landowners at 2%. The effective royalty rate is 2%, of which the government's share is approximately 50% (Papua Petroleum Limited, 2008).

In 2015, the government started a review of the electricity tariff methodologies to improve the competitiveness of the electricity system.

Investment prospects in PNG are currently hampered by the low prices in the agricultural and natural resources sectors. This is putting pressure on the government's ability to finance projects and its own expenditure.

ENERGY EFFICIENCY

Energy efficiency (EE) policies and regulations are regulated by the Energy Efficiency Division of the DPE. While EE is not currently a major priority for the PNG Government, it might prove to be important if the DSP 2010–30 goals are to be achieved. Since there are only two separate power grids (the Port Moresby grid, which depends heavily on diesel generation and the Ramu grid), urban areas are forced into expensive and inefficient self-generation, and large industries such as mining sites operate using off-grid self-generated power.

In 2014, the Asian Development Bank (ADB) funded the Promoting Energy Efficiency in the Pacific (phase 2) project, which carried out several projects in the Pacific to improve EE, including lighting, solar power generation, EE in hotels and the commercial and public sectors, and data collection. The analysis revealed that in an aggressive efficiency scenario, PNG could save over 30% on the current level of consumption (ADB, 2014). When the potential growth of PNG is considered, that level of saving would improve the possibility of meeting its targets as it reduces significantly the generation and distribution requirements.

RENEWABLE ENERGY

The PNG 2050 Vision states the government's target of 100% electricity generation from renewable sources by 2050. This is a challenge because although PNG's renewable energy potential is very high, its remote

locations and difficult terrain restrict access to the best sites and the development of infrastructure to provide electricity to load centres. Currently, the ageing Rouna hydro scheme in the Port Moresby network represents the majority of renewable electricity. This scheme, however, is ageing and losing capacity. Recent renewable development is limited to privately developed hydro and geothermal generation in mining sites to support their mining operations.

In February 2007, Newcrest Mining Limited commissioned a 20 MW geothermal power plant. This is in addition to a 6 MW geothermal power plant constructed in 2003, and a 30 MW geothermal plant commissioned in 2005. This increased the company's total geothermal generating capacity to 56 MW.

The use of geothermal energy for electricity generation and its expansion of capacity are consistent with the government's goal of promoting green energy (see the 'Climate Change' section) and reducing dependency on fuel oil for electricity generation. The Lihir Mine's geothermal plant generates approximately 40% of its current power requirement and provides free electricity to residents residing near the Lihir mine site. It saves the plant approximately USD two million per year in fuel oil costs (Booth and Bixley, 2005).

The DPE's Energy Division assessed 45 hydro-electricity power sites in 1987 and completed three small hydro systems in 1992. In 2010, the Australian state of Queensland discussed a partnership with PNG to develop a 1 800 MW hydro-electricity power plant on the Pukari River. This plant would make 600 MW available for local use and the majority would go to Queensland through a 350 km undersea cable (IRENA, 2013).

In 2002, the Chinese Government donated 50 small combined wind/solar generators, some of which have been installed at coastal locations (IRENA, 2013).

NUCLEAR ENERGY

PNG has no nuclear energy industry and there are no current plans to develop one.

CLIMATE CHANGE

PNG is directly threatened by the effects of climate change as tropical cyclones are a major hazard and sea level rise threatens its primarily coastal nature. The PNG 2050 Vision and associated strategic documents have included climate change as one of the key pillars for the future. The Office of Climate Change and Development (OCCD) administers PNG's Climate Compatible Development Management Policy (NCCDMP), which is based on the National Strategic Plan.

This strategy aims to achieve GDP per capita of USD 3 000 by 2030, while reducing GHG emissions by 50%. PNG has identified changes to improve land use, land-use change and forestry as the main source of emissions reductions besides the renewable energy target mentioned before. In the strategy, the government intends PNG to become carbon neutral by 2050 (OCCD, 2014).

However, the NCCDMP identifies significant challenges for the delivery and adoption of clean technologies such as geographical barriers and lack of transport access. Furthermore, it identifies the lack of coordination of government strategies and agencies as hampering the government's ability to sustain robust development.

The geothermal power plant (mentioned in the 'Renewable Energy' section) was the first project in PNG to be registered for carbon credit trading under the Kyoto Protocol. The amount of GHG emissions reduced by the geothermal plant is approximately 4% of PNG's total CO_2 emissions (Newcrest, 2012). There are currently nine clean development mechanism (CDM) projects registered with the United Nations Framework Convention on Climate Change CDM Board (OCCD, 2014). DMs allow developed countries to set up emissions reduction projects in developing countries to earn certified emissions reduction credits under the Kyoto Protocol.

NOTABLE ENERGY DEVELOPMENTS

There are several areas of development mentioned in the strategic documents; however, specific project development is limited. The only detailed projects to date are included in the PNG Power Fifteen-Year Power Development Plan up to 2028 and include:

- Generation feasibility studies for several hydro and geothermal sites.
- Transmission and generation improvements in Kimbe, including a 6 MW run-off-the-river hydro scheme.

- Port Moresby System transmission and distribution improvements including connecting 3 000 households and rehabilitation of 8 MW of hydro generation and transmission interconnections to the Ramu system.
- Development of the 80 MW Naoro Brown hydro project.
- Refurbishment of the Ramu 1 Hydro scheme to increase capacity by 15 MW and development of the 240 MW Ramu 2 project, which is in the initial geotechnical studies stage.
- Geothermal energy development document and potentials research.

These developments have a strong component of donor funding such as the World Bank or the ADB. The strategy considers other opportunities such as biomass development from palm oil, new gas potential, hydro potential, including a very large 2.5 gigawatts (GW) potential project that includes a demand creation component.

UPSTREAM DEVELOPMENT

Several international companies have shown a renewed interest in investing in PNG's upstream oil and gas sector in recent years. At the end of 2007, the total number of petroleum prospecting licences was 37, compared with 17 in 2003. The surge in interest has been principally attributed to the September 2003 introduction of internationally competitive fiscal incentives designed to attract oil exploration.

LNG PROJECTS

In March 2008, the project's participants signed a joint operating agreement (JOA) for the PNG LNG Project, namely: ExxonMobil (41.6%), Oil Search (34.1%), Santos (17.7%), AGL, Merlin Petroleum Company (a subsidiary of Nippon Oil) and local landowners. The feed gas is sourced from the Kutubu, Gobe and Moran oilfields as well as the Hides, Juha and Angore gas fields. In May 2008, the joint project's participants and PNG signed a gas agreement. The project aims to export 6.9 million tonnes of LNG from PNG annually. Production began in April 2014, and the first deliveries commenced in May 2014. It is the largest-ever private sector investment in PNG and is expected to increase its GDP by 21% in 2015 (ADB, 2014).

REVIEW OF THE MINING AND PETROLEUM TAXATION REGIME

The International Monetary Fund provided technical assistance to the PNG Department of Treasury to conduct a review of the mining and petroleum taxation in 2013. The review's purpose is to determine the 'appropriateness of the mining and petroleum taxation arrangement compared to similar resource-rich countries' (CTR, 2014).

RENEWABLE ENERGY DEVELOPMENT AND RURAL ELECTRIFICATION

In 2013, the World Bank and the PNG Government signed a four-year agreement for renewable energy development and rural electrification. The project aims to help expand electricity to millions of people in Port Moresby and rural communities, and to develop clean energy options. Assistance will be provided in the form of finance, expert advice and studies to help PPL and the PNG Government. The project will aim to increase electrification rates from below 10% to 70% by 2030 (World Bank, 2013).

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PERU

INTRODUCTION

Peru is a constitutional republic located on the west central coast of South America, bordered by the Pacific Ocean, with Chile to the south, Ecuador and Colombia to the north, and Brazil and Bolivia to the east. With a land area of 1.3 million square kilometres (km^2), Peru is divided into three main geographical regions: the Costa to the west, the mountain region (Andes Mountains) and the Amazon region (Selva), covered by the Amazon rainforest. The economy is divided into 25 political departments (administrative regions). In 2013, the economy had a total population of about 30 million, an increase of 1.3% from the previous year (EGEDA, 2015). By 2014, around 23% of its population was considered poor and 4.3% extremely poor. The major population centre of Peru is the Lima region, which represents nine million people, nearly a third of the total population (INEI, 2015). The urbanisation rate of Peru is 76% (INEI, 2011).

Since 1990, the economy has been driven by its internal demand, mainly private investment, exports and domestic consumption. Peru has a market-oriented economy, and in 2014, its key segments were services (49%), manufacturing and construction (21%), and mining (12%) (BCRP, 2014). Between 2000 and 2013, the AAGR was 5.7% higher than the level reached in 2014 (2.4%) due to the deceleration of the emerging economies and the global uncertainty. This resulted in negative growth rates in total exports (-1%), private and public investments (-1.6% and -2.4%, respectively), and reduction in private consumption growth rate from 5.3% in 2013 to 4.1% in 2014 (BCRP, 2014). Mining is especially important, since Peru is a major global producer, ranking third in silver, third in zinc, third in copper and tin, fourth in lead and sixth in gold (USGS, 2015). Consequently, mineral exports have consistently accounted for a significant share of the export revenue of the economy, being as much as 55% in 2014 (BCRP, 2014).

By 2013, the GDP of the economy reached USD 339 billion (2010 USD purchasing power parity [PPP]), with its GDP per capita growing at 4.4% to reach USD 11 095 (EGEDA, 2015). In addition, the foreign reserves reached a record USD 66 billion while its fiscal balance was 2.2% of the GDP (BCRP, 2014).

Owing to its scarce oil resources, Peru is a net importer of oil. Specifically, domestic production is not only insufficient to meet the economy's demand, but since most crude oil produced is of extra-heavy quality and domestic refineries are unable to process it, a substantial share of the domestic production is exported. In contrast, the proven gas reserves in the economy were 0.4 trillion cubic metres (tcm) in 2013. The Camisea Gas Project is the largest energy project in Peru, which commenced operations in 2004 by supplying gas to the local market. By 2010, Peru started to export through the LNG port located in Pisco (south of Lima).

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b, c, d]	
Area (million km^2)	1.3	Oil (million barrels)	1 400
Population (million)	30	Gas (trillion cubic metres)	0.4
GDP (2010 USD billion PPP)	339	Coal (million tonnes)	9.9
GDP (2010 USD PPP per capita)	11 095	Uranium (kilotonnes of U)	1.4

Sources: a. EGEDA (2015); b. BP (2014); c. MEM (2014); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2013 was 21 515 kilotonnes of oil equivalent (ktoe), a decrease of 2.3% from 2012, due to the lower production of oil and natural gas. By energy source, in 2013, almost half (10 352 ktoe) of the TPES was from oil, 26% from natural gas (5 781 ktoe) and 4% from coal (880 ktoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others constituted the remainder at 21% (4 501 ktoe) (EGEDA, 2015).

The proven gas reserves of the economy were 0.4 tcm in 2013, and are expected to increase to 0.8 tcm by 2025, based on the information from the Ministry of Energy and Mines (MEM) (MEM, 2014). The Camisea Gas Project is located 500 km from Lima, in the region of Cusco. The pipeline has a length of 560

km and passes through the Andes from the Las Malvinas plant (Cusco) to the liquefaction port in Pisco. A second pipeline connects the Las Malvinas plant to Ica and Lima (715 km), and is used to distribute gas to residential and industrial consumers. A third pipeline, with a transport capacity of 1 500 million cubic feet per day (MMcf/D) is under construction from Camisea to the regions of Arequipa and Moquegua in the south of Peru.

The Camisea project was initially aimed to satisfy the domestic demand for natural gas. However, as production levels have increased at an average annual rate of 63% since 2004, this has allowed the development of an export market in the form of liquefied natural gas (LNG), which is sent by ships primarily destined for Mexico, Japan and Europe. In 2013, Peruvian LNG exports from the 'Melchorita' liquefaction plant amounted to 9.5 billion cubic metres (bcm) (Perupetro, 2015).

Peru's proven coal reserves are around 9.9 million tonnes (Mt), with about 95% being constituted by anthracite and the remainder by bituminous coal. The majority of the reserves are located in the La Libertad, Ancash and Lima departments. Peru is a net importer of coal, with 82% of its coal demand in 2013 being met by imports and 18% by domestic production (MEM, 2013).

In 2013, Peru's electricity generation totalled 43 295 gigawatt-hours (GWh), an 8.5% increase from the 39 909 GWh generated in 2012. Of the total, electricity generated from hydropower constituted the maximum share of 53% (22 890 GWh), that from thermal plants accounted for 46% (19 762 GWh) and the remainder was generated from other sources such as biomass and wind (EGEDA, 2015).

In the other energy sectors, other types of biomass (such as firewood, vegetable coal, dung and yareta—a moss-type plant dried and then burned) are used for heating and cooking. In 2013, the renewable sources used for energy supply included firewood (38%), hydropower (48%) and other biomass sources constituted the rest (MEM, 2013).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	23 184	Industry sector	4 942	Total power generation	43 295
Net imports and others	-1 838	Transport sector	7 279	Thermal	19 762
Total primary energy supply	21 515	Other sectors	5 041	Hydro	22 890
Coal	880	Non-energy	704	Nuclear	—
Oil	10 352	Total final energy consumption	17 966	Others	643
Gas	5 781	Coal	573		
Others	4 501	Oil	10 149		
		Gas	1 761		
		Electricity and others	5 483		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

The final energy consumption in Peru grew by 6.5% in 2013, reaching 17 966 ktoe. Transportation was the most dynamic sector, growing 6.8% from the previous year, and representing 41% of the total final energy consumption in 2013. The share of the industrial sector was 28%, while the combined 'other' residential, commercial and agricultural sectors consumed 28%. Accordingly, oil products dominated the total energy consumption in 2013 with 56%, the majority of which was consumed as diesel, gasoline and liquefied petroleum gas (LPG) (MEM, 2013). Electricity constituted 31% of the total end-use energy demand, while gas and coal accounted for the remaining 10% and 3%, respectively (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

Peru's energy intensity has been decreasing since 2012 due to the better use of energy sources. The primary energy intensity of the economy in 2013 was 63 tonnes of oil equivalent per million USD (toe/million USD), decreasing by 7.8% from 69 toe/million USD in 2012. In contrast, the final energy demand increased its energy intensity by 0.7% from 53 toe/million USD in 2012 to 53 toe/million USD by 2013. Industry energy intensity increased from 14 toe/million USD in 2012 to 15 toe/million USD (4%) in 2013, while that of the transport sector increased from 21 toe/million USD in 2012 to 22 toe/million USD in 2013 (0.9%).

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	69	63	-7.8
Total final energy consumption	52.6	53.0	0.7
Industry	14	15	4.0
Transportation	21	22	0.9
Others	15.1	14.9	-1.7
Non-energy	2.2	2.1	-5.5

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In Peru, the organisation responsible for the formulation and evaluation of energy and mining policies as well as the energy sector's guidance is the MEM, which is divided into two sub-ministries: the Vice-Ministry of Energy and the Vice-Ministry of Mines. MEM is also responsible for environmental issues concerning energy and mining activities. Through its General Directorates (Electricity, Rural Electrification, Hydrocarbons, Energy Efficiency, Mining, Energy-Environmental Issues and Mining-Environmental Issues), the ministry covers the major areas of influence in the sector, overseeing its activities and promoting investment to achieve sustainable development. In addition to MEM, the Supervisory Agency for Investments in Energy and Mining (OSINERGMIN), is an autonomous regulatory agency created in 1996, and is responsible for setting electricity tariffs and gas transportation rates. Its goal is to promote efficiency in the power and gas sectors at the lowest possible cost for the customer by designing and implementing effective regulations.

The challenge for Peru is to generate the energy resources needed to support future economic growth, and build the infrastructure that enables their use. The Peruvian Government has prepared the National Energy Plan 2014–25 (MEM, 2014), detailing the policies and objectives to guide the energy policy of the economy. The overarching goal is to have a reliable, continuous and sufficient energy system that can support sustainable development, in part by promoting investments in infrastructure (transport, refinery and production) and exploration.

In 2014, the Peruvian Government presented the Energy Plan 2014–25, whose main goals are as follows (MEM, 2014):

- To provide energy security and universal access to energy supply; and
- To develop energy resources under a social and environmental perspective.

Under the energy efficiency goals, Peru has:

- Established new labelling rules for electrical appliances, water heaters, lighting, electric engines and cauldrons;
- Promoted an Energy Efficiency culture;
- Established an exclusive way for the public transportation system;
- Maximised the use of natural gas in transportation;
- Promoted the substitution between natural gas, LPG and diesel; and
- Strived to maintain energy prices in real terms.

At the same time, the Energy Plan considers the expansion of gas pipelines to cover the entire coastal region. This is expected to increase the consumption of natural gas in Peru by 2025 to reach almost 35% of the final energy demand.

The plan mentions some social indicators as summarised below:

- Electric Frontier: 99% of the population with direct access to electricity;
- Connections to a natural gas grid: 1 800 000 in 2025 versus 164 000 in 2013.

Seeking to become an energy hub in the South American region, Peru is encouraging energy integration projects with Ecuador, Colombia and Chile in electricity, Brazil in hydro, and Bolivia in gas. Peru has electricity interconnection projects with Ecuador through two transmission lines (500 kilovolts (KV) and 220 KV). Agreements with Bolivia intend to support transportation of its gas to the LNG terminal in Peru, which is expected to commence operations by 2018. In electricity, additionally, Peru and Bolivia are undertaking studies to assess the potential to interconnect their own power systems in order to jointly supply electricity to Chile. Finally, Peru and Brazil have a cooperation agreement to generate up to 6 000 megawatts (MW) of hydropower in the Peruvian territory, which would be transmitted to the Brazilian territory (MEM, 2010).

In energy security, in 2012, the Peruvian Government published the Law to Ensure Energy Security and Promote the Development of the Petrochemical Industry (OSINERGMIN, 2012). It states that the government aims to improve energy security by diversifying energy sources, reducing external dependence and boosting reliability of the energy supply chain. Peru has high-energy self-sufficiency, based on the domestic production of natural gas and the potential of hydropower. Despite this, Peru is projected to become more dependent on oil imports as the rapid growth of the transport sector increases the demand. To address this challenge, the government is overhauling the existing facilities of the Talara refinery so that heavy oil can be refined domestically.

The project, with a cost of around USD 3.5 billion, is expected to increase the refinery capacity from 65 000 to 95 000 barrels per day (bbl/d). The government is also encouraging state-owned companies to become active in energy exploration and production projects in the north and east of the economy. The government is reducing the time required to obtain exploration permits and facilitating communication with local communities to help reduce protests against exploration and production of extractive activities.

The Peruvian Government is implementing the Social Energy Inclusion Program aimed to improve the quality of life of the people residing in isolated regions and close to the economy borders. The program intends to increase electricity coverage to cover 2.2 million people by expanding the electricity grid or providing access to non-conventional energy sources. Further, implementation of the Social Energy Inclusion Fund aims to provide 1.2 million low-income families with access to LPG through discount coupons. Finally, the distribution of improved cooking kits aims to encourage a more efficient use of Biomass among low-income families. These improved cooking kits are 50% more efficient in the use of traditional Biomass, reducing CO_2 emissions and reducing the risk of respiratory infections.

Table 4: Energy social inclusion indicators of Peru, Energy Plan 2014–25

	2013	2016	2025
Electricity Access (% population)	90.3	95.8	99.0
LPG Discount Coupons (Families)	645 000	1 200 000	1 200 000
Improved Cooking Kits (Families)	72 000	144 000	500 000

Source: MEM (2014).

ENERGY MARKETS

The Peruvian economy has become more market-oriented following the structural reforms of the 1990s, resulting in the privatisation of the mining, electricity, hydrocarbons and telecommunications industries. Several new laws have established a regime under which domestic and foreign investments are subject to equal terms, and this has encouraged foreign companies to participate in almost all economic sectors. In 1999, Peru passed the Law for Promotion of Natural Gas Industry Development (Law No. 27133), which established specific conditions to promote the development of the natural gas industry, fostering competition and diversifying energy sources to increase the reliability of the energy supply and improve the competitiveness of a productive sector of the economy (El Peruano, 1999).

In 1992, the Peruvian Government issued the Electric Power Concession Law. This law established a new regulatory framework to promote competition and efficiency in generation, transmission and distribution of electric power. This law is very important because it permits to set electricity tariffs based on the marginal costs and free market forces. In this context, the government has enabled the introduction of bidding and incentives for the optimal supply of electrical energy; establishment of a spot market;

modification of the functions held by the Electric Energy Operation and Dispatch Committee (Comité de Operación Económica del Sistema Interconectado Nacional—COES), which is a private, independent operator and planner for the electricity system; and adjustments to the legal framework related to the formation of transmission prices. Finally, an option was implemented for the large electricity customers to negotiate directly with generation and distribution companies to obtain better tariffs for the energy that they demanded.

Peru has two main electrical systems, the North-Central System (which includes Lima) and the Southern System. These systems are interconnected and constitute the National Integrated Electrical System (SEIN), which is fed by hydro and thermal power plants. Since 2012, the SEIN also integrates solar, wind and biomass sources.

In 2013, the SEIN accounted for 85% of the installed power in Peru and 93% of the total energy generation (MEM, 2013). In 2013, 38 companies were responsible for electricity generation—63% private and the rest state companies. In the same period, there were eight transmission and 21 distribution companies (52% private and 48% state companies) (OSINERGMIN, 2013).

The National Energy Policy has stated the goal of developing the natural gas industry and expanding its use. It encourages projects for power generation, prioritising the use of renewable energy (hydro) and natural gas. The next major energy project, a 2 000 MW generation plant using natural gas simple-cycle turbines and located in the southern region, is expected to boost generation in the southern system by around 150%. The project, representing an estimated investment of USD 3.6 billion, is linked to the extension of the pipeline from the Camisea gas field in Cusco to Moquegua and Arequipa. This expansion is a necessary step to integrate Peru with other power markets in the region.

FISCAL REGIME AND INVESTMENT

The Peruvian Government strives to attract foreign investment to sustain economic growth and improve competitiveness. In recent years, Peru has expanded and streamlined the available investment schemes, with particular focus on areas involving exports, infrastructure and services to the population. As such, investments in oil and gas upstream activities are conducted under licence or service contracts granted by the government through the MEM. Some of the conditions in upstream and downstream activities are summarised in Table 5.

Table 5: Investments required according to the Energy Plan 2014–25

Upstream Activities	
Exploration	Authorisation up to seven years.
	The Ministry of Energy and Mines can extend it up to three additional years.
Exploitation	Maximum 30 years for crude oil.
	Maximum 40 years for non-associated natural gas and condensates.
Downstream Activities	
Transportation	Done by ships or pipelines.
	Concession up to 60 years.
Refinery	Authorised by the General Directorate of Hydrocarbons (Ministry of Energy and Mines).
Distribution	Liquid hydrocarbon and similar hydrocarbon by-products require authorisation from the Ministry of Energy and Mines.

Source: E&Y (2014).

The Peruvian Government guarantees legal stability to foreign investors, mainly on income tax regulations and dividend distributions. Additionally, Peruvian laws, regulations and practices cannot discriminate between Peruvian and foreign companies. In that sense, both kinds of companies are equal under the law. There are no restrictions on repatriation of revenues, international transfers of capital, remittance of dividends, interests and royalties.

The production scale methodology sets a percentage for royalties (starting at 5%) over a certain scale of production (i.e. volume of barrels per calendar day) for liquid hydrocarbons and natural gas liquids, and other royalty percentages for natural gas for each valuation period. (E&Y, 2014).

Table 6: Energy investment incentives

Investment Incentives	Tax losses can be carried forward for four years or indefinitely
	Stabilisation agreements
	Value Added Tax exemptions on imports of goods for exploration activities
	Value Added Tax recovery

Source: E&Y (2014).

The Global Competitiveness Report 2013 ranked Peru 61 among 144 countries. According to this ranking, Peru is among the top countries in Latin America in terms of macroeconomic environment, market size, financial market development, labour market efficiency and goods market efficiency (E&Y, 2014).

The increasing energy demand and the abundance of natural gas will challenge the economy to increase energy investments to meet future energy infrastructure requirements. The Energy Plan forecasts that USD 50 billion to USD 53 billion will be required for energy investment, based on the average GDP growth expected until 2025, covering the electricity, gas and oil sectors.

Table 7: Investments required according to the Energy Plan, 2014–25

		GDP 4.5%	GDP 6.5%
Electricity	Generation	6 700	7 300
	Transmission	1 700	1 700
Gas	Upstream	5 200	6 000
	Gas pipelines	11 550	11 680
	Petrochemicals	5 000	5 000
Oil	Upstream	16 000	18 000
	Downstream refineries	3 500	3 500
Total *USD million		49 650	53 180

Source: MEM (2014).

ENERGY EFFICIENCY

In 2009, the MEM presented the Benchmark Plan for Efficient Use of Energy from 2009 to 2018. This plan outlines various projects that are expected to be implemented in the industry through 2018 with potential energy savings of 15% compared to a scenario without energy efficiency measures. This plan calls for the replacement of lighting systems, boilers and engines, as well as implementation of a labelling scheme for computers. To date, the implementation of the plan has been delayed due to shortage of audit firms and a lack of incentives.

In 2000, the government passed the Law for the Promotion of the Efficient Use of Energy (Ley de Promoción Del Uso Eficiente de la Energía), Law No. 27345. Consistent with this legislation, and with the 2007 Supreme Decree No. 053–2007–EM, the Peruvian Government, through the President, created significant initiatives to support energy efficiency through few mechanisms. These included DS–No. 034–2008–EM of 19 June 2008 (Energy Saving Measures in Public Services), and RM No. 038–2009–MEM/DM of 21 January 2009 (Energy Consumption Indicators and their Monitoring Methodology). Through the Supreme Decree No. 034–2008–EM of June 2008, the Peruvian Government promoted energy-saving measures in the public sector, such as replacing less-efficient incandescent lamps with compact fluorescent lamps and acquiring equipment with energy efficiency labels.

In September 2009, the government, through MEM, organised a workshop on the efficient use of energy, during which the Referential Plan for the Efficient Use of Energy 2009–18 was approved. This is the main instrument to achieve the energy efficiency goals of the economy through action plans proposed for each sector (MEM, 2009). The Referential Plan aims to reduce energy consumption by 15% from the 2007 levels by 2018 through energy efficiency measures. The plan includes an analysis of energy efficiency in Peru and identifying sector programs that could be implemented to achieve the proposed targets.

In workshop discussions, the following actions were identified as current priorities:

- Reinforce strategic alliances with other economies to promote electricity security, efficient use of energy and environmental protection;
- Develop tax benefits for private companies that operate with efficient technologies;
- Strengthen the Energy and Mines Regional Offices (DREMs) to enable them to implement the Referential Plan;
- Use renewable energies according to the geography and climatic conditions of several regions; and
- Obtain the commitment of the mining and energy sectors to being role models of efficiency.

In May 2010, the Peruvian Government created the DGEE within the Vice-Ministry of Energy (through Supreme Decree No. 026–2010–EM). The DGEE serves as the technical regulatory body, proposing and assessing energy efficient use and production while also covering non-conventional renewable energy issues. The DGEE also leads the energy planning of the economy, and is responsible for developing the National Energy Plan.

RENEWABLE ENERGY

The Renewable Energy Policy in Peru promotes the use of solar, wind, geothermal, biomass and mini hydro (<20MW) energy sources. Peru has established goals to increase renewable energy use and has developed a legislative and policy program to support their development. Electricity generation from renewable resources is being expanded from an already significant reliance on hydropower generation.

By 2006, Law No. 28876, to promote the use of renewable energy, provided an advance tax reimbursement on the electricity sales of renewable energy-based utilities. In 2008, Law No. 1058 was passed, which allows tax benefits to investment participants in electricity generation based on renewable energy (including hydro), by accelerated depreciation of their investments by up to 20% per year, in order to improve the projects' feasibility (MEM, 2010). Finally, the Law on Promotion of Investment for Electricity Generation with Renewable Energies (Law No. 1002), was enacted in May 2008, and the Regulations for Generation of Electricity with Renewable Energies (Supreme Decree No. 050–2008–EM) were issued in October 2008. Some of the incentives provided by the law are (El Peruano, 2008a, 2008b):

- A five-year target for the share of domestic power consumption to be generated from renewable energy sources, excluding large hydropower generation (i.e. less than 20 MW of installed capacity);
- A firm price guaranteed for bidders who are awarded energy supply contracts for up to 20 years; and
- Priority in loan dispatch and access to networks.

To achieve these goals, MEM established open auctions for renewable energy suppliers to ensure competitive conditions for the electricity generators and their customers. By 2015, the total generation capacity and average cost by technology were as follows:

- Wind: 232 MW at USD 78 per megawatt-hours (MWh).
- Mini Hydro: 496 MW at USD 56 per MWh.
- Photovoltaic: 96 MW at USD 173 per MWh.

Table 8: Generation Potential

Renewable Energy Source	Potential (MW)	Installed Capacity (MW)
Photovoltaic[a]	540	96
Wind[b]	22 000	232
Hydropower[b]	69 000	391
Biomass[b]	177	27
Geothermal[b]	3 000	-

Source: a. IFC (2011) b. MEM (2014).

NUCLEAR ENERGY

Although Peru does not use nuclear energy for electricity generation, a government-run nuclear program has been operational since 1975. This program involved constructing basic infrastructure, human resources training and the establishment of the Peruvian Institute of Nuclear Energy (IPEN) as part of the MEM. The mission of the IPEN is to promote and develop research in nuclear application to civil purposes to improve the competitiveness of the economy and the quality of life of its inhabitants. Peru has been a member of the International Atomic Energy Agency since its creation in 1957.

CLIMATE CHANGE

As part of its environmental strategy policy, in October 2003, the Peruvian Government, by the Supreme Decree No. 086–2003–PCM, approved the National Strategy on Climate Change (NSCC) for the mitigation of an adaptation to climate change (El Peruano, 2003). The main objectives of the NSCC are to reduce climate change impacts through integrated studies on vulnerability and adaptation, and to control both local pollution and greenhouse gas (GHG) emissions by using renewable energies and energy efficiency programs in production sectors.

Peru accounts for 0.1% of the world's GHG emissions (CAIT, 2012). Based on the Intended Nationally Determined Contribution (INDC), Peru is aiming to reduce GHG emissions by 30% by 2030 compared with the Business-As-Usual (BAU). The absolute reduction is estimated at 90 million tonnes of CO_2 equivalent, with 50% of this reduction being in the forestry sector, including land use, land use change and forestry (LULUCF) (UNFCCC, 2015).

NOTABLE ENERGY DEVELOPMENTS

In September 2015, the MEM modified the Electricity Regulation on Distribution to Promote the Energy Access Act to include the possibility of a feed-in tariff system for those who generate their own electricity based on non-conventional renewable technologies. This modification is awaiting the new regulation and it is expected to be approved by the first part of 2016. Additionally, during March 2016, the MEM also approves the project that allows the exports of electricity surplus generation to other economies. This project has to be approved in the Peruvian Congress before the end of 2016.

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USEFUL LINKS

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Banco Central de Reserva del Perú—www.bcrp.gob.pe

Comité de Operación Económica del Sistema Interconectado Nacional—www.coes.org.pe

Instituto Nacional de Estadística e Informática—www.inei.gob.pe

Instituto Peruano de Energía Nuclear—www.ipen.gob.pe

Ministerio del Ambiente—www.minam.gob.pe

Ministerio de Economía y Finanzas—www.mef.gob.pe

Ministerio de Energía y Minas—www.minem.gob.pe

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Programa de Adaptación de Cambio Climático—www.paccperu.org.pe

Proyecto Camisea—www.pluspetrol.net/camisea.html

THE PHILIPPINES

INTRODUCTION

As an archipelago, the Philippines comprises 7 107 islands, covers a total land area of 300 000 square kilometres (km^2) and its coastline extends to about 36 289 kilometres. It is located in the south-eastern part of Asia, bordered by the Philippine Sea in the east and west, the Luzon Strait in the north and the Celebes Sea in the south. The economy has three major geographical divisions, namely: Luzon, Visayas and Mindanao islands. Manila, located in Luzon, is the capital of the Philippines and is one of the 70 largest cities in the world based on United Nation report (UN, 2014). In 2013, the economy's total population was 97.6 million, up by 1.6% from 2012. Based on the 2014 World Population Ranking, it is the twelfth most populated economy in the world and the seventh in Asia (WB, 2014).

The Philippine economy is moving towards inclusive growth with a 7.2% increase in gross domestic product (GDP), from USD 569 billion in 2012 to USD 610 billion in 2013 (2010 USD purchasing power parity [PPP]) (EGEDA, 2015). This remarkable growth was mainly driven by the service sector, which accounted for almost 60% of the GDP. The combined effects of a robust domestic trade and the boom in the real estate business helped augment the aggregate value-added in the service sector by 7%. Meanwhile, the industry sector contributed about 33% to the economy's total output. This could be attributed to the increased manufacturing output as well as the rebound in public construction due to the much needed government stimulus in infrastructure spending. The Agriculture, Fishery and Forestry (AFF) sector, which had the least contribution to GDP at 11%, grew by 1.1% owing to the increase in rice production output attributed to the expansion in the area harvested and improvement in yield, despite the several typhoons that plagued the economy in 2013 (Navarro and Llanto, 2014). Further, the GDP per capita income also exhibited significant growth, registering an increase of 5.5% from the 2012 level of USD 5 926 (EGEDA, 2015). The revival in investments and the buoyant external trade contributed to the healthy growth of the economy during the period (PSA-NSCB, 2014).

With the positive economic outlook of the Philippines, the rating agencies Standard and Poor's and Fitch and Moody's upgraded the credit ratings of the economy to that of 'stable outlook' (high quality with very low/minimal credit risks) (Official Gazette, 2014). Likewise, the economy's ranking by the World Economic Forum had improved from being 65th out of 144 countries in 2012 to 59th out of 148 countries in 2013 (Navarro and Llanto, 2014).

The robust economic development poses a challenge to the government to meet the growing demand for energy. Harnessing the domestic energy resources remains a priority policy of the government as this will not only bring in additional investments in the economy but will also significantly reduce reliance on imported fuels as well as achieve its goal of increasing the self-sufficiency level. The continuous implementation of the Philippine Energy Contracting Round (PECR) is a measure to attract investments in the exploration and development of oil, gas and coal resources in the economy. The economy has modest proven reserves of around 76 million barrels of oil (includes condensate), 24 billion cubic metres (834 billion cubic feet [Bcf]) of natural gas and 440 million tonnes (Mt) of coal (DOE, 2015a). On the other hand, the economy's renewable energy resources contribute significantly to its energy mix. Since the passage of R.A. 9513, otherwise known as the Renewable Energy Act of 2008, the Philippine Government has awarded 617 renewable energy service/operating contracts with a total aggregate capacity of 15 233 megawatts (MW) (DOE, 2015j).

Table 1: Key data and economic profile, 2013

Key data[a, b]		Energy reserves[c]	
Area (thousand km^2)	300	Oil (million barrels)	76
Population (million)	97.6	Gas (billion cubic metres)	24
GDP (2010 USD billion PPP)	610	Coal (million tonnes)	440
GDP (2010 USD PPP per capita)	6 250	Uranium (kilotonnes of U)	–

Sources: a. WB (2014); b. EGEDA (2015); c. (DOE, 2015a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The economy's total primary energy supply (PES) in 2013 grew by 7.3%, reaching 45 783 kilotonnes of oil equivalent (ktoe) from the 2012 supply level of 42 668 ktoe (EGEDA, 2015). More than 56% of the economy's energy requirement was sourced locally, largely from renewable energy and coal, which significantly improved its self-sufficiency level by 1.5 percentage points from the 55% level in 2012. Oil remained a dominant energy source, accounting for about 30% of the economy's primary energy supply mix. The growing oil demand for transport and households constitutes the bulk of the economy's primary oil supply requirement. However, the total primary oil supply decreased by 0.8% from 13 826 ktoe in 2012 to 13 715 ktoe in 2013. The decrease was attributed to the reduction of oil demand in the household sector, being the most vulnerable to oil price escalation (DOE, 2014a). Coal followed next, contributing 22% to the PES, posting an increase of 7.4% in 2013 (10 000 ktoe) from the level in 2012. On the other hand, production of natural gas from the Malampaya gas field decreased by 2.3% from its 2012 level to 3 066 ktoe in 2013. During the same period, the aggregate share of renewable energy resources was registered at 42% of the PES. Wind, geothermal and hydro production levels exhibited a decline of 13%, 6.3% and 2.3%, respectively. Production of other renewables such as solar and biomass increased by 7.1% and 2.9%, respectively (DOE, 2014a).

FOSSIL ENERGY

The Philippines relies on energy imports, specifically fossil fuels, to meet its energy demand requirement. The economy's net imports increased by 4.7% from 19 632 ktoe in 2012 to 20 555 ktoe in 2013. The bulk of the energy imports were oil and oil products, constituting about 67% of the total, while the remaining was contributed by coal (32%), and biofuels (1%).

The hike on energy imports was mainly due to the increasing demand for coal in the power generation sector. Coal imports increased by 49% in 2013 from the 2012 level, and was sourced mostly from Indonesia, Australia and Vietnam. On the other hand, local coal production decelerated by 3.5% from 3 879 ktoe in 2012. The decrease in the production output of the economy's major coal producer (Semirara Mining Corporation) significantly affected the production level. Unprofitable operations of other major domestic coal producers from Zamboanga and Cebu also contributed to the declined production level of indigenous coal in the economy (DOE, 2014a).

RENEWABLE ENERGY

Renewable energy sources contributed substantially to the economy's supply mix, contributing 40% to the TPES in 2013. Geothermal provided the bulk of the renewable energy contribution, about 32%, to the total indigenous primary energy supply. Biomass, which is mostly utilised in the residential sector, contributed 29% to the total. Meanwhile, hydro's share in the indigenous energy supply was 9.8% in 2013, with a decline in production due to the "El Niño" (drought) causing reduced availability of water. Solar and wind, which had the smallest contribution, are expected to increase their respective shares in the future with a growing number of awarded contracts issued by the government. Wind contribution increased with the installation of an additional 283 MW wind power plant in 2014 (DOE, 2014a).

As a government priority policy, greater private sector involvement will be promoted and intensified for the development and utilisation of the economy's vast renewable energy potential. As stipulated in the National Renewable Energy Program (NREP), the economy intends to triple the 2010 renewable energy-based installed capacity as an aspirational target. This is intended for power generation, as well as its contribution to non-power applications to increase the share of renewable energy in the primary energy mix by 2030 (DOE, 2013).

ELECTRICITY GENERATION

The economy's total electricity generation in 2013 grew by 3.2%, from 72 922 gigawatt-hours (GWh) in 2012 to 75 266 GWh. Coal remained the dominant source of electricity, especially for baseload accounting, for more than 42% of the economy's total power supply in 2013. Natural gas continued to contribute significantly to the economy's total electricity generation (25%). However, power generation from natural gas declined slightly by 4.3% during the same period due to the decrease in production of the Malampaya gas field, which affected the power generation of three natural gas-fired power plants. On the other hand, the aggregate level of renewable energy in power generation decreased by 4.1% in 2013, from 20 762 GWh in 2012. This is mainly due to the decreased production output from geothermal and hydropower-based plants, about 6.2% and 2.2% respectively, from the 2012 levels. Hydro and geothermal both contributed 13% each to the total power generation mix, lower by one percentage point from the previous year's level.

Similarly, wind also exhibited a drop in power generation by 15%. Only solar and biomass posted an increase in their generation in 2013, 8% and 15%, respectively (DOE, 2014c).

Table 2: Energy supply and consumption, 2013

Primary Energy Supply (ktoe)		Final Energy Consumption (ktoe)		Power Generation (GWh)	
Indigenous production	25 812	Industry sector	6 299	Total power generation	75 266
Net imports and others	20 555	Transport sector	8 466	Thermal	55 363
Total primary energy supply	45 783	Other sectors	11 625	Hydro	10 019
Coal	10 003	Non-energy	314	Nuclear	–
Oil	13 715	Total final energy consumption	26 704	Others	9 884
Gas	3 066	Coal	2 196		
Others	18 999	Oil	12 249		
		Gas	67		
		Electricity and others	12 192		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

The sturdy growth of the Philippine economy was reflected in the 13.6% increase in the economy's total final energy consumption (TFEC), from 23 502 ktoe in 2012 to 26 704 ktoe in 2013. All economic sectors exhibited an increase during this period, with transport and industry still being the largest energy-consuming sectors. Energy use in the transport sector, which accounted for 32% of the TFEC, increased by 4.4% in 2013. This was attributed to the increased utilisation of gasoline, diesel and ethanol for public transport, as well as jet fuel for domestic aviation. Meanwhile, the increase in production output of the industrial sectors, particularly in the cement and basic metal industries, increased its aggregate energy requirement by 9.9%. The other sectors' energy consumption accounted for an aggregate share of 45% in 2013 (DOE, 2014a).

Petroleum products continued to be the major fuel for the economy, accounting for 46% of the total energy demand, as its demand level increased by 6%, from 11 556 ktoe in 2012 to 12 249 ktoe in 2013. Similarly, electricity and others (biomass) remarkably expanded by around 21%, contributing an aggregate share of 46% to the total.

ENERGY INTENSITY ANALYSIS

The GDP growth rate of 7.2% in 2012 (2010 USD PPP) increased the total primary supply requirement of the economy by 7.3%. This could be translated into an economy-wide primary energy intensity level of 75.1 tonnes of oil equivalent per million USD (toe/million USD) in 2013 with a minor increase from 2012.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	75.0	75.1	0.1
Total final energy consumption	41	44	6.0
Industry	10.1	10.3	2.5
Transportation	14.2	13.9	–2.6
Other sectors	17	19	14
Non-energy	0.2	0.5	120

Source: EGEDA (2015).

In terms of final energy demand, the intensity level increased from the 2012 level. Among the sectors, the non-energy sector registered the largest increase, specifically triggered by oil-related products used for petrochemical processing. Other sectors and industry sector followed next with both posting an increase from previous year's level. The other sectors' demand increased by 14% due primarily to mid-term election held in 2013, which required additional energy demand for the production of campaign materials and other

related activities needing energy. Similarly, the industry's energy demand could also have been affected by the election period. Only the transport sector posted a decrease in intensity as the continuous increase in petroleum prices made several vehicle owners more judicious in fuel use, as well as the adoption of more fuel-efficient vehicles.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Cognizant that energy is an economic driver to fuel local productivity and boost countryside development, the Department of Energy (DOE) has been continuously implementing and intensifying its plans and programs directed at attaining energy security and bringing reliable and affordable energy services to the greater populace. The Philippine Energy Plan 2012–30 has outlined several measures being undertaken by the government and energy stakeholders in creating a sustainable future with less carbon footprints. Specifically, the Plan outlines the following policy thrusts with specific goals and targets that are to be achieved within the planning period 2012–30:

a. Ensure energy security
   - Triple the capacity of renewable energy by 2030 (from 5 438 MW in 2010 to 15 304 MW by 2030).
   - Promote indigenous fossil fuels.
   - Ensure reliable and efficient power supply.

b. Expand energy access
   - Achieve 90% household electrification by 2017 and 100% local electrification level for sitios (an administrative-territorial category in the Philippines) by 2016.
   - Ensure transmission system reliability and integrity.

c. Promote low-carbon future
   - Achieve 10% energy savings on total energy demand.
   - Achieve 30% of all public utility vehicles running on alternative fuels.

d. Climate-proof the energy sector
   - Promote a climate-change-resilient energy sector.

e. Promote investments in the energy sector
   - Operationalise a one-stop-shop for energy projects.
   - Strengthen closer partnerships with local government units (LGUs) and industry players.

f. Develop regional energy plans
   - Formulate more responsive geographic plans (DOE, 2013).

ENERGY MARKETS

OIL AND GAS

To boost exploration and development of the economy's 16 sedimentary basins (with combined oil and gas reserves of 4 777 million barrels of oil equivalent (MMBOE) or 690 million tonnes of oil equivalent [Mtoe]), the DOE has been constantly conducting the PECR to provide a transparent and competitive system of tendering onshore and offshore oil and gas blocks for exploration to both local and foreign investors. In 2014, the PECR5 was launched, which offered 11 petroleum potential areas in the economy to prospective investors. In the same year, the DOE supervised and monitored 29 existing petroleum service contracts (DOE, 2015e).

Production from the existing oil and gas fields of the economy yielded about 1.9 million barrels (Mbbl), 124 Bcf of natural gas and 4.1 Mbbl of condensate in 2013. A reduction of 4.3% was observed in oil production, including condensate, during this period due to the shutdown of the Galoc field during the months of August and September in preparation for the production line and tie-in of the two new wells

from Galoc 5 and 6 (DOE, 2014b). Likewise, the economy's natural gas producing fields, Malampaya and Libertad, produced an aggregate of 124 Bcf in 2013, which is 7.9% lower compared to the 2012 level of 135 Bcf. The 30-day shutdown of the Malampaya gas production facility and the 24-day halt in the operation at the Libertad gas field in Cebu contributed to the decreased production of natural gas. This was also coupled with the repair and maintenance activities at the Ilijan, San Lorenzo, and Sta. Rita natural gas power plants in Batangas City, which are the major users of Malampaya gas, and the stoppage in the operation of the 1 MW Desco natural gas plant in Cebu (DOE, 2014a).

COAL

The Philippines also has 13 coal basins with an estimated total resource potential of 2.4 billion metric tonnes. The largest coal resources are found in Semirara in Antique (Visayas) with a total potential of 570 Mt.

As coal remains a dominant source of fuel in the economy, efforts for expanding the utilisation of the vast domestic coal reserves are continuously being pursued. Greater partnerships between the government and the private sector are extensively promoted to encourage investors to explore the coal resource potential of the economy. The newly awarded 22 exploration contracts during the conduct of PECR4 in 2011 (15 contracts) and PECR 5 in 2014 (seven contracts) are expected to boost the coal reserves in the economy (DOE, 2015e). Currently, a total of 75 coal-operating contracts (45 exploration and 30 development/production) are being monitored and supervised by the DOE to ensure timely completion of the proponent's work program.

In 2013, the total coal production reached 7.1 Mt of coal, lower by 4.3% from the 2012 level of 7.4 Mt. The bulk of the production was from Semirara contributing 96% to the total. However, its production together with that of other coal basins in Zamboanga and Cebu, including small-scale mines, had decreased considerably due to unprofitable operations as a result of the low price of coal. Several contract holders were also cancelled/terminated due to breach of contract obligations, while other contracts did not follow through with the operation because of market problems and high operating costs.

MARKET REFORMS

ELECTRICITY

The Philippine Government continuously oversees and pursues the implementation of power sector reforms in accordance with the Republic Act 9136 or the Electric Power Industry Reform Act (EPIRA) of 2001. Consistent with Section 31 of the EPIRA, the operating and regulatory policies and guidelines for the implementation of the Retail Competition and Open Access (RCOA) were established to provide guidance to retail market participants and to ensure a smooth transition. Full commercial operation of RCOA commenced on 26 June 2013 with a total of 275 registered participants (DOE, 2014b). The RCOA is being implemented to improve competition in the generation and supply sector, which is seen to result in competitive tariffs for electricity.

The DOE has consistently monitored and supervised the operation of the Wholesale Electricity Spot Market (WESM) under the Philippine Electricity Market Corporation (PEMC). In 2013, the integrated WESM (Luzon and Visayas) had a total of 246 registered participants comprising 54 generating companies and 192 customer-trading participants (DOE, 2014b). In order to facilitate the inclusion of the ancillary services requirement of the power grid in the WESM operation, the DOE issued Department Circular (D.C.) 2013-02-0027 in December 2013 '*Declaring the Commercial Launch for the Trading of Ancillary Services in Luzon and Visayas under the Philippine Wholesale Spot Market'*. As stated in the D.C., the Reserve Market will have to commence commercial operations in March 2014 after all requisite systems and procedures are already in place (DOE, 2014b). On 26 February 2014, the PEMC launched the Trial Operation Plan (TOP) comprising two phases. The first phase involves testing the protocols, procedures and interfaces development for the Market Operator-System Operation and Reserve Market Working Group, as well as resolving the remaining operational issues. Meanwhile, the second phase (the main TOP) involves the demonstration of operations of the Reserve Market and familiarisation of trading participants in all processes. To further prepare the market participants, the DOE issued D.C. 2014-03-0009 *'Declaring a New Commercial Launch Date for the WESM Reserve Market and Directing PEMC to Develop a Protocol for Central Scheduling and Dispatch of Energy and Contracted Reserves'* (DOE, 2015e). It is envisioned that the Reserve Market will benefit the power industry with the co-optimisation of energy and reserves. This would help achieve greater competition among energy and reserve providers that could lead to transparent and competitive energy prices. Likewise, the Reserve Market will also facilitate the entry of renewable energy in accordance with the Renewable Energy Act of 2008.

The DOE has implemented several programs as part of their sustainable solutions to address the power shortage in Mindanao (southern part of the Philippines) to provide stakeholders with the power of choices and draw in available energy resources and untapped power capacities for additional supply to the

grid. The roadmap for sustainable solutions to Mindanao includes the establishment of a market for transparent and efficient utilisation of available power capacities. This market would encourage participation of existing power generating capacities and interruptible loads, and entry of new generating capacities in Mindanao. To establish such a market, the DOE directed the PEMC to develop and implement an Interim Mindanao Electricity Market (IMEM) and correspondingly issued D.C. 2013-05-0008 in May 2013 *'Promulgating the IMEM Implementing Rules'* and D.C. 2013-09-0023 in September 2013 *'Declaring the Launch of IMEM and the Terms and Conditions for the Commencement of the Full Commercial Operations of IMEM'*. The said Circular had set the dates for the initial and full commercial operation of IMEM in September and November 2013, respectively (DOE, 2014b). To strengthen the operation of IMEM, the IMEM Rules were amended in May 2014 to include 'Demand-side bidding and transitory arrangement' (DOE, 2015e).

The Interruptible Load Program (ILP) is another measure being implemented in Mindanao. Under this program, customers of a distribution utility (DU) will be compensated for voluntarily de-loading itself from the grid by operating its generation facility for its own use during peak demand hours. The DU will then charge and collect from the customers within its franchise area the corresponding energy 'freed up' (in kilowatt-hours) by the ILP customers. This will be used to pay these customers based on the Energy Regulatory Commission-approved ILP rates (DOE, 2015b). Initially, the program was implemented to solve the power shortage issues in the Visayas and Mindanao islands, but with the tight power supply in Luzon Island during the summer months of 2015, it was also implemented there.

Aimed at enhancing the operations of the National Electrification Administration (NEA) and the economy's electric cooperatives (ECs), President Aquino enacted on 07 May 2013 the Republic Act No. 10531, otherwise known as *'An Act Strengthening the National Electrification Administration (NEA), Further Amending for the Purpose of Presidential Decree No. 269, as Amended, otherwise known as the National Electrification Administration Decree'*. This Act provides greater accountability for NEA as the regulator of ECs with the additional mandate to supervise the operation of problematic ECs towards the goal of improving its operational parameters and standards. The new law has the following objectives:

i. Promote sustainable development in rural areas through rural electrification;

ii. Empower and strengthen NEA to pursue the electrification program and bring electricity through the electric cooperatives as its implementing arm, and to the countryside even in missionary or economically unviable areas; and

iii. Empower the ECs to cope with the changes introduced by the restructuring of the electric power industry pursuant to RA 9136.

It has been a challenge for the government to provide greater access to electricity in some areas that are isolated from the grid. Due to the geographical landscape of the economy, the government has devised and implemented mechanisms to energise these areas through a decentralised RE system such as photovoltaic solar home system (PV-SHS) and micro-hydro systems. The Qualified Third Party (QTP) is another electrification program of the government, which opens up unviable areas for private sector investment, intending to provide an integrated power generation and distribution service to the households. By the end of 2013, the household and sitio electrification levels were already registered at 79% and 74%, respectively (DOE, 2014b).

OIL

As mandated under Republic Act 8479 or the Downstream Oil Industry Deregulation Act of 1998, the DOE ensures a continuous, adequate and stable supply of oil in the economy. As such, monitoring the cost of crude and product imports/exports, local production, industry demand, inventory levels, distribution and marketing facilities, and other downstream capability statistics continue to be a major undertaking of the department. These will facilitate prospective investors to engage in business in the downstream oil sector. In 2014, a total of 249 oil companies were already engaged in marketing, distribution and storage of petroleum products in the Philippines with an accumulated investment cost amounting to PHP 48 billion (DOE, 2015e).

As a measure to ensure oil supply and address the risks from supply-related problems such as geopolitical uncertainties and calamities, the government is enforcing the Minimum Inventory Requirement (MIR) on oil companies, bulk suppliers and LPG players operating in the economy. An equivalent to 30 days for total in-country stocks of crude and finished products are required for refiners, while an equivalent of 15 days in-country stock is required for bulk marketers and seven days for the LPG players. The oil companies are compliant and normally maintain more than the required minimum level of inventory (DOE, 2014b). Supply situationer is regularly released particularly during contingencies in areas affected by natural calamities (DOE, 2015e).

As a response during emergency situations caused by natural calamities such as the super typhoon Haiyan that hit the economy in 2013, a Memorandum was issued to the oil companies to serve as a reminder to implement the DOE Circular No. 211-03-003 on Mutual Product Sharing Accommodations (MPSA). The MPSA intends to provide and stabilise oil supply in calamity-affected areas as it permits the oil companies to supply petroleum products to the facilities of other oil companies to ensure a steady supply of petroleum products in the affected areas (DOE, 2014b). Likewise, a Memorandum of Agreement (MOA) was signed on 22 October 2014, which embodies the commitments of the following entities: Metro Manila Development Authority (MMDA), Office of Civil Defence (OCD)/The National Disaster Risk Reduction and Management Council (NDRRMC) and members of the Philippine Institute of Petroleum, Inc. (PIP), namely: Pilipinas Shell, Chevron, Petron Corp, Isla LPG Corp., PTT Philippines and Total Philippines, to develop a framework that will enable a sustainable supply of petroleum products to areas and organisations affected by emergencies, disasters and calamities (including but not limited to those resulting from earthquakes, typhoons, floods, conflagrations and spills) (DOE, 2015e).

DOWNSTREAM NATURAL GAS

The development of natural gas is considered an important component of the fuel supply diversification strategy of the economy, thus ensuring greater energy supply security and reliability. Having a balance or diversified energy mix reduces dependency on any particular fuel/resource, and mitigates vulnerability to any supply disruptions due to unforeseen situations. Natural gas is considered the best alternative to oil-based energy for power generation, transport and industry uses. With this, the government intends to expand the utilisation of natural gas in different demand sectors of the economy. Apart from the Malampaya Gas-to-Power Project, the government is also promoting the development of liquefied natural gas (LNG) terminals and gas pipeline distribution networks.

The technical feasibility study conducted by the Pilipinas Shell Petroleum Corporation (PSPC) on the establishment of a Floating Storage Regasification Unit (FSRU) in Batangas concluded in July 2013. Results of the study confirmed the viability of developing an import regasification terminal in the economy, particularly a floating storage instead of a land-based terminal. The FSRU is more appropriate for the economy given its weather patterns. Likewise, the FSRU can service a demand up to 2000 MW and can complement the growing renewable industry in the economy (PhilStar, 2013). Meanwhile, the Philippine National Oil Company (PNOC) commissioned the Public-Private Partnership (PPP) Center for the detailed feasibility study of the 105 km Batangas-Manila pipeline (BatMan 1) to supplement the Japan International Cooperation Agency (JICA) study completed in June 2014 (DOE, 2015e). It may be noted that JICA studied the entire natural gas supply chain, which includes the LNG facility, regasification facility, pipeline and offtake facilities, among others.

On the other hand, the DOE is closely monitoring the on-going construction of an LNG terminal and a merchant gas-fired power plant in Pagbilao, Quezon. The LNG facility comprises two unit storage tanks with a capacity of 130 000 cubic meters each. The project has an on-site 600 MW merchant gas-fired power plant, which will serve as an anchor load for the project (DOE, 2015e).

A Natural Gas Quality Standard was formulated in February 2015 for possible promulgation by the Bureau of Product Standards. This standard is considered necessary for more efficient supply acquisition and distribution of natural gas in the economy.

Cognizant of the importance to have a clear and comprehensive policy and regulatory frameworks governing the development of the downstream natural gas industry, the government has drafted a Natural Gas Bill, which was filed in both Houses of Congress. Pending approval and promulgation of the Natural Gas Bill, the DOE D.C. issued in 2002 on the '*Interim Rules and Regulations Governing the Transmission, Distribution and Supply of Natural Gas*' serves as the guiding policy of the government for the promotion of the natural gas industry in the Philippines.

ALTERNATIVE FUELS

The government continues to embark on a fuel diversification program that envisions equal sharing of fuels and technologies with a preference for cleaner fuels and lessening dependence on imported fuels. As such, the DOE has strengthened its implementing policies and programs on alternative fuels for the transport sector. The enactment of the Biofuels Act underscores the government's efforts in further intensifying the production of the economy's local biofuels. Currently, the government mandates the use of 2% biodiesel blend and 10% bioethanol blend. As a continuing effort, the DOE has issued a Notice to Proceed Construction for the three bioethanol producers with a total annual rated capacity of 59.4 million litres. These new additions have increased the economy's total number of biofuel producers to 19 (11 biodiesel

and eight bioethanol) (DOE, 2015e). The government is studying the possible increase in biodiesel blend from 2% to 5%. Continuous research and development has been undertaken through partnerships with various academic institutions and other stakeholders on areas for potential biofuel feedstocks and in increasing the blend rate, specifically for biodiesel.

As support for the government campaign on Compressed Natural Gas (CNG)-fuelled buses, the Land Transportation Franchising and Regulatory Board (LTFRB) under the Department of Transportation and Communications (DOTC) has guaranteed the availability of franchises for the remaining 169 CNG buses (from 200 CNG buses targeted in the pilot phase). On the other hand, to strengthen the Auto-LPG program, the government has entered into an MOA with two academic institutions in 2014 to produce proficient technicians who will be involved in the conversion from gasoline-fed to auto-LPG, including the repair and maintenance of such vehicles.

The government has also engaged in an electric vehicle program, which is seen to contribute to reduce oil consumption of the transport sector and to lower the emission level. The program was carried out under the Asian Development Bank (ADB) Loan Assistance Program involving deployment of 100 000 electric tricycles or e-trikes (a motorcycle with an attached passenger sidecar used as a local-based public utility vehicle).

The DOE is also proposing to enter into MOA with the Development Academy of the Philippines to develop an Alternative Fuels Roadmap, which will serve as a blueprint for the implementation of the program.

ENERGY EFFICIENCY

The government has continuously been implementing high impact programs and projects such as the National Energy Efficiency and Conservation Program (NEECP) to support the energy requirements of the productive sectors of the economy through efficient management of energy use. The NEECP was launched in 2004 as an umbrella and banner program of the government for its various initiatives on energy efficiency and conservation, including:

- Social Mobilisation and Information, Education and Communication (IEC) Campaign;
- Energy Efficiency Standards and Labelling Program;
- Government Energy Management Program (GEMP);
- Energy Management Services/Energy Audits;
- Recognition Award Program;
- Fuel Conservation and Efficiency in Road Transport (FCERT); and
- Power Conservation and Demand Management (Power Patrol).

The FCERT is an IEC campaign to establish significant data for a vehicle-labelling program in the future.

Dissemination of information through the conduct of workshops and trainings has been steadily carried out to encourage involvement of various economic sectors on the government's initiative. The DOE, in partnership with the Development Academy of the Philippines launched the 'Usapang Klima at Enerhiya: Facilitators' Training on Energy Efficiency and Conservation' in 2013 to inform educators, particularly science teachers and coordinators in secondary public schools, about energy efficiency and conservation practices and measures as a response to climate change, which in turn could be taught and relayed to their students (DOE, 2015e). The government also took advantage of the benefits of the tri-media campaign through the publication of promotional materials on broadsheets as well as the establishment of the Watt Matters website (www.wattmatters.org.ph). These provide consumers with energy saving tips and practical ways to use energy efficiently, while the establishment of the website allows energy consumers to view the energy consumption of their household appliances and lets them calculate their electric bills. This website intends to provide consumers the power of choice in selecting the best and most efficient appliances in the market.

The implementation of the Energy Standards and Labelling Program is a way to promote the use of energy efficient household electrical appliances. This program helps consumers choose the appliance model that provides the same amount of performance with lower electricity consumption. At present, the program covers household air conditioners, household refrigerators, compact/linear/circular fluorescent lamps and ballasts (DOE, 2014b). The government plans to expand the coverage of the program to include other

household electric appliances and industrial equipment, such as electric fans, washing machines, televisions, industrial fans and blowers, and even vehicles.

To set a good example to the public, the GEMP is also implemented, which mandates all government offices to reduce their monthly consumption of electricity and petroleum products (transport) by at least 10%. This program also aims to reduce the public sector's electricity bill and fuel expenses. Since the inception of the program in September 2005 to December 2013, accumulated savings of the government reached about PHP 1.8 billion in electricity bill and PHP 283 million in fuel expenses (DOE, 2014b). To further reduce electricity consumption, the DOE recommended a scheme to replace the existing non-inverter window-type and package-type air conditioning units with inverter-type ones. The study conducted by DOE comparing an inverter-type with non-inverter type of air conditioning wherein the thermostat was set at 25 °C, revealed that using inverter-type reduces electricity consumption by about 44%, from 0.9 kilowatt-hours (kWh) to 0.5 kWh (DOE, 2015e).

The DOE also offers audit services to manufacturing plants, commercial buildings and other energy intensive companies to determine their energy use patterns and identify energy conservation measures, which could be adopted in their respective companies. A team of engineers from the DOE evaluates the energy utilisation efficiencies of equipment, processes and operations of these companies and recommends energy efficiency conservation measures in order to achieve energy savings. In accordance with D.C. 2008-09-20004, the DOE undertakes accreditation of Energy Service Companies (ESCO) in the economy. Such accreditation aims to promote ESCO as an emerging business industry. To date, there are 14 ESCOs accredited by the DOE (DOE, 2015e).

Other major undertakings involved collaborations with international institutions to provide technical assistance for the development and introduction of a new and efficient technology. The DOE has partnered with the United Nations Industrial Development Organization (UNIDO) and the Department of Trade and Industry (DTI) to implement the Philippine Industrial Energy Efficiency Project (PIEEP) funded by the Global Environment Fund (GEF). The PIEEP intends to improve the energy efficiency in the industrial sector, which includes the provision of tools and capacity building on energy management system and energy system optimisation. The project will introduce the application of ISO 50001 to select industrial sectors such as chemicals, food and beverage, iron and steel, and pulp and paper. The project is expected to generate about 2 million megawatt-hours (MWh) of energy savings. On the other hand, the EU-funded Switch-Asia Policy Support Program in the Philippines is assisting the government in revising the economy's Energy Efficiency and Conservation Roadmap (DOE, 2015e).

RENEWABLE ENERGY

Providing clean and sustainable energy to the citizens is one of the key priorities of the government. Efforts to further expand the utilisation of the economy's renewable energy (RE) resources were apparent with the adoption of the NREP in June 2011. The NREP intends to increase utilisation of indigenous RE resources, institutionalise a comprehensive approach to address the challenges and gaps that prevent wider application of RE technologies in a sustainable manner and outlines the action plans necessary to facilitate and encourage greater private sector investments in RE development (DOE, 2011).

To stimulate the implementation of the NREP, the following policy mechanisms are espoused under the RE law:

- Feed-in Tariff (FiT);
- Renewable Portfolio Standards (RPS);
- Green Energy Option Program; and
- Net-Metering for Renewable Energy

The FiT provides guaranteed payment on a fixed rate per kWh for RE generation excluding generation for own use, particularly for run-of-river hydro, biomass, wind and solar. There is no FiT rate initially approved for the Ocean Thermal Energy Conversion (OTEC) resource as further study and more data analysis must be first undertaken. The FiT Rules and FiT Rates were promulgated and approved by the Energy Regulatory Commission (ERC) upon recommendation by the DOE on 12 August 2010 and 27 July 2012, respectively. The initial FiT rates approved by the ERC are as follows:

- Solar—PHP 9.7/kWh
- Wind—PHP 8.5/kWh
- Biomass—PHP 6.6/kWh

- Hydro—PHP 5.9/kWh

The approved FiT rates shall be subject to review and readjustment by the ERC after three years of initial implementation or when the installation targets for each technology as set by the DOE have been met. The PHP 9.7/kWh rate for solar was effective until 15 March 2015, whereas the new rate of PHP 8.7/kWh, which was approved by ERC will be effective until 15 March 2016. Initially, the FiT installation target of 760 MW is set for the first three years from 2013 to 2015. In August 2014, the DOE issued a certification endorsing an increase in the FiT installation target for solar from 50 MW to 500 MW with application of a lower FiT rate for the additional capacity. Similarly, the FiT installation target for wind was also increased in April 2015 from 200 MW to 400 MW (DOE, 2015f). These increases brought the total installation targets to 1 410 MW, divided as follows:

- 250 MW Run-of-River Hydropower
- 250 MW Biomass
- 400 MW Wind
- 500 MW Solar
- 10 MW Ocean

On the other hand, the RPS is a market-based policy that requires mandated electric power industry participants such as generators, distribution utilities and electric suppliers to source an agreed portion of their energy supply from eligible RE resources. Other mechanisms include the Green Energy Option Program, which provides end-users with the option to choose RE resources as their source of energy. Meanwhile, the Net Metering is a consumer-based RE incentive scheme wherein the electric power generated by an end-user from an eligible on-site RE generating facility and delivered to the local distribution utility may be used to offset electricity provided by the distribution utilities to the end-user during the applicable period. Enabling rules on the net metering for RE were approved on 27 May 2013 (DOE, 2014c).

Since the passage of the RE law, the economy has consistently accelerated the installation of RE capacity. In 2013, the total installed generating capacity from RE already stood at 5 543 MW (DOE, 2014c). With the awarding of 617 RE service contracts comprising an estimated aggregate capacity of 15 233 MW, the NREP target of tripling the RE capacity (based on the 2010 level) may be achieved by the economy.

NUCLEAR ENERGY

As a matter of policy, the government is open to all potential and available energy resources for the economy to have a secure, reliable and stable energy supply to meet its growing energy requirements. With this, the government still considers nuclear energy as a long-term option for power generation based on its benefits for supply security and the environment, particularly on CO_2 emissions. Several initiatives were carried out to reintroduce nuclear energy in the power supply mix. The government even created an Inter-agency Core Group on Nuclear Energy in 2009 through a Joint Department Order between the DOE and the Department of Science and Technology (DOST). The Core Group was tasked to develop, manage and formulate policies and strategies on nuclear power generation, as well as to study the 19 infrastructure requirements for a nuclear energy program as prescribed by the International Atomic Energy Agency (IAEA). Likewise, the Core Group was envisioned to serve as the Interim Nuclear Energy Program Implementing Organization (NEPIO). However, all initiatives were debilitated after the Fukushima incident in 2011.

The advancement in nuclear energy technology coupled with enhancement in safety and safeguard standards as the lessons learned from the Fukushima incident could encourage the economy to adopt a nuclear energy policy in the future.

CLIMATE CHANGE

The Climate Change Commission is created by the government by virtue of the Philippine Climate Change Act of 2009 (RA 9729) as a policy-making body under the Office of the President with the same status as that of a national government agency. The Commission monitors and evaluates programs and action plans relating to climate change (CCC). A Cabinet Cluster on Climate Change Adaptation and Mitigation was also created through Executive Order 43 issued by the President of the Philippines in May 2011 to serve as an advisory committee to the President on matters relating to climate change. The Cabinet Cluster will take the lead in pursuing measures to adapt to and mitigate the effects of climate change on the Philippine archipelago, and undertake all the necessary preparations for both natural and man-made disasters (PMS, 2011).

During the 21st Session of the Conference of Parties (COP21) of the United Nations Framework on Climate Change, the Philippines expressed intention to undertake about 70% CO_2 reduction by 2030 relative to its BAU scenario of 2000–30 as indicated in the economy's 'Individual Nationally Determined Contributions' (INDC). Energy is identified as being among the sources of CO_2 reduction together with the transport, waste, forestry and industry sectors. The mitigation reduction is conditioned on the availability of financial resources, technology development, and transfer and capability building (UNFCCC, 2015).

NOTABLE ENERGY DEVELOPMENTS

REGIONAL ENERGY PLAN

The DOE is drafting regional energy plans for the three major islands—Luzon, Visayas and Mindanao—of the economy to address and provide appropriate measures to the specific local energy issues and concerns. The Mindanao Energy Plan (MEP) was already completed and published including policies and programs on sustainable and long-term solutions to the region's power supply shortfall problem. The Visayas Energy Plan (VEP) is currently being formulated to be followed by the Luzon Energy Plan (LEP). Simultaneously, the DOE is also formulating a Power Development Plan in close partnership with the local stakeholders particularly in missionary areas or those provincial areas not connected to the main power grid. The Palawan, Mindoro and Bohol (an island province but connected to the Visayas grid) Provincial Power Development Plans are in progress for adoption by the Provincial Council/Board.

RENEWABLE ENERGY

The DOE issued D.C. 2015-07-0014 in July 2015 prescribing a policy for maintaining the share of renewable energy to the total power installed at a minimum of 30% through FiT and other mechanisms as stipulated in the Renewable Energy Act (DOE, 2015i). Such D.C. could serve as an energy mix policy of the economy, which would further accelerate the development and utilisation of renewable energy, and achieve the NREP aspirational target. The DOE is currently undertaking a study on a fuel mix policy for the economy with the primary aim of sustaining the share of RE to 30% within the planning horizon of 2014–30. The fuel mix study aims to consider the issues on diversification of energy resources, increasing energy efficiency, environmental sustainability and reasonable electricity prices.

An earlier D.C. was also issued in April 2015 providing the framework for the implementation of a must and priority dispatch of RE resources in the Wholesale Electricity Market (DOE, 2015d). Under the said D.C., renewable energy power plants will be allowed to have maximum penetration to the grid considering system security and economically short-run dispatch of ancillary services.

The government launched the 2014 Wind Atlas and the Geo-Spatial Toolkit for the economy, which was developed in collaboration with the United States Department of Energy's National Renewable Energy Laboratory (NREL). The new assessment provided information on economically viable wind potential areas, which are closer to loads and infrastructure. This information would help promote wind development and attract prospective international investors/developers to the economy.

In 2014, four wind grid-connected power projects commenced operation with a total aggregate capacity of 304 MW, of which three are located in northern Luzon where the first wind power plant in the economy is situated. The largest among these wind projects is the 150 MW Nagsurot-Saoit in Burgos, Ilocos Norte (DOE, 2015e).

On the other hand, 10 solar power projects with a total estimated generation capacity of 230 MW were issued with a Certificate of Compliance by the ERC under the FiT system.

PENDING ACTIONS

The DOE is pursuing several legislative agenda to further enhance the economy's energy policies and regulatory frameworks. Several bills have been filed in both Houses of Congress for a policy regulatory framework covering specific energy sub-sectors, while other bills are filed for purposes of amending the existing framework for improvement, and to provide additional incentives to encourage and attract more private investments. These energy bills include:

- Energy Efficiency and Conservation Act;
- Downstream Natural Gas Industry Development Act;
- Liquefied Petroleum Gas (LPG) Industry Regulation and Safety Act;
- Amendments to the Electric Power Industry Reform Act of 2001 or Republic Act No. 9136;

- Amendments to the Petroleum Act of 1949 or Republic Act No. 387; and
- Amendments to Presidential Decree (PD) 87 or the Oil Exploration and Development Act of 1972.

MARKET REFORMS

Several D.C.s were issued by the DOE to improve the power sector. Through D.C. 2015-06-0008 signed on 19 June 2015, the DOE is mandating all distribution utilities to undergo a competitive selection process in securing power supply agreements. This is to ensure security and certainty of electricity prices to the consumers in the long term. With this D.C., the distribution utilities will be guided by the following principles:

- Increase transparency in the procurement process in order to reduce risks;
- Promote and instil competition in the procurement and supply of electric power;
- Ascertain least-cost outcomes that will be not be challenged in the future; and,
- Protect the interest of the public (DOE, 2015h).

Likewise, the DOE issued D.C. 2015-06-0009 on 15 June 2015 providing additional guidelines for distribution utilities in complying with their mandate to ensure supply security. The object of the circular is to ensure supply security for electric power through incorporation of standard contractual terms to clearly delineate the responsibilities of the contracting parties in the event of any forced majeure or events affecting delivery of power supply or delays in commercial operations of committed power projects (DOE, 2015g). On the other hand, the D.C. 2015-06-0010 issued on 20 March 2015 provides policies to facilitate the full implementation of RCOA in the electric power industry (DOE, 2015c).

CLEAN TECHNOLOGY FUND PROJECT

Through the EU-Funded Switch Asia Policy Support Program in the Philippines, the DOE is enhancing the Energy Efficiency and Conservation Roadmap. This roadmap intends to improve and accelerate the implementation program and provide long-term policy direction for the economy on energy efficiency and conservation. Overall, the objective of the roadmap is to achieve 40% reduction in energy intensity based on the 2010 levels.

On the other hand, the DOE is also implementing the Joint Development Program for Climate Change in the Philippines, in partnership with the Korean Energy Management Corporation (KEMCO). The Joint Development Program aims to develop investment projects on improving energy efficiency and new and renewable energy to mitigate the effects of climate change. The program includes information exchange, identification of applicable technologies for project development, and support in undertaking a pre-feasibility study to include the development of financing plans (DOE, 2015e).

GOOD GOVERNANCE AND TRANSPARENCY INITIATIVES

The DOE established the Energy Virtual One Shared System (EVOSS) in June 2015, a web-based system project, with the support of the United States Agency for International Development (USAID). EVOSS is designed to facilitate online tracking of Renewable Energy Service Contract (RESC) applications and processing permits, which will eventually extend to other technology/resource applications in the future. The system will facilitate and help streamline business processes as it is expected to reduce cost; promote efficiency in the government service; foster healthy relationships with stakeholders; increase private investments and promote transparency.

Other good governance initiatives implemented by the government to provide data and information transparency to the public include creating websites on 'Kuryente', 'Wattmatters' and 'Langis'. The Kuryente website (www.kuryente.org.ph) offers consumers easy access to information on all distribution utilities in their franchise area pertaining to the components of electricity rates charged to customers, such as systems losses, collection efficiency and liabilities. Meanwhile, the Wattmatters website provides information on energy conservation and more efficient appliances available in the market for the residential sector. The new addition is the 'Langis' website (www.langis.org.ph) providing information on factors affecting pump prices of petroleum products and international price movements.

The DOE is carrying out Open and Competitive Selection Process (OCSP) for awarding service/operating contracts for RE. This process promotes a greater transparency and competitive system for RE developers in the economy.

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Philippine National Oil Company (PNOC)—www.pnoc.com.ph/

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THE RUSSIAN FEDERATION

INTRODUCTION

Russia is the world's largest economy, spanning over 17 million square kilometres (km²). It is the only APEC economy located in both Europe and Asia, surrounded by the Arctic and the North Pacific oceans. Its territory is characterised by broad plains west of the Urals, vast coniferous forests in Siberia, the tundra along the Arctic seaboard and uplands and mountains in the southern regions. Russia's vast natural resources include major deposits of coal, natural gas, oil and other minerals. Despite its land area advantage, two-thirds of the economy is a zone of high-risk agriculture, due to mostly continental climate, which is either too cold or too dry. Centralised district heating is provided for 6–8 months per year, while cooling during the summer is not widely used.

From 1990 to 2008, the Russian population declined from 148 million to 143 million, however, from 2008 to 2013, there was an increase to 144 million (EGEDA, 2015). The share of urban and rural population has remained unchanged from 2009 at 74% and 26% respectively. Russia's average population density is 8.4 people per square kilometre, with the majority of the population living in the European part of the economy (GKS, 2015).

Russia's economic growth has slowed from the 2012 level of 3.4% to 1.3% in 2013 with an average growth rate of 4.4% for the period 2000–13. In 2009, the global economic and financial crisis affected the Russian economy, with the GDP) declining by 7.8% in 2009 from the 2008 level. The recovery in 2010–13 was driven by soaring world prices for oil and natural gas.

Table 1: Key data and economic profile, 2013

Key data[a, b]		**Energy reserves**[c, d]	
Area (million km²)	17	Oil (billion barrels)	105
Population (million)	143.5	Gas (trillion cubic metres)	33
GDP (2010 USD billion PPP)	3 200	Coal (billion tonnes)	157
GDP (2010 USD PPP per capita)	22 294	Uranium (kilotonnes of U)	262

Note: NEA data is for uranium reserves recoverable at a production cost of less than 260 USD per kg.
Sources: a. EGEDA (2015); b. GKS (2015); c. BP (2015); d. NEA (2014).

Russia's major industries include oil and gas production, petroleum refining, mining, iron and steel, chemicals, machinery and motor vehicles. The energy sector's output accounts for about 30% of Russia's GDP, which is more than 50% of the tax and custom duty payments, 70% of total export and 30% of the total investment, and is important not only for Russia's economic development, but to the survival of its population during harsh winters.

In terms of proven reserves, as of 2013, Russia holds 17% of the world's gas, 6.2% oil, 18% coal (BP, 2015) and about 18% of its reasonably assured resources of uranium (NEA, 2014). Several other resources remain undiscovered, but the formidable obstacles of climate, terrain and distance hinder their exploitation.

Russia's oil resources in the traditional oil-producing regions are believed to be heavily depleted, as more than 50% of the economically recoverable resources have already been produced. In the Urals and Volga regions, resource depletion is considered to exceed 70%. The share of the remaining resources that are more complex to recover is constantly growing. Nearly 80% of Russia's oil production is from large fields with remaining lives of 8 to 10 years. Newly developed resources are often concentrated in medium- and small-size deposits (ME, 2014).

Russia's gas industry is in a more favourable resource situation than its oil industry. The proven natural gas reserves in Russia, estimated at 33 trillion cubic metres, should be adequate to meet both the domestic market and export demands for the foreseeable future.

The remaining proven reserves of coal in Russia amount to more than 157 billion tonnes, or 18% of the world's reserves. At current rates of coal consumption in the economy, these reserves should be sufficient for 800 years.

The refining industry in Russia includes about 30 major refineries with a total capacity for the primary processing of about 277 million tonnes (Mt) of crude oil per year (ME, 2014).

Russia has the world's largest and oldest district heating system, with centralised heat production and distribution networks in most major cities. The system has a high number of combined heat and power (CHP) installations. Given the obsolescence of this heating infrastructure, a considerable amount of energy can be saved through relatively accessible technologies and cost-effective energy saving practices. The energy sector is very important to the security of the global energy supply. The economy is the world's largest exporter of energy overall, the largest exporter of natural gas and the second-largest exporter of oil. In addition, Russian-labelled nuclear fuel is used at 74 commercial reactors (17% of the global market) and 30 research reactors in 17 economies worldwide, and the economy provides over 40% of the world's uranium enrichment services (ME, 2014).

In 2013, exports of crude oil, petroleum products and natural gas accounted for two-thirds of the total exports of the economy. Russia holds leading positions in each of the world's energy markets: uranium enrichment (40%), natural gas trading (about 20%), reactor construction (almost 20%), spent nuclear fuel conversion (15%), crude oil and petroleum products trading (more than 10%), and coal trading (about 10%).

In 2013, Russia exported 234 Mt of crude oil, 206 billion cubic metres (bcm) of natural gas (including Liquefied Natural Gas [LNG]) and 143 Mt of coal.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Russia's total primary energy supply in 2013 was 731 million tonnes of oil equivalent (Mtoe), comprising natural gas (54%), crude oil and petroleum products (22%), coal (15%) and others, including nuclear and hydro (9.2%).

By destination, more than 90% of Russia's total energy exports are directed to Western and Eastern Europe, including the Commonwealth of Independent States (CIS). To secure its future energy exports, since 2008 Russia has actively been diversifying its export routes towards regional markets in the Asia–Pacific region, aiming to deliver oil, natural gas and coal to China, Japan and Korea in north-east Asia.

Russia produced 523 Mt of crude oil and gas condensate in 2013. The oil heartland province of West Siberia accounted for about two-thirds of the total production. Refiners consumed 279 Mt of crude oil as feedstock, producing 269 Mtoe of petroleum products, including 39 Mt of gasoline, 78 Mt of diesel oil, 71 Mtoe of fuel oil and 10 Mtoe of kerosene.

Oil exports declined from 241 Mtoe in 2012 to 238 Mtoe in 2013. Petroleum products exports amounted to 116 Mtoe in 2013, a 10 Mtoe increase from the 2011 level. There are prospective onshore oilfields in the Timano–Pechora and East Siberia regions and offshore in the Arctic and Far East seas, and on the North Caspian shelf.

Natural gas production increased from 541 Mtoe in 2012 to 563 Mtoe in 2013. Net exports of natural gas in 2013 accounted for 174 Mtoe (159 Mtoe in 2012) or 31% of the production. Nearly all natural gas exports were destined for Western and Central Europe, including Turkey, with small amounts piped to the Transcaucasian states. Huge but undeveloped reserves of natural gas are located in remote regions, where the lack of infrastructure prevents the start-up of upstream operations.

Russia produced 184 Mtoe of coal in 2013. Coal exports reached almost 89 Mtoe. From 2000 to 2013, of the total coal produced, the proportion exported increased from 17% to 49%, despite the fact that the main coal-producing areas (the Kuznetsky and Kansko–Achinsky basins) are landlocked in the south of Siberia, some 4 000–6 000 km from the nearest coal shipping terminal for the Atlantic/Pacific markets. Enormous prospective coal deposits have been found in even less-developed and more remote areas of eastern Siberia, south Yakutia and the Russian Far East.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 339 967	Industry sector	123 672	Total power generation	1 057 589
Net imports and others	–592 993	Transport sector	93 540	Thermal	700 556
Total primary energy supply	730 559	Other sectors	148 227	Hydro	181 151

Coal	108 289	Non-energy	69 079	Nuclear	172 508
Oil	160 110	Total final energy consumption	434 519	Others	3 374
Gas	395 161	Coal	11 746		
Others	66 999	Oil	121 725		
		Gas	126 473		
		Electricity and others	174 575		

Source: EGEDA (2015).

Russia produced 1 058 terawatt-hours (TWh) of electricity in 2013, of which 66% was from thermal power plants, 17% from hydropower and 16% from nuclear energy. The economic potential of hydropower is estimated at 852 TWh per year, but only 20% of this has been developed. Russia has enormous technical potential for renewable energy production, such as hydro and biomass in Siberia, wind along its Arctic and Pacific shores and geothermal in Kamchatka and the Kuril Islands. However, the use of this potential is constrained by the huge distances over which the renewable energy would have to be delivered to consumers.

FINAL ENERGY CONSUMPTION

In 2013, the total final energy consumption (TFEC) in Russia was 435 Mtoe, a decrease of 3.1% compared to 2012. By sector, industry accounted for 29%, transport 22% and other sectors 50%. By energy source, coal accounted for 2.7% of the total consumption, petroleum products 28%, natural gas 29% and electricity and others, including heat, 40%. Due to Russia's extremely cold climate, the most important energy use is for space heating, constituting about one-quarter of the TFEC.

The traditional energy-intensive industrial structure has been one of the major drivers of economic development. New policies on energy efficiency increase the share of less energy-intensive services in existing industries, and improve the efficiency of the heat supply to the residential and commercial sectors. It is estimated that Russia's energy saving potential ranges from one-third to almost half of its TFEC.

ENERGY INTENSITY ANALYSIS

The growth of Russia's real GDP of 1.3% in 2013 resulted in a 2.7% improvement in the economy's total primary energy supply. This could be translated to an economy-wide level of 228 tonnes of oil equivalent per million USD (toe/million USD). For final energy demand, the energy intensity level decreased by 4.4% from the 2012 level of 142 toe/million USD to 136 toe/million USD in 2013.

According to a sector-wide analysis, in 2013 industry registered a reduction of 7% in energy use per million USD of GDP from the 2012 level of 42 toe/million USD to 39 toe/million USD. Such a progress shows the effect of energy efficiency policies, especially in the Industry. The intensity in the transport sector improved by 1.4% to 29 toe/million USD, compared to its 2012 level, due to the increased share of more efficient vehicles introduced into the Russian market during 2013. The other sectors' energy intensity also decreased by 6.9% from the 2012 level, which could also be attributed to improvements in energy efficiency and availability of energy efficient technology, especially in district heating systems.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	235	228	–2.7
Total final energy consumption	142	136	–4.4
Industry	42	39	–7.0
Transportation	30	29	–1.4
Other sectors	50	46	–6.9
Non-energy	21	22	2.5

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Russia's Energy Strategy 2020 was adopted in August 2003, and was a milestone in the economy's energy sector development. The strategy identified the economy's long-term energy policy and the mechanisms for its realisation. The current revised Energy Strategy of Russia 2030 was adopted in November 2009 (IES, 2010). The new version of the strategy was updated to include new realities and priorities in the energy sector as affected by the global recession. The strategy is a framework within which more detailed industry-oriented medium-term and short-term programs can be developed.

In 2015, the Russian Government continued to work on the revised version of the Strategy 2035, but the strategic objective of Russia's external energy policy is unlikely to change. The objective will continue to be the use of Russia's energy potential to effectively maximise its integration into the world's energy markets, strengthen Russia's position in these markets and maximise the benefits of energy resources to the economy.

To achieve this, Russia will implement several measures to improve the security of domestic energy consumption and energy export obligations, and will make efficiency improvements along the entire energy supply chain. This will include the development of new hydrocarbon provinces in remote areas and offshore. It will also include the rehabilitation, modernisation and development of an energy infrastructure, including the construction of additional trunk oil and gas pipelines, to enhance the economy's energy export capacity. Furthermore, to better integrate Russia into the world energy markets, export delivery markets will be diversified. It is anticipated that at least 27% of Russia's total energy exports in 2030 will be delivered to the Asia–Pacific region (IES, 2010).

Russia's nuclear energy industry remains a priority for Russia's development despite the Fukushima nuclear accident that occurred in Japan in 2011. The share of domestic nuclear power generation is expected to continue to increase, with many units being constructed abroad. Russia intends to remain a key player in the practical implementation of improved nuclear fuel technology. Despite the existing programs for renewable energy development outlined in the Energy Strategy 2030, the economic efficiency of renewable energy projects is still lower than that of fossil fuels.

The Energy Strategy 2030 calls for a 40% reduction in the energy intensity of the economy by 2030 (IES, 2010). Reducing Russia's relatively high energy intensity (about 335 tonnes of oil equivalent per million USD in 2009) needs to be one of the main objectives of the Russian energy policy. This would improve the competitiveness of the domestic industry in the global market, and stimulate Russia's economic development.

Perhaps the most important measures in the Energy Strategy 2030 are directed towards developing energy market institutions, such as fair pricing mechanisms and transparent trading principles, while ensuring the availability of sufficient energy transportation infrastructure. State participation in energy sector development will mainly comprise supporting innovative developments in the energy sector, as well as providing a stable institutional environment for the effective functioning of the sector (IES, 2010).

Under the general framework of the Energy Strategy 2030, medium- and long-term programs and industry-wide schemes are being developed. These include the Federal Program for Development of the Nuclear Industry up to 2015, approved in 2006, and the general scheme of electric infrastructure development—a scheme relating to electricity network infrastructure and electricity plant locations—up to 2020, approved in 2008 and later extended to 2030.

In April 2011, a general scheme for the development of the oil industry up to 2020 was approved. This provides for the comprehensive development of the oil sector—exploration and utilisation of associated petroleum gas, crude oil and petroleum products, crude oil refining and transportation infrastructure.

The general scheme for the development of the gas industry up to 2030 was reviewed and approved in October 2010. The document represents a complex project, which defines a path for Russian gas industry development in the long term. This strategic document covers all components of the gas industry: exploration, drilling, production, storage and transportation to consumers of hydrocarbons, and refined products.

In 2007, the federal government approved the East Gas Program to develop the natural gas fields and build extensive trunk gas pipelines in Eastern Siberia and the Russian Far East up to 2030. The program also includes building export pipelines to the East Asian economies. Gazprom, the state gas monopoly and the owner of the economy-wide gas pipeline system, is the coordinator of the program and is responsible for conducting long-term sales contracts for natural gas deliveries.

In 2011, the Ministry of Energy forwarded to the Russian Government the second phase development plan up to 2030 for the economy's gas and petrochemical industry. This includes an updated general plan for the development of key oil and gas investment projects; an updated program for the division of petrochemical capacities into six clusters, including pipeline transportation projects, projects to build new facilities and upgrade existing ones for the primary processing (pyrolysis) and further processing of raw materials; and activities for the scientific and educational support of the industry.

In January 2012, the Government Presidium of Russia approved a long-term program for developing the coal industry up to 2030. This document specifies the basic provisions of the energy strategy 2030 relating to the coal industry. The main task of the program is to realise potential competitive advantages for Russian coal companies while implementing the government's long-term energy policy.

In November 2010, the Federal Targeted Program (FTP) on Energy Saving and Energy Efficiency Improvement 2020 was approved by the government, which is concerned with energy policy formulation. The draft 'General Scheme for the Natural Gas Industry Development 2030' will be a major development stimulus for Russia's energy sector, considering the soaring importance of the gas industry in the international stage and that of natural gas in the economy's primary energy supply. In addition, the mid-term Scheme on the Unified Energy System Development is a tool to coordinate federal, regional and local governments with private businesses and industry regulators. The scheme is amended on an annual basis and serves as a seven-year outlook for generation and transmission line projects. It includes an outlook for electricity demand by region, maximum loads, generation capacity reserves, power exchange, retirement of old facilities, maintenance, retrofitting and commissioning of new generation and transmission facilities with more than 5 megawatts (MW) capacity/110 kilovolts (kV) and higher voltage, respectively.

LAWS AND REGULATIONS

The basic laws on specific energy-related industries are either being implemented or developed. These acting laws include:

- Subsoil (since February 1992);
- Price Control for Electricity and Heat Supply (since April 1995);
- Natural Monopolies (since August 1995);
- Production Sharing Agreements (since December 1995);
- Energy Conservation (since April 1996);
- Gas Supply (since March 1999), Power Industry (since March 2003);
- Nuclear Industry (since February 2007);
- Heat Supply (since July 2010); and
- Energy Conservation and Increase of Energy Efficiency (since August 2010).

The last law is the logical extension of the Power Industry law because the major sources of heat supply in Russia are cogeneration plants (CHP), where electricity is a by-product of residential and industrial heat supply. However, while crude oil extraction and refining is an important industry in Russia, the draft of the oil law is still being developed in light of its international influence and the growing domestic economic and social challenges.

As a rule, the Ministry of Energy is responsible for issuing regulations and instructions, etc., to enforce the smooth implementation of the basic energy laws and to coordinate current economic development with the long-term energy policy. Other major government institutions actively participate in the development and implementation of the regulatory framework regarding energy consumption and energy supply, and the export and import of energy. The major federal government institutions involved in the development and endorsement of Russia's energy policy and its regulatory framework include:

- Ministry of Energy;
- Ministry of Natural Resources and Environmental Protection:
    - Federal Subsoil Resources Management Agency;
    - Federal Water Resources Agency; and
    - Federal Supervisory Natural Resources Management Service;

- Ministry of Industry and Trade;
- Federal Antimonopoly Service;
- Federal Customs Service; and
- Federal Tariff Service.

ENERGY SECURITY

Russia considers issues related to energy security a global phenomenon. Due to the increasing interdependence of energy producers, importers and transition economies, improving partnership relations is regarded as an effective mechanism for international energy security. The key approach is to coordinate the actions of energy producers and consumers in emergency and/or crisis situations. To facilitate international energy security cooperation, Russia has made a proposal to develop a Convention on International Energy Security that would cover all aspects of global energy cooperation, considering the balance of interests of all actors in the international market. The infrastructure projects, including new oil and gas export trunk lines from Russia to its European and Asian markets, provide a solid contribution to improving the global energy security. The development of an international infrastructure for the reliable maintenance of the nuclear fuel cycle, under strict International Atomic Energy Agency (IAEA) supervision, is another Russian contribution to the improvement of the global energy security.

ENERGY MARKETS

MARKET LIBERALISATION

One of the main issues in Russia is the gradual liberalisation of the natural gas and electricity markets. Coal and petroleum prices have already been fully liberalised. The government is controlling the tariff setting for natural monopolies—power transmission lines and pipelines (gas, crude oil, petroleum products transportation systems and heat supply for residential and commercial sectors) as well as energy tariffs in remote and isolated areas. The authorities are authorised to set maximum regional tariffs for natural gas, electricity and centralised heat supply. One of the objectives of the Energy Strategy 2030 of Russia is to complete the full liberalisation of domestic energy markets, where at least 20% of the energy should be traded on commodity exchanges.

In 2006, the simultaneous liberalisation of natural gas and electricity prices by 2011 was approved. Deregulating both markets is important as 50% of the total electricity generation is from natural gas, and nearly 45% of the primary gas supply is for the power industry. However, due to social issues, the regulated tariff for residential energy supply will remain even after 2014.

The oil market in Russia has been deregulated since the 1990s, but crude oil and petroleum trading is not based on commodity exchanges. Most crude oil in the domestic market is traded on a term basis, in which prices are linked to international benchmarks. Petroleum is traded in irregular tenders, which allows producers to control the market. Regional petroleum storage plays an important role in establishing fuel markets. The government intends to make up to 25% of the compulsory purchases of the government's petroleum products supply through commodity exchanges, such as the St. Petersburg Oil Exchange established in late 2006. The Federal Antimonopoly Service has an element of control over oil and gas prices through its role in monitoring the market share of sellers, but it has no responsibility for regulating prices.

The government's control over coal pricing was removed in the early 1990s and the coal market was liberalised, with similar institutions to the crude oil and petroleum product markets.

The transition to transparent, free trading pricing mechanisms in domestic markets was originally scheduled to be completed in 2011, but the transition period has since then been extended. The government will maintain control over the residential and commercial energy tariffs to gradually eliminate the cross-subsidies.

OIL AND GAS

Russia's oil and gas industry was privatised in the 1990s. However, the government retained control over major oil companies and crude oil and petroleum trunk pipelines, and owns 73% of the shares of Russia's biggest gas company, Gazprom.

The oil sector is heavily controlled by the government and this control increased after the state-owned Rosneft takeover of TNK-BP. The USD 55 billion merger in 2013 created the world's largest listed oil company with a daily output of 4.6 million barrels in oil-equivalent terms (Reuters, 2013).

As of 2015, the oil industry in Russia comprised 10 vertically integrated companies (VIC) constituting 87% of the crude oil output, and 182 small-scale independent enterprises, along with operators of three production-sharing agreements. The refining sector comprises 28 large owned by VIC, nine companies not owned by VIC and 34 small refineries with the total refining capacity of 312 Mt of crude oil per year. After the merger of the crude oil and petroleum products pipeline companies Transneft and Transnefteprodukt, the state controlled 75% of the combined company's shares. Private oil pipelines do exist in Russia—the most important being the Caspian Pipeline Consortium for crude oil transit from Kazakhstan to the Black Sea ports—but other private pipelines operate in the European part of Russia and in Siberia.

The federal government remains the key shareholder in the economy's gas monopoly, Gazprom, which in 2014 extracted 67% of the natural gas in Russia and is the owner of the economy-wide gas pipeline system. The remainder of the Russian natural gas supply comes from independent producers (7.3%), NOVATEK (8.4%), joint operators (4.3%) and vertically integrated companies (13%).

International oil companies, such as ConocoPhillips, ExxonMobil, Royal Dutch Shell, BP, CNPC and Total, hold up to 10 billion barrels of oil and natural gas reserves in Russia through their stake in state and private companies, and produce at least 14% of the economy's crude oil and 7% of its natural gas. Foreign investments accounted for USD 52 billion worth cumulative investments in the Russian energy sector from January 2000 to June 2010.

At the beginning of 2001, there were no Russian oil/petroleum export facilities on the shores of the Baltic Sea. Since then, the Baltic Pipeline System (BTS) and the new Primorsk and Vysotsk oil export terminals have been developed. The general capacity of this system reached 75 Mt in 2006. In July 2009, work began on the construction of BTS-2, which will be able to deliver 50 Mt to the new oil export facilities at the Ust-Luga port on the Baltic Sea.

Refining volumes are expected to stay flat over the next decade, but quality will be a key issue. Gas developments are planned to increase the share of independent producers, that is, other than Gazprom, to about 30% by 2030. The Nord Stream pipeline helps maintain Russia's traditional European market, but more gas trunk pipelines are needed to tap into the Asian market, specifically China. New LNG projects in the European Arctic, like those on the Yamal Peninsula, are considered an important means of delivering natural gas to international markets.

COAL

The Russian coal sector was restructured in the 1990s, and foreign participation in the sector is practically absent. Unlike the oil and gas sector, the coal industry has no large state-controlled company and is almost entirely privatised.

As of 2013, 202 coal enterprises were operational in the Russian coal industry (84 mines and 118 open-pit mines), with a total annual production capacity of 350 Mt. Coal processing is carried out by 56 processing plants and mechanical installations.

Industry development is based two-thirds on equity and one-third on loans. In recent years, there has been an active renewal of the fixed assets of the coal industry. There are no restrictions on exporting coal, but the geographical size of Russia's vast economy requires coal to be transported over long distances. Coal is the single largest commodity transported by Russia's railway network, accounting for almost 30% of its total freight.

ELECTRICITY

Russia started restructuring the power industry in 2000. Federal laws and government decrees identified the main principles for the future functioning of the power industry under competitive conditions. All thermal generation and regional power distribution companies were privatised before July 2008. From July 2008, the generation and transmission assets in Russia have been separated under binding regulations. Generation assets are consolidated into interregional companies of two types: seven wholesale thermal power plant generation companies (WGCs) and 14 territorial generation companies (TGCs). Six thermal WGCs were constructed according to extraterritorial principles, with one state-owned holding company, RusHydro, which controls over 53 hydropower plants. TGCs manage facilities in neighbouring regions. The initial design of the WGCs provided them with roughly equal starting conditions in the market, with respect to installed capacity, asset value and average equipment. Each WGC has power plants located in different regions of Russia to prevent possible monopoly abuse.

Backbone transmission lines are assigned to the Federal Grid Company, while distribution grids are owned and operated by 11 interregional distribution grid companies. The Federal Antimonopoly Service is responsible for monitoring the long-distance power transportation market, in which the threshold is less

than 20% of the transmission line capacity per company. The wholesale power market infrastructure includes the following organisations:

- Non-profit Partnership Administrator of Trading System;
- System Operator–Central Dispatch Administration of the Unified Energy System; and
- Federal Grid Company of the Unified Energy System

The Non-Commercial Partnership 'Administrator of Trading System of the Wholesale Power Market' (NP ATS) was established in November 2001. The main objectives of NP ATS are to organise trade and arrange financial payments in the wholesale electricity and power markets, increase the efficiency of power generation and consumption, and protect the interests of both buyers and suppliers. NP ATS provides infrastructure services, which are related to the organisation of trade, the wholesale power market, ensuring the execution and closing of transactions, and the fulfilment of mutual obligations. The System Operator with 100% state ownership exercises technological control within the power grids and provides dispatching services to wholesale market participants. The Federal Grid Company, which was established in 2002, with 78% state control, owns and operates the transmission lines, provides consistent technological management and is responsible for the reliability of power transmission services.

In monetary terms, the market shares needed to maintain the system's power reliability are 48% of electricity sales, 47% of power sales and 5% of services sales.

The free electricity trading market (one-day forward) was launched in November 2003 within the framework of the Federal Wholesale Electricity Market ('FOREM'). In September 2006, the regulated sector of the wholesale market was replaced by a system of contracts to be concluded between the buyers and sellers of electricity and electric power. In the FOREM, power generators and importers sell electricity and power to guarantor suppliers and distribution companies, as well as to large consumers and exporters. In the distribution market, guarantor suppliers and distribution companies sell electricity and power to end-use consumers in the residential, commercial and industrial sectors.

Since 2008, the share of tariffs established by the regulatory asset base methodology for distribution grids has been increasing. It is expected to become the major method for calculating middle-term tariffs. The methodology is regarded as transparent and provides incentives for investors to rehabilitate and improve the operations of the energy service companies.

HEAT SUPPLY

Residential and commercial heat supplies have important social implications and are a major concern for local governments in Russia. Historically, the heat supply industry was subsidised by local budgets and thus has scope for considerable efficiency improvements. The Law on Heat Supply was introduced in July 2010 to create investment opportunities, minimise energy losses and subsidies and provide business incentives. A transparent market for the heat supply will provide additional incentives to develop combined heat and power facilities as a primary option for generators. The use of registration equipment will be compulsory for new buildings. The industry's restructuring will be a cornerstone for energy conservation activities and provide significant business opportunities for both domestic and international businesses.

NUCLEAR

Russia's nuclear industry restructuring started in 2001, when the state-owned company Rosatom took over all civil reactors, including those under construction, and their related infrastructure. In 2007, the new Law on Nuclear Industry was adopted. It provided a legal framework for industry restructuring by separating military and civil facilities, and by introducing regulations for nuclear materials management. Russian business entities are now allowed to hold civil-grade nuclear materials, but they are still under state control.

In April 2007, a single, vertically integrated, state-owned nuclear energy company was established. The operations of this new corporation, AtomEnergoProm (AEP), include uranium production, engineering, design, reactor construction, power generation and research facilities. AEP holds a significant share of the world's enriched uranium and nuclear fuel supply, has 24 GW of existing Russian nuclear energy plants and manages the construction of 14 reactors. There are seven reactors under construction in Russia, including one floating-type unit to power remote areas, and seven reactors in four Asian and European countries. AEP provides the full production cycle of nuclear energy engineering, from uranium extraction to nuclear fuel services to nuclear energy plant construction and electricity production. The company has up to 16% of the world's market for new nuclear energy plant construction, and is affiliated with Tenex (40% share of the world's uranium enrichment services market), TVEL (17% share of the world's nuclear fuel market) and Atomredmetzoloto (9% share of the world's uranium mining).

TRANSPORT

Russia's economy faces challenges due to the underdevelopment of its transport infrastructure. In particular, the current condition of Russian airports and air transport facilities provides insufficient capacity and slows the performance of air transportation services. Further modernisation of air and rail transport is planned in connection with Russia's programs for the 2018 Football World Cup and the 2020 World Expo.

The total length of Russian roads in 2013 was 1 395 601 km, 70.5% of which were paved. The member economy had only 30 146 km of high-speed divided highways connecting big cities (GKS, 2016). Further development of highways will be necessary to connect big cities.

Russia has a state railway system with a total length of 85 641 km, but only some cities have high-speed train services. Almost all towns in Russia, regardless of size, are served by regional bus services. Subway systems have been introduced in seven of Russia's major cities, and all cities have extensive city bus systems.

Russia's pipeline transport is underdeveloped relative to the potential oil and gas supply. The total length of the pipeline system in the economy was 249 700 km in 2010, of which 70% is gas pipeline, 22% oil pipeline and the remaining 8% oil products pipeline.

FISCAL REGIME AND INVESTMENT

In 2007, dozens of oil and gas fields were decreed to be 'strategic' fields. The strategic status makes the hydrocarbon deposits inaccessible to foreign companies unless they establish joint project operations with Russian companies. Under the current regulations, the strategic status is applied to oilfields with reserves larger than 70 Mt and gas fields with reserves larger than 50 bcm. In March 2009, regulations were adopted for the compensation of costs associated with the discovery and exploration of deposits under exploration licenses, the further development of which is prohibited due to their strategic status.

From January 2009, tax holidays from the mineral extraction tax for crude oil production in East Siberia were extended to areas north of the Arctic Circle, the Azov Sea, the Caspian Sea and the Nenetsk and Yamal regions. In addition to the existing tax reductions for East Siberian oil, this creates favourable conditions for the development of new capital-intensive projects in remote areas that lack an energy infrastructure. From 1 January 2010, zero export duty was introduced for crude oil extracted from East Siberia oilfields to maintain a stable market for Russian crude exported eastward to the Asia–Pacific region.

A draft plan for a new tax regime was prepared in 2011 as a part of the development of the new Law on Oil. On 1 October 2011, a new tax regime for the oil industry called the '60–66' came into force in Russia. Under the new rules, the duty on oil exports decreased by 7.4% to USD 411 per tonne, and fees for light and heavy petroleum products were set at 66% duty on crude oil. For several fields in Eastern Siberia and the North Caspian, there will be a preferential export duty, which, as of October 2011, is set at USD 204 per tonne. A reduced duty on crude oil is achieved by changing the formula for calculating it. According to the norms of the '60–66', from now on duty on crude oil will be at 65% and 60% of the difference between the market price and standard price of oil at a rate of USD 182 per tonne.

The size of the duty on exports of gasoline is set at 90% of the duty on crude oil. Before May 2011, the duty on exports of gasoline was 60% of the duty on oil, but because of the sharp rise in home prices and gasoline shortages in some regions, it was increased to 90%. It is believed that such new fees will allow oil companies to obtain additional funds for the exploration of new fields and will thus increase current oil production. In addition, the unification of tariffs on exports of petroleum products at 66% will make exports less competitive for dark petroleum products and more profitable for light petroleum products; it will also encourage companies to increase the refining depth at existing plants.

To facilitate coal exports, rare subsidies to the coal industry are provided under the railway's cargo tariff regulations for some export routes.

ENERGY EFFICIENCY

The energy intensity of the Russian economy is considerably higher than that of most developed economies. The introduction of effective energy efficiency (EE) measures is estimated to save over 300 Mtoe, including more than 160 Mtoe from energy extraction, transformation and transportation.

EE has become a critical factor in the government's energy policy since 2008, when a presidential decree set a target to reduce the energy intensity of Russia's GDP by 40% by 2020, compared with 2005. Improving EE and energy savings has become one of the priority areas of the Energy Strategy 2030.

On 23 November 2009, the federal government adopted a Law on Energy Conservation and Increase of Energy Efficiency to take effect from 1 August 2010. To supplement and make the new EE law more effective, about 40 sub-laws amending some existing laws and technical regulations were drafted. The new

federal law sets a legal framework and targets for the use of energy resources in Russia by promoting the rational use of energy resources and alternative fuel resources for electricity and heat generation. The law introduces various measures to improve EE and energy conservation across all sectors of the economy. These measures include:

- EE standards for equipment and buildings, including mandatory energy passports;
- EE labelling of goods and the compulsory commercial inventory of energy resources;
- Improvements in EE monitoring, focusing on mandatory energy audits and the compulsory installation of metering systems;
- Creating a single and unified interagency information network and analytical EE system; and
- Other measures to help achieve energy savings (promoting energy service contracts, prohibiting incandescent light bulbs, introducing incentives and tax benefits for Russia's heavy industries to replace highly energy-inefficient machinery and equipment, etc.).

In addition to the new federal law, on 27 December 2010 the federal government adopted (FTP) on Energy Saving and Energy Efficiency Improvement 2020. The Program will be carried out in two stages: from 2011–15, and from 2016–20. The energy intensity of Russia's economy is expected to decline by at least 7.4% by 2015 and 14% by 2020. In addition, the program outlines measures to achieve the federal target of 'at least a 40%' decrease in the economy's energy intensity by 2020, compared to 2007, through the rational use of energy resources and other measures to encourage EE and energy conservation. These measures include the enhancement and coordination of federal, regional and municipal EE and energy-saving programs; establishment of information dissemination, public awareness and the promotion of education initiatives; introduction of financial measures to promote the efficient use of energy; and a 4.5% target for the share of renewable energy in power generation by 2020.

In accordance with the EE federal law and the Program, all regions are required to prepare their own respective regional programs on energy efficiency improvements. The implementation of these programs will be financed jointly by regional governments and the federal government.

On 22 December 2009, the government established the Federal Energy Agency within the Ministry of Energy, which has 70 regional branches. Its key tasks focus on operating the federal EE and energy-saving information system; and administering, monitoring and coordinating efforts for the effective implementation of the EE law, the FTP and other measures for improving EE and energy conservation efforts in the budgetary, power generation, industrial and residential sectors of Russia's economy. In addition to these measures and policies for strengthening the EE legal framework, the federal government launched the following six pilot Presidential energy efficient projects in several regions:

- Metering (installing metering devices and automation);
- EE in the government sector (piloting energy performance contracting in schools and public buildings);
- Energy-efficient districts (targeting the residential sector);
- Energy-efficient lighting (replacing street lighting and other measures);
- Small-scale cogeneration; and
- New energy sources (renewable and other non-carbon energy resources)

Upon their successful completion, these projects are expected to be applied across all regions. In addition, technical potential exists to save almost half of Russia's primary energy demand through energy conservation (ME, 2015). However, a major impediment for businesses to improve their EE is the absence of appropriate financial mechanisms.

The regulatory framework described in the FTP on Energy Saving and Energy Efficiency Improvement 2020 estimates that the total investments into EE up to 2020 will be approximately RUB 9.3 trillion (USD 320 billion), amounting to 8% from governments and 92% from private investments. The economic effect of such investments up to 2030 is expected to exceed RUB 26.5 trillion (over USD 880 billion). Governments at different levels will provide more than USD 10 billion in guarantees on loans for businesses involved in activities to improve EE in either the industrial, residential or commercial sectors.

RENEWABLE ENERGY

The technical potential for renewable energy (RE), excluding large hydro, in Russia is estimated at 4 400 Mtoe per year, or almost eight times more than Russia's current TFEC. However, the economic potential is much smaller (about 240 Mtoe per year, less than 1% of the total electricity production). In 2010, the installed RE capacity totalled 2 200 MW, of which, less than 25 MW was hydro.

The government's policy goals and mechanisms to promote RE were introduced in January 2009 through the federal government's order, *The Basic Directions of a State Policy of Renewable Energy Utilisation up to 2020*. The major mechanisms to increase the share of renewables are feed-in tariffs (FiT) and subsidies for grid connection. The government is expected to develop regulations for FiT and grid connection subsidies, for the compulsory share of RE in the wholesale market to be purchased by electricity consumers, and for bringing together RE generators, transmission lines and guarantor suppliers of energy. By 2030, Russia is expected to generate from 80 to 100 billion kWh of RE, excluding large hydro, or roughly 4–6% of total generation.

In October 2010, the government published a ruling on federal subsidies for connecting renewable energy generators to the power grid that would encourage 'green' energy production in Russia. Conditions of the ruling include that the nominal capacity of single RE generators should not exceed 25 MW, and that owners should not be under bankruptcy proceedings. This ruling paves the way for financial mechanisms for RE.

NUCLEAR ENERGY

Russia holds important stakes in the international nuclear fuel market. All of the Russian, Commonwealth Independent States and Eastern European nuclear reactors are supplied by Tenex—the state company responsible for the nuclear fuel cycle business. In addition, Tenex meets 40% of the nuclear fuel requirements of the United States, 23% of Western Europe and 16% of the Asia–Pacific region.

In the Global Nuclear Infrastructure Initiative, announced in early 2006, Russia proposed to host several types of international nuclear fuel cycle service centres as joint ventures with other economies. The centres will be strictly controlled by the IAEA. Their most important roles will be uranium enrichment, reprocessing and storage of used nuclear fuel, along with standardisation, uniform safeguard practices, training and certification, and research and development.

In 2007, the International Uranium Enrichment Centre (IUEC) was established in Angarsk, Siberia, as a joint venture between Russia and Kazakhstan, but open to other interested parties. Ukraine joined the IUEC in 2010. The IUEC's objective is to provide low-enriched uranium (LEU) to those economies interested in nuclear energy development and ready to comply with the IAEA's non-proliferation regulations. The existing enrichment plant in Angarsk will be used to serve the IUEC.

In February 2007, the IUEC was certified by the IAEA for international operations. A program for the IUEC's expansion at Angarsk by 2015 was developed. The program includes three phases:

- Use part of the existing capacity in cooperation with Kazatomprom under the IAEA's supervision;
- Expand capacity with funding from new partners; and
- Full internationalisation with the involvement of many customer economies under the IAEA's auspices.

Russia also announced that guaranteed reserves of low-enriched uranium hexafluoride—equivalent to two 1 000 MW reactor loads—would be created at the IUEC as a fuel bank available under the IAEA's control. The first phase of the capacity enhancement was scheduled for 2011, when one million separation work units were expected to be commissioned, with a target of five million expected to be achieved in 2017.

In November 2009, the IAEA's Board of Governors adopted a resolution supporting a Russian initiative to establish and maintain in Russia a stock of low-enriched uranium (LEU), and to carry LEU supplies for the IAEA member states. This was a breakthrough in the establishment of an international system guaranteeing reliable nuclear energy plant fuel supplies and lowering the risks of the proliferation of sensitive nuclear technologies. It was suggested that the stock will be managed by the IUEC and transferred under contract from the IUEC to the IAEA when an appropriate supply request is obtained from the IAEA.

One major concern for world energy development is nuclear safety, which has become a key agenda after the Fukushima accident in Japan. Russia has adopted the 'closed' fuel cycle, which includes spent nuclear fuel processing and the mandatory return of fissionable nuclear materials to the fuel cycle. To provide the legal framework for managing spent nuclear fuel and radioactive waste, the laws on

environmental protection and the use of nuclear energy were amended in June 2010. Since 2007, the expired contracts for depleted uranium hexafluoride enrichment/conversion have not been extended.

Rosatom's long-term strategy up to 2050 involves moving to inherently safe nuclear energy plants, using fast reactors with a closed fuel cycle and mixed oxide fuel. In the period 2020–25, fast neutron reactors are expected to play an increasing role in Russia. The improved design will lead to an extended operating life of up to 60 years, a shorter construction period of up to 46 months and operating costs at less than RUB 1 per kilowatt-hour (kWh). The prospects for future international cooperation in the nuclear energy industry are promising; the construction of 35 reactors in 15 economies is in the pipeline, and contracts have been signed for 19 reactors in seven economies.

For the next 20 to 25 years, three core reactor technologies have been chosen for nuclear energy development in Russia:

- Water reactors, VVER type, and their modification and advanced development;
- Sodium fast neutron reactors; and
- High-temperature helium reactors.

CLIMATE CHANGE

Russia's key environmental and climate policy is outlined in the Climate Doctrine and Environmental Policy until 2030 (Kremlin, 2009; 2012). In November 2004, Russia ratified the Kyoto Protocol (UN COP3). This decision confirmed Russia's strong commitment to addressing climate change and working with the international community on dealing with this global challenge. Ratification by Russia satisfied the '55%' clause and brought the Kyoto Protocol into force, effective from 16 February 2005.

Russia is considered the world's largest potential host for 'joint implementation' projects under the Kyoto Protocol. In May 2007, procedures for the approval and verification of Russia-based joint implementation greenhouse gas (GHG) reduction projects were adopted. Responsibilities were assigned for setting up and keeping the Registry of Carbon Units, thus paving the way for the implementation of GHG mitigation projects in Russia.

At the Conference of Parties 15 in December 2009, Russia pledged to reduce its GHG emissions by 25% from the 1990 level by 2020, a figure comparable to the targets of the European Union member states, and by 50% from the 1990 level by 2050. These emission reductions are contingent on the following conditions: appropriate accounting of the contribution of emissions reductions from Russia's forestry activities will be introduced, and all major emitters will undertake legally binding obligations to reduce GHG emissions caused by human activities.

In December 2012, Russia refused to endorse extended pollution limits under UN COP3 at the UN climate change conference in Doha, since the biggest polluters—US, China and India—have not joined it.

In April 2016, the Russian Government has signed a directive approving the Paris Agreement of the Conference of the Parties to the UNFCCC (UN Framework Convention on Climate Change) (RG, 2016) also known as UN COP21.

NOTABLE ENERGY DEVELOPMENTS

PROGRAM ON ENERGY SAVING AND ENERGY EFFICIENCY IMPROVEMENT UP TO 2020

The main objective of the State Program on Energy Saving and Energy Efficiency Improvement 2020 is to reduce the energy intensity of the GDP of Russia by 14%. This is expected to combine with other factors to provide an overall reduction of 40% in the energy intensity of the GDP in the period 2007–20. Other expected results of the program are savings of 330 bcm of natural gas (301 Mtoe), 630 billion kWh of electricity (54 Mtoe), 1 550 million Gcal of heat (155 Mtoe) and 17 Mt of petroleum products (19 Mtoe) through the duration of the program.

The program also aims for a significant reduction in energy costs and to ensure the competitiveness and financial stability of the Russian economy, the provision of high quality energy services at affordable prices and reducing GHG emissions, thereby strengthening the health of the population. The funding of the program is divided between RUB 70 billion from the federal budget, RUB 625 billion from budgets of the regions of Russia and RUB 8.8 trillion from extra budgetary sources.

Gazprom has adopted the FTP on Energy Saving and Energy Efficiency Improvement 2020, which should lead to a 1.2% annual decline in energy consumption by this giant energy company up to 2020. Gazprom's current energy demand for natural gas extraction, processing and transportation is close to 10% of the economy's total extracted energy. The major share of improvements is expected from measures related to its pipeline operations (estimations are up to 85%).

POWER MARKET DEVELOPMENT

The Ministry of Energy presented concepts for a program of power sector modernisation up to 2020. The central theme of this modernisation is to introduce new technologies, both domestic and imported, increasing the reliability of the electricity supply and energy security.

OIL AND GAS DEVELOPMENT

In May 2014, OAO Gazprom and China National Petroleum Corporation (CNPC) inked a historic agreement on Purchase and Sale Agreement for the Russian gas supply via the eastern route. The 30-year contract provides for gas supplies amounting to 38 bcm of gas per year.

As part of the APEC summit in Beijing in November 2014, several documents related to the Russian-Chinese cooperation in the energy sector were signed in the presence of the Russian President Vladimir Putin and Chinese President Xi Jinping.

OAO Gazprom and CNPC signed a Framework Agreement on gas supplies via the western route. In particular, the document reflects such conditions as the volume and terms of supply, the take-or-pay level and the location of the gas delivery point on the border. The Framework Agreement defines the schedule of compiling a gas purchase and sale agreement, a technical agreement and an intergovernmental agreement on the western route. In addition, Alexey Miller and Wang Yilin, Chairman of the CNOOC Board of Directors signed a confidential Memorandum of Understanding for cooperation in the oil and gas sector (Gazprom, 2014).

COAL INDUSTRY DEVELOPMENT

In the framework of the Russian strategy for developing the coal sector through 2030, as mapped out by the Russian Energy Ministry, Rostech, the Russian state-controlled technology corporation, signed an agreement with China's Shenhua Group, the largest producer of coal in the world, to explore and develop coal deposits in Russia's Siberia and Far East.

The Russian strategy for developing the coal sector through 2030 foresees transferring the centre of the coal production to Russia's eastern regions to supply Asian markets, which now constitute 80% of the world's consumption.

NUCLEAR AND RENEWABLE ENERGY DEVELOPMENT

Russia will join the International Renewable Energy Agency (IRENA). Accession to IRENA will provide Russia wide access to the existing practice of using and implementing renewable energy sources, results of the latest studies and will allow Russia to participate in the elaboration of international standards, as well as influence the renewable energy sector's development worldwide.

ENERGY SECURITY IMPROVEMENTS

In late 2011, the Ministry of Energy approved a joint statement between Russia and the International Energy Agency (IEA), agreeing on regular bilateral consultations. Those consultations will strengthen their collaboration in an effort to maximise the contribution of the energy sector in reconstruction and economic development, enhance global energy security and reduce the environmental impact of energy production and consumption.

IMPORT SUBSTITUTION

In 2014, the government approved a plan of supporting the import substitution in industry, including the fuel and energy sectors. This involves actions to increase the share of local content, domestic workforce, engineering services and domestically developed computer services.

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USEFUL LINKS

OFFICIAL BODIES OF RUSSIA

Structure of the Government of Russia—http://government.ru/en/

Ministry of Energy—www.minenergo.gov.ru/

Ministry of Natural Resources—www.mnr.gov.ru/

Federal Service on Ecological, Technological and Nuclear Supervision—www.gosnadzor.ru/

Ministry of Economic Development—www.economy.gov.ru/minec/main/

Federal State Statistics Service—www.gks.ru/

Ministry of Industry and Trade—www.minprom.gov.ru/

Federal Agency on Technical Regulating and Metrology—www.gost.ru/wps/portal/pages.en.Main

Federal Antimonopoly Service—www.fas.gov.ru/

Federal Customs Service—www.russian-customs.org/

Federal Tariff Service—www.fstrf.ru/

ENERGY-RELATED NON-PROFIT AND STATE-OWNED BUSINESS INSTITUTIONS

AtomEnergoProm—www.atomenergoprom.ru/en/

Federal Power Grids—www.fsk-ees.ru/

Non-commercial Partnership of the Wholesale Power Market—www.np-ats.ru/

Gazprom—www.gazprom.ru/

Rosneft—www.rosneft.ru/

RusHydro—www.rushydro.ru/

Transneft—www.transneft.ru/

Transnefteprodukt—www.transnefteprodukt.ru

STATE ENERGY-POLICY-RELATED RESEARCH CENTRES

Institute of Energy Strategy—www.energystrategy.ru/

Centre for Energy Policy—www.cenef.ru/

Energy Research Institute of the RAS—www.eriras.ru/

Energy Systems Institute of the SB of RAS—www.sei.irk.ru/eng/index.htm

MAJOR ENERGY-RELATED MEDIA IN RUSSIA

Official newspaper, *Rossiyskaya Gazeta*—www.rg.ru/

Central Dispatching Unit of the Fuel and Energy Complex—www.riatec.ru/

SINGAPORE

INTRODUCTION

Singapore is located south of the Malaysia Peninsula between the Strait of Malacca and the South China Sea. This South-East Asian economy's land area was 714 square kilometres (km^2) in 2013 with a population of 5.4 million.

Singapore is completely urbanised and highly industrialised, with a robust and growing diversified economy despite its lack of domestic energy and mineral resources and small land size of which a significant part is reclaimed land. The economy's impressive economic success is due to certain factors including turning itself into a regional hub for tourism, financial activities, shipbuilding, petroleum and related equipment, biotechnology, high tech and solar energy, and its expanding role in international cargo and fuel shipping.

The economy's gross domestic product (GDP) of USD 414 billion and per capita of USD 76 149 (2010 USD purchasing power parity [PPP]) in 2013 reflected growth of 4.4% and 2.7%, respectively, from 2012 levels. Services producing industries accounted for the largest GDP share (66%), with the biggest sub-sector represented by wholesale and retail trade (18%), followed by goods-producing industries (23%), with manufacturing and housing representing 17% and 4.3%, respectively (SingStat, 2015a).

Singapore's exports in 2013 amounted to USD 513 billion of which the respective shares of domestic exports (USD 274 billion) and re-exports (USD 239 billion) were 53% and 47%. Non-oil products accounted for the bulk of the exports (76%), with machinery and equipment representing the largest share (46%), followed by chemicals and chemical products (12%), miscellaneous manufactured articles (8.7%), manufactured goods (3.2%) and food, beverages and tobacco (2.2%), leaving the rest for miscellaneous transaction articles (1.2%), crude materials (0.7%) and animal and vegetable oils (0.1%). Oil exports (refined oil products and lubricants) accounted for 24% of the economy's exports (SingStat, 2015b).

Table 1: Key data and economic profile, 2013

Key data		Energy reserves	
Area (km^2)	714	Oil (billion barrels)	–
Population (million)	5.4	Gas (billion cubic metres)	–
GDP (2010 USD billion PPP)	414	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	76 149	Uranium (kilotonnes U)	–

Source: EGEDA (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Singapore imports all its crude fossil fuel requirements. The economy's total primary energy supply (TPES) in 2013 was 26 592 kilotonnes of oil equivalent (ktoe) (EGEDA, 2015). Oil had the largest share (over 60%) and experienced an increase of 5.8% over 2012, from 15 117 ktoe to 16 006 ktoe. Natural gas had a 36% share (9 653 ktoe), with a modest growth (5%) compared to the preceding year when gas experienced a substantial increase of almost 39% over its 2010 share. Coal's share increased tenfold to 264 ktoe from 2012, when the economy imported coal (25 ktoe) for the first time, but it remained only a small share (0.9%) of the total (EGEDA, 2015).

Singapore's total imports of energy (crude oil, petroleum products, gas and coal) in 2013 were 159 314 ktoe, which included supplies to meet its energy requirements as well as those to meet the needs of its oil refineries whose refined products are mainly exported (ESTO, 2015). Of these imports and their produced refined products, about 53% (84 168 ktoe) were exported (ESTO, 2015). Most of the remaining imports were used at home for marine bunkering (26%; 41 995 ktoe) and aviation bunkering (4.4%; 7 165 ktoe), signifying the role of Singapore in international shipping and aviation (ESTO, 2015).

The economy's electricity generation in 2013 reached 47 964 gigawatt hours (GWh), showing an increase of 2.2% over 2012 (46 915 GWh) (EGEDA, 2015). The peak demand for electricity of 6 814 megawatts (MW) was slightly larger than that in 2012 (6 639 MW) (EMA, 2015a).

Thermal power plants operated by Singapore's six main power producers (44 555 GWh) accounted for the bulk of its total power generation (93%) in 2013. Auto-producers accounted for the remaining 7.1% (3 409 GWh) of which the share of waste-to-energy was 3.5%, reflecting a significant increase compared to 2012 (2.7%). Grid-connected photovoltaic (PV) installations make a very small contribution to the economy's power generation despite the substantial growth in their installed capacity in 2013 (15 megawatts peak [MWp]), equal to about a 50% increase over 2012 (10 MWp) (EMA, 2015a).

The licensed power generation capacity of thermal power plants in 2013 was 10 964.3 MW, showing a significant increase of 12% over 2012 (9 831 MW). Of this, the combined capacity of the cycle gas turbine power plants was 8 082 MW, followed by steam turbine plants (2 702 MW) and open cycle gas turbine plants (180 MW) (EMA, 2015a). Waste-to-energy plants generated 257 MW of electricity (EMA, 2015a).

The respective shares of Singapore's residential and non-residential grid-connected solar PV system installations in 2013 were 15 MWp and 1 MWp (EMA, 2015a).

Natural gas dominated Singapore's fuel mix for power generation in that year, with a share of 92%, leaving small shares for petroleum products (5%) and other fuels (3.5%), mainly waste with a very small contribution of coal and solar (EMA, 2015a). Compared to 2012, the power mix reflected a major increase in the share of gas (7.2%) and a relatively significant increase in that of others, mainly, waste-to-energy (0.8%), but a large decrease in that of oil (8%).

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	670	Industry sector	11 114	Total power generation	47 964
Net imports and others	75 023	Transport sector	2 357	Thermal	44 555
Total primary energy supply	26 592	Other sectors	2 306	Hydro	–
Coal	264	Non-energy	–	Nuclear	–
Oil	16 006	Total final energy consumption	15 777	Others	3 409
Gas	9 653	Coal	129		
Others	670	Oil	10 343		
		Gas	1 442		
		Electricity and others	3 862		

Source: EGEDA (2015).

FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (FEC) was 15 777 ktoe in 2013, increasing 26% from 2012. Oil accounted for the bulk of this (10 343 ktoe), with a share of about 66%, followed by electricity and others (24%, 3 863 ktoe), natural gas (9.1%, 1 442 ktoe) and coal (0.8%, 129 ktoe). In terms of sector consumption, industry was 70%, transport 15% and others 15% (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

Singapore is fully committed to contribute to APEC's objective of a 45% energy intensity reduction by 2035 (2005 as base year) as set by the APEC leaders in 2011. However, the economy's efforts to reduce its energy intensity began earlier. In 2009, it set for itself an ambitious 35% reduction target by 2035, whereas the APEC target was 25% by 2030 (APEC, 2014). Singapore's Inter-Ministerial Committee on Sustainable Development (IMCSD) declared that target in the Sustainable Singapore Blueprint as a national strategy for its sustainable development (MEWR, 2014).

Various government initiatives have aimed at helping the economy achieve its commitment to APEC's target of 2011. Recent examples include its Energy Conservation Act 2013 (ECA), which focuses on a range of inter-related energy issues including improving energy conservation, efficiency and intensity, while reducing CO_2 emissions (GBS, 2014). The Act aims to help Singapore achieve its intensity reduction target by improving the energy performance of the economy's companies (EMA, 2012). Other initiatives seeking improvements in energy conservations and efficiencies are discussed in this chapter.

Singapore experienced a slight increase (1.1%) in its energy intensity (energy consumption per unit of GDP growth) in 2013 over that of 2012 when it significantly reduced its energy intensity (2%) over the preceding year. The final energy demand in 2013 rose 21% over 2012, with industry and transportation representing the major contributors to this increase, with the shares of 24% and 27%, respectively.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	64	65	1.1
Total final energy consumption	32	38	21
Industry	22	27	24
Transportation	4.5	5.7	27
Other sectors	5.4	5.6	3.3
Non-energy	–	–	–

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Singapore has implemented various energy policies to ensure that it will meet its energy requirements while taking into considerations energy-related challenges and opportunities. The recent major ones are detailed below.

The Economic Strategies Committee's (ESC) Subcommittee on Ensuring Energy Resilience and Sustainable Growth released a report in 2010, which made the following recommendations as the key strategies for Singapore to meet its energy policy objectives (ESC, 2010):

- **Strategy 1: Diversify Energy Supplies.** A diversified energy portfolio is essential to safeguard Singapore's energy security. Singapore's Liquefied Natural Gas (LNG) terminal, which commenced operations in May 2013, helps diversify energy sources as it allows the import of LNG globally. Singapore is also studying other medium- to long-term energy options such as electricity imports and renewables to further diversify its energy mix.

- **Strategy 2: Enhance Infrastructure and Systems.** Singapore continues to improve the liberalisation of its electricity and gas markets to achieve greater competition in energy prices and improve efficiency. Investing in critical energy infrastructure ahead of demand and enhancing existing infrastructure has helped make its energy markets more efficient, open new areas for economic development and strengthen energy security. Singapore is currently conducting an Intelligent Energy System (IES) pilot that is testing and evaluating smart grid technologies and related applications that will enable consumers to manage their electricity use more efficiently.

- **Strategy 3: Improve energy efficiency.** Energy efficiency (EE) underpins Singapore's efforts to reduce its energy and carbon footprint. Businesses and households can benefit from energy and cost savings through various EE measures. However, market barriers such as lack of awareness and limited financing schemes are impeding EE implementation and investments by businesses. To address these barriers and promote more efficient energy use among consumers, the Government administers several

programs coordinated by the Energy Efficiency Program Office (E^2PO) to help companies reduce their energy costs and improve their competitiveness, while reducing the economy's carbon footprint.

- **Strategy 4: Strengthen the Green Economy**. To meet the economy's energy challenges and facilitate the growth of the clean energy sector, Singapore will continue to invest in research, development and demonstration, facilities and manpower development as key enablers. This effort is through inter-agency collaborations on energy research, development and demonstration (RD&D), such as the Energy National Innovation Challenge (NIC) and the Energy Innovation Program Office (EIPO), and through private-public partnership initiatives to enhance manpower capabilities for the power utilities sector.

- **Strategy 5: Pricing Energy Right.** Price signals influence energy consumption and investment decisions to achieve efficiency and conservation. Singapore does not subsidise consumption of energy as such subsidies lead to the inefficient use of a scarce and precious resource. This is to ensure that the economy is able to adapt to the rising cost of energy and to a carbon-constrained world.

In July 2014, the Energy Market Authority (EMA) issued a Final Determination Paper making several enhancements to the market and regulatory framework for intermittent generation sources, such as solar energy, as follows (EMA, 2014).

- After careful consideration of the feedback received from solar industry players, electricity market licensees, companies and the public, the EMA is implementing the following key enhancements set out in this determination paper:
  - Clarified the licensing requirements for IGS;
  - Simplified the commissioning procedures for solar PV installations to connect to the grid, while ensuring safety;
  - Streamlined market participation and settlement to make it easier for IGS to receive payments for excess electricity exported into the grid; and
  - Streamlined the monitoring requirements for IGS.
- It is also important to recognise the characteristics of IGS and its effects on the power system. For example, IGS output is intermittent as it fluctuates based on weather conditions, cloud cover and shadows. To manage the effects of intermittency, the EMA will adopt a 'dynamic pathway' framework to ensure that there is sufficient reserves (or back-up) capacity in tandem with the growth in IGS capacity. There will be a further study on the reserves charging mechanism to recognise the intermittent nature of IGS, as there are trade-offs which need to be carefully considered. To this end, the EMA will issue a second public consultation paper in Q4 2014 to seek industry feedback on the framework.
- Moving forward, the EMA will continue to review the rules in consultation with stakeholders to ensure that the regulatory framework remains relevant as technologies and business models evolve.

In October 2014, the International Advisory Panel (IAP) emphasised the need for 'further innovative policy initiatives and technology development to allow Singapore to meet its growing energy needs and be ready to seize new opportunities in the energy sector' (MTI, 2014). The IAP was set up by Singapore's Ministry of Trade and Industry (MTI) to 'provide insights and perspectives on emerging trends in the global energy arena and to advise on the strategic directions for the energy sector in Singapore' (MTI, 2014). It made the following suggestions and recommendations based on certain global energy issues of relevance to the economy.

- **Facilitating Liquefied Natural Gas (LNG) Trading and Strengthening Singapore's Natural Gas Position**

The IAP noted that the global LNG market would likely double in the next two decades with strong growth in Asia. This will occur in the context of the US unconventional gas revolution, regional gas developments, international climate change considerations, the shift towards more market-oriented pricing and evolving energy policy of other countries.

The IAP was of the view that there is an emerging need for supply flexibility and market efficiency in the natural gas market, particularly in Asia. The panel suggested that given Singapore's reputation for a stable

regulatory framework, its political neutrality, existing trading and financial infrastructure and its efficient decision-making, there is a real prospect of a centre for trading of natural gas in Singapore in collaboration with regional countries and industry partners.

Noting that other trading hubs took time to develop, the IAP recommended that Singapore take a long-term view and continue to expand its LNG infrastructure and develop ancillary services. Singapore should also develop trading mechanisms and standards to facilitate gas trading and expand its regional and international dialogue on gas market opportunities. This will collectively enhance Singapore's energy security.

- **Exploring Energy Options**

The IAP also supported Singapore's efforts to facilitate greater deployment of solar energy, welcoming in particular its decision not to subsidise deployment and its commitment to liberalised markets. The IAP recognised that solar is at present Singapore's only technically and economically viable renewable energy source. It agreed that Singapore's renewable energy strategy is comprehensive in promoting the integration of solar energy and accelerating its adoption in the market.

The IAP emphasised the importance of materials research to improve modular and system-level efficiencies to reduce costs, while developing attractive financing models. In that regard, the IAP commended the Singapore Government for its consistent efforts in supporting research at the Solar Energy Research Institute of Singapore (SERIS) and the various institutes of higher learning.

- **Research Development & Demonstration (RD&D) as a Key Enabler**

The IAP supported Singapore's RD&D strategy to direct investments towards developing solutions across both supply- and demand-side initiatives to assure a reliable, affordable, sustainable and secure energy system. The panel endorsed Singapore's RD&D priorities in solar photovoltaics, energy efficiency and new materials in buildings, and smart infrastructure solutions to address the effects of intermittency of renewable energy. The IAP encouraged strong collaborations between research institutes and the industry, in line with Singapore's focus on applied research and bringing solutions from the laboratory to market.

ENERGY SECURITY

Energy security is of outmost importance for Singapore as a trading economy, a hub for international shipping and aviation and a major tourist destination, among many other reasons. Therefore, the economy has taken steps to enhance its energy security within the framework of its geological and geographic restrictions. The latter limit its options by excluding all types of renewables apart from waste-to-energy and, to a very limited extent, solar energy as feasible and/or viable ones. Facing this reality, Singapore has sought to increase the share of gas in its energy requirements as the cleanest type of fossil energy, and diversify its sources of supplies, suppliers and supply routes as detailed below.

Natural gas is now the major fuel for electricity generation in Singapore as evident in its share (96%) of the economy's power mix in 2015 (EMA, 2015a). Four offshore natural gas pipelines supply Singapore's piped natural gas needs. The first gas pipeline, located in the northern part of the main island, was commissioned in 1991 and supplies the economy with 4.2 million cubic metres per day (mcm/d) (150 million cubic feet per day [MMcf/D]) of natural gas from Malaysia. Senoko Energy Ltd (formerly known as Senoko Power Ltd) imports Malaysian gas for its power generation plant. Since January 2001, the second pipeline, from the West Natuna gas field in Indonesia, has supplied the economy with 9.2 mcm/d (325 MMcf/D) of natural gas. The third pipeline, from South Sumatra, Indonesia, started supplying gas to Singapore in September 2003, and the fourth pipeline, from Malaysia, began its operation in 2007, supplying since that year 3.1 mcm/d (110 MMcf/D) of natural gas, mainly for power generation. Keppel Gas Pte Ltd is the importer of natural gas for the fourth pipeline.

PowerGas Ltd, a subsidiary of Singapore Power, owns and manages the gas pipeline network conveying natural gas and town gas. It provides open and non-discriminatory access to the gas pipeline network. SP PowerGrid Ltd conveys gas and manages the gas pipeline network. SP PowerGrid Ltd is licensed by the EMA as the gas transport agent.

The diversification of the gas supply has become an important issue, given its large and growing share of electricity generation. Towards this end, the Singapore Government announced a plan in 2006 to import LNG and build the first LNG receiving terminal to meet the rising demand for electricity generation and diversify its sources of natural gas. PowerGas Ltd was appointed the developer of the LNG terminal in 2007. However, due to the difficulty of proceeding with the project on a commercial basis, the Singapore Government announced

its decision to take over the development and ownership of the Singapore LNG terminal in June 2009. As a result, the EMA formed the Singapore LNG Corporation Pte Ltd (SLNG) to develop, build, own and operate the LNG terminal. On 8 February 2010, SLNG awarded the contract for the engineering, procurement and construction of Singapore's first LNG terminal.

Singapore completed and commenced commercial operations of the LNG terminal on 7 May 2013, with an initial capacity of 3.5 million tonnes per annum (Mtpa), located at an approximately 40-hectare site on the south-west part of Jurong Island. This capacity increased to 6 Mtpa in January 2014 when the third LNG tank, the fourth Open Rack Vaporiser and two High Pressure Booster Pumps were completed and brought into service. Additionally, the Secondary Berth and the Gas Engine Generator achieved mechanical completion at that time (SLNG, 2014a).

The terminal's capacity will further rise to 11 Mtpa when the fourth tank (under-construction and set for completion in 2018) and additional regasification facilities (planned for completion in 2017) are operational (EMA, 2015b). The LNG terminal is designed to have the scalability to provide new services such as LNG trucking, industrial gas manufacturing and liquid petroleum gas (LPG) imports and exports in the future (SLNG, 2014b).

Singapore has also undertaken major projects apart from LNG to enhance the security of its required hydrocarbons.

The economy has initiated a project to build a floating storage facility for oil and petrochemical products. The initiative, known as the Very Large Floating Structure (VLFS), comprises two rectangular modules, each with a storage capacity of 150 000 cubic metres. The VLFS will occupy only seven hectares of foreshore space as compared to 20 hectares of land for the same storage capacity. This 'mega-float' platform, coupled with utilities and amenities support, will boost the Singapore industry's competitiveness in providing additional logistic capacity for the refining and petrochemicals and oil trading sectors. The project is not yet realized as of March 2016.

Finally, Singapore has embarked on a project to build South-East Asia's first underground liquid hydrocarbon storage facility called the 'Jurong Rock Caverns', located at a depth of 130 metres under the Banyan Basin on Jurong Island (JTC, 2014). This project can also be used for other higher value-added petrochemical processes. Phase One of the project, with a storage capacity of approximately 1.5 million cubic metres, was completed September 2014 (SGC, 2014a).

ENERGY TECHNOLOGY/RESEARCH AND DEVELOPMENT

Singapore supports and promotes energy research and development (R&D) for many reasons including the following: developing capabilities to support the clean energy sector as a key growth area; growing a viable industry that will create jobs; and meeting Singapore's energy challenges and its sustainable development objectives. To this end, the National Research Foundation (NRF) allocated SGD 170 million in 2007 and another SGD 195 million in 2011 to the EIPO (formerly known as the Clean Energy Program Office). In total, the NRF provided USD 210 million of funds to the EIPO to promote R&D in the energy sector between 2011 and 2015 (EMA, 2015c). Additionally, 'about $140 million has been set aside for the Energy Innovation Research Programme' (EIRP) (EMA, 2015c).

The EIRP, co-led by the EDB (Economic Development Board) and the EMA, is a competitive R&D grant call initiative under EIPO that aims to strengthen Singapore's R&D capabilities and address its energy-related challenges. Between 2012 and 2014, 12 grant calls were launched in areas such as solar, green buildings, power generation, energy storage, smart grids and gas, and over USD 70 million awarded to various Singapore-based institutes of higher learning, research institutes and industry. In 2015, the EIPO launched its 13th grant call (RFP 13) under the EIRP as it invited 'White Papers for R&D Programmes, each comprising multiple projects under a unifying theme to address the following research objective: Innovations to lower the Levelised Cost of Electricity (LCOE) of solar PV systems in Singapore' (NUS, 2015a).

The EMA also offered various research grants in 2015 on behalf of the EIRP. They include the Energy Storage Grant Call 2015 to support 'innovative solutions in the following domain area: Cost-effective energy storage innovations that can be effectively deployed in Singapore' (NUS, 2015b). In partnership with Sembcorp, the EMA also provided a grant under the Sembcorp-EMA Energy Technology Partnership (SEETP) Grant Call 2015 to support research on 'Domain A: Increasing the accuracy and speed of boiler inspection process for

defect localisation (Target ≥ 40%) to reduce down time and enhance availability of power plants. Domain B: Improving the energy efficiency of bio-sludge treatment process (Target ≥20%)' (NUS, 2015c).

Singapore's government has supported the establishment of research centres for clean energy under EIPO. For example, the Solar Energy Research Institute of Singapore (SERIS) was established in 2008 to conduct industry-oriented R&D in solar energy technologies, focusing on materials, components, processes and systems for solar PV electricity generation and energy-efficient buildings.

EIPO has also supported the establishment of the Energy Research Institute at Nanyang Technological University (ERI@N), with the objective of advancing research aimed at improving the efficiency of the current energy systems and maximising the use of alternative energy sources. In a related effort, the Agency of Science, Technology and Research (A*STAR) set up the Experimental Power Grid Centre (EPGC), a program that undertakes R&D activities in areas such as intelligent and decentralised power distribution, control and management of distributed energy resources, and smart and interactive energy utilisation. It features a 1 MW experimental power grid, which is designed to create various power network configurations at near grid-like conditions. This facility acts as a platform for researchers, industry and public agencies to develop energy technologies before bringing them to larger-scale test-beds or commercialisation.

To meet Singapore's long-term energy challenges, the government allocated SGD 300 million to the first National Innovation Challenge on 'Energy Resilience for Sustainable Growth' or 'Energy NIC'. The Energy NIC aims to develop cost-competitive energy solutions for deployment within 20 years to help Singapore improve energy efficiency, reduce carbon emissions and increase energy options.

Solar energy is Singapore's most viable renewable energy, apart from waste-to-energy, within the mentioned limits, given the economy's location in the tropical Sunbelt (EDB, 2014a). A key player in this field is the SERIS, which conducts world-class industry-oriented R&D and trains manpower for the solar energy sector. It has attracted world-renowned talent in the solar industry and is now home to some 160 researchers. Singapore is now a prime location for major solar companies such as Phoenix Solar, Renewable Energy Corporation (REC), Trina Solar and Yingli, which aim not only to improve the economy's domestic market, but markets all over Asia. Moreover, Singapore also houses a range of key wind technology players such as Keppel and Vestas.

Finally, the National Environment Agency (NEA) also plays a role supporting environmentally focused energy research as part of efforts to help Singapore achieve environmental sustainability. Towards this end, the Singapore Environment Institute (SEI) acts as the NEA's training and knowledge division (NEA, 2015a). Additionally, the NEA, in its capacity as Singapore's Designated National Authority (DNA) for Clean Development Mechanism (CDM) projects under the Kyoto Protocol to the UNFCCC, issued a Letter of Approval (LoA) to CDM projects that meet Singapore's sustainable development criteria. The LoA supports the registration of the project by the UNFCCC CDM Executive Board (EB)' (NEA, 2015b).

ENERGY MARKETS

ELECTRICITY

Singapore began restructuring of its energy sector in 1995 through corporatising its electricity and gas industries as vertically integrated companies. Major activities in this regard have since included corporate and industry structural reforms, the creation of an institutional regulatory framework and market rules for the contestable parts of electricity generation and retail of electricity, separate from the natural monopoly of electricity transmission at the ownership level. Furthermore, the Singapore Electricity Pool was established in 1998 to facilitate the trading of electricity between generation and retail companies in a competitive environment.

Singapore's government introduced additional reforms in 2000, separating Singapore Power Ltd into two parts. These were the natural monopoly or non-contestable part of the electricity market (the electricity transmission and distribution grid) and the competitive or contestable part (power generation and retail). As a result, SP Power Assets Ltd (then known as the electricity grid—PowerGrid Ltd) and SP Services Ltd (then known as Power Supply Ltd) remained under Singapore Power Ltd. However, the power generation companies, namely, Senoko Power Ltd and PowerSeraya Ltd, would compete with each other and other power generation companies in Singapore. Additionally, Singapore's government founded an independent power system operator and liberalised the electricity retail market.

The government's other major restructuring initiatives included forming the EMA in April 2001 to regulate the electricity and gas industries and promote competition in these industries. This was followed by the

commencement of operations of the National Electricity Market of Singapore (NEMS) in 2003, where generation companies compete to sell electricity at half-hour intervals in the wholesale electricity market.

The retail market's liberalisation has been implemented in phases, with plans to open up the market to full retail contestability. Its final phase (full retail contestability) is currently under review (EMA, 2014a). This phase covers the remaining non-contestable consumers, mainly small businesses and household consumers—about 1.3 million in number—that represent 25% of total electricity sales. As stated by the MTI minister during the Singapore International Energy Week (SIEW) in October 2015, the EMA is working with the industry stakeholders to launch full retail contestability (FRC) in 2018 (EMA, 2015d).

GAS

Gas is a key energy resource for Singapore as apparent in the large share of gas in its power mix in 2015 (96%). The gas industry has been restructured since 2008 to ensure a competitive electricity market. As explained by the EMA, similar to the electricity market, the gas market is structured in a way that fosters competition (EMA, 2015b). As a result, 'the gas transportation business is separated from the competitive businesses of gas import, shipping and retail. A set of rules called the Gas Network Code (GNC) governs the activities of gas transportation, providing open and non-discriminatory access to the onshore gas pipeline network' (EMA, 2015b).

The passage of the Gas Act (Act 11) in 2001 began the restructuring of Singapore's gas industry. The Act sets the legal basis for separating the contestable part of the gas industry (gas retail and gas imports) from the monopolistic part (gas transportation). A gas grid company owns the gas transmission and distribution network, which provides market players with open and non-discriminatory access to the network.

In January 2002, PowerGas Ltd divested its contestable activities, namely, gas imports, production and retail. Consequently, City Gas Ltd's manufactured gas production and gas retail activities and Gas Supply Ltd's natural gas import activities were transferred to Temasek Holdings to make PowerGas Ltd a gas transporter. Under the new gas industry framework, the transportation of natural gas would be regulated.

The GNC, which came into effect on 15 September 2008, initiated Singapore's newly restructured gas market operation. The EMA developed and enacted the GNC in consultation with industry players. The GNC's rules govern the activities of gas transportation, providing open and non-discriminatory access to Singapore's onshore gas pipeline network. The GNC outlines the common terms and conditions between the gas transporter (PowerGas Ltd) and those industry players who engage the transporter to transport gas through the pipeline network. To ensure the gas transporter is not in commercial conflict with common interests, PowerGas Ltd is banned from participating in the electricity and gas businesses open to competition such as gas importing, trading and retailing. Other gas industry participants will not be allowed to transport gas.

The exit of Sembcorp Gas from the gas transportation business on 15 September 2008 affirmed PowerGas Ltd as a gas transport monopoly. The company, which had diversified interests in gas transportation, import and retail businesses, exited the gas transportation business and transferred its gas pipelines to PowerGas Ltd, via a statutory transfer under section 98 of the Gas Act.

The gas market's restructuring is mainly to support the liberalisation of the electricity industry by providing a competitive source of natural gas for electricity generation. Singapore's government expects greater competition in the gas and electricity sectors and the benefits of competition, such as lower prices and a wider choice of retailer, to be passed through to consumers.

The economy's LNG terminal, which began operation in May 2013, has since made a major contribution to the diversification of its gas market and boosted its gas security by making LNG available to Singapore's gas market (EMA, 2014b). On 21 August 2006, Singapore introduced controls on importing of new piped natural gas (PNG) supply to allow the build-up of demand for LNG, given the need for a baseload of LNG demand to ensure that the LNG terminal can operate safely and maintain financial viability. As a result, Singapore will not allow new PNG to be imported for all new gas demand. The Singaporean government will review the policy on PNG import controls when LNG imports reach 3 Mtpa or in year 2018, whichever comes first (EMA, 2015e).

TRANSPORT

Singapore promotes the use of public transport as part of its efforts for fuel efficiency and energy conservation. The economy has innovative policies to discourage car ownership and usage, such as a vehicle quota system and

electronic road pricing, towards this end. The Singaporean government has also offered a green vehicle rebate to encourage the purchase of green vehicles such as hybrid, compressed natural gas and electric cars.

The Green Vehicle Rebate (GVR) program is an inter-agency effort by Singapore's Ministry of Finance, Ministry of the Environment and Water Resources, Ministry of Transport, Land Transport Authority and NEA. The program offers incentives to promote green vehicles, which are more fuel-efficient and emit less air pollutants than their conventional petrol or diesel equivalents through narrowing the cost differential between green vehicles and conventional vehicles (NEA, 2015c).

The program was first introduced in January 2001 for the registration and use of electric and hybrid cars, but was extended to compressed natural gas (CNG) vehicles in October 2001 and imported used electric and petrol-electric hybrid vehicles registered as of 1 July 2010 (NEA, 2015c).

The rebate was increased from 20% to 40% of the vehicle open market value in January 2006 to offset the additional registration fee.

An inter-agency Electric Vehicle Taskforce (EVTF) led by the EMA and the LTA (Land Transport Authority) launched the electric vehicle (EV) test-bed from June 2011 to December 2013 to determine feasibility of EVs in Singapore (EMA, 2014c). Findings from the test-bed have shown that EVs are technically feasible in Singapore, but are still limited by issues such as high EV costs.

In December 2014, the EDB and the LTA announced the next phase of the EV test-bed. This test-bed will focus on vehicle fleets such as EV car-sharing and E-taxis (LTA, 2014).

ENERGY CONSERVATION

Singapore has taken measures to decrease its energy consumption through conservation. Towards that end, the Singaporean Parliament passed the Energy Conservation Act 2013 (ECA) to be jointly administered by the Ministry of the Environment and Water Resources and the Ministry of Transport; it came into effect in 2013 (EMA, 2012).

The ECA requires large users of energy to implement energy management initiatives. Companies that consume more than 15 GWh or 1.3 ktoe of energy annually are required to appoint an energy manager to monitor and report their energy use and greenhouse gas emissions and to submit plans for energy efficiency improvement to the relevant agencies.

The Act also consolidates energy efficiency related legislation currently found in different Acts including the Mandatory Energy Labelling Scheme, Minimum Energy Performance Standards and the Fuel Economy Labelling Scheme for passenger cars and light goods vehicles under the Environmental Protection and Management Act.

Apart from the ECA, the economy has also sought to decrease energy consumption through improving the energy efficiency of its industry, transportation, buildings and households sectors.

ENERGY EFFICIENCY

Singapore has actively sought to increase its energy efficiency for various reasons. These reasons include curbing unnecessary consumption of fossil energy for environmental, financial and health considerations and improving competitiveness of its industries. Consequently, the economy's key strategies in mitigating greenhouse gas emissions, for example, are to switch to less carbon-intensive fuels and to improve its energy efficiency. It has adopted measures to improve its energy efficiency and to reduce the energy use of various sectors of its economy. The government established the E²PO, a multi-agency committee led by the NEA and the EMA, to implement energy efficiency. Together, the EMA, the E²PO and the NEA actively promote energy efficiency in both public and private sectors through legislation, incentives and information (NEA, 2014). Their energy efficiency efforts are targeted at various sectors such as power generation, industry, transport, buildings and households.

To that end, the E²PO activities are the most prominent. The entity promotes and facilitates the adoption of energy efficiency in Singapore under the following five strategic goals (E²PO, 2014):

- Promote energy efficiency through regulation and standards, incentives and open information;
- Develop human and institutional capabilities by developing a local knowledge base and expertise in energy management and collaborating with institutes of higher learning (IHLs);

- Promote emerging energy efficient technologies and innovation through supporting the research development and demonstration of new energy efficient technologies, innovation and business process improvements;
- Profile and promote energy efficiency internationally through various platforms such as Singapore International Energy Week (SIEW), Asia-Pacific Economic Cooperation (APEC) and East Asia Summits (EAS);
- Benchmark Singapore's energy efficiency initiatives against other countries and international frameworks.

The E²PO has targeted Singapore's main energy consumers, namely, industry, transportation, buildings and households, through its various programs aimed at improving energy efficiency and reducing their CO_2 emissions. Recent examples include: for buildings, the Building Control Act's Chapter 29 Part IIIB—Environmental Sustainability Measures for Existing Buildings (E²PO, 2015a); for industry, the 2013 Mandatory Energy Management Requirements (E²PO, 2015b); and for households, the 10% Energy Challenge of 2008, aimed at encouraging households to save at least 10% (E²PO, 2015c). Expanding the mass rapid transit (MRT) system has been the major emissions-reduction policy for the transport sector (E²PO, 2015d).

INDUSTRY

Various government initiatives have sought to improve industry's energy efficiency. They include:

- The Energy Efficiency Improvement Assistance Scheme (EASe): EASe encourages and helps companies identify potential energy efficiency improvement opportunities. Under the EASe, up to 50% of the cost of appraisals for buildings and facilities will be co-funded.
- The Investment Allowance Tax Scheme: This program encourages companies to invest in energy-efficient equipment. The EDB administers the Investment Allowance Tax Scheme, which is a capital allowance on qualifying equipment costs that allows a deduction against chargeable income
- Design for Efficiency Scheme (DfE): Introduced in 2008, it encourages investors to incorporate energy and resource efficiency considerations into their facilities' development plans early in the design stage. Under the DfE, up to 80% of the cost to conduct design workshops will be co-funded.
- The Grant for Energy Efficiency Technologies (GREET): GREET is a co-funding scheme launched in 2008 to incentivise owners or operators of industrial facilities to invest in energy efficient technologies or equipment.
- The Singapore Certified Energy Manager (SCEM) training program and grant: This program provides a thorough understanding of the key energy issues facing the building and industry sectors. It helps participants develop the technical skills and competencies needed to manage energy issues of the organisations that they serve. A training grant is also offered to cover about 80% of the training costs.
- Energy Efficiency National Partnership (EENP) Program: This is a voluntary outreach program to assist companies in improving their energy efficiency and reducing energy wastage. The EENP promotes the adoption of energy management systems, such as ISO 50001, at the organisational level and provides a platform for training and sharing best practices under the EENP Learning Network. EENP partners who have implemented excellent energy management practices and demonstrated tangible results will be recognised through the EENP Award.

Other initiatives aimed at building energy efficiency capabilities include incentive schemes for small and medium-sized enterprises (SMEs) (E²PO, 2015b). Singapore intensified such efforts in 2013 when it required energy-intensive industrial companies with annual energy consumption of 54 terajoules (TJ) or more to comply with the Mandatory Energy Management Requirements.

Finally, Singapore's energy-intensive industries are required, as of April 2013, under the ECA to register with the NEA within six months of qualifying as a registrable corporation and to implement mandatory energy management practices as follows: appointing an energy manager; monitoring and reporting energy use and greenhouse gas emissions annually; and, submitting energy efficiency improvement plans annually (E²PO, 2015b).

TRANSPORT

Singapore's has sought to increase its transport sector's energy efficiencies through a variety of measures. This objective has manifested in the economy's land transport strategies, which seek to integrate transport and land-use planning, promote the greater use of public transport and apply intelligent transport systems to manage road use. The government has also pioneered innovative policies such as a vehicle quota system and electronic road pricing to reduce congestion, a green vehicle rebate to encourage more fuel-efficient vehicles and trials of green technologies such as diesel hybrid buses and electric vehicles.

Decreasing the role of private vehicles in favour of more-fuel efficient MRT has been a major component of Singapore's efforts towards the mentioned objectives as well as reducing its carbon footprint. The economy is currently constructing new MRT lines and adding new stations to existing lines (LTA, 2015).

Singapore's major efforts to increase sector energy efficiencies include the following:

- Carbon Emissions-Based Vehicle Scheme (CEVS): The CEVS was introduced in January 2013 to improve the number of green vehicles purchased, with cars enjoying rebates for having low carbon emissions, while those with high carbon emissions having to pay a surcharge. Replacing the green vehicle rebate (GVR), the results of CEVS has been encouraging with more than 50% of the new cars registered in 2013 receiving CEVS rebates, whereas about 10% paid the surcharge. The CEVS will be extended until July 2015 before the full impact of the scheme will be refined.

- Fuel Economy Labelling Scheme (FELS): As of 2009, passenger cars and light goods vehicles that are sold in Singapore must be affixed with a fuel economy label. With the fuel economy information, car buyers are able to make better-informed decisions on fuel efficiency when purchasing new cars.

- Green Mark for Rapid Transit System: The rapid transit system (RTS) is the backbone of Singapore's public transport system and is also the most energy efficient means of transporting a large number of commuters. By 2020, the RTS network will be doubled to 278 km. The objectives of the green mark for the RTS framework are to promote sustainable and environmentally friendly RTS design as well as to provide guidance in the formulation of engineering standards for conceptualisation, design and construction of new RTS lines. The framework has three key pillars—the effective use of energy, water conservation, and environmental protection and sustainable development—and covers various aspects of an RTS line (rolling stock, electrical and mechanical systems, civil works, station design as well as operational considerations).

- Trial of Diesel Hybrid Buses: LTA and public transport operators are collaborating on a trial of diesel hybrid buses. Diesel hybrid buses have been found to be effective in other cities in reducing both the carbon emissions and particulate matter (PM) emissions of the bus fleet. If the trial is successful, more diesel hybrid buses may be deployed in the future.

- Facilitating Cycling: Cycling does not consume external energy. To facilitate cycling as an alternative mode of transport for short-distance, intra-town trips, programs are progressively being rolled out to design and construct dedicated cycling paths in seven selected housing development board (HDB) towns (Tampines, Yishun, Sembawang, Pasir Ris, Taman Jurong, Bedok and Changi-Simei) as well as Marina Bay. More and better-designed bicycle parking facilities are being provided near MRT stations to help cyclists transfer to the public transport system for longer distance travel. Foldable bicycles are allowed on buses and trains during off-peak hours.

- Park and Ride (P&R) Scheme: The scheme allows people who have vehicles to park their vehicles at designated car parks located near an MRT station, bus interchange or bus stop, and continue their journey hassle-free by bus, MRT or LRT. The purpose of this scheme is to allow motorists to switch to the more energy efficient public transport for part of their journey in a convenient way.

- The Green Vehicle Rebate (GVR) Program: The program offers incentives to promote green vehicles that are more fuel-efficient and emit less air pollutants than their conventional petrol or diesel equivalents (NEA, 2015c).

BUILDINGS

Singapore has plans to improve the energy efficiency of the building sector as a major energy consumer, for which a major consideration is achieving a sustainable environment as a key factor for its sustainable development. To realise this vision, the Building and Construction Authority (BCA) and the NEA set out to accelerate the adoption of environmentally friendly green building technologies and building design practices, and to encourage energy efficiency in buildings.

Singapore's energy efficiency initiatives include the following:

- EASe for Buildings: The EASe scheme is available to building owners and operators.
- Singapore Certified Energy Manager (SCEM) for buildings: This initiative, consisting of both a program and grant, is available to professionals who wish to build their careers as energy managers in the building sector.
- BCA Green Mark Scheme: Launched in January 2005, the BCA green mark scheme is a green building rating system that promotes the adoption of green building design and technologies to improve energy efficiency and reduce the impact of buildings on the environment. Under the BCA green mark scheme, buildings are assessed for energy efficiency, water efficiency, indoor environmental quality and environmental protection as well as other green features and innovations.
- Building Control (Environmental Sustainability) Regulations: The regulations took effect in 2008 to require new buildings and existing ones undergoing major retrofitting with a gross floor area greater than 2 000 square metres to achieve the minimum green mark certified level.
- Green Mark Gross Floor Area (GM GFA) Incentive Scheme: To encourage the private sector to develop buildings that attain higher tier green mark ratings (i.e. Green Mark Platinum or Green Mark Gold^{PLUS}), BCA and URA introduced the green mark gross floor area incentive scheme on 29 April 2009 for a period of five years. For developments attaining Green Mark Platinum or Gold^{PLUS}, URA will grant additional floor area over and above the master plan gross plot ratio (GPR) control.
- Green Mark Incentive Scheme for New Buildings (GMIS-NB): On 15 December 2006, a sum of SGD 20 million was set-aside for the green mark incentive scheme for new buildings for a period of three years. The scheme offered cash incentives to developers, building owners, project architects and engineers who made an effort to achieve at least a BCA Green Mark Gold rating or higher in the design and construction of new buildings. The fund was fully committed.
- Green Mark Incentive Scheme for Existing Buildings (GMIS-EB): A sum of SGD 100 million was set-aside for the green mark incentive scheme for existing buildings on 29 April 2009 for a period of five years. The GMIS-EB provides a 'cash incentive for an upgrading and retrofitting' scheme that co-funds up to 35% (capped at SGD 1.5 million) of the costs of energy-efficient equipment installed to improve the energy efficiency of existing buildings. In addition, the GMIS-EB includes a 'health check' scheme; this is an energy audit, which determines the efficiency of a building's air-conditioning plants. BCA co-funds 50% of the cost for conducting this health check; the remaining 50% is borne by the building owner.
- The Design Prototype (GMIS-DP): A sum of SGD 5 million was set-aside for the GMIS-DP on 1 December 2010 for a period of four years. GMIS-DP aims to encourage developers and building owners to strive for greater energy efficiency in buildings by placing more emphasis on this at the design stage. The scheme provides funding support for the engagement of environmentally sustainable design (ESD) consultants to conduct collaborative design workshops and to help in simulation studies early in the project to achieve an optimal design for green buildings. The developments must aim to exceed the green mark platinum standards, demonstrating energy savings of at least 40% or better than the current base code or equivalent.
- Building Retrofit Energy Efficiency Financing (BREEF) Scheme: In September 2011, BCA announced a new pilot scheme called the Building Retrofit Energy Efficiency Financing (BREEF), which provides loans to building owners and energy services companies to enable them to carry out energy retrofits. BCA and participating financial institutions committed to sharing the risk of any loan default. The pilot scheme took effect 1 October 2011 for a period of two years.

- Higher Green Mark Standards for Land Sales Conditions in Strategic Growth Areas: To achieve higher green mark standards (i.e. Green Mark Platinum or Green Mark GoldPlus) for projects developed on government-sold sites, the higher green mark standards will be set as part of the land sale conditions for all new developments in selected new strategic growth areas. This will ensure these land sale projects are truly green, high quality and distinctive. The aim is to accelerate the adoption of environmentally friendly green building technologies and building design practices to enable the development of more economically viable green buildings in the future.

- Public Sector Taking the Lead: The public sector is committed to environmental sustainability and takes a long-term view of resource efficiency. Public sector agencies have put in place environmental sustainability measures that encompass energy efficiency, water efficiency and recycling. New public sector buildings with an air-conditioned area of greater than 5 000 square metres must attain the Green Mark Platinum rating, while existing public sector buildings with an air-conditioned area of greater than 10 000 square metres must attain the Green Mark Gold^{Plus} rating by 2020.

Among the most recent initiatives is the introduction of legislation in 2012 aimed at achieving a sustainable building environment to ensure the continuity of efficient operation of existing buildings throughout their life cycle (E^2PO, 2015a) as follows.

- Building Control Act's Chapter 29 Part IIIB—Environmental Sustainability Measures for Existing Buildings: The Act requires building owners to comply with the minimum environmental sustainability standard (green mark standard) for existing buildings; submit periodic energy efficiency audits of building cooling systems; and submit information in respect to energy consumption and other related information as required.

HOUSEHOLDS

Improving energy efficiency of households has been a major target for Singapore as part of its commitment to sustainable development demanding reductions in fossil energy consumption and CO_2 emissions. Accounting for about a sixth of the electricity consumed in Singapore, households are encouraged to purchase energy-efficient appliances and adopt energy-efficient habits. Energy efficiency programs for households include:

- The 10% Energy Challenge: To increase public awareness of ways to be more energy efficient, the 10% Energy Challenge was launched in April 2008. The aim of the challenge was to teach households simple energy saving habits to reduce their energy use by 10% and save money. By doing so, they also help fight climate change.

- Mandatory Energy Labelling Scheme (MELS) and Minimum Energy Performance Standards (MEPS): To assist households in making better energy choices, the MELS was introduced for the two most energy intensive appliances, namely, air conditioners and refrigerators, in January 2008. The scheme was extended to clothes dryers in 2009. Under the Environmental Protection and Management Act, all household refrigerators, air conditioners and clothes dryers sold in Singapore must be affixed with an energy label. In addition, MEPS were introduced in September 2011 for household air-conditioners and refrigerators. The MEPS remove the most inefficient appliance models from the market by prohibiting the sale of models that fall short of specified minimum energy efficiency levels, and encourage suppliers to bring in more energy-efficient appliances as technology improves.

- Residential Envelope Transmittance Value Standard: As set in place in 2008, residential buildings with a gross floor area of 2 000 square metres or more must comply with the BCA residential envelope transmittance value standard.

RENEWABLE ENERGY

Singapore has very limited options in terms of renewables due to its geological and geographical situations. Hydro, wind, geothermal and tidal energy are not feasible and there are limits to solar expansion. Apart from a limited expansion of grid-connected rooftop solar panels, waste-to-energy is Singapore's main renewable energy source, accounting for 3.7% of Singapore's power mix in 2014 (EMA, 2015a). Due to such constraints, Singapore is pursuing growth opportunities in waste-to-energy and, to the extent possible, solar for power generation. It has also been producing biodiesel since 2010 to help diversify its liquid energy demand.

Several renewable energy initiatives are underway to help the economy diversify its energy mix and reduce its heavy dependency on fossil energy as follows.

Singapore's modern, electricity-generating incineration plants make use of renewable waste-to-energy technologies, annually consuming about 2.7 million tonnes of waste, which generates a growing amount of green energy from four incineration plants (Tuas IP 46 MW, Senoko WTE Plant two x 28 MW, Tuas South IP 80 MW and Keppel Seghers Tuas WTE Plant 22 MW). These plants generated 691 ktoe of electricity in 2014 (EMA, 2015a).

Regarding solar energy, Singapore has embarked on R&D and test-bedding initiatives to help companies and researchers advance the development of the required technologies. Singapore's test-bedding efforts seek to improve the understanding of the best practices for optimising the performance of solar PV systems in tropical, urbanised environments.

Households are a major beneficiary of solar energy for electricity generation. For that matter, The HDB has test-bedded solar PV systems at two existing public housing precincts in Serangoon and Wellington, generating 220 kWh of electricity per day for each precinct in the process. The government agency has been utilising the rooftop space of residential buildings to set up solar systems in land-scarce Singapore.

As of the second half of 2014, there were 636 grid-connected PV installations with the total capacity of 33 MWp, comprised of 226 residential (2.3 MWp) and 410 non-residential (30.8 MWp) installations (EMA, 2015a). The HDB will install solar panels over 900 HDB blocks and eight government buildings by the end of 2017 through a tender (EMA, 2015f).

The government agency has been investing substantially in solar R&D. Under its USD 31 million Solar Capability Building Program, HDB has been test-bedding different solar capabilities to build up expertise on solar installations. It has also helped to promote data sharing with other government agencies and the industry. These include learning points such as those on procurement and solar aggregators.

The HDB is also promoting solar leasing, a business model in which the agency buys only the electricity generated (EMA, 2015f). The power produced could be used to power lifts, corridors and staircase lights in common areas, for instance. Under a solar leasing model, a private company will design, finance, install, operate and maintain 2 MWp of solar PV systems. The Pasir Ris-Punggol Town Council will pay Sunseap for solar power generated and consumed at a rate that is not higher than the retail electricity tariff rate.

Added to HDB efforts to expand solar energy, the EDB and Public Utilities Board (PUB) will pilot a SGD 11 million floating PV project at Tengeh Reservoir, which aims to assess the feasibility of installing floating solar PV systems (2 MW) as an alternative to rooftop-based installations (NEA, 2015d). This is the first project of this nature in South-East Asia.

Singapore has also launched the SolarNova Programme to aggregate demand for solar energy 'across government buildings and spaces, to yield savings from economies of scale' while seeking to 'demonstrate solar energy's viability in Singapore [to] catalyse further adoption by the private sector' (MTI, 2015).

The EMA has increased the Intermittent Generation Threshold from 350 MWp to 600 MWp to help expand solar energy growth (EMA, 2015g). This threshold covers power generation from renewables that varies for natural reasons (sunshine in the case of solar) and require fossil fuel-fired generators as back-up.

Finally, the 'Handbook for Photovoltaic (PV) Systems' has been published by the EMA and the BCA to facilitate the implementation of solar PV systems in Singapore. The handbook provides information on licensing, market and technical requirements, and building and structural issues relating to solar installations.

Biodiesel production is also a vibrant sector. In November 2010, the Finnish oil refining and marketing company Neste Oil opened its 800 000 tonnes per year renewable diesel refinery in Singapore at the cost of EUR 550 million. The refinery uses Neste's proprietary NExBTL technology to produce a renewable diesel product superior to regular biodiesel and fossil-based diesel. Renewable diesel reduces greenhouse gas emissions by over 50% compared to fossil-based diesel (Neste Oil, 2012). The refinery is the world's largest of its kind along with Neste Oil's Rotherdam facility (Neste Oil, 2015).

SUSTAINABLE DEVELOPMENT

Singapore's IMCSD unveiled its Sustainable Development (SD) Blueprint on 27 April 2009. The SD Blueprint contains strategies and initiatives for achieving both economic growth and a good living environment for Singapore over the next 20 years.

The document details new targets and initiatives to improve resource efficiency and to enhance Singapore's urban environment. Improved efficiency in the use of resources such as energy, water and land will contribute to enhance the city-state's competitiveness in the long run. Under the blueprint, efforts will be made to improve air quality, expand and open up green and blue spaces, conserve biodiversity and enhance public cleanliness. These efforts will contribute to making the city a more liveable and attractive place, even as Singapore continues to grow and develop. Targets have been set to measure the progress in these areas. The blueprint has a 20-year timeframe, with identified key goals for 2030. The blueprint's goal for the energy sector is to reduce energy intensity by 35% by 2030 from 2005 levels, with an intermediate goal of 20% by 2020 from the 2005 levels (NEA, 2013).

In 2015 Singapore released 'an extension of the efforts outlined in the 2009 edition', namely, the Sustainable Singapore Blueprint 2015 (MEWR, 2015). The document takes into consideration feedback obtained from more than 130 000 people through recent initiatives, including the Land Transport Master Plan 2013 and the Urban Redevelopment Authority's Master Plan 2014 (MEWR, 2015). Its emphasis is on sustainable housing and transportation aimed at reducing waste to zero through reduction of consumption, recycling and reuse of all materials and adopting greener practices by businesses (MEWR, 2015). The objective is to turn Singapore into a 'hub for the cutting-edge business of sustainable development' to achieve three objectives: a liveable and endearing home; a vibrant and sustainable city; and, an active and gracious community (MEWR, 2015).

As part of its sustainable development objective, Singapore has taken steps to increase the solar share of its electricity generation as the only viable type of renewable for Singapore, apart from waste-to-energy, by facilitating its growth. Among others, the EMA has taken steps towards this end, including setting a policy of proactively enhancing the required market and regulatory framework to facilitate the deployment of solar units (EMA, 2014d).

NUCLEAR ENERGY

Singapore currently does not have a nuclear energy industry. In 2010, the economy embarked on a pre-feasibility study of nuclear energy to objectively evaluate the opportunities, challenges and risks of nuclear energy and its feasibility as a long-term energy option for Singapore. The study, finalised in 2012, concluded that nuclear energy technologies presently available, though safer than the older designs still in use in many countries, were not suitable for deployment in Singapore given the economy's small size and high population density (MTI, 2012).

CLIMATE CHANGE

Singapore is a small and completely urbanised city-state whose CO_2 emissions account for less than 0.2% of global emissions. The economy has made major progress in reducing its CO_2 emissions, although its options for non-CO_2 emitting energy are very limited (mainly confined to waste-to-energy and a very small amount of solar) and nuclear energy is not an option as mentioned earlier (EMA, 2014d).

Hence, in 2009, Singapore pledged in the context of the UNFCCC negotiations to reduce emissions by 16% from 2020 business-as-usual (BAU) levels in the event of a legally binding global agreement under which all countries will implement their commitments. The economy set up the National Climate Change Secretariat on 1 July 2010 as a dedicated agency under the Prime Minister's Office to coordinate its domestic and international policies, plans and actions on climate change (NEA, 2014).

Ahead of the pending conclusion of a legally binding global agreement, the economy has begun to implement measures that are expected to lead to a 7–11% reduction in emissions from BAU levels. Apart from increasing the share of solar in its power generation energy mix, which is currently very small (33 MWp in 2014), it has significantly reduced its grid-generated emissions through greater use of natural gas for electricity generation by increasing its share of the power mix. Singapore has switched from fuel oil to natural gas as the main energy source for such generation as it produces the least carbon emissions per unit of electricity generated among fossil fuel-fired power plants. By increasing the share of natural gas used in electricity generation from only 19% in 2000 to 96% in 2015, Singapore has substantially reduced its emissions growth over the last 10 years (NEA, 2014). Singapore's efforts have resulted in improving its average operating margin grid emission factor from 0.4 kg CO_2/kWh in 2013 to 0.4 kg CO_2/kWh in 2014 (EMA, 2015a).

Singapore is also intensifying efforts to promote more efficient energy use to decrease its CO_2 emissions. As part of its contribution to the post-2020 climate change agreement, Singapore intends to 'reduce its emissions intensity by 36% from 2005 levels by 2030 and to stabilise emissions with the aim of peaking around 2030' (MTI, 2015). This is a remarkable objective as Singapore is already one of the least carbon-intensive economies in the world, ranking 113 out of 140 countries (IEA, 2014).

NOTABLE ENERGY DEVELOPMENTS

PREPARING FOR FUTURE POWER GENERATION INVESTMENTS IN SINGAPORE

In October 2015, the EMA released a consultation paper, Preparing for Future Power Generation Investments in Singapore (EMA, 2015h). The document's rationalization is based on a need for a long-term view on the outlook of the energy landscape in Singapore given the high capital cost, significant lead time and long payback period for power generation investments. Towards that end, the EMA's document seeks to share with the industry the EMA's view of the long-term outlook of the sector, including 'projected growth of electricity system demand, as well as an indicative mix of generation sources (gas-fired plants, solar, electricity imports, etc.) in 2030 based on technology developments, evolving business models and broader policy considerations'.

This is part of the EMA's objective of working 'with the industry to further facilitate power generation investment decisions in Singapore through making available more information and providing greater visibility to investors'.

The consultation paper consists of three key sections: i) proposed information that the EMA hopes to put out on the long-term outlook of the energy market; ii) proposed enhancements to the regulatory approval process for new and existing generation assets to give greater visibility to the capacity coming onstream; and iii) a proposed framework to allocate land for new generation assets.

GRANT CALLS

The EMA rolled out a series of grant calls in 2015 covering areas including smart grids, power utilities (gas/LNG) and energy storage (EMA, 2015i). This was part of its plan to catalyse R&D of innovative technologies and solutions. The main objective was to 'address industry-relevant challenges and opportunities in the energy sector and lead to long-term solutions for Singapore's energy challenges'.

POST-3 MTPA LNG IMPORT FRAMEWORK

On 30 June 2014, the EMA launched a request for proposal (RFP) to appoint up to two LNG importers to supply Singapore with LNG beyond the first 3 Mtpa from BG Singapore Gas Marketing Pte. Ltd (EMA, 2015j). The RFP was conducted in two stages. Its Stage One closed on 31 December 2014. At that point, the EMA shortlisted four companies to participate in Stage Two, namely, BG Singapore Gas Marketing Pte. Ltd, Pavilion Gas Pte. Ltd, Sembcorp Industries and Shell Eastern Petroleum [Pte] Ltd).

On 29 May 2015, Stage Two was opened followed by the EMA releasing Corrigendum No. 1 on 2 November 2015, as per the following extract:

EMA will extend the closing date of Stage Two of the Post-3 Mtpa Request-for-Proposal ('RFP') in response to feedback from some LNG market stakeholders that it would be useful to provide more time for negotiations and for entering into binding commitments. The four shortlisted companies will now have to submit their proposals to EMA by 30 June 2016 instead of 29 February 2016. EMA will thereafter appoint up to two companies to import LNG for Singapore.

INAUGURATION CEREMONY OF REMEX INCINERATION BOTTOM ASH (IBA) METAL RECOVERY FACILITY

On 1 December 2015, REMEX Minerals Singapore Pte Ltd inaugurated its metal recovery facility located at Tuas Marine Transfer Station (TMTS) (NEA, 2015e). The facility recovers ferrous and non-ferrous metals from the incineration bottom ash (IBA) generated by the waste-to-energy (WTE) incineration plants in Singapore. It is the first IBA metal recovery facility in Asia and part of the NEA's long-term strategy to manage solid waste in Singapore.

ENERGY STORAGE PROGRAMME

In October 2014, the EMA announced a SGD 25 million Energy Storage Programme to support the development and integration of large scale, cost-effective Energy Storage Systems (ESS) for Singapore's power

system. In Singapore, ESS could be used to reduce demand during peak periods; as reserves for frequency regulation; and to support the deployment of intermittent generation sources like solar energy.

SEMBCORP-EMA ENERGY TECHNOLOGY PARTNERSHIP

The EIPO established a Sembcorp-EMA Energy Technology Partnership (SEETP) under the EIRP October 2014 (SEETP, 2015). Thus, the EMA partnered with Sembcorp in a SGD 10 million (about USD 8 million) initiative to encourage the translation and commercialisation of energy research into technologies and solutions to address Singapore's energy needs. Through this partnership, researchers and companies have the opportunity to develop new technologies that could potentially be test-bedded at Sembcorp's facilities and leverage Sembcorp's strong business networks for commercialization (SEETP, 2015).

The SEETP is an entity, which 'encourages the translation of ideas from the laboratory to market and addresses a current gap where the potential of promising technologies is often not exploited beyond the research and development (R&D) stage' (SEETP, 2015).

PULAU UBIN MICRO-GRID TEST-BED

The EMA is conducting a micro-grid test-bed on the island of Pulau Ubin to assess the impact of intermittent energy sources, such as solar, on grid operations. Phase 1 of the test-bed was successfully completed and launched by Minister S. Iswaran on 10 October 2013 to supply electricity to end-users at the Pulau Ubin jetty area. Under Phase 2, the micro-grid will offer companies and research organisations a platform to develop and pilot innovative, close-to-market energy technologies for Singapore (in areas such as energy analytics, energy storage and grid asset management). Awarded projects will be announced by the second half of 2015.

BIOMASS CLEAN COAL COGENERATION PLANT

Currently, Tuas Power operates the Biomass Clean Coal (BMCC) cogeneration plant, as part of the Tembusu multi-utilities complex that serves the industries on Jurong Island. The increased efficiencies of cogeneration and the use of biomass help reduce the carbon emissions of the plant per unit of electricity and steam generated. Further, to ensure that environmental sustainability is not compromised, low-sulphur and low-ash coal is used in the BMCC plant to substantially reduce the emissions of sulphur dioxide and the amount of waste generated. The bulk of the fuel used in the plant is renewable biomass, natural gas and diesel. The facility has been in use since 2013 and will be fully operational in 2017 to generate 160 MW of electricity in addition to steam (EDB, 2014b).

NEW GENERATION CAPACITY

On 26 October 2015, the NEA signed a Waste-to-Energy Services Agreement (WESA) with TuasOne Pte Ltd to build Singapore's sixth WTE plant scheduled to be operational in 2019 (NEA, 2015f). The plant will be Singapore's largest WTE plant with the capacity to incinerate 3 600 tonnes of waste per day to generate 120 MW of electricity per day. TuasOne Pte Ltd is a company formed by the consortium of Hyflux Ltd and Mitsubishi Heavy Industries Ltd (MHI). This is the second WTE plant that the NEA has awarded to a private enterprise to design, build, own and operate under the Public-Private Partnership (PPP) scheme after the Keppel Seghers Tuas WTE plant, which became operational in 2009.

Singapore's major electricity-generating companies are Senoko Energy, YTL Power Seraya, Tuas Power Generation, SembCorp Cogen, Keppel Merliamu Cogen and PacificLight Power (SGC, 2014b). PacificLight Power started operation in June 2014 and is Singapore's first fully LNG operated power plant. This state-of-the-art 800 MW plant was built at a cost of USD 1.2 billion.

Keppel has entered into an agreement with Singapore's NEA to provide additional incineration capacity for the Senoko WTE plant. Thus, the plant will undergo upgrading, currently planned to take place between the third quarter of 2015 and the third quarter 2016, to increase by up to 10% its current capacity of 2 100 tonnes per day (Keppel, 2014a).

Keppel completed the expansion of its co-generation Keppel Merlimau Cogen Plant located at the Tembusu sector of Jurong Island in 2013. Since the beginning of its operation in 2007, its total generation capacity has now increased to 1 300 MW. It supports the needs of the surrounding industries with electricity, steam supply and demineralised water requirements (Keppel, 2014b).

Keppel secured financial closure in 2011 for its two 420 MW combined cycle power plant project at Jurong Island in Singapore. The engineering, procurement and construction contract, as well as the associated long-

term service agreement, were signed in 2010. The power plants entered into commercial operation in 2013 (Keppel, 2011).

Sembcorp completed the construction of the first phase of a gas-fired combined cycle co-generation power plant in July 2014. Being located in the Tembusu sector of Singapore's Jurong Island, the plant's total generation capacity is 815 MW, the first phase electricity capacity of 400 MW and the steam production capacity of 200 tonnes per hour (Sembcorp, 2014). Its second phase is due for completion in the near future.

Senoko Energy announced in late 2009 the commencement of its Stage 2 repowering project to convert three 30-year-old 250 MW oil-fired steam plants into two 431 MW LNG/gas-fired combined cycle plants that are technologically modern and environmentally friendly. The plants, which make extensive re-use of the existing equipment and infrastructure, entered commercial operation in 2012 (Senoko, 2012).

Tuaspring Pte Ltd, a subsidiary of Hyflux, was awarded the contract in late 2011 for a new 411 MW natural gas-fired combined cycle power plant to supply electricity to the Tuaspring Desalination Plant in Tuas, Singapore; its excess power will be sold to the power grid. Tuaspring signed a water purchase agreement to supply the PUB with 318 500 cubic metres per day of desalinated water over a 25-year period from 2013 to 2038, under a design, build, own and operate (DBOO) model. The Tuaspring Desalination Plant is Singapore's second and largest seawater reverse osmosis desalination plant (Hyflux, 2012).

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CHINESE TAIPEI

INTRODUCTION

Chinese Taipei is an archipelago consisting of Taiwan, Penghu, Kinmen and Matsu, located off the south-east coast of China and south-west of Japan. With an area of 36 193 square kilometres (km^2), Chinese Taipei represents a natural gateway to East Asia. Although only one-quarter of the land is arable, the subtropical climate permits multi-cropping of rice and the growing of fruit and vegetables perennially.

In 2013, Chinese Taipei's gross domestic product (GDP) was USD 942 billion, and its per capita income was USD 40 368 (2010 USD purchasing power parity [PPP]). Its GDP grew on average at a rate of 4.7% from 2000–13. Within the past few decades, Chinese Taipei's economic structure has changed substantially, shifting from industrial production to the services sector, wherein the latter constituted 65% of the GDP, followed by industry (33%) and agriculture (1.7%) in 2013 (BOE, 2015). Chinese Taipei is one of the most densely populated areas in the world, but its population growth rate has been relatively flat; the economy's population of 23 million grew at a rate of 0.4% in 2013 compared with 2012 (EGEDA, 2015).

Lacking natural resources, Chinese Taipei is highly dependent on energy imports to meet domestic energy demand. According to the U.S. Energy Information Administration, Chinese Taipei holds only 2.3 million barrels and 6.2 billion cubic metres, respectively, of oil and gas reserves. Coal reserves in the economy are rather scarce, and owing to the high mining cost, there has been no coal production in the economy since 2000.

Table 1: Key data and economic profile, 2013

Key data[a, b]		Energy reserves[c]	
Area (km^2)	36 193	Oil (million barrels)	2.3
Population (million)	23	Gas (billion cubic metres)	6.2
GDP (2010 USD billion PPP)	942	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	40 368	Uranium (kilotonnes of U)	–

Sources: a. EGEDA (2015); b. National Statistics (2015); c. EIA (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

As mentioned earlier, Chinese Taipei relies heavily on overseas energy resources for its needs. In 2013, energy imports accounted for 98% of total primary energy supply (TPES) in Chinese Taipei (BOE, 2014a), indicating the low energy self-sufficiency rate as well as fragile energy security.

The growth of the TPES in Chinese Taipei is stable and has largely remained unchanged over the past few years, rising from 107 457 kilotonnes of oil equivalent (ktoe) in 2012 to 108 440 ktoe in 2013, an increase of 9.1%. Regarding the composition of the TPES, fossil fuels continue to be the dominant fuel with 88% of the total supply. By fuel type, oil contributes the largest share (39%), followed by coal (34%), natural gas (15%) and other fuels (13%) (EGEDA, 2015).

In 2013, Chinese Taipei imported 45 million barrels of crude oil, 15% lower than the 53 million barrels imported in 2012. The Middle East is the major supplier, accounting for 82% of total oil imports, followed by Angola (8.4%) and the Republic of Ghana (2.8%). To prevent supply disruption, the Petroleum Administration Act 2001 requires Chinese Taipei's refiners to maintain stocks of more than 60 days of sales volumes.

With regard to coal, Australia and Indonesia are the major suppliers, respectively, accounting for 45% and 40.4% of total coal imports worth 0.9 million tons in 2013. Most of this fuel is used for power generation.

As indigenous natural gas only accounts for 1.9% of the total natural gas supply in Chinese Taipei, almost the entire gas demand is met by imports of liquefied natural gas (LNG). Qatar, Malaysia and Indonesia are the largest suppliers, accounting for 44%, 21% and 16% of the supply, respectively, in 2013. The total LNG import in 2013 was 12.5 million tonnes (Mt), 4.7% higher than the 12.4 Mt imported in 2012 (BOE, 2015).

Table 2: Energy supply and consumption, 2013

Primary Energy Supply (ktoe)		Final Energy Consumption (ktoe)		Power Generation (GWh)	
Indigenous production	13 880	Industry sector	22 664	Total power generation	252 250
Net imports and others	97 378	Transport sector	11 792	Thermal	194 912
Total primary energy supply	108 440	Other sectors	11 931	Hydro	8 610
Coal	36 797	Non-energy	22 125	Nuclear	41 639
Oil	41 740	Total final energy consumption	68 513	Others	7 089
Gas	16 338	Coal	7 380		
Others	13 566	Oil	38 732		
		Gas	2 809		
		Electricity and others	19 592		

Source: EGEDA (2015).

In 2012, electricity generation in Chinese Taipei reached 252 352 gigawatt-hours (GWh). Of the total electricity production, the hydropower generated by the Taiwan Power Company (TPC) comprised 3.4%, thermal power 48% (25% coal, 2.1% oil and 20% LNG), nuclear power 16.5%, wind power 0.3%, cogeneration 16% and independent power producers (IPPs) 16%. In terms of the generating capacity, the TPC dominates Chinese Taipei's electric power sector with 68% and IPPs account for 16% of the total capacity. IPPs are required to sign power purchase agreements with the TPC, which distributes power to consumers. To expand foreign participation, in January 2002, the government permitted foreign investors to own up to 100% of an IPP (BOE, 2015).

FINAL ENERGY CONSUMPTION

Final energy consumption in Chinese Taipei was 68 513 ktoe in 2013, 3.8% higher than in 2012. The industrial sector consumed 33% of the total energy used, followed by the transport sector (17%). The other sectors, including residential and services, consumed 48% of the total energy used. By energy source, petroleum products accounted for 57% of total final energy consumption, followed by electricity (29%), coal (11%) and gas (4.1%). In comparison with 2012, the energy consumption in 2013 was 2.6% higher (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

Chinese Taipei is committed to reduce its energy intensity by 12% and 18% of the 2010 level respectively by 2020. In terms of the TPES, Chinese Taipei showed an improvement with a reduction of 1.3%, declining from 131 tonnes of oil equivalent per million USD (toe/million USD) in 2012 to 130 toe/million USD in 2013. However, the final energy consumption intensity showed a slight increase of 1.5%, from 81 toe/million USD in 2012 to 82 toe/million USD in 2013, which was mainly contributed by the non-energy sector since the energy intensity of all the other sectors declined from 2012 to 2013.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	131	130	−1.3
Total final energy consumption	81	82	1.5
Industry	27.0	27.1	0.3
Transportation	14.4	14.1	−2.2
Others	14.5	14.2	−1.7
Non-energy	25	26	6.8

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Bureau of Energy (BOE) is responsible for formulating and implementing Chinese Taipei's energy policy. There are three fundamental energy policies. The Framework of Taiwan's Sustainable Energy Policy was released in 2008. It is based on three core beliefs, namely energy security, environmental protection and economic growth, creating the first step toward sustainable energy development for the economy (BOE, 2008). Later, in 2011, the New Energy Policy of Taiwan was released in response to the nuclear disaster in Fukushima, Japan, its objective being to 'Ensure Nuclear Security, Steadily Reduce Nuclear Dependence, Create a Low-carbon Green Energy Environment & Gradually Move towards a Nuclear-free Homeland' (BOE, 2014b). Lastly, to cope with the worldwide energy challenges, in 2012, the BOE released Guideline on Energy Development. Given that it is based on the Energy Administration Act, which enshrines the principles of ensuring energy security, protecting the environment and promoting economic development, the guideline serves as the primary reference to the economy's energy policy (BOE, 2012).

The three fundamental energy policies mentioned above encompass the specific acts for each energy market and its management, including the Energy Administration Act, 'The Electricity Act', 'Petroleum Administration Act', 'Natural Gas Enterprise Act' and 'Renewable Energy Development Act'. These acts aim to supervise energy enterprises, plan energy supply and demand, establish energy information systems, promote energy saving measures, promote research and development (R&D) in the energy sector as well as boost international energy cooperation.

The Framework of Taiwan's Sustainable Energy Policy includes:

- Policy objectives to create a win-win-win solution for the energy sector, the environment and the economy, and to set targets for improving energy efficiency, developing clean energy and securing a stable energy supply;
- Policy principles to establish a high efficiency, high value-added, low-emissions and low dependency energy consumption and supply system;
- A two-part strategic framework for a cleaner energy supply and rationalised energy demand;
- Follow-up work for government agencies to formulate concrete action plans which clearly set carbon-reduction targets, to build monitoring and follow-up mechanisms to regularly review the effectiveness and performance of the action plans and to establish quantitative objectives for each task in order to measure performance and facilitate implementation;
- Targets for energy conservation, which aim to reduce energy intensity by 20% by 2015 (based on 2005 base levels), with a further reduction of 50% by 2025 through technology breakthroughs and appropriate administrative measures;
- Targets for reducing carbon dioxide (CO_2) emissions such that they return to the level in 2008 between 2016 and 2020, and reduce further to the level in 2000 by 2025; and
- Plans to establish a secure energy supply system to meet economic development goals.

Chinese Taipei declared the year 2010 as the 'Year for Energy Conservation and Carbon Reduction'. In order to promote the Framework of Taiwan's Sustainable Energy Policy, Chinese Taipei set up a Committee of Energy Conservation and Carbon Reduction in the Executive Yuan (the executive branch of the government). The committee acts as the highest authority with regard to the State Energy Conservation and Carbon Reduction Projects. The committee is chaired by the Vice Premier of the Executive Yuan with members from each ministry. The State Energy Conservation and Carbon Reduction Projects cover 10 major sectors and 35 landmark projects are underway to emphasise and implement key energy policies.

The New Energy Policy of Taiwan notes the following as the economy's major strategies on nuclear power (BOE, 2014b):

- Comprehensive safety examinations of nuclear power plants to ensure nuclear safety;
- Steady reduction of nuclear energy dependence by actively reducing electricity demand and peak loads, and promoting alternative energy sources to ensure a stable power supply;
- Refusal to grant any extension to the life spans of existing plants and proceeding with plant decommissioning as planned;

- Rigorous security checks of the Fourth Nuclear Power Plant prior to its commercial operation; and
- Early termination of operations at the First Nuclear Power Plant if the two reactor units of the Fourth Nuclear Power Plant reach steady state before 2016.

Lastly, the Guideline on Energy Development reiterates the issues of security, efficiency and clean policies for future energy supply and demand in Chinese Taipei. Apart from diversifying the sources and methods of acquiring energy and enhancing the rate of its own energy production, Chinese Taipei is promoting energy development and proliferation of energy new technologies. However, high costs and stability of supply continue to pose difficult questions. The development of accessible and affordable clean energy domestically is a major challenge for technological research and will require new technology breakthroughs (BOE, 2012).

ENERGY SECURITY

Since Chinese Taipei relies heavily on energy imports, the government has been striving to enhance overseas supply security. To stabilise oil supply, the Petroleum Administration Act requires that refiners and importers maintain 60 days of sales volumes (calculated from the average domestic sales and private consumption over the preceding 12 months). The government uses the Petroleum Fund to finance the storage of oil and also stockpiles 30 days of oil demand. The Act mandates that a liquid petroleum gas stockpile of more than 25 days of supply be maintained (BOE, 2014a).

For many years, the Chinese Petroleum Corporation (CPC) has engaged in cooperative exploration with governments and large international oil companies in operations throughout the Americas, the Asia–Pacific region and Africa under the banner Overseas Petroleum and Investment Corporation (OPIC). Following the rising cost of oil in recent years, the CPC has made strenuous efforts to develop upstream exploration to secure oil sources. In line with the government's policy of deepening energy supply safety mechanisms and promoting international energy cooperation, the CPC has engaged in international cooperation in exploration and development in the hope of discovering new reserves of oil and natural gas. As of the end of 2014, this cooperation extended to 22 fields spread over 8 economies.

Within Chinese Taipei, the CPC completed seismic surveys of about 48 km^2 and geological surveys of 73 km^2 and repaired four wells in 2014. There are currently 37 producing oil and gas wells in the Tiezhenshan, Qingcaohu, Jinshui, Chuhuangkeng and Guantian fields, yielding 387 million cubic metres of natural gas and 9 000 kilolitres (kL) of condensate annually.

In its future strategic deployment, the CPC will seek to leverage its situation in overseas exploration and production by optimising the value of its existing overseas oil and gas field assets, establishing core areas with high rates of growth, participating actively in bidding for open blocks, seeking opportunities to take over fields from major oil companies and pursuing opportunities for mergers and acquisitions in new oil and gas fields so as to add further reserves (CPC, 2015).

ENERGY MARKETS

ELECTRICITY MARKETS

The government of Chinese Taipei aims to secure a total electricity supply with a reserve capacity of 15% (BOE, 2014a) based on peak demand. During the 1990s, some of the TPC's new power plants were unable to meet their construction schedules because of environmental issues and complex government approval processes, thus reducing the total electricity supply below the required reserve capacity between 1990 and 2004.

From 1990–95, the actual reserved capacity was between 4.7% and 7.4%, considerably lower than the then targeted reserved capacity of 20%; therefore, the government decided to open the power generation sector to IPPs, wherein the electricity produced by IPPs must be sold to the TPC through its transmission lines. In 2013, the TPC provided 66% of the total installed capacity in 2012, sourcing 17% from IPPs and 17% from cogeneration plants.

In order to enhance the stability of the electricity supply, the TPC continues to improve its transmission and distribution system. As of the end of 2013, several substation and transmission facilities underwent retrofitting, including 87 units of transformers, 426 transmission towers, 543 circuit kilometres (ckt-km) of overhead transmission lines, 301 ckt-km of ground lines and 46.9 ckt-km of overhead transmission lines that were changed to underground cables. Modifications were also made to the distribution system by adding 512 newly expanded feeders (i.e. 44% of the total feeders were automated). These improvements are expected to greatly reduce the duration of forced power outages. The System Average Interruption Duration Index (SAIDI) was 18 minutes/customer-year and the System Average Interruption Frequency Index

(SAIFI) was 0.27 frequency/customer-year in 2013. Despite the increase in power supply from the south to the north, the line loss was controlled at a high standard of 4.3% (TPC, 2015).

To comply with the schedule for privatising the TPC and promoting the liberalisation of the domestic power market, the Ministry of Economic Affairs (MOEA) has completed a program for the liberalisation of the electricity industry. Based on this program, a draft amendment to the Electricity Act was submitted to the Legislative Yuan for review and was passed in the Executive Yuan on 16 July 2015. The draft notes that:

- IPPs will be allowed to sell power to consumers directly or via power distributors;
- An independent system operator (ISO) will be established to dispatch power in a fair and transparent manner; and
- The TPC will continue to enjoy a monopoly in the power transmission sector.

FISCAL REGIME AND INVESTMENT

Chinese Taipei has limited indigenous energy resources and thus has no formal policy on investment in upstream assets. However, in order to secure new energy sources, Chinese Taipei has invested in oil exploration both in the Taiwan Strait and abroad through the state-owned enterprise, the CPC. Chinese Taipei also welcomes the participation of foreign investors in bidding in the IPP electricity market.

ENERGY EFFICIENCY

In 2013, the total energy consumption classified by sector amounted to 33% for the energy and industrial sectors, 17% for the transportation sector, 17% for the other sectors and 32% for non-energy uses. The government considers it important to improve the energy efficiency of all industry sectors, especially energy management in energy-intensive industries, and among major energy users. It amended the Energy Management Act 1981 to establish an evaluation mechanism for energy development and utilisation to foster gradual improvements in energy efficiency in newly constructed or expanded factory plants via advanced management mechanisms (BOE, 2014a; EGEDA, 2015).

The major activities and achievements of Chinese Taipei with regard to energy intensity reduction and attaining government targets included the following (BOE, 2014a).

- Successful completion of energy audits of major energy users and providing them assistance in establishing internal energy auditing systems and reporting the results to the government: A total of 4 658 high-energy users (3 242 manufacturers and 1 416 non-manufacturers) were audited by the government in 2013. The audits showed that major energy users made energy savings of about 54 million litres of oil equivalent (Mloe).
- Creation of an energy service team and provision of energy technology services to help energy users diagnose their energy systems and improve their energy efficiency: A total of 592 companies were visited in 2013, amounting to a potential energy savings of up to 107 Mloe.
- Promotion of voluntary accreditation of high energy-efficient products and an energy labelling system since 2001: A total of 45 product categories were included in the energy labelling system, and 369 manufacturers and 7 671 brands gained accreditation by the end of 2013. In addition, more than 165 million labels were issued in 2013.
- Introduction of a mandatory multi-level energy efficiency labelling mechanism since July 2010: Four product categories were included in the first stage, namely, air conditioning units, refrigerators, vehicles and motorcycles. Humidifiers were included in March 2011, and fluorescent lamps, in July 2011. The program was scheduled to be expanded to gas stoves and instantaneous gas water heaters in December 2012. In 2013, mandatory energy label applications were passed for 7 929 air conditioner, 1 159 refrigerator, 280 dehumidifier, 1 700 compact fluorescent lamp (CFL), 3 143 gas-fired water heater and 3 684 gas-fired furnace models.
- Promotion of a series of demonstration projects pertaining to light-emitting diodes (LEDs) from 2008: In 2011, the replacement of incandescent lighting with LED traffic lights saved an estimated 247 GWh of energy, equivalent to nearly 0.2% of total electricity consumption by the sector. By 2013, nearly 300 000 mercury vapour streetlights had been replaced by LEDs, saving an estimated 120 GWh of electricity.
- Introduction of more technology and capital for energy saving through the promotion of Energy Service Companies (ESCOs) by the BOE: The BOE extended support to the operations of the Taiwan Association of Energy Service Companies and Taiwan ESCO Business Association. In

2006, the BOE established an ESCO office to assist government institutions, schools and hospitals with regard to utilizing ESCOs. Later, it expanded the program to the private sector, including the low-carbon community and service industry. This program is estimated to have saved 55 GWh, amounting to an energy bill of TWD 190 million.

- Continued focus on technology R&D programs: The major programs and achievements in the R&D area included (BOE, 2014a):
  - Key technologies for smart energy-saving network systems: This program integrates energy management technology, sensing and monitoring technology and information communication technology to develop the key technologies, products and components for smart energy network systems. The technology can be employed in existing systems without changing any equipment and enables more flexible management of energy-efficient living environments and efficiency in the industrial manufacturing process. By 2012, this system was already employed in 1 570 convenience stores in Chinese Taipei and is ready for export or technology transfer to other economies. A total of 108 manufacturers are involved in this initiative, amounting to a revenue of TWD 1.8 billion in 2013.
  - Air conditioning and refrigeration technologies: The air conditioning industrial chain in Chinese Taipei is considerably advanced as most of the companies have their own R&D capability and are able to offer high efficiency products in accordance with government policy. Major projects in this area include energy efficiency management for chillers as well as the development of highly efficient oil-free impellers with magnetic bearings. Other major achievements in 2013 were:
    - Promotion of the inverted impeller technology, wherein the test efficiency of the R-134a 500RT inverted impeller compressor reached CPO6.2 and IPLV9.7, both exceeding the 2015 international standard.
    - Successful development of the 180RT impelled chiller with magnetic bearings: After the US, Chinese Taipei was the second economy in the world to have achieved this milestone. The chiller has been in operation in Industrial Technology Research Institute's 64th building.
    - Establishment of an energy efficiency management network platform and an inspection unit: Twelve chiller efficiency qualified logos have been issued and energy efficiency inspection for chillers has officially started.
- Advanced lighting technology: Given its various advantages (namely, energy saving, eco-friendliness, small volume, and easy control) solid-state lighting technology is the most promising technology in terms of green lighting in the 21st century. In the past three years, there have been major improvements in white-light LED technology, which now surpasses fluorescent light bulbs in terms of efficiency. Thus, LED lighting has become one of the major projects of interest for the green energy industry. The major achievements in this area in 2013 were:
  - Development of highly efficient white-light LED lighting technology, including advancements in red phosphorescent material science, attaining a luminous efficiency of 22.4 lumens/watt @ 1 150 nits and an external quantum efficiency (EQE) of 14% at a wavelength (λ) of 604 nm.
  - Development of smart LED surface light sources, LED intelligent lighting, and high-value solid-state lighting luminary and system applications.

RENEWABLE ENERGY

The three main renewable energy (RE) industries in Chinese Taipei are photovoltaic (PV) power, wind power and bioenergy. Chinese Taipei has chosen Penghu Island as a low-carbon demonstration site for the economy. The government's major efforts to promote RE industries in 2013 included the solar, wind and bioenergy sub-sectors, as detailed below (BOE, 2014a; 2015).

PHOTOVOLTAIC SYSTEMS

After the Renewable Energy Development Act was passed in 2009, a feed-in tariff mechanism replaced the subsidies formerly used to promote RE. The new mechanism has attracted more private sector investment to install PV systems. At the end of 2013, the total installed capacity was 392 megawatts (MW), with electricity generated reaching 338 GWh.

Chinese Taipei's PV industry is based on crystalline silicon solar cell materials and components, combined with upstream semiconductor materials and downstream industrial power systems. In 2013, the 257 companies in this sub-sector earned a revenue of about TWD 157 billion. To increase the value and competitiveness of its PV industry in the global market, the government provides partial subsidies for the application of a building-integrated photovoltaic (BIPV) demonstration system.

WIND POWER SYSTEMS

The development of the wind power industry is vital mainly for the domestic market. The TPC and private wind energy developers continue to develop onshore wind turbine systems. By the end of 2013, Chinese Taipei had installed 311 sets of wind turbines domestically, with a total installed capacity of 614 MW and an annual output of 1 640 GWh of electricity. For offshore wind energy, a demonstration incentive program was announced in July 2012, and in January 2013, three companies were selected to receive subsidies to build offshore wind demonstration projects.

BIOENERGY

The bioenergy industry includes the biodiesel, bio-methane, bio-heat and power industries. From June 2010, the government of Chinese Taipei mandated the addition of 2% biodiesel in diesel used by transportation vehicles. By the end of 2013, the consumption of biodiesel reached 96 000 KL and 11 companies were approved as qualified biodiesel manufacturers. The biodiesel industry mainly uses waste cooking oil as its raw material (BOE, 2014a). Chinese Taipei also successfully conducted a demonstration project for adding 3% methane to gasoline used by transportation vehicles in major cities. In 2013, 14 gasoline stations provided bio-methane whose total consumption reached 237 KL in 2013.

In addition to the application of biodiesel in the transportation sector, Chinese Taipei has a total of 740 MW of installed capacity employing bioenergy or waste as the input fuel, which generated 256 GWh of electricity in 2012.

RESEARCH AND DEVELOPMENT PROGRAMS

The Chinese Taipei Government continues to focus on technology R&D programs. The major programs and achievements in this area in 2013 were as follows (BOE, 2014a).

Photovoltaic technology

The R&D focus included the development of high-efficiency silicon solar cells and thin-film devices, next-generation silicon solar cells and modules and dye-sensitised solar cell technology. The major achievements in 2013 were:

- Development of thin silicon wafer solar cell fabrication using atomic layer deposition of thickness 150 micrometres (μm), efficiency 19.5% and silicon material of specification 5.1 grams/watt.
- Development of heterojunction silicon-based solar cells passivation technology and improved wafer carrier lifetime, enhancing the open circuit voltage of the solar cells and increasing cell efficiency by up to 20%.
- Mass production of a 60 × 120 centimetres chemical bath deposition apparatus; the related technology and patent authorization is under discussion with solar cell and apparatus companies.

Bioenergy

R&D in this area focused on the lignocellulosic hydrolysis technology and key microalgae biofuel technologies.

Wind power

R&D in this sub-sector focused on developing offshore wind power engineering technology and equipment, and the establishment of a comprehensive systems analysis and integration design capacity. Chinese Taipei also conducts R&D on product differentiation and energy security, to develop specific projects for enhancing the global competitiveness of the local wind power industry. The major achievements in 2013 were as seen below.

- Onshore wind power: Established a monitoring platform that collects operational status of the economy's wind farm and wind turbines, providing the maintenance companies auxiliary information to maintain the wind farms and wind turbines.
- Offshore wind power: Completed development of offshore wind farm operation and maintenance (O&M) technology, evaluated 30 sets of 3.6 MW wind farms located 5–10 km offshore, and devised appropriate maintenance strategies for the same.

Fuel cell and hydrogen applications

To promote hydrogen and distributed power generation technologies, the first R&D project in this area focused on the development of fuel cell applications using hydrogen, supported by advanced production and storage technologies for hydrogen. The major achievements in 2013 included:

- Completion of the palladium membrane mass production test, which enhanced the production rate fourfold compared to the original rate.
- Successful mass production of low-cost bipolar plate material and a smart cell stack manufacturing system.

NUCLEAR ENERGY

Since Chinese Taipei is short of indigenous energy, the government encourages developments in nuclear energy to diversify its power generation mix. Currently there are four nuclear power plants in Chinese Taipei, of which three are operational and one is under construction. In 2013, the total installed capacity of the three operational nuclear power plants was 5 144 MW, accounting for 17% of the economy's total power generation mix.

In response to the Fukushima accident in 2011, Chinese Taipei released a New Energy Policy on 3 November 2011 to 'ensure nuclear security, steadily reduce nuclear dependence, create a low-carbon green energy environment and gradually move towards a nuclear-free homeland'. This policy aims to steadily reduce nuclear dependence by lowering electricity demand and peak loads, and by promoting alternative energy sources to ensure a stable power supply.

The new policy prohibits life-span extensions for existing nuclear plants and outlines decommissioning plans as follows: Units 1 and 2 of the first plant will be decommissioned in 2018 and 2019; Units 1 and 2 of the second plant, in 2021 and 2023; and Units 1 and 2 of the third plant, in 2024 and 2025.

Construction of the Fourth Nuclear Power Plant was halted as a result of public concern over the safety of building such a unit in an earthquake-prone region. The government has stated that this suspension does not necessarily mean an abandonment of its plans to construct the plant; however, the future of the Fourth Plant remains undecided.

CLIMATE CHANGE

GREENHOUSE GAS EMISSIONS

Chinese Taipei produces CO_2 emissions that account for about 1% of global emissions. Therefore, the government believes it has a moral obligation to reduce emissions even though the economy is not a member of the United Nations, and as a consequence is not eligible to sign the Kyoto Protocol or directly required to adhere to its emissions reduction requirements. Unlike other UN members, Chinese Taipei is unable to conduct carbon emissions trading in the international market to achieve cross-border cooperation in carbon reduction, or to pursue cost-effective carbon reduction plans. It is thus necessary for Chinese Taipei to seek alternative ways to reduce the impact of its carbon emissions (BOE, 2008).

In 2011, Chinese Taipei established the 'Energy Conservation and Carbon Reduction Service Team', which includes a 'Technology Service Group', an 'Advocacy Group' and a 'Volunteer Group', to provide technology consulting services to all energy users and the public. By the end of 2011, the Service Team had acted on 2 860 calls for field assistance, organised 198 training workshops and seminars, and answered 12 128 remote help calls via the telephone or internet.

In 2008 and 2009, total CO_2 emissions showed negative growth for the first time in 20 years. Carbon intensity also showed a decrease of 3.6% for 2010 and 1.7% for 2011.

Emissions from fossil fuel combustion are the major source of greenhouse gas (GHG) emissions in Chinese Taipei. The economy emitted 250 Mt of CO_2 in 2013, 0.7% higher than 2012. Between 2008 and 2013, CO_2 emissions amounted to 245 Mt to 250 Mt, an annual reduction of 0.4%. In 2013, the economy reduced CO_2 emissions by 5 Mt, exceeding the stated reduction target of 4.16 Mt by 121%. To reduce the environmental impact of its development, Chinese Taipei must seek the most advantageous development objectives for the economy from among the various policies on environmental protection, industrial development and energy supply (BOE, 2014a).

PROMOTION OF LOW-CARBON ENERGY TECHNOLOGY AND INDUSTRY

Chinese Taipei's green energy industry has achieved several key milestones. However, if it is to continue responding to future developments and competition, it needs to gain full access to key and innovative technologies. Faced with fierce competition globally, the economy is strengthening its R&D and innovation

capabilities so that it can master niche technologies and enhance the economy's competitiveness. Chinese Taipei has been ranked sixth by the International Institute for Management Development in terms of creating competitive advantages in the green technology industry.

The development of emerging industries such as the green energy industry depends on the economy changing its traditional focus from export processing to an industrial model that involves the aggressive development of key technologies. The latter will compensate for the lack of independent intellectual property rights development in the past. Chinese Taipei has gradually changed its mainstream industrial model from that of original equipment manufacturer (OEM) to that of original design manufacturer (ODM). The focus now is on enhancing the integration of the industrial chain and transforming development strategy from one concerned with manufacturing key components into one that utilises vertical system integration. This will enhance the international competitiveness of the economy's green energy industry and help entrench the importance of value creation over production output.

To create an energy-efficient society and low-carbon economy, in 2009, Chinese Taipei selected seven green energy industries that showed development potential in terms of their information technology (IT) status and human resources. The PV and LED lighting industries are regarded as the most significant of those seven green energy industries. Other promising industries include the wind power, biomass, hydrogen and fuel cell, energy information communication technology (EICT) and electric vehicle industries. Total revenue from these green energy industries was TWD 420 billion in 2013, recording a growth of 163% compared with 2008. Cumulative new investments from 2009 to 2012 amounted to TWD 275 billion, accompanied by the creation of new employment opportunities for 68 250 people from 2008 to the end of 2013.

NOTABLE ENERGY DEVELOPMENTS

THE MILLION SOLAR ROOFTOP PROGRAM

In response to public concerns about nuclear safety after the Fukushima earthquake, Chinese Taipei comprehensively reviewed the possibility of expanding the development of RE from mid-2011. The BOE established an office to promote the 'Million Solar Rooftop Program' on 28 March 2012. The Promotion Office intends to foster a PV-friendly environment in Taiwan and assist governments and industries in promoting solar PV installations, the aim being to reach a capacity of 6 200 MW by 2030 (BOE, 2014c).

By integrating related resources for harnessing solar energy, the Promotion Office helps resolve barriers hindering the installation of solar energy generation systems. The Promotion Office was established as a single window for total solutions for local solar energy businesses, city and county governments, and system installation contractors in the utilisation of solar energy.

Due to the decreasing cost of solar PVs, their installation in Chinese Taipei has increased significantly. The total installed PV capacity in 2013 was 392 MW and grew rapidly to 620 MW in 2014. In 2015, the installation target for PVs was revised from 6 200 MW to 8 700 MW by 2030.

THE THOUSAND WIND TURBINES PROGRAM

Chinese Taipei has an estimated wind potential of more than 15 GW. To accelerate the development of the wind energy industry, Chinese Taipei plans to shift its focus from onshore wind energy to offshore wind energy, and set up more than 1 000 wind turbines by 2030. The accumulated capacity of wind energy will thus reach 4 200 MW by 2030 (BOE, 2014c).

The economy intends to begin by developing superior onshore wind energy farms before harvesting from secondary wind energy farms. A demonstration incentive scheme was announced to encourage developers to set up three pioneering offshore wind energy farms in shallow waters (at depths below 20 metres) by 2015. The capacity of each wind farm is 100–200 MW. Chinese Taipei has earmarked TWD 250 million toward wind farm development, which includes an equipment subsidy of 50% for the first two turbines of each wind farm. The economy plans to learn from the experiences gained from these developments before exploiting areas with deeper water (depths above 20 metres) at the mass production scale. By 2030, the economy plans to develop 450 onshore wind turbines of 1 200 MW and 800 offshore wind turbines of 4 000 MW, respectively. The total accumulated capacity would add up to 5 200 MW, comprising about 30% of Chinese Taipei's RE targets (TWTP, 2015).

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Industrial Development Bureau, Ministry of Economic Affairs—www.moeaidb.gov.tw

Ministry of Economic Affairs—www.moea.gov.tw

Ministry of Transportation and Communications—www.motc.gov.tw

Taiwan Power Company—www.taipower.com.tw

THAILAND

INTRODUCTION

Thailand has been known as 'the window to South-East Asia' as it is surrounded by fast growing economies such as Myanmar, the Lao People's Democratic Republic and Cambodia to the north and east, and shares borders with Malaysia to the south. Thailand had an area of 513 115 square kilometres (km^2) and a population of about 67.5 million in 2013. Its GDP that year reached USD 915 billion (2010 USD purchasing power parity [PPP]), a 2.9% increase from USD 889 billion in 2012. In the same period, GDP per capita increased 2.5%, from USD 13 236 (2010 USD PPP) to USD 13 561 (2010 USD PPP). The largest contributors to its GDP were the services (41%) and manufacturing (29%) industries (NESDB, 2015).

Thailand has limited energy resources. At the end of 2013, Thailand had proved reserves of 427 million barrels of oil, 285 billion cubic metres of natural gas, and 1 239 million tonnes of coal. Based on its production rate in 2013, it will deplete its domestic supply very soon—oil resources within three years and natural gas in six years (BP, 2015). Most coal in Thailand is lignite, which is a low rank coal with high emissions. Notwithstanding its resources, Thailand is highly dependent on energy imports, particularly oil, with about 85% of its oil supply coming from imported stock in 2013, as well as 22% of its gas supply (DEDE, 2015a).

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b]	
Area (thousand km^2)	513	Oil (million barrels)	462
Population (million)	67.5	Gas (billion cubic metres)	285
GDP (2010 USD billion PPP)	915	Coal (million tonnes)	1 239
GDP (2010 USD PPP per capita)	13 561	Uranium (kilotonnes of U)	–

Sources: a. EGEDA (2015); b. BP (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Thailand's total primary energy supply in 2013 was 114 888 kilotonnes of oil equivalent (ktoe), which represented an increase of 3.5% from 2012. Oil accounted for 39.4% of the total primary supply, while gas, coal and others accounted for roughly 42%, 13% and 5.5%, respectively. It is the first time that the gas supply surpassed the oil supply. As most of Thailand's proved coal reserves are lignite coal with lower calorific values, imported stock is needed to meet the energy demand for both power and industry sectors. In 2013, coal supply was 15 345 ktoe, up 3.5% from the previous year.

Natural gas supply in 2013 was 48 002 ktoe, a 5.1% increase from 45 658 ktoe in 2012. Although natural gas is mostly used for power generation in Thailand, it is also promoted in the transport sector as a replacement for conventional petroleum products such as fuel oil, diesel and gasoline. Thailand has increased its reliance on imported natural gas, both in the form of piped gas and liquefied natural gas (LNG).

In 2013, total electricity generation was 197 629 gigawatt-hours (GWh). Thermal generation, mostly from natural gas and coal, accounted for nearly all of its power generation (83%), with hydropower and others accounting for the rest. In addition to its domestic capacity, Thailand purchased power from the Lao People's Democratic Republic and Malaysia.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	64 088	Industry sector	19 018	Total power generation	197 629
Net imports and others	55 635	Transport sector	22 916	Thermal	164 145
Total primary energy supply	114 888	Other sectors	15 092	Hydro	8 642
Coal	15 345	Non-energy	22 611	Nuclear	–
Oil	45 275	Total final energy consumption	79 636	Others	24 843
Gas	48 002	Coal	5 563		
Others	6 266	Oil	51 960		
		Gas	7 928		
		Electricity and others	14 185		

Source: EGEDA (2015).

NATURAL GAS

Thailand's proved gas reserves at year-end 2014 amounted to 7.8 trillion cubic feet (Tcf), consisting of 7.4 Tcf in gas fields in the Gulf and 0.3 Tcf in onshore areas. Compared with the previous year, the proved gas reserves fell by 0.7 Tcf (about 7.9%). The main reason for this drop was continued production without new field discoveries (DMF, 2015). Natural gas production in Thailand began in 1981 in the Erawan field; to date, additional major gas fields have been discovered: Bong Kot, JDA (Thailand-Malaysia Joint Development Area), Arthit and Pailin. In 2014, domestic natural gas production was at a level of 4 703 million standard cubic feet per day (MMscfd), accounting for 80% of Thailand's gas. The remaining 20% was imported from Myanmar, 843 MMscfd, and imported LNG, 182 MMscfd, for a total natural gas supply in Thailand of 5 098 MMscfd. LNG was imported in Thailand starting in May 2011 (EPPO, 2015a).

CRUDE OIL AND CONDENSATE

At the end of 2014, Thailand's proved reserves of oil and condensate reserves stood at 387 million barrels (Mbbl), of which 326.5 Mbbl came from the Gulf and 60 Mbbl from onshore areas. The total proved reserves fell by 53.9 Mbbl (12%) from the previous year. Condensate reserves in the Gulf fell similarly to natural gas reserves. Falling oil prices, which made platforms with low production rates uneconomic, resulted in a reduction of proved reserves, despite the new production areas, including the Manora Field in the Gulf, which came on line in late 2014, and Wichian Buri (onshore), which included the discovery of new volcanic reservoirs (DMF, 2015). The accumulated domestic oil production in 2014 was 138 758 barrels per day (bbl/d). The major crude oil fields in Thailand are comprised of Benjamas, Sirkit, Tantawan, Jasmin and the Big Oil Project of Unocal (Thailand) Co. Ltd (EPPO, 2015a).

COAL/LIGNITE

Thailand has lignite (low-grade coal), which can be utilised for 70 years. Domestic lignite production is from two major sources. One source is the mines of the Electricity Generating Authority of Thailand (EGAT) and the other is the mines of private producers. There are two sources of EGAT's lignite. The first is the Mae Moh mine in Lampang province, used as fuel for power generation at the Mae Moh Power Plant for the northern part of Thailand. The second source is the Krabi province, which serves the demand from the industrial sector in southern Thailand. Most of the imported coal is sub-bituminous and bituminous. The amount of coal imports have been increasing continuously because domestic lignite concessions have begun to expire and the price of coal is cheap compared with other energy prices (EPPO, 2015a).

ELECTRICITY

The EGAT used to be the sole power producer in Thailand. Later, the government promoted the private sector role in power generation in order to encourage competitiveness in the power generation business. Since 1994, a number of independent power producers (IPP) and small power producers (SPP) have taken part in the power supply industry, resulting in an improvement in power generation and service quality. Currently, the use of renewable energy in power generation has been promoted, resulting in a growing number of very small power producers (VSPP) using renewable energy as main fuel to supply power to the grid. In the last decade, Thailand's overall electricity capacity has been increasing. The electricity capacity of EGAT decreased proportionally from 60% in 2005 to 45% in 2014, whereas there was a large increase in IPP, SPP and imported electricity. In 2014, Thailand's power generating capacity stood at 34 668 megawatts

(MW), divided into the generating capacity of EGAT, 45%; IPP, 38%; SPP and VSPP, 10%; and imported electricity from Lao PDR and exchange with Malaysia, 7% (EPPO, 2015a).

FINAL ENERGY CONSUMPTION

Thailand's total final energy consumption in 2013 was 79 636 ktoe, an increase of 7.1% from the previous year. The transport sector was the largest energy-consuming sector, accounting for 22 916 ktoe, or 29% of total final energy consumption. The second largest energy consumer was the industrial sector, which consumed 19 018 ktoe in 2013, an increase of 0.8% from 2012. Beside the energy-consuming sectors, non-energy products, which are mostly used in the industry sectors as feedstock, account for 28% of the total final energy consumption, or 22 611 ktoe. By fuel type, oil accounted for 65% (51 960 ktoe) of total energy consumption in 2012, followed by electricity and others (18%), gas (10%) and coal (7%).

Natural gas demand increased significantly by 18%, from 6 703 ktoe in 2012 to 7 928 ktoe in 2013. Oil consumption also increased by 10.2%, from 47 158 ktoe in 2012 to 51 960 ktoe in 2013. In contrast, coal consumption decreased significantly by 16%, from 6 643 ktoe in 2012 to 5 563 ktoe in 2013. Domestic electricity and other energy demand in 2013 increased by 2.3% from 13 871 ktoe in 2012 to 14 185 ktoe in 2013. The growth in demand in 2013 was mainly due to increased consumption in the transport sectors and the use of non-energy products.

ENERGY INTENSITY ANALYSIS

Thailand's energy intensity (energy consumption/GDP) of its primary energy in 2013 was 126 tonnes of oil equivalent per million USD (toe/million USD), which increased by 0.6% from 125 toe/million USD in 2012. The energy intensity of final energy demand increased 4.1%, from 84 toe/million USD in 2012 to 87 toe/million USD in 2013. The energy intensity of the industry and transport sectors decreased by 2.1% and 1.2%, respectively, while the energy intensity of the others sector, which mainly include the commercial and residential sectors, decreased significantly by 5.4%. The energy intensity of the non-energy products sector increased significantly by 26%. When excluding non-energy products, the energy intensity of the final energy demand decreased 2.7% from the previous year.

Table 3: Energy intensity analysis, 2013

Energy	Energy Intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	125	126	0.6
Total final energy consumption	84	87	4.1
Industry	21.2	20.8	–2.1
Transportation	25.4	25.1	–1.2
Other sectors	17	16	–5.4
Non-energy	20	25	26

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Energy's aim is to support sustainable energy management that ensures the economy has sufficient energy to meet its needs. The Ministry is responsible for:

- establishing energy security;
- promoting the use of alternative energy;
- monitoring energy prices and ensuring prices are at levels appropriate to the wider economic and investment situation;
- effectively saving energy and promoting energy efficiency; and
- supporting energy developments domestically and internationally while simultaneously protecting the environment and mitigating climate change.

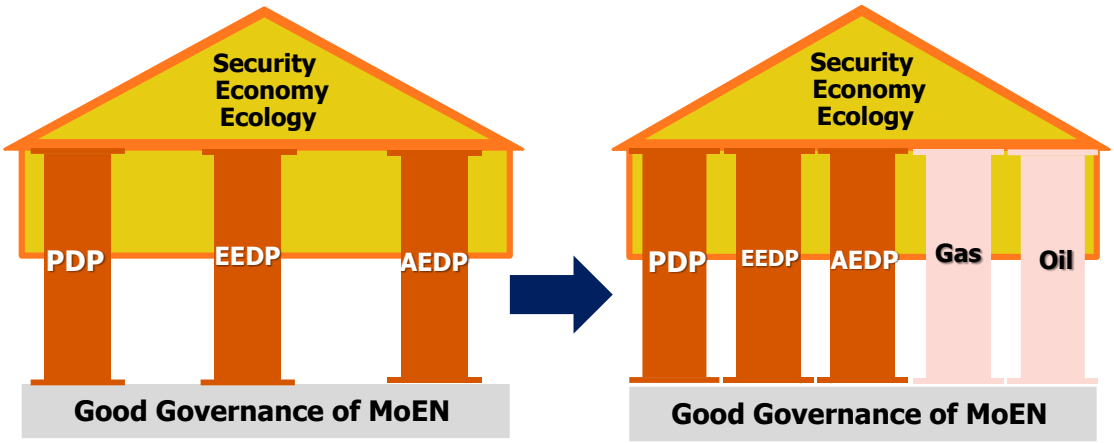
The Ministry of Energy is the main government institution responsible for energy policy in Thailand. Under the Ministry, there are six departments and four state enterprises as follows.

- Office of the Minister—coordinates with the Cabinet, the parliament and the general public;
- Office of the Permanent Secretary—establishes strategies, translates policies of the ministry into action plans, and coordinates international energy cooperation;
- Department of Alternative Energy Development and Efficiency (DEDE)—promotes the efficient use of energy, monitors energy conservation activities, explores alternative energy sources, and disseminates energy-related technologies;
- Department of Energy Business—regulates energy quality and safety standards, environment and security, and improves the standards to protect consumers' interests;
- Department of Mineral Fuels—facilitates energy resource exploration and development;
- Energy Policy and Planning Office (EPPO)—recommends economy-wide energy policies and planning;
- Electricity Generating Authority of Thailand (EGAT)—the state power generating enterprise;
- Petroleum Authority of Thailand (PTT) Exploration and Production (E&P) Public Company Limited and the Bangchak Petroleum Public Company Limited—two autonomous public companies;
- Energy Fund Administration Institute—a public organisation; and
- Energy Regulatory Commission (ERC) and the Nuclear Power Program Development Office—two independent organisations.

According to the recent energy policy established under the government of Prime Minister Prayuth Chan-o-cha and presented to the National Legislative Assembly of Thailand on 12 September 2014, the energy price structure would be reformed to reflect actual costs and taxes for different types of fuels and different groups of consumers. This reformation of the energy price structure would lead to energy efficiency, consumer awareness and behaviour changes. On the supply side, the government will proceed with new surveys and exploration for oil and gas, both onshore and off. Additionally, the construction of new power plants using fossil fuels and all renewable energy by state-owned enterprises and the private sector will be pursued continuously through open consultation with the public, transparency and fairness as well as accounting for environmental concerns. The development of energy resources together with neighbouring countries is also one of the prioritised policies (The Royal Thai Government, 2014).

In 2015, Thailand achieved an important milestone in energy policy development by integrating all major energy policy plans into a single comprehensive plan, namely the 'Thailand Integrated Energy Blueprint' (TIEB) (EPPO, 2015b), under the three principles of economy, ecology and security. The blueprint consists of five long-term plans including the Power Development Plan (PDP2015) (EPPO, 2015c), the Energy Efficiency Development Plan (EEDP2015) (EPPO, 2015d), the Renewable and Alternative Energy Development Plan (AEDP2015), the Gas Plan 2015 and the Oil Plan 2015. All the plans have been updated and developed to cover the same time period, 2015–36. The PDP2015 includes an energy efficiency target to reduce energy intensity by 30% from 2010 levels, and also includes a target of the AEDP2015 to develop renewable energy generating capacity of about 20 gigawatts (GW) or 20% of the total generating capacity by 2036.

Figure 1: The Development of Thailand Integrated Energy Blueprint



Source: (Sutabutr, 2015)

ENERGY SECURITY

The government's energy security policy will intensify energy development for greater self-reliance, with a view to achieving a sufficient and stable energy supply. It will do this by:

- advancing the exploration and development of energy resources at domestic and international levels;
- negotiating with neighbouring economies at the government level for the joint development of energy resources;
- developing an appropriate energy mix to reduce supply, price volatility and production cost risks;
- encouraging electricity production from potential renewable energy sources, particularly from small-scale or very small-scale electricity generating projects; and
- investigating other alternative energy sources for electricity generation.

All of the plans under the TIEB contribute to energy security. The PDP2015 aims to strengthen the energy security of power generating systems in Thailand by diversifying fuel mix and setting reserve margins greater than 15%. The PDP2015 has already included energy savings from the EEDP2015, which identifies 89 672 GWh of electricity saving. The building sector is expected to deliver the biggest savings through a variety of measures such as building energy codes, minimum energy performance standards (MEPS)/high energy performance standards (HEPS) and promotion of LED use. Electricity demand will be reduced through the EEDP2015 by 89 672 GWh or 22% compared to BAU (business as usual). The targets of power generation from renewable energy under the AEDP are also included in the PDP2015. Generating capacity of 20 GW from solar, biomass, wind, hydro and waste to energy are expected by 2036. The share of renewable energy in power generation will be 20% by 2036. The new gas and oil plans will help to ensure a long-term energy supply along with the PDP2015.

As Thailand has limited energy resources, it will deplete its domestic supply very soon—oil resources within three years and natural gas in six years. To maintain a degree of energy security, the economy must pursue new explorations quickly. Since 1971, the Department of Mineral Fuels (DMF) has launched 20 concession-bidding rounds, the latest announced in 2007. In 2014, the DMF invited bids for exploration and production rights for various exploration blocks; however, the initiative was halted. The Petroleum Act was to be amended along with the government's energy reform before the twenty-first round of the concession-biddings (DMF, 2015).

To secure a natural gas supply for the long-term, the PTT Public Company Limited entered into a contract to buy 2 million tonnes of LNG per year for the next 20 years from the Qatar Liquefied Gas Company Limited (Qatargas). The first stock of imported LNG was delivered to Thailand in January 2015. The Ministry of Energy also entered into an MOU with Lao PDR to import 7 000 MW of electricity. Under the MOU, Thailand has already imported 2 000 MW of electricity power from Lao PDR. The latest project is the Hong Sa coal power plant, which expects to connect 1 500 MW to the grid in 2016.

FISCAL REGIME AND INVESTMENT

ENERGY PRICES

The government's energy price policy aims to supervise and maintain energy prices at appropriate, stable and affordable levels. It will do this by:

- setting an appropriate fuel price structure that supports the development of energy products and that best reflects actual production costs;
- managing prices through market mechanisms and the Oil Fund to promote the economical use of energy; and
- encouraging competition and investment in energy businesses including the improvement of service quality and safety.

The strategy to achieve this involves supervising energy prices through market mechanisms to ensure that domestic energy prices are stable, fair and affordable, and reflect the actual production costs. The energy costs for Thai people must not be higher than those in neighbouring economies. The government is supervising the pricing policies and price structures of oil, LPG and natural gas to align them with world market mechanisms and to reflect actual costs; ensuring fairness for the general public through the efficient use of the Oil Fund; and monitoring refining and marketing margins to maintain them at appropriate levels. The recent decline in oil prices has created an opportunity for Thailand to restructure fuel pricing and reduce energy cross-subsidies.

INVESTMENT

The Government is keen to encourage competition and investment in energy businesses by creating a favourable environment for investment, transparent competition and internationally accepted energy-related standards. It will do this by designating an agency, the Investor Relations Office, to be responsible for investment procedures and processes in the energy industry; and by creating a mechanism for a company to be a 'service company' in the operations and maintenance of the electricity industry, refineries, gas separation plants, and both domestic and overseas oil and gas rigs.

ENERGY EFFICIENCY

The first long-term energy policy on energy efficiency, namely the EEDP, was launched in 2011 with a target to reduce energy intensity (EI) by 25% in 2030 from 2010 levels, or equivalent to a reduction in final energy consumption of 24% in 2030 (38 200 ktoe). The EEDP set the targets of energy reduction for major economic sectors including transportation, industry, and commercial and residential in six strategic areas:

- Apply a number of combined measures, for example mandatory measures via rules, regulations and standards, and promotional and supportive measures via incentive provision;
- Introduce measures that will have a wider impact in terms of raising awareness and changing behaviour related to the energy consumption of consumers, including the decision-making behaviour of business operators, as well as market transformation;
- Support the potential and important role of the private sector in the public-private partnership to promote and implement energy conservation measures;
- Delegate tasks related to the promotion of energy conservation in public and private agencies/organisations that are readily equipped with resources and expertise, such as power utilities and industrial associations, with backup support from the Ministry of Energy;
- Use professionals and energy services companies (ESCO) as important tools to provide consultancy and to implement energy conservation measures in which the use of more advanced technology is involved; and
- Increase self-reliance in indigenously developed technology to reduce technological costs and to increase access to energy-efficiency technology including the promotion of highly energy-efficient product manufacturing processes.

To implement the plan, 16 specific measures were established under five overarching approaches. The approaches and measures are as follows.

MANDATORY REQUIREMENTS VIA RULES, REGULATIONS AND STANDARDS

- Enforce the Energy Conservation Promotion Act B.E. 2535 (1992), which would put in effect an energy management system based on energy consumption reporting and verification imposed on designated buildings and factories;
- Introduce mandatory energy efficiency labelling to provide options for consumers to buy or use highly energy-efficient equipment/appliances, vehicles and buildings;
- Enforce the MEPS for equipment/appliances, buildings and vehicles to prevent the distribution and use of low energy-efficient products;
- Determine the Energy Efficiency Resource Standards (EERS), or the minimum standards for large energy businesses to implement energy conservation measures, encouraging their customers to use energy efficiently, which will be an important mechanism for providing both technical and financial assistance to small and medium enterprises (SMEs).

ENERGY CONSERVATION PROMOTION AND SUPPORT

- Promote a 'voluntary agreement' to save energy within the public and commercial/industrial sectors, especially among various business associations and large-scale businesses;
- Support and incentivise provision to encourage voluntary energy-efficiency labelling for highly energy-efficient equipment/appliances, buildings and vehicles;
- Promote travelling by mass transit systems as well as goods transportation by highly energy-efficient logistics systems;
- Subsidise investment in the implementation of energy conservation measures by (a) providing subsidies for the amount of energy saved that can be verified, as per the project proposals approved under the DSM (demand-side management) bidding scheme for large-scale businesses, and (b) providing subsidies for the amount of energy saved and/or reduction of peak load that can be verified or accurately assessed for SMEs, as per the project proposals submitted under the Standard Offer Program (SOP) scheme, which requires no bidding;
- Support the operation of ESCO companies (e.g. the use of funding from the Energy Conservation Promotion Fund to increase credit lines given by the ESCO Fund) to alleviate the technical and financial risks of entrepreneurs wishing to implement energy conservation measures.

PUBLIC AWARENESS CREATION AND BEHAVIOURAL CHANGE

- Promote public relations and the dissemination of knowledge about energy conservation to the general public via the teaching/learning process at educational institutions, fostering youth awareness and other public awareness activities such as eco-driving;
- Put forth the concepts and promotional activities related to the development of a low carbon society and low carbon economy; this will bring about cooperation between local administration organisations and the business sector in the planning and implementation of activities that can lead to a reduction of GHG emissions and efficient use of energy;
- Set energy prices that reflect actual costs and application of tax measures as an important tool to promote energy conservation with a view to fostering public awareness and changing energy consumption behaviour.

PROMOTION OF TECHNOLOGY DEVELOPMENT AND INNOVATION

- Promote research and development (R&D) that improves energy efficiency and reduces technological costs, particularly those related to equipment/appliances with large markets and manufacturing in Thailand including production processes and materials as well as buildings and housing that are energy efficient;
- Promote demonstrations of energy-efficient technologies that have been technically proven but not yet commercialised in the domestic market including the support for any necessary preparation to implement wide commercial deployment of such technologies.

HUMAN RESOURCES AND INSTITUTIONAL CAPABILITY DEVELOPMENT

- Support the development of professionals in the energy conservation field so that they will have the needed skills to be responsible for energy management and operation, verification and

monitoring, consultancy and engineering services provision and the planning, supervision and promotion of the implementation of energy conservation measures;

- Support the development of the institutional capabilities of agencies/organisations in both the public and private sectors responsible for the planning, supervision and promotion of the implementation of energy conservation measures.

Furthermore, the Energy Efficiency Action Plan (EEAP) has been developed under the strategic framework of the EEDP. The EEAP was approved by the National Energy Policy Committee (NEPC) and endorsed by the cabinet in early 2013. The plan includes 67 major measures/projects. Most of the measures are sector-wide. The rest are sector-specific measures that include 18 in the transport sector and five measures in each of the following sectors: industry, large commercial building and small commercial building and residential. The total amount of energy saved by the plan is expected to be 38 845 ktoe, with 16 257 ktoe from the industry sector, 15 323 ktoe from the transport sector, 3 635 ktoe from the small commercial building and residential sector and 3 630 ktoe from the large commercial building sector. Moreover, the EPPO has completed the development of a 10-year R&D master plan for energy efficiency to guide R&D directions in line with the EEAP and EEDP framework.

Recently, the EEDP has been updated using the same timeframe with other energy plans (e.g. 2015–36) and is now known as the 'Energy Efficiency Plan 2015' or 'EEP2015'. The EEP2015 set a target to reduce energy intensity (EI) 30% by 2036 from 2010 levels. This savings target equals 56 142 ktoe, which is comprised of 7 41 ktoe of electricity (or 89 672 GWh) and 44 059 ktoe of heating. It also equates to a 30% reduction in BAU energy consumption in 2036 (EPPO, 2015d).

RENEWABLE ENERGY

The Ministry of Energy is very keen to develop alternative and renewable energy to secure new energy resources and provide affordable energy to all Thais. There have been several revisions of the renewable and alternative development plan during the last decade. The 10-Year Renewable and Alternative Energy Development Plan 2012–21 (AEDP), formerly the 15-Year Renewable Energy Development Plan 2008–22 (REDP), set as a target an increase in the share of renewable and alternative energy to 25% of total energy consumption by 2021. The plan states the Thai Government will encourage the use of indigenous resources, including renewable and alternative energy (particularly for power and heat generation), and supports the use of transport biofuels such as ethanol-blended gasoline (gasohol) and biodiesel. The plan also strongly promotes community-scale alternative energy use, encouraging the production and use of renewable energy at the local level through appropriate incentives for farmers. It also rigorously and continuously promotes R&D in all forms of renewable energy.

To achieve these targets, Thailand has set up incentive programs and mechanisms to encourage investment, such as the Fund for Energy Services Companies, which act as special-purpose vehicles for renewable energy development projects, and investment grants from the Energy Conservation Fund. Some of the previously successful self-workable measures, such as the Revolving Fund that provides low interest rates, will be terminated.

Recently, the AEDP has been updated for the time frame 2015–36, now called AEDP2015. The AEDP2015 sets a target for renewable energy share of 30% of total final energy consumption by 2036. This target is equal to 39 389 ktoe, which can be divided into power generation of 19 684 ktoe, heating of 25 088 and biofuels of 8 712 ktoe. The breakdown of this target is shown in Table 4.

Table 4: The AEDP's Targets by 2036

Type of Energy	Targets in 2036	
Electricity	**5 588**	**ktoe**
	19 684	**MW**
1. Municipality Waste	500	MW
2. Industrial Waste	50	MW
3. Biomass	5 570	MW
4. Biogas (Sewage/Waste)	600	MW
5. Small Hydro Power	376	MW
6. Biogas (Energy crop)	680	MW
7. Wind	3 002	MW
8. Solar	6 000	MW
9. Large Hydro Power	2 904	MW
Heating	**25 088**	**ktoe**
1. Waste to Energy	495	ktoe
2. Biomass	22 100	ktoe
3. Biogas	1 283	ktoe
4. Solar	1 200	ktoe
5. Others	10	ktoe
Biofuels	**8 712**	**ktoe**
1. Biodiesel	14	million litre/day
2. Ethanol	11	million litre/day
3. Pyrolysis-Oil	0.5	million litre/day
4. Compressed biogas (CBG)	4 800	tonne/day
5. Others	10	ktoe
Renewable Energy Consumption	**39 388**	**ktoe**

Source: AEDP2015, DEDE (2015b).

NUCLEAR ENERGY

Nuclear power is recognised as one of the alternative energy resources, which provides low emissions and cheaper prices compared with fossil fuels and renewable energy. The Thailand 20-Year Power Development Plan (PDP2010) had included 5 GW of nuclear power, with the aim to ensure sufficient energy supply and diversify the power energy mix. After the Fukushima Daiichi Nuclear Power Plant disaster caused by the earthquake and tsunami in March 2011, the Second Revision PDP 2010 postponed the scheduled commercial operation date (SCOD) of the first unit of the nuclear power project by three years (from 2020 to 2023). Subsequently, the Third Revision PDP 2010 further shifted the SCOD of the first unit out to 2026 and scheduled the second unit to begin operations in 2027. By 2030, the last year of the plan, nuclear power would comprise 5% of total generation capacity. The latest PDP2015, which encompasses the time frame 2015–36, includes 1 GW of nuclear power to the grid in 2035 and another 1 GW in 2036.

CLIMATE CHANGE

Climate change is one of the important policies in Thailand, even though in 2012 Thailand contributed to only 0.8% of the global GHG emissions. In terms of GHG emissions per capita and per GDP, Thailand is lower than the world average. In Thailand's Second National Communication, it indicated that 67% of its total GHG emissions comes from the energy sector. At the COP20 in Lima, Thailand pledged a pre-2020 contribution of 7–20% GHG emission reduction from BAU levels in the energy and transport sectors. Thailand also recognises that long-term and continuous effort is required to address climate change as its Climate Change Master Plan 2015–50 states. The master plan provides a continuous framework for measures and actions over the long-term that achieve climate-resilient and low-carbon growth in line with a sustainable development path by 2050. This framework plan has already been approved by the Cabinet and now relevant agencies in various sectors are formulating specific sector plans to address climate change. Recently, Thailand submitted its intended nationally determined contribution (INDC) to the UNFCCC. Thailand's INDC indicates its intention to reduce its GHG emissions by 20% from current BAU levels by

2030 (ONEP, 2015). The ambitious targets in the PDP2015, AEDP2015 and EEP2015 will significantly contribute to this national intention.

NOTABLE DEVELOPMENTS

THAILAND'S INTEGRATED ENERGY BLUEPRINT

The Ministry of Energy has achieved one of its significant milestones in accordance with the government's policy to ensure domestic energy security. It has established a comprehensive energy plan, namely the TIEB, under the three principles of economy, ecology and security. The blueprint consists of five long-term plans including the PDP, the EEDP, the AEDP, the Gas Plan and the Oil Plan. The formulation process of these plans is delicately designed to ensure that public opinion is taken into consideration through a number of public hearings throughout Thailand.

THE APEC FOLLOW-UP PEER REVIEW ON ENERGY EFFICIENCY IN THAILAND—TRANSPORT SECTOR

Thailand conducted the APEC follow-up peer review on energy efficiency focusing on the transportation sector on 3–7 August 2015. The final report was endorsed by the EWG (Environmental Working Group) members December 2015. There are 48 recommendations to Thailand on energy efficiency in transportation, covering six key issues including: transport financing and investment; urban land use and transport integration; low carbon transport systems; travel development management; vehicle fuel economy labelling and standards; and high efficiency vehicle technologies.

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USEFUL LINKS

Department of Alternative Energy Development and Efficiency (DEDE)—www.dede.go.th

Department of Mineral Fuels (DMF)—www.dmf.go.th

Electricity Generating Authority of Thailand (EGAT)—www.egat.co.th

Energy Policy and Planning Office (EPPO)—www.eppo.go.th

Ministry of Energy (MoEN)—www.energy.go.th

Prime Minister's Office—www.opm.go.th

UNITED STATES

INTRODUCTION

The United States (US) is the world's largest economy with a GDP of USD 15.9 trillion (2010 USD purchasing power parity [PPP]) in 2013 (EGEDA, 2015). The US spans 9.9 million square kilometres (km²) and has a population of 316.5 million people. The economy's population growth rate has continued to decline from the rate of 1.1% in 2000 to 0.8% in 2013 (EGEDA, 2015).

The US enjoyed a long economic expansion from 1990 to 2000, recording a growth of 3.4% in real terms, which then slowed down to a rate of 1.7% from 2000–13. In 2013, economic growth declined slightly, from 2.3% to 2.2%, compared with 2012 (EGEDA, 2015).

The US is the second-largest producer and consumer of energy in APEC. It is rich in energy resources. In 2013, the US had 49 billion barrels of proven oil reserves, 9.6 trillion cubic metres (tcm) of natural gas reserves and 237 billion tonnes of coal reserves (BP, 2015).

Table 1: Key data and economic profile, 2013

Key data[a]		Energy reserves[b, c]	
Area (million km²)	9.9	Oil (billion barrels)	49
Population (million)	316.5	Gas (trillion cubic metres)	9.6
GDP (2010 USD billion PPP)	15 902	Coal (billion tonnes)	237
GDP (2010 USD PPP per capita)	50 224	Uranium (kilotonnes of U)	472

Sources: a. Census (2010); b. EGEDA (2015); c. BP (2015); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in the US in 2013 was 2 189 million tonnes of oil equivalent (Mtoe). In terms of fuel type, 36% of supply came from crude oil and petroleum products, 28% from natural gas, 20% from coal and the rest from other sources such as nuclear energy, hydropower and geothermal energy. Only 14% of the economy's primary energy requirements in 2013 were from net imports. The share of energy imports declined from 32% in 2006 (EGEDA, 2015).

The economy's total primary energy supply in 2013 increased by 2.3% compared to the 2012 level of 2 141 Mtoe. The increase resulted mainly from the 3% increase in gas supply, 2% increase in coal supply as well as the increase in the supply of oil by 1%. Likewise, a substantial reduction in the net imports of the economy, namely an 18% reduction from the previous year, was recorded in 2013 (EGEDA, 2015). The economy has showed constant reduction in import dependency since 2006, recording an average annual decline of 11% over the last seven years, which was brought about by the increase in crude oil production by North Dakota and Onshore Texas, mainly from shale and other tight (having very low permeability) formations (EIA, 2013). In 2013, the US remained the third-largest crude oil, natural gas liquids and condensates producer in the world, with production averaging 10 million barrels per day (bbl/d), a 13% increase from the previous year (BP, 2015).

The US' primary natural gas supply totalled 610 Mtoe in 2013. While the economy's natural gas supply has grown modestly from 1990 to 2013, with an annual growth rate of 1.4%, the primary natural gas supply (including net imports in 2013) grew by 2.5% from the 2012 level (EGEDA, 2015). In recent years, rapid production of cheap unconventional gas reserves from shale formations has resulted in an abundant supply and low wellhead prices. Relatively low natural gas prices and the substitution of gas for coal by power producers have helped lower emissions from power generation.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 881 624	Industry sector	258 975	Total power generation	4 286 903
Net imports and others	308 315	Transport sector	608 895	Thermal	2 907 720
Total primary energy supply	2 189 230	Other sectors	507 075	Hydro	270 856
Coal	432 406	Non-energy	119 093	Nuclear	822 004
Oil	780 582	Total final energy consumption	1 494 038	Others	286 323
Gas	609 933	Coal	20 209		
Others	366 308	Oil	762 203		
		Gas	332 975		
		Electricity and others	378 651		

Source: EGEDA (2015).

The US held about 5.1% of the world's natural gas reserves in 2013 (BP, 2015). As of 2014, the economy's natural gas pipeline transmission network was more than 485 000 kilometres (km) long (PHMSA, 2016). In 2013, approved major pipeline projects amounted to 466 km and 0.2 billion cubic metres (bcm) per day. The corresponding numbers for 2014 and 2015 were 679 and 765 km and 0.3 and 0.4 bcm per day (FERC, 2015a). Underground gas storage capacity in the US has grown only slightly since the mid-1970s, and the total end-of-year stock in 2015 stood at about 77% of the working gas-designed capacity of the 390 active storage fields (EIA, 2016a, 2016b).

From 2006, the introduction of horizontal drilling in combination with hydraulic fracturing enabled the economic extraction of unconventional gas, largely from shale formations. In particular, shale gas production in the US has increased rapidly, from about 8% of gross withdrawals in 2007 to 44% in 2014 (EIA, 2015a, 2015b). The size of proved unconventional gas reserves, including shale gas and coalbed methane, is estimated to be 6.1 tcm or over 50% of total reserves as of year-end 2014 (EIA, 2015c), and thus, further increases in shale gas production are anticipated. Interest in liquefied natural gas (LNG) exports has grown thanks to abundant supplies and its relatively low price compared with other LNG supplies. By 2019, 104 million tonnes per year of exporting capacity would be added, if all the export terminals approved by the Federal Energy Regulatory Commission are completed (FERC, 2016). .

The primary energy supply of coal in the United States totalled 432 Mtoe in 2013. In 2013, primary coal supply increased by 1.7% over the previous year's level of 425 Mtoe (EGEDA, 2015). The US' coal reserves are concentrated east of the Mississippi River in Appalachia and in several key western states (EIA, 2015d).

In 2013, the United States was the fourth-largest coal exporter in the world, behind Indonesia, Australia and Russia (EIA, 2015e). In 2013, coal exports amounted to 118 million short tons, a 6.4% reduction from 2012. Coal imports have steadily declined from a peak of 36.3 million short tons in 2007 to 8.9 million short tons in 2013 (EIA, 2015f). More than 55% of exported coal is metallurgical, with the rest being steam coal. Europe is the largest importer of coal from the US, accounting for almost 45% of net exports (EIA, 2015g).

In 2013, the US produced 4.3 million gigawatt-hours of electricity, 68% of which came from fossil fuel plants, 19% from nuclear power and 13% from renewable energy and other sources (EGEDA, 2015).

The US generates more nuclear power than any other economy. Currently, five new nuclear reactors are being constructed (EIA, 2015h). The Three Mile Island accident in 1979 raised concerns about nuclear power plant safety. Ad hoc regulatory responses to those concerns drove up the cost of new plants. Thus, both factors deterred further expansion. In 2007, work resumed on the partially built Watts Bar 2 reactor, construction on which had been suspended in 1985. The commercial operation of this reactor is expected to begin in 2016 (TVA, 2015). In 2014, the average utilisation rate of the US' 99 operable commercial nuclear units (down from a peak of 112 units in 1990) rose to 91.7%, and it has continued to rise since then (EIA, 2015f). Many nuclear plants have applied to the Nuclear Regulatory Commission (NRC) for 20-year extensions of their operating licences, which would enable them to operate until the plant completes 60 years. In early 2016, the NRC had approved licence extensions for 83 nuclear reactor units and had applications for another 11 extensions under review, while another 5 units had informed the Agency of their intention to seek extensions between 2016 and 2022 (NRC, 2016).

Recently, nuclear energy has suffered a major setback with the first closures of operating plants in 15 years. Four nuclear power plants were closed earlier than expected. Two of the reactors, one each in Vermont and Wisconsin, cited stiff economic competition as the reason for their closing, and the other two plants, one each in California and Florida, closed owing to structural damage and safety concerns. However, in late 2014, the Department of Energy (DOE) issued the Advanced Nuclear Energy Projects loan guarantee solicitation, which provides USD 12.5 billion to support innovative nuclear energy projects as a part of the Administration's All-of-the-Above Energy Strategy.

Total renewable energy production in the US in 2013 was approximately 235 Mtoe, or 11% of the total primary energy supply, according to the Energy Information Administration (EIA). Production from non-hydro (or new and renewable) sources increased 16.0% from the previous year, recording an annual growth rate of 14.2% since 2005 (EIA, 2015h, 2015f).

By consumption of renewable energy type in 2013, biomass, as a whole, represented 49.9% of the total; hydroelectric power, 27%; geothermal energy, 2.3%; wind, 17% and solar photovoltaic, 3.3%. There has been a particularly rapid expansion of wind power; between 2000 and 2013, wind power recorded an average annual growth rate of 29.2% (EIA, 2015f). Government incentives, including the subsidies and renewable energy mandates discussed below, in addition to cost reductions relative to fossil-fuelled alternatives, spurred the growth of renewable energy production.

FINAL ENERGY CONSUMPTION

In 2013, total final energy consumption in the US was 1 494 Mtoe, an increase of 4.1% from the previous year. The transport and other sectors accounted for 40.8% and 33.9%, respectively, of the total demand, with the remaining share consumed by the industrial sector (17.3%) and non-energy sector (8%). In terms of fuel, petroleum accounted for more than 51% of the final consumption, while electricity and natural gas accounted for 25.3% and 22.3%, respectively. Coal contributed a modest 1.4% (EGEDA, 2015).

ENERGY INTENSITY ANALYSIS

The energy intensity of the US for 2013 has improved considerably across all sectors. Primary intensity in 2013 worsened by 0.1% from the previous year's value of 137.6 tonnes of oil equivalent per million USD (toe/million USD). However, the final energy consumption worsened by 1.9% compared with the previous year's energy demand level. The decline in the final energy intensity was mainly due to the increases in the intensity of the 'other' and 'non-energy' sectors in 2013 (Table 3).

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2012 vs 2013
Total primary energy supply	137.6	137.7	0.1
Total final energy consumption	92	94	1.9
Industry	16.0	16.3	1.6
Transportation	38.5	38.3	–0.4
Others	31	32	2.7
Non-energy	6.7	7.5	12

Source: EGEDA (2015).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

JURISDICTION AND POLICY

Within the US Government, jurisdiction over the production, transformation, transmission and consumption of energy is shared by several agencies in the executive branch. Supervision of the use of natural resources falls under the Department of the Interior. Energy-related research, development and deployment (RD&D) takes place under the auspices of the DOE. The Federal Energy Regulatory Commission (FERC) oversees the interstate transmission of energy, and the Environmental Protection Agency (EPA) regulates the environmental impacts of energy transformations throughout the economy.

The Department of Transportation (DOT) also plays an important role as the regulator of vehicle fuel economy. A new White House Office of Energy and Climate Change Policy was created in 2009 to coordinate some of the activities of these agencies.

While all these federal agencies have some voice in energy policy, the US Congress is responsible for creating the laws that govern the activities of these agencies and sets the rules for energy markets. Since the 1970s, several major legislative packages have been introduced to define the US' energy policy. The National Energy Act of 1978 included legislation to promote energy conservation, shift towards alternative energy sources, create a market for independent power producers and give FERC greater authority over natural gas markets (DOE, 2013.). The Energy Policy Act of 1992 further opened electricity markets to competition, encouraged integrated resource planning by utilities, targeted improved energy management in federal agencies, promoted alternative transportation fuels, and required RD&D of technologies to enhance the production and efficient utilisation of renewable, fossil and nuclear energy resources (US House, 1992).

In 2005, the new comprehensive Energy Policy Act of 2005 (EPAct) was introduced as the successor to the Energy Policy Act of 1992. This was followed shortly after by the Energy Independence and Security Act of 2007 (EISA). Together, these recent legislative packages substantially define the current US federal energy policy. The American Recovery and Reinvestment Act of 2009 (ARRA) is also noteworthy for having dramatically increased funding for many federal energy programs. Key elements of these recent acts are described in the following thematic discussions.

ENERGY SECURITY

Given the high dependence of the US on imported oil, policies meant to improve energy security have often focused on three areas:

- Improving efficiency in the transportation sector, where more than 70% of oil products are consumed,
- Enhancing domestic production of liquid fuels, and
- Advancing transportation technologies that are less dependent on liquid fuels, such as hybrid electric vehicles (HEVs).

In order to improve energy security in the transportation sector, the EPA and the DOT's National Highway Transportation Safety Administration (NHTSA) jointly developed vehicle greenhouse gas (GHG) emissions standards and fuel economy standards of 23.2 km per litre (54.5 miles per gallon) for passenger cars, light-duty trucks and medium-duty passenger vehicles to be manufactured in 2025 (MY 2025) (EPA, 2012a). As part of the Climate Action Plan announced in June 2013 (see below), the EPA and NHTSA set fuel economy standards for the first time for medium- and heavy-duty vehicles and engines. The first phase is expected to reduce GHG emissions by nearly 250 million metric tons and save approximately 500 million barrels of oil over the life of vehicles sold during 2014 to 2018. (EPA, 2010) The second phase under development for 2018-2027 seeks to reduce CO2 emissions by 1 billion metric tons and save 1.8 billion barrels of oil (EPA, 2016a).

The 2005 EPAct promoted the domestic production of oil by removing some regulatory barriers and offering incentives for production from deep-water resources, low-production wells and unconventional sources. One regulatory change was to exclude the underground injection of hydraulic fracturing fluids from the Safe Drinking Water Act of 1974, which allowed the exploitation of tight sand and shale hydrocarbon resources. While making changes to this Act, Congress also clearly stated that development of unconventional oil resources should be encouraged in order to reduce US dependence on foreign oil imports (DOE, 2005).

Biofuels, which represent another avenue for improving the US' energy security, have received strong policy support. While the development of vehicles powered by alternative fuels and biofuel production is already promoted under the 2005 EPAct, in 2007, EISA brought biofuels to the forefront of the US' energy security policy. EISA mandated a fivefold increase from previous biofuel use targets by 2022, requiring fuel producers to use a minimum of 136 billion litres (36 billion gallons) of biofuel, up from 42 billion litres (11 billion gallons) in 2009. This included the increase in advanced biofuels usage (that is, renewable fuels other than ethanol derived from corn starch whose lifecycle GHG emissions are at least 50% less than baseline lifecycle GHG emissions) from 2.3 billion litres (0.6 billion gallons) in 2009 to 79 billion litres (21 billion gallons) by 2022. EISA also stipulates that the production of advanced biofuels should be encouraged by a grant program. Most of the new biofuel is to be produced domestically, and the target includes provisions to reduce the required volumes if the costs are judged to be too high or if supplies are inadequate (CRS, 2007). Since this law was passed, U.S. consumption of oil has, in fact, declined in recent years, causing the biofuel blend ratio in gasoline to rise unexpectedly. Many auto manufactures have stated

that their warranties will not cover any damage from biofuel blending above this ratio. In response, refineries are purchasing renewable credits to waiver their obligations instead of complying with the mandated targets (CRS, 2013). As a result, biofuel production is already tracking below the current targets. Nearly all of U.S. gasoline contains 10 percent ethanol. EPA mandated that more than 18 billion gallons of biofuels overall be blended into the fuel supply for 2016, still short of the 22.25 billion gallons envisioned by Congress in 2007 (EPA, 2015).

The Recovery Act sought to advance the commercialisation of electric vehicles by investing in facilities manufacturing batteries and other electric vehicle components. The government has invested more than USD 2 billion in nearly 50 different electric vehicle and component manufacturing projects (DOE, 2010a). Electric vehicles offer energy security benefits by shifting transportation energy demand from oil to electricity. Total HEV sales during 2014 amounted to 452 172 (94% cars and 5.9% light trucks), down 8.7% from 2013, but electric vehicle sales rose steadily from 2000 (DOE, 2015).

Coal-fired power plants provide less than half of the US' electricity. Coal is a domestically abundant resource and thus provides energy security benefits. However, coal's high carbon dioxide (CO_2) emissions present a challenge for the US' climate policy, as discussed below.

ENERGY MARKETS

In 2013, American consumers spent an estimated USD 1.4 trillion on energy purchases (EIA, 2015f). The government plays many roles in this large market, such as resource owner, industry regulator and supporter of research and development (R&D).

UPSTREAM DEVELOPMENT

The Department of Interior's (DOI) Bureau of Land Management (BLM) administers over 2.8 million km^2 of mineral estate, of which about 180 000 km^2 is currently leased for oil and gas development (BLM, 2010). The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), another office of the DOI, leases another 174 000 km^2 of offshore energy and mineral resources (BOEMRE, 2010). The BLM and BOEMRE also lease public lands and offshore areas for the development of above-ground energy resources such as solar and wind. While the US Government plays a large role in leasing surface and mineral rights, it is not the sole owner of such rights. States and individuals also own and lease surface lands and underground mineral rights for energy extraction (BLM, 2009).

State and federal governments share regulation pertaining to upstream development. In some cases, the division between state and federal responsibility is clear. For example, state oil and gas commissions prevent the waste of resources and protect public safety in state territories (IOGCC, n.d.). In the federal offshore territory, the offices of the DOI exercise similar responsibilities. However, such clear divisions may not always exist. For example, the state offices of environmental protection monitor environmental impacts and enforce state environmental laws. At the same time, the EPA acts as a backstop on environmental issues, ensuring that, at a minimum, upstream activities comply with federal laws such as the Clean Air Act of 1970 and the Clean Water Act of 1972. In cases where state and federal regulatory responsibilities overlap, coordinating the activities of both agencies becomes an important task (EPA, 2012b).

ELECTRICITY AND GAS MARKETS

The federal government regulates the interstate transmission of electricity and gas, as well as wholesale sales of electricity, under FERC. FERC's mandate is to 'ensure supplies of energy at just, reasonable and not unduly discriminatory or preferential rates'. In regulating wholesale electric power markets, FERC has implemented a policy of fostering competition (FERC, 2008). This has meant granting open access to transmission lines, thereby allowing wholesale customers to meet their needs with purchases from any number of wholesale suppliers connected across a regional grid. Competitive wholesale electricity markets function using distinct models in different regions. Regional transmission organisations and independent system operators administer transmission networks and operate wholesale markets across large parts of the US and Canada. In other regions, bilateral contracting between consumers and suppliers, with separate contracting for transmission, remains the norm (DOJ, et al., 2007).

Retail electricity markets are regulated by the states. There are thousands of retail electricity providers in the US, and they operate under a variety of regulations. Seventy-two per cent of retail customers are served by regulated, investor-owned utilities, 15% by public power systems and 13% by cooperatives (EIA, 2015i). State regulators ensure that these providers serve their customers at rates that are 'fair, reasonable and non-discriminatory' (NARUC, 2009). In the 1990s, many states began to explore options for restructuring retail electricity markets to create competition among electricity providers while continuing to regulate distribution networks as natural monopolies. In 2014, 21 states allowed some customers a choice of electricity service provider, but efforts to deregulate retail electricity markets slowed in 2000 and 2001,

when California's newly deregulated retail market proved vulnerable to abuse, leading some customers' bills to quickly triple and forcing some distribution utilities into bankruptcy (DOJ, et al., 2007; EIA, 2015i).

Natural gas markets are similar to electricity markets, with competitive wholesale markets supplying federally regulated transmission pipelines and delivering to state-regulated distribution networks. FERC used to set natural gas prices, but wellhead prices were fully deregulated in 1993.

Presently, FERC's pricing activities for natural gas are limited to determining pipeline rates for gas transmission. The DOT's Pipeline and Hazardous Materials Safety Administration regulates gas transmission pipelines to ensure they are operated safely. The pricing and safety of natural gas distribution networks are regulated by state agencies (FERC, 2015b; EIA, 2009).

RESEARCH AND DEVELOPMENT

The scope of energy-related R&D supported by the US Government has expanded from a focus on nuclear energy and basic science in the 1960s to include fossil fuels, energy efficiency, renewable energy and carbon sequestration. Much of this expansion occurred in the immediate aftermath of the 1973 oil crisis. In the five years following the crisis, spending on energy-related R&D more than tripled. New support for fossil energy, renewable energy and improved efficiency absorbed much of the increase. Though the amount of spending declined sharply during the 1980s, the broader scope was preserved (Dooley, 2008).

The DOE is the lead agency for R&D activities. It funds 21 laboratories and technology centres, as well as the research conducted at universities across the US. Currently supported research ranges from particle physics to pilot projects for carbon capture and sequestration (CCS) (DOE, 2010b). Total government spending for energy-related R&D remained relatively stable at around USD 3 billion a year (in USD 2005 terms) from the 1990s until 2009, which saw the enactment of the Recovery Act (Dooley, 2008). The Recovery Act changed this by investing billions more in R&D facilities, pilot projects and the new Advanced Research Projects Agency for Energy (DOE, 2010c). However, the Recovery Act was a one-time economic stimulus. After hitting an all-time high in FY09 at USD 3.79 billion, U.S. federal funding for energy R&D slid downward for the four years to USD 2.29 billion in FY 13 before modestly increasing to USD 2.41 billion in FY 14 and an estimated USD 2.43 billion in FY 2015, still above pre-Recovery Act levels (NSF, 2015). Some business leaders in the US have argued that to confront the energy challenges that the US faces, the government should more than triple spending on clean energy R&D (AEIC, n.d.)

FISCAL REGIME AND INVESTMENT

The US' fiscal policy is quite complex, particularly as it relates to the energy sector. This section provides a limited introduction to the taxation of energy commodities and to the multitude of fiscal incentives that shape energy-related investments. Energy-producing businesses are taxed like other US corporations, at a maximum statutory federal rate of 35%, while state rates range from 0% to 10%. However, tax rules result in very different effective tax rates (CBO, 2005). A detailed discussion of the taxation of energy businesses is beyond the scope of this overview, but some provisions specifically related to energy investments are described here.

Royalty payments on the production of oil, gas and coal are made to the owner of mineral resources, which is often the government. The US Office of Natural Resources Revenue collected USD 13.2 billion in royalty and other payments in Fiscal Year 2014 (ONRR). Downstream, sales of some important energy commodities, such as gasoline and diesel, are taxed by state and federal governments. The federal tax on gasoline and diesel is about USD 0.05 per litre (18.4 cents per gallon) and USD 0.06 per litre (24.4 cents per gallon), respectively. On average, state taxes on these fuels are similar to the federal taxes, but there is considerable variation among the states (API, 2012). Some states have also introduced a 'public goods charge' on retail electric and natural gas sales, the proceeds of which fund energy efficiency programs.

A variety of tax breaks have been introduced by the federal and state governments to promote investments in energy-related infrastructure. Two key federal instruments are investment tax credits (ITCs) and production tax credits (PTCs). ITCs allow taxpayers investing in certain qualified energy facilities to reduce their tax burden by some fraction of the amount invested. Similarly, PTCs reduce the taxpayer's tax burden, but in an amount proportional to the energy production of the facility over a defined period. The types of facilities qualifying for ITCs range from coal gasifiers to hydrogen refuelling stations.

Tax credits for investments in renewable energy or in energy-efficient home improvements are also available to individuals. At the state level, reduced sales and property tax rates are often granted to preferred energy technologies (DSIRE, 2016). Some of these incentives are described in the following sections on energy efficiency and renewable energy.

ENERGY EFFICIENCY

Incentives to promote energy efficiency exist at the federal, state and local levels. Federal tax credits and loans support residential efficiency improvements. Taxpayers could claim a tax credit of up to 30% of the cost of a residential efficiency measure through the end of 2010. Homeowners can also obtain loans from the federal government to finance energy-efficiency measures in new or existing homes (DSIRE, 2016). Much of the Recovery Act allocation for energy efficiency was distributed through state energy programs that provide loans, grants and other assistance for energy-efficiency projects in homes, businesses and public facilities (CRS, 2009). Locally, utilities are generally required to consider energy efficiency on an equal basis with new generation in their planning, and many utilities administer demand-side management programs that provide incentives and technical assistance to reduce demand for electricity and natural gas (DSIRE, 2016; US House, 1992).

RENEWABLE ENERGY

In 2014, the US' cumulative wind energy capacity reached 64 850 megawatt (MW) or approximately 6.1% of total electricity generating capacity in the US. In 2014, the total wind energy installation amounted to 4 878 MW, and from 2007 to 2011, wind installations accounted for roughly 35% of all new electricity generating capacity in the US (AWEA, 2012). Another significant change under the Recovery Act is that new renewable energy (NRE) facilities may select either the PTC, a 30% business energy ITC or, for a limited period, a cash grant equal to the value of the ITC. Manufacturers of renewable energy technologies are also eligible for tax credits under the Recovery Act, to offset investments in new or expanded manufacturing capacity. New solar facilities do not qualify for the PTC as a result of the 2005 EPAct, but they are eligible for the ITC. A related individual tax credit of 30% is available for residential solar electric system expenditures without cap, as are similar tax credits for small residential wind and geothermal systems. Several federal loan and loan guarantee programs also exist to encourage the development of renewable energy and other advanced energy facilities (DSIRE, 2016).

Many state and local governments have established financial measures that complement federal incentives for NRE investment. In addition to subsidies, state legislation has also provided significant indirect incentives for NRE development through the establishment of policy frameworks such as renewable portfolio standards (RPS), which mandate that a certain share of electricity sales be sourced from renewable energy. Thirty-eight states, the District of Columbia, Guam, Puerto Rico, the Virgin Islands, the N. Mariana Islands and the Federated States of Micronesia had enacted the RPS legislation with varying degrees of stringency by the end of 2015 (DSIRE, 2016).

Other measures have also been introduced to support NRE development, such as generation disclosure rules, mandatory utility green power options, green power purchasing policies and the use of public benefit funds (DSIRE, 2016).

NUCLEAR ENERGY

The US Government has enhanced its support for the nuclear industry through various means, including legislative and financial ones. For example, the EPAct of 2005 included several provisions considered important to revitalising the American nuclear power industry. It extended the Price–Anderson Nuclear Industries Indemnity Act of 1957 (the Price–Anderson Act) limiting the legal liability of nuclear operators, introduced loans to cover costs incurred by legal or regulatory project delays, and established a public–private project to design and construct a pilot Next Generation Nuclear Plant. The Act also continued support for R&D in nuclear energy, and established a loan guarantee program intended to improve access to financing for new nuclear plants and other energy projects that reduce air pollution emissions or introduce new technologies (DOE, 2005). Thus, as authorised by its Title XVII, the Advanced Nuclear Energy Projects Solicitation provides 'loan guarantees to support construction of innovative nuclear energy and front-end nuclear projects in the US that reduce, avoid or sequester greenhouse gas emissions' (DOE, 2014a). In February 2014, the DOE issued USD 6.5 billion in loan guarantees to support the construction of two Westinghouse AP1000 Generation III+ reactors at the Alvin W. Vogtle Electric Generating Site, which currently has two older generation 4-loop pressurised water reactors in operation (DOE, 2014b).

Since the Energy Reorganisation Act of 1974, the DOE has held responsibility for the development and promotion of nuclear energy, and the NRC has served as the regulatory overseer of the industry. The federal government is also required to provide a site for the permanent disposal of high-level radioactive waste, with disposal costs to be paid by nuclear operators. However, a suitable site remains to be found (NRC, 2011). The partially completed waste depository facility in Yucca Mountain, Nevada was recently abandoned, and there is no viable long-term storage option for nuclear waste. The US Government handles the financial burden of storing spent fuel and currently compensates utilities for storing their nuclear waste on-site. However, the US Court of Appeals for the District of Columbia Circuit's ruling in June 2012 banned

the NRC from issuing new reactor licenses or renewals until it sufficiently assessed the risk of storing spent radioactive fuel at nuclear plant sites, and thus, the environmental consequences of not building a permanent waste repository. This ruling prompted the NRC to issue an order in August 2012, suspending actions related to issuing license renewals and new operating licenses (EIA, 2014a).

The US has the world's largest nuclear energy sector, consisting of 99 operating reactors generating 797 000 million kilowatts of electricity in 2014 (EIA, 2015f), as well as five under-construction reactors. The NRC has the authority to issue initial operating licenses to newly built reactors for a period of 40 years after which they need license renewals to extend their lifetime for an additional 20 years of operation. Given the majority of these reactors were built before the 1990s (mainly in the 1960s and 1970s), they have already undergone lifetime extensions or need to go through this process in this decade or the next. After about two years of deliberation, as requested by the mentioned court ruling, on 18 September 2014, the NRC issued the revised and renamed Continued Storage of Spent Nuclear Fuel Rule, effective on 20 October 2014. Consequently, it may now legally resume issuing license renewals as well as new operating licenses. In fact, the NRC resumed license issuance in October 2014 when it renewed the operating licenses for Limerick Generating Station Units 1 and 2 located in north-west of Philadelphia. It extended their license expiration dates by 20 years, to 2044 and 2049, respectively (EIA, 2014a). Over time, the NRC has granted 20-year license renewals to 83 of the 100 operating American reactors, enabling them to operate for a total period of 60 years. Currently, the NRC is reviewing license renewal applications for an additional 11 reactors while expecting to receive 5 more applications in the next few years (NRC, 2016).

The American reactors could operate beyond 60 years (for up to 20 additional years), if their operating companies apply for and receive a Subsequent License Renewal (SLR) from the NRC (EIA, 2014b). In August 2014, backed by the May 2014 findings of the NRC's Advisory Committee on Reactor Safeguards, the NRC determined that the 'existing license renewal regulations were sufficient to support the SLR process' (EIA, 2014b).

The March 2011 accident at Japan's Fukushima Daiichi Nuclear Power Plant prompted the strengthening of the American nuclear safety regulations as well as operating standards of its nuclear power plants to avoid similar accidents in the US. The NRC and the US' nuclear industry have been working together towards this end. Thus, in the aftermath of the accident, they initiated 'an immediate coordinated response to the accident, as well as long-term actions' meant to ensure the safety of the existing and planned American nuclear reactors (EIA, 2014c). One of the subsequent major activities was the NRC's comprehensive review of its own processes and regulations, leading to the release of a report by its Near-Term Task Force, namely, *Recommendations for Enhancing Reactor Safety in the 21st Century*. It consisted of 12 recommendations covering short- and long-term actions, which were followed by the NRC's issuing an additional three orders with respect to the short-term recommendations in March 2012. The orders, which appear below, required the implementation of the following measures while requiring the affected nuclear power plants' operators to submit their initial status reports in 60 days and their integrated plans by February 2013 (EIA, 2014c).

- All boiling-water reactors (BWRs) with Mark I and II containment systems must have reliable hardened containment venting capability to reduce pressure and hydrogen build-up. This may require improving or replacing existing containment ventilation systems,
- Reactors must have enhanced instrumentation installed to monitor water levels in their spent fuel pools in the event of an emergency, and
- Nuclear power plants must be capable of responding to multiple simultaneous events and ensuring that reactors and spent fuel pools remain cooled. The order specifies a three-phase approach involving use of installed on-site resources, use of portable on-site equipment and indefinite use of off-site resources.

For its part, the American nuclear industry has taken certain measures. They include developing its FLEX strategy through the Nuclear Energy Institute (NEI). It is a 'comprehensive, flexible and integrated plan to mitigate the effects of severe natural phenomena and to take steps to achieve safety benefits quickly'. Scheduled to become fully operational by 2014, the plan provides for two regional response centres to be located near Memphis, Tennessee, and Phoenix, Arizona, from where 'critical emergency equipment can be delivered to nuclear power plants within 24 hours' (EIA, 2014c).

CLIMATE CHANGE

As a part of the United Nations Framework Convention on Climate Change (UNFCCC), the US has submitted its Intended Nationally Determined Contributions (INDC) to lower economy-wide emissions by

26–28% below 2005 levels by 2025 in response to the UN Secretariat's request in Lima. As of 2015, the Clean Air Act, the Energy Policy Act, and the Energy Independence and Security Act are the key federal government legislation that address the economy's carbon emissions, both through higher emissions standards and lower energy demand. State and local governments have developed their own goals and action plans. Several state and regional initiatives incorporate a price for carbon emissions (e.g. the plans implemented in California and north-eastern US).

GREENHOUSE GAS ENDANGERMENT FINDINGS

There are two ways that GHGs may be regulated at the federal level in the US. First, Congress may pass a legislation to control GHG emissions. Alternatively, the EPA may issue a ruling (an 'endangerment finding') that CO_2 poses a danger to human health and should therefore be regulated under existing air quality legislation. The former solution offers a more flexible approach to reducing emissions. However, a 2007 decision by the Supreme Court judged that GHGs are pollutants that should be covered under the Clean Air Act. This decision required the EPA to determine whether to issue an endangerment finding. In December 2009, the EPA issued an endangerment finding, which gave it the authority to issue rules to limit GHG emissions. The EPA has used this authority to make vehicle emission standards more stringent and to define GHG permit requirements for large CO_2 emitters (EPA, 2012a). The EPA engenderment finding was challenged through the Court of Appeals but upheld in mid-2012. Further appeals are under consideration in the US Supreme Court. The outcome of this ruling and subsequent plans to limit GHG emissions will have major implications for future energy development in the US.

Principally, the EPA proposes to limit CO_2 emissions in the power sector. The proposed standard restricts CO_2 emissions to a maximum of 454 kg (1 000 lb) for every megawatt-hour of electricity produced. These proposed restrictions apply to new generating units and currently exclude existing units in operation or under construction. However, the EPA attempted to set CO_2 emission limits for existing generating units. Accounting for each state's energy mix, the so-called Clean Power Plan (CPP) was announced in September 2015. The final rule was issued a few months later, and the Supreme Court stayed the implementation pending further judicial review. The emission regulation was aimed at limiting climate change by enforcing the use of modern and more efficient fossil fuel generation technologies (EPA, 2012c, 2016b). The carbon restriction would essentially require new coal plants to operate using the latest high-efficiency technology, employ biomass co-firing fuels or utilise carbon sequestration.

In addition to the GHG emissions limits, the EPA enforced emission standards on mercury and toxic pollutants in 2012 to be fully enforced by 2015. After a decision by the U.S. Supreme Court that EPA must consider cost in the finding supporting the standards. EPA undertook studies and in April 2016 issued a final finding that it is appropriate and necessary to set standards for emissions of air toxics from coal- and oil-fired power plants (EPA, 2016c). This will have a major impact on reducing toxic emissions from coal, primarily in the electricity sector (EPA, 2012a). The new standards will require expensive technological retrofits to existing facilities and will affect almost half the coal generating capacity. Most of the affected coal facilities are over 40 years old, and the new standards are likely to result in extensive capacity retirements, which may exceed 50 gigawatts.

STATE- AND CITY-LEVEL CLIMATE CHANGE INITIATIVES

In the absence of an economy-wide roadmap to reduce GHG emissions, a number of regional, state and city level initiatives were undertaken since 2010.

In California, the Global Warming Solutions Act (AB 32) was signed into law in September 2007. This law builds upon the 2000 California Climate Action Registry and the 2005 Executive Order S-3-05, which noted that the state was particularly vulnerable to the impact of global warming, citing impacts to 'water supply, public health, agriculture, the coastline, and forestry'. The Act sets a mandatory state-wide GHG emissions cap equal to 1990 levels by 2020, with penalties for non-compliance (ARB, 2014). In December 2008, the California Air Resources Board approved the implementation of a climate action plan, which includes regulations, market mechanisms, voluntary actions and other measures, with the option of adopting a cap-and-trade program in the period 2012–20 (ARB, 2008).

Nine states in the north-eastern US are members of the Regional Greenhouse Gas Initiative (RGGI). This initiative has a narrower scope than the California Plan, as it focuses on reducing CO_2 emissions from the power sector by 45% of 2005 levels by 2020. The first permit auction for the cap-and-trade system was conducted in September 2008, and the first three-year compliance period began in January 2009 (RGGI, 2009). Six New England states are also party to the New England Governors/Eastern Canadian Premiers Climate Change Action Plan, whose 11 members have resolved to reduce the region's GHG emissions to 10% below 1990 levels by 2020 (NEG & ECP, 2008).

The Midwestern Greenhouse Gas Reduction Accord, signed in November 2007, with members including six US states and one Canadian province, aims to establish GHG reduction targets and possible regulatory or market mechanisms that might be used to achieve them (MGA, 2007).

A host of other regional initiatives focusing on climate change or clean energy have formed between the US, Mexican states and Canadian provinces. Examples include the Western Governors' Association Clean and Diversified Energy Initiative, the Southwest Climate Change Initiative, the West Coast Governors' Global Warming Initiative and the Western Climate Initiative (comprising six states and two Canadian provinces aiming to reduce emissions to 15% below 2005 levels by 2020) (WCI, 2007). These regional initiatives represent attempts to actively collaborate on goal setting and the development of action plans. Except for the RGGI in the north-east, all the initiatives are still in the design phase. In 2015, Canada, Mexico and the United States announced the establishment of a North American Energy Ministers' Working Group on Climate Change and Energy. It is facilitating expanded cooperation to deploy innovative renewable energy technologies, modernize the grid, and increase energy efficiency to combat climate change and reach greenhouse gas targets while growing low-carbon economies in North America (DOE, 2015b).

Municipal governments have undertaken other GHG initiatives, notably the US Mayors' Climate Protection Agreement, launched in Seattle in 2005. By December 2009, there were 1 016 signatories to the voluntary agreement, under which US mayors strive to meet or beat the Kyoto Protocol targets in their own communities, urge state and federal governments to meet the US' Kyoto Protocol GHG emissions targets, and commit to taking actions within their own communities that will help to comply with or exceed Kyoto Protocol targets (USCM, 2009).

VEHICLE EMISSION STANDARDS

In 2007, EISA mandated a 40% increase in combined car and light truck fleet fuel economy (CAFE) standards by 2020, to reach 14.9 km per litre (35 miles per gallon), and required further study into commercial vehicle fuel economy (CRS, 2007). In 2009, the administration proposed a plan to speed the introduction of the new CAFE standards. In July 2011, a new US CAFE standard was agreed to by 13 major automakers in cooperation with the State of California, to harmonise economy-wide fuel standards to 23.2 km per litre (54.5 miles per gallon) for cars and light-duty trucks by 2025. The supportive automakers together account for over 90% of all vehicles sold in the US (NHTSA, 2011). In addition, the EPA and NHTSA are completing phase one (2014-2018) increases for heavy duty vehicles, which are expected to reduce the fuel consumption of heavy-duty vehicles by 10–20% between 2014 and 2018 (EPA, 2011). EPA and NHTSA released proposed standards for Phase 2 (2018-2027) in April 2016. Based on projected fuel savings, vehicle owners are expected to recover the additional upfront costs of the more efficient vehicles in one to five years (NHTSA, 2011).

The new standards, however, have several loopholes, which may inhibit their effectiveness. The chief concern is the use of a size-weighted average fuel economy, where larger vehicles have lower fuel efficiency targets. This policy was included to eliminate penalties, which favour the sales of small vehicles over large vehicles. However, sales of larger vehicles in the market share may increase and reduce real fuel efficiency improvements. A published study suggests that average vehicle sizes, particularly for light trucks, may increase between 2% and 32% under the new standards. This would result in a net reduction in the average fuel economy of between 1 and 4 miles per gallon (between 0.4 and 1.7 km per litre) (Whitefoot & Skerlos, 2011). Other uncertainties that may reduce the standards' effectiveness include low fees for non-compliance, overstated fuel economy ratings and low targets for heavy trucks. These negative effects are expected to be limited and real efficiency improvements are likely to accelerate under these rules, but perhaps at a lower than anticipated rate.

PROGRAMS UNDER THE AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009

As of late 2015, over USD 31 billion was spent on energy-related projects under ARRA (DOE, 2016). Major investment programs include the Weatherisation Assistance Program, which invests in energy efficiency improvements in low-income family homes. Other notable projects include the development of electric vehicles and smart grid technology as well as greater support for renewable energy. ARRA provides tax credits for the purchase of alternatively fuelled vehicles. ARRA also provides USD 800 million for research and development on clean coal projects, including carbon capture and sequestration (EIA, 2014d).

NOTABLE ENERGY DEVELOPMENTS

CLIMATE ACTION PLAN

On 25 June 2013, President Obama announced the Climate Action Plan for tackling climate change. The President's Climate Action Plan consists of a wide variety of executive actions and the following three key pillars (The White House, 2013):

- **Cut Carbon Pollution in America**
  In 2012, even as the economy continued to grow, the US' carbon emissions fell to their lowest level in two decades. In order to build on this progress, the Obama Administration is introducing tough new rules to cut carbon pollution.
- **Prepare the US for the Impacts of Climate Change**
  Besides taking new steps to reduce carbon pollution, the Plan also addresses preparations for facing the impacts of the changing climate, which are already being felt across the economy. Moving forward, the Obama Administration will help state and local governments to strengthen roads, bridges and shorelines, to better protect people's homes, businesses and way of life from severe weather.
- **Lead International Efforts to Combat Global Climate Change and Prepare for its Impacts**
  It is understood that no economy is immune from the impacts of climate change and no economy can meet this challenge alone. Hence, it is imperative for the US to couple action at home with international leadership. The US must help forge a truly global solution to this global challenge by galvanising international action to significantly reduce emissions (particularly among the major emitting countries), prepare for climate impacts and drive progress through international negotiations.

QUADRENNIAL ENERGY REVIEW

On 9 January 2014, President Obama issued a Presidential Memorandum directing his Administration to conduct a Quadrennial Energy Review (QER). The effort aims to establish a comprehensive and integrated energy strategy to ensure clean, affordable and secure energy and services that are essential in improving the US' economic productivity, protecting the environment and ensuring the economy's security (DOE, 2014b).

The first instalment of the QER examined ways to modernise the US' energy infrastructure to promote economic competitiveness, energy security and environmental responsibility. Its primary focus was energy transmission, storage and distribution, gas and oil pipelines, wires, waterways, railroads and other facilities. The QER identified vulnerabilities in the US' energy system and provided major policy recommendations and investments to replace, expand and modernise infrastructure, where appropriate. The second instalment is conducting a comprehensive review of the nation's electricity system, from generation to end use. It is including a more comprehensive look at electricity transmission, storage, and distribution infrastructure, and considering the roles and activities of all relevant actors, industries, and institutions integral to continuing to supply reliable, affordable electricity at a time of dramatic change in technology development (DOE, 2016).

THE 2015 UNITED NATIONS CLIMATE CHANGE CONFERENCE

The 2015 United Nations Climate Change Conference (COP21) took place in Paris in November–December 2015. In December 2015, the US signed the COP21 Agreement on Climate Change, which aims to 'keep a global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels'. However, the Agreement remains to be ratified. In addition, at COP21, the US along with 19 others, including the APEC Member Economies of Australia, Canada, Chile, China, Indonesia, Japan, Mexico and Korea, announced they would double investment in clean energy R&D over five years as part of a long-term response to shared climate challenges (MI, 2015).

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VIET NAM

INTRODUCTION

Viet Nam, in the centre of South-East Asia, is bordered by China to the north, Laos and Cambodia to the west, and the East Sea and Pacific Ocean to the east and south. Viet Nam has a land area of 330 967 square kilometres (km²) with diverse geography and an exclusive economic zone stretching 200 nautical miles from its 3 260-km coastline (excluding islands). As it is in a tropical monsoon zone and profoundly impacted by the East Sea, Viet Nam has warm weather, abundant solar radiation, high humidity and generous seasonal rainfall.

Viet Nam is a dynamic, emerging economy with a population of 89.8 million (32% live in cities and 68% in rural areas) (GSO, 2015) and a gross domestic product (GDP) of USD 450 billion (2010 USD at purchasing power parity [PPP]) in 2013 (World Bank, 2015a). Over the past 30 years, with its transformation from a centrally planned economy in 1986 to its current open, socialist-oriented market economy and active international integration (especially, after the removal of US economic embargos in 1994), Viet Nam's GDP grew continuously, at an annual rate of over 7% between 1990 and 2008, and 5.8% during the global financial crisis and recession period of 2008–15. Its economic structure has gradually changed through contributions from the industry and service sectors, expanding from representing 62% of the economy in the early 1990s to 80% in 2013. Major exports have diversified with more manufactured products, such as electronics, machinery and vehicles (28% of total exports in 2014) and textiles, garments and footwear (21%), in contrast to traditional fishery products, coffee and rice (nearly 10%) and crude oil (nearly 5%) (Viet Nam Customs, 2015). Population growth slowed to about 1% per year during 2009–14, below the Association of Southeast Asian Nations (ASEAN) average, contributing further to improvements in Viet Nam's per capita income. The economy reached the World Bank's lower-middle income classification in 2010 and is today among the most successful economies in realising the Millennium Development Goals (UNDP, 2015)

As of 2015, Viet Nam's business environment ranking has risen above the East Asia and Pacific average according to the World Bank's assessment (World Bank, 2015b). Comprehensive legislative and institutional reforms have accelerated since 2010 when the government engaged in a series of multilateral high-profile negotiations for free trade cooperation that extended beyond 2015, including the ASEAN Economic Community (AEC), the Viet Nam–Customs Union of Russia, Belarus and Kazakhstan free trade agreement (FTA), the EU-Viet Nam FTA, the Trans-Pacific Partnership (TPP) and the Regional Comprehensive Economic Partnership (RCEP). These reforms focus particularly on stabilising the macro-economy and implementing a free, competitive business environment based on market mechanisms, transparent, fair and effective governance and sustainable environmental development. The government has promoted 'Green growth' since 2012 for Viet Nam's new phase of industrialisation and modernisation.

Table 1: Key data and economic profile, 2013

Key data [a, b]		**Energy proven reserves** [c, d]	
Area (km²)	330 967	Oil (billion barrels)	4.4
Population (million)	89.8	Gas (billion cubic metres)	600
GDP (2010 USD billion PPP)	450	Coal (million tonnes)	150
GDP (2010 USD PPP per capita)	5 021	Uranium (kilotonnes U)	1

Sources: a. GSO (2015); b. EGEDA (2015); c. BP (2015); d. WEC (2010).

Viet Nam is endowed with diverse energy resources, such as oil, gas and coal, as well as renewables. Fossil energy potential is estimated to be moderate, although thorough resource assessments have yet to be carried out across the entire territory, especially in deep layers and deep-sea areas. As of the end of 2013, Viet Nam's proven fossil energy reserves were 4.4 billion barrels of oil, 600 billion cubic metres (bcm) of gas and 150 million tonnes (Mt) of coal (BP, 2015). Surveys and assessment for renewable energy's potential are still at preliminary stages, except for large hydropower. The economic and technical potential of large hydro is estimated at 95–100 terawatt-hours (TWh)/year or 25 gigawatts (GW). Technical potential of small hydropower (less than 30 megawatts [MW]) is about 7 GW (MOIT, 2015c). Other renewable sources under the government's consideration for deployment over the next 15 years include wind, solar, biomass and municipal solid wastes (MSW). Potential capacity for wind power developments is 6 GW, solar 12 GW

(PMVN, 2016), biomass 2 GW and municipal solid wastes (MSW) 320 MW (MOIT, 2015c). The energy sector is important in attracting significant foreign investment and boosting industry growth, export earnings and science and technology development.

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Viet Nam's total primary energy supply (TPES) in 2013 was 45 900 kilotonnes of oil equivalent (ktoe), which is a slight increase of 2.8% from the 2012 level and 78% higher compared to the 2005 level (EGEDA, 2015)[14]. By energy source, 38% of the supply came from coal, 34% from oil, 19% from natural gas and 10% from other sources.

COAL

Viet Nam's coal production and exports had average annual growth rates of 21% and 39%, respectively, during 2000–07, and then slowed down to –0.6% and –11.9% per year, respectively, during 2008–13, reflecting changes in government policy prioritising coal conservation for long term domestic uses rather than boosting exports for generating foreign currencies. In 2013, Viet Nam produced about 22 985 ktoe of anthracite and semi-anthracite coals, which is 3.2% less than what it produced in 2012. With increasing domestic demand for coal, coal exports have steadily declined to 7 169 ktoe in 2013, about 31% of the economy's production and roughly 40% of its export peak in 2007.

Viet Nam had about 49 billion tons as of 2010 in estimated potential coal resources (PMVN, 2012b). The sub-bituminous-rich coal basin of the Red River Delta (in the provinces of Thai Binh, Hung Yen and Nam Dinh) accounts for 81%. The anthracite-rich coal basin in the north-east (in the provinces of Quang Ninh, Bac Giang and Hai Duong) accounts for 18%. Additionally, the share of the other mines in the provinces of Hai Phong, Thai Nguyen, Lang Son, Nghe An and Quang Nam account for about 7%. Peat coal in the Mekong delta accounts for about 1%. Until now, Viet Nam's domestic coal has been produced and supplied mainly by opencast and underground mines in the Quang Ninh province. Vinacomin (Viet Nam National Coal and Mineral Industries Holding Corporation Ltd) is the dominant coal producer in Viet Nam with output accounting for about 95% of Viet Nam's total coal production. Exploration activities in the Red River Delta coal basin are still preliminary, and given its characteristics of complex geological conditions and a sensitive environmental and economic area, the exploitation of coal resources in this basin is predicted to take place only after 2020.

Coal imports are predicted to increase significantly beyond 2017 to meet fuel requirements for over 41 GW of new coal–fired power capacity that the government has planned to build during 2016–30 in central and southern parts of Viet Nam (PMVN, 2016).

OIL

Oil reserves are mainly offshore and in the southern part of Viet Nam. Active and successful offshore exploration has continuously increased the number of oil reserves in recent years. Crude oil production grew 1.8% from 17 518 ktoe in 2012 to 17 834 ktoe in 2013 (15% down from a peak of 20 940 ktoe in 2004), 49% of which was exported. As of the end of 2013, there were 23 oil-producing fields in Viet Nam (PVN, 2014). According to the Viet Nam Oil and Gas Group (Petrovietnam or PVN) forecast and planning, oil production based on current proven reserves will be about 16–18 Mt/year through 2022 and then it will decline since major fields in the Cuu Long basin matured.

Viet Nam is a net crude oil exporter but a net importer of petroleum products. There were 9 178 ktoe of imported petroleum products in 2013 and they continue to account for the majority (59%) of Viet Nam's total primary oil supply. Petroleum product imports have shown a downward trend since 2009 as the first refinery in Viet Nam, the 140 000 billion barrels per day Dung Quat refinery, began operation during that period. According to the government's existing master plan for refinery development through 2025, five new refinery construction projects (the Dung Quat expansion, Nghi Son, Vung Ro, Long Son and Nhon Hoi) will be added. This expansion expects to increase Viet Nam's refining capacity to 25 Mt by 2020 and 45–58 Mt by 2025.

[14]EGEDA excludes non-commercial energy sources such as traditional biomass, wood waste, etc.

NATURAL GAS

Viet Nam is self-sufficient in terms of natural gas supply. There are three offshore gas pipeline systems built to deliver gas from Viet Nam's oil and gas fields in the petroleum basins of Cuu Long, Nam Con Son and Malay-Tho Chu to shores in the south-east and south-west regions of Viet Nam. They are:

- Rang Dong-Bach Ho with 1.5 bcm per year capacity and in operation since 1995;
- Nam Con Son with 7 bcm per year capacity and operating since 2003; and
- PM3-Ca Mau with 2 bcm per year capacity and operating since 2007.

In 2013, 13 oil and gas fields produced an annual natural gas supply of 9.8 bcm, a 4.2% increase over the 2012 level (PVN, 2014). Growth in the electricity, fertiliser and petrochemical industries have driven demand for natural gas. Under the government's orientation, PVN and PVGas are preparing for the development of two major gas projects in order to have additional gas supplies of about 7–10 bcm per year from Block B, Ca Voi Xanh field and adjacent sources to southern and central markets beyond 2020 (PMVN, 2016, PVN, 2014). Viet Nam also has plans to develop new infrastructure for importing LNG, first in the south, to diversify gas supply sources and ensure national energy supply security for the period beyond 2015 (PMVN, 2014; MOIT, 2015a).

POWER GENERATION

In 2013, with a total installed power capacity of nearly 31.7 GW (VNEEP, 2015a), Viet Nam produced 127 329 gigawatt-hours (GWh) (or 10 950 ktoe), increasing 8.3% from its 2012 level, and equal to almost five times its output in 2000. Of this total electricity output, about 41% came from hydropower plants and 59% from thermal power plants (EGEDA, 2015). During 2008–13, according to Viet Nam's energy statistics, the installed hydropower capacity doubled from 6 GW to 15 GW, reflecting average annual growth of 17%, higher than for the overall thermal power plants, which was 13% per annum. As a result, hydropower's share of Viet Nam's total installed capacity increased significantly from 38% in 2008 to 48% in 2013. Among thermal power sources, gas-fired power plant contribution remained the largest in terms of capacity in absolute value (stable at 7.7 GW since 2009); however, coal-fired power plants recorded the fastest growth in development, averaging 24% per year from 2008–13. With an installed capacity of 7 GW, coal power's share increased considerably to 23% in 2013 from 4% in 2008. Growing deployment of hydropower and coal power led to relative reductions in the roles of gas and oil power plants in Viet Nam's electricity system. Gas power plants experienced a sharp decline in share, from a record level of 41% in 2008 down to 25% in 2013. The share of oil power plants decreased slightly, from 6% to 4% in the same period.

In order to optimise the electricity supply and cost-effectiveness in all regions in the economy, since 2004, Viet Nam has also relied on power sources from biomass and electricity imports from neighbouring economies and countries such as China and Laos. However, these sources were still very marginal in its economy's power system during 2008–13.

Table 2: Energy supply and consumption, 2013

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	53 810	Industry sector	16 208	Total power generation	127 329
Net imports and others	–6 535	Transport sector	10 527	Thermal	75 131
Total primary energy supply	45 900	Other sectors	8 294	Hydro	51 955
Coal	17 239	Non-energy	1 946	Nuclear	–
Oil	15 470	Total final energy consumption	36 975	Others	243
Gas	8 522	Coal	10 559		
Other	4 668	Oil	14 969		
		Gas	1 460		
		Electricity and others	9 988		

Note: Industrial energy consumption includes petroleum products and natural gas used as feedstock
Source: EGEDA (2015)

FINAL ENERGY CONSUMPTION

In 2013, Viet Nam's total commercial final energy consumption (TFEC) was 36 975 ktoe, up 5% from 2012. By fuel source, oil contributed the largest share (41%), followed by coal (29%), electricity and others (27%) and gas (3.9%). Between 2008 and 2013, consumption of coal and oil continued to be constrained; this represented, on average, 5% and 1.6% per year, respectively; by contrast, gas and electricity grew rapidly, with average annual growth of 22% and 11%, respectively.

Industry[15] is an important sector in GDP growth and has represented the largest segment of TFEC at nearly 44%. This sector consumed mainly coal at 49%, electricity at 29%, petroleum products at 13% and natural gas at 8%. The transport sector was the second largest energy-consuming sector, accounting for 29% of TFEC and remained the main consumer of petroleum products at 70% of the economy's total requirement. The other sector's (residential, agricultural and commercial) consumption represented 22% of TFEC. In this sector, electricity accounted for 57%, oil 24% and coal 19%. Demand for electricity grew rapidly in the residential sector, reflecting improvements in household income and creating an increase in electric appliance use and power supply quality.

ENERGY INTENSITY ANALYSIS

In 2013, Viet Nam's energy intensity (primary energy consumption/GDP) was 102 tonnes of oil equivalent per USD million GDP (toe/million USD), which is a decrease of 2.5% from 104 toe/million USD in 2012, yet still 11% higher than 2005 levels. There were however only slight improvements in energy efficiency from end-use sectors. The transport sector recorded the fastest decline in energy intensity, at –6.7% in 2013 from its level of 25 toe/million USD in 2012. The industry sector (including fuels used as feedstock) increased its energy intensity 0.3% compared to the previous year and remained the sector with the highest level of energy intensity. Other sectors had the lowest energy intensity at 18.4 toe/million USD in 2013, which is an increase of 2.1% from 2012 levels.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2012	2013	2013 vs 2012
Total primary energy supply	104	102	–2.5
Total final energy consumption	82.4	82.1	–0.4
Industry	35.9	36.0	0.3
Transportation	25	23	–6.7
Other sectors	18.0	18.4	2.1
Non-energy	3.5	4.3	25

Note: Industry includes petroleum products and natural gas used as feedstock
Source: EGEDA (2015)

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In 2007, Viet Nam issued the National Energy Development Strategy to 2020, with a vision to 2050 (PMVN, 2007a), which addresses the Vietnamese government's energy development key objectives, major policies and measures to be realised up to 2020 in energy industries. Meanwhile, detailed development strategy and master plans by energy subsectors include the following:

- Viet Nam Oil and Gas Development Strategy to 2015, with a perspective to 2025 (PMVN, 2006b);

[15] In the EGEDA statistics, Viet Nam's industrial energy demand includes petroleum products and natural gas used as feedstock as well.

- Viet Nam Gas Development Master Plan to 2015, with a perspective to 2025, also known in brief as the GMP2011 (PMVN, 2011b);
- Viet Nam Power Development Master Plan for the period 2010–20, with a perspective to 2030, also known as PDP7 (PMVN, 2011c and PMVN, 2016 for the revised version);
- Viet Nam Coal Development Master Plan to 2020, with a perspective to 2030 (PMVN, 2012b).
- Viet Nam Renewable Energy Development Strategy to 2030, with a vision to 2050 (PMVN, 2015b)

Below is the summary of some of the main targets for energy development in Viet Nam over the next 10–15 years:

- Ensuring a sufficient and high quality supply of energy to meet the demands of socio-economic development, in which primary energy is expected to reach 100–110 million tonnes of oil equivalent (Mtoe) in 2020 and 310–320 Mtoe in 2050;
- Ensuring the phased development of refineries to meet domestic demand for petroleum products and increasing the capacity of refineries to about 25–30 Mt of crude oil in 2020;
- Ensuring strategic oil stockpiling adequate for 60 days in 2020 and 90 days in 2025;
- Achieving a share of renewable energy (including large hydropower) in the total primary energy supply of 31% in 2020, 32% in 2030 and 44% in 2050; Renewable power development (including large hydro and pumped-storage hydropower) of about 24 GW in 2020 and 49 GW in 2030.
- Completing the rural electrification program for rural, mountainous and remote island areas increasing the proportion of rural households with access to electricity to 100% in 2020;
- Changing the electricity, coal and oil and gas sectors to operate in competitive markets with state regulation; establishing a functioning competitive retail market by 2015 for coal and petroleum products and for electricity after 2022; and
- Carefully reviewing safety issues and actively preparing conditions for the first unit of a nuclear power plant operation in 2028; then gradually expanding the role of nuclear power in the economy's energy structure.

The Ministry of Industry and Trade (MOIT) oversees all energy industries. Formed in 2007 out of the merger of the Ministry of Industry and the Ministry of Trade, it operates currently in accordance with functions, tasks and powers as defined in the government's Decree 36/2012/ND-CP dated 18 April 2012 and the government's Decree 95/2012/ND-CP dated 12 November 2012. It drafts laws, policies, development strategies, master plans, economy-wide target programs, technical-economic programs and important projects for all energy sectors. It submits these to the government and the Prime Minister for issue or approval. The Ministry administers the implementation of these laws, policies and plans. It takes on responsibility for issuing technical regulations and standards, eco-technical norms and guidelines on the implementation of approved law and policies. The Ministry carries out the state management of public services, state-owned enterprises in energy sectors and is in charge of communicating the government's policies as well as reporting on sector development results.

Within the MOIT, the General Directorate of Energy (GDE) and the Energy Regulatory Authority of Vietnam (ERAV) are two key advisory and executive units assisting the MOIT's Minister with the management of the energy sectors.

On 25 October 2011, the Prime Minister of Viet Nam's (PMVN) Decision 50/2011/QD-TTg established the GDE and it commenced operation (PMVN, 2011a). It focuses on formulating law, policy and planning, and generally managing all energy sectors.

The PMVN's Decision 258/QD-TTg, signed on 19 October 2005 (in accordance with Provision 66 of Electricity Law 2004), and the PMVN's Decision 153/2008/QD-TTg, dated 28 November 2008, established the ERAV. The ERAV specialises in regulatory activities in the electricity sector in order to ensure a safe and high-quality supply of electricity for the economy. It also fosters the economical and efficient consumption of electricity and upholds the equity and transparency in the sector in compliance with the law. ERAV's concrete tasks include:

- Implementing regulatory activities relating to the electricity market and tariffs (including approving the Termed Bilateral Purchase Power Agreements (PPA));
- Reviewing provincial/city power development master plans and power development projects;
- Monitoring and making the mid- and long-term forecasts for the electricity supply-demand balance;
- Granting permits for power businesses; and
- Overseeing the inspections of electricity activities.

PVN, the Viet Nam National Petroleum Group (Petrolimex), Viet Nam Electricity (EVN) and Vinacomin are the leading state-owned enterprises (SOEs) in the energy industries in Viet Nam. They actively contribute to formulating and implementing development strategies, master plans and annual plans issued by the government in energy sectors. In particular, PVN still participates in some regulatory activities relating to oil and gas exploration and exploitation and gas distribution; EVN owns and is directly involved in many key operations (such as dispatch direction, monitoring and measurement for the national power system) of the Viet Nam electricity competitive market. The government has gradually restructured the SOEs to operate on a commercial basis and with transparency in terms of their business performance and financial information (GOV, 2013)

ENERGY SECURITY

The government of Viet Nam's energy security priorities include:

- Synchronously developing various energy sources;
- Exploiting and using domestic energy sources in an economical and efficient manner;
- Reducing dependence on imported petroleum products,
- Exporting a rational quantity of coal (in the immediate future, reducing annual coal exports);
- Connecting to regional energy systems;
- Expanding stockpiles of petroleum products; and
- Combining energy security with the economy's general defence and security assurance.

To lessen dependency on oil imports and to ensure energy security, the government has implemented the following detailed policies and measures:

- Strengthen domestic energy supply capacity through legislative reforms (specifically in terms of price, fiscal systems, equity among enterprises forms and information transparency) and the expansion of infrastructure;
- Apply preferential policies for financing and expanding international cooperation to strengthen the exploration and development of indigenous resources, thereby increasing reserves and the exploitability of oil, gas, coal and new and renewable energy;
- Improve energy efficiency, reduce energy losses and implement extensive measures for the conservation of energy;
- Encourage Viet Nam's oil companies to invest in exploration and the development of oil and gas resources overseas;
- Intensify regional and international energy cooperation and diversify energy import sources; and
- Develop clean energy, especially new and renewable energy.

ENERGY MARKETS

ELECTRICITY MARKET

Viet Nam's electricity market is characterized by the active participation of several SOEs and various private players who are involved in power generation and distribution on a BOT (Build-Operate-Transfer) and IPP (Independent Power Producer) basis. As the leading SOE in the Viet Nam's power sector, EVN is entrusted to manage the development and operation of the national power transmission system. In 2014, the electricity generation structure by ownership was as follows (EVN, 2015):

- EVN's power plants accounted for 60.2% of the total 34 GW installed capacity;
- PVN's power plants accounted for 13%;
- Vinacomin's power plants accounted for 4.4%; and
- Various other local investors' power plants accounted for 14%.
- Foreign investors' power plants accounted for 8.4%;

Since 2004, the government of Viet Nam has established a vision for a competitive power market as part of a long-term development strategy for the electricity sector. The implementation of the competitive market is deemed a means to create a new dynamic in Viet Nam's power sector. It aims to reinforce the effectiveness of production and business activities within the electricity sector, facilitate a decrease in electricity selling prices and enhance the transparency and efficiency of power generation and distribution activities to ensure the robust development of the electricity sector over time.

The Electricity Law of December 2004 (effective 1 July 2005 and amended on 20 November 2012) outlines the major principles for establishing the power market in Viet Nam. The scheme and conditions for the power market are detailed in the PMVN's Decision 26/2006/QD-TTg dated 26 January 2006 (hereafter Road Map) and revised by PMVN's Decision 63/2013/QD-TTg dated 8 November 2013. According to the Road Map, Viet Nam's competitive power market has three phases of development:

- Phase 1 (up to 2014): Competitive Generation Power Market;
- Phase 2 (2015–21): Competitive Wholesale Power Market (the first two years are pilot); and
- Phase 3 (2021 forward): Competitive Retail Power Market (with a pilot period from 2021–23).

Each phase contains two steps: pilot and full operation. Additional regulations and guidelines are enacted to complement the Road Map. These cover licensing and technical concerns, market rules, tariffs and contract regulation.

On 1 July 2011, Viet Nam's competitive generation power market (VCGM) launched its pilot operation and commenced full operation on 1 July 2012. By the end of 2014 Q3, there were 55 power plants with a total capacity of 12.8 GW directly participating in selling electricity in the spot market. Those 55 power plants constitute 40% of total capacity of the power system. There were about 52 power plants with a total capacity of over 18 GW or 60% of the total capacity of the power system yet to participate.

The first actual pilot year of the competitive wholesale power market started January 2016, according to MOIT's conceptual and detailed design of the Viet Nam Wholesale Electricity Market (VWEM) issued during 2014–15 (MOIT, 2014a and 2015b). This year the market will process the simulation of wholesale transactions in paper only (or by notes), yet still with real payments. ERAV assessed the total number of power plants and installed capacity that are directly involved in the VCGM in 2016; this could increase to 79 power plants and 21 GW, of which 63 power plants with an installed capacity of 14.9 GW have their firm plans in place (ERAV's Decision No 79/QD-DTDL dated on 20 November 2015). This estimation excluded power plants that were eligible not to participate in VWEM including:

- multi-purpose strategic hydropower plants;
- small-hydro plants with capacity 30 MW or lower with inappropriate infrastructure;
- other renewable power plants of all-sizes;
- BOT power plants having PPA or HOA concluded before January 2016;
- IPPs built in industrial zones and not to supply their total production to the national power network; and
- gas-fired power plants using PM3-CAA gas source.

This category accounts for about 31–42 power plants, equivalent to an installed capacity of 16.3–20 GW in 2016.

The MOIT's Circular 30/2014/TT-BCT, dated 2 October 2014, requires certain payment settlement principles of power generating companies involved in the competitive market. Contract coverage not higher

than 95% applies in the first year of the electricity market, which gradually decreases in the following years to no lower than 60%. For example:

- From 1 July 2012 to 31 Dec 2012, contract coverage applied to both hydro power plants and thermal power plants was 95%;
- From 1 January 2013 to 31 March 2013, contract coverage applied to both hydro power plants and thermal power plants was 90%; and
- From 1 April 2013 to current day, the contract coverage applied with a reservoir more than two days is 80% and for hydropower plants with a reservoir less than two days as well as thermal power plants is 90%.

As part of the electricity sector reform, EVN has been creating corporate subsidiaries from its member enterprises since the early 2000s. Thus far, the following generation and distribution companies have been restructured:

- In 2008, four power transmission companies were merged into one company, the National Power Transmission Corporation, which is a separate entity under the management of EVN (or an independent cost-accounting subsidiary of EVN);
- In 2010, five power corporations were established after merging 11 power companies who are eligible customers in VWEM; and
- In 2012, EVN established three generation companies (GENCOs) including GENCO 1, 2 and 3.

In addition, the Electricity Power Trading Company (EPTC), which is the 'single buyer' in VCGM and the buyer of power plants not yet participating directly in VWEM, the National Load Dispatch Centre (NLDC), which manages the spot market's transactions, and the Information and Communications Technology Center (EVNICT, responsible for electric measurement and market monitoring) still operate as branches of EVN. Strategic power plants, including large hydropower plants, namely Hoa Binh, Tri An, Yaly and Son La and nuclear power plants (in the future) also remain under the management of EVN and operate as EVN's dependent-accounting units.

TARIFFS

Electricity prices are in accordance with the market and under the regulation of the government (Provision 29 of Electricity Law 2004 and amendments in 2012). The baseline of the average retail electricity tariff in Viet Nam is calculated annually by the MOIT and is based on:

- the audited costs;
- the generation, transmission and distribution sectors investors' reasonable profits; and
- the costs of regulating, managing and supporting services in the electricity system.

The baseline is the threshold for the electricity retail tariff adjustments. Adjustments occur following changes in fundamental costs such as fuel costs, exchange rates and generated capacity. Any changes that occur within the tariff scope are approved by the Prime Minister.

For the period between 2013–15, following the PMVN's Decision No 2165/QD-TTg dated 11 November 2013, the average retail tariffs were allowed to fluctuate in the range from VND 1 437 per kilowatt-hours (kWh) (USD 6.8 cents) to VND 1 835/kWh (USD 8.7 cents). According to the PMVN Decision No. 69/2013/QD-TTg dated 19 November 2013 (effective 1 January 2014), EVN is allowed to increase retail tariffs only when:

- the fundamental costs change from 7% to under 10%;
- the Electricity Price Stabilisation Fund has been used; and
- the MOIT, through consultation with the Ministry of Finance (MOF), provides an endorsement.

Any tariff increase outside of the approved tariff scope and in cases of cost fluctuation of 10% or more require a decision by the Prime Minister. The government's policy aims for tariff adjustments that are transparent and publically announced. The minimum timeframe between two consecutive electricity tariff adjustments is six months. The government can deploy the Electricity Price Stabilisation Fund and other

measures stipulated in legislations when it is necessary to stabilise the electricity tariff in order to minimise negative impacts on the stability of the macro-economy and the welfare of the population.

CRUDE OIL MARKET

Players in the upstream oil sector in Viet Nam include PVN, various international oil companies and other foreign enterprises. According to the Petroleum Law 1993 and amendments in 2000 and 2008, the government reserves the right to be a priority buyer of oil production from contractors and in such a case, foreign contractors have the right to sell their profit oil at international prices.

There is only one refinery in Dung Quat, Quang Ngai province, with a capacity of 6.5 Mt per year. Operated by the Binh Son Refinery Company (BSR) starting in 2009, it is a 100%-owned PVN subsidiary. BSR has bought crude oil mainly via the Petrovietnam Oil Corporation (PVOil), a subsidiary of PVN.

PETROLEUM ENGINE FUEL MARKET

Petroleum engine fuels (PEF) include gasoline, diesel, jet A1, fuel oil, kerosene, biofuels and other engine fuels, excluding LPG and CNG (GOV, 2014).

The government, represented by the MOIT, the Ministry of Planning and Investment (MPI) and the Ministry of Finance (MOF), controls the PEF market. The MOIT regulates all enterprises participating in the market, especially refineries, importer-wholesale enterprises and the development of petroleum trading infrastructures (import terminal, strategic stockpiles, commercial stockpiles and oil products pipelines) in order to ensure the supply of PEF for the economy. Annually, the MOIT selects qualified enterprises to implement PEF imports, allocates the import quota[16] to these enterprises based on the MPI's forecast of total PEF demand for the economy and approves their importing and production plans. The MOIT manages the development of refineries and oil-trading infrastructure according to the master plans approved by the Prime Minister. The MOF manages all fiscal and economic issues including tax rates, retail prices and the Petroleum Price Stabilisation Fund.

As of June 2013, there were 17 wholesale enterprises in the domestic PEF market, of which Petrolimex was the leading SOE with a market share of 48%, PVOil had 17% (PVOil also distributes BSR's output products) and the remaining 35% was from 15 other companies. Fourteen of the 17 wholesale enterprises were authorised by the MOIT to import products in 2013. The list of importers can change every year depending on each enterprise's business performance and whether or not it achieved the import quota of the previous year. In general, three SOEs, namely, Petrolimex, PVOil and Saigon Petro, hold the largest quotas, and together they make up nearly 80% of the total annual imports. Key enterprises, including refineries and importer-wholesale enterprises, are responsible for ensuring the petroleum engine fuel supply for the whole economy, both in terms of quantity and range of products. Foreign investors are yet to participate in the PEF trading in the domestic Viet Nam market.

In terms of the retail market, Viet Nam has more than 12 000 petrol stations as of 2013. SOEs financed 30% of these stations and private investors financed 70%. The government is planning to increase the number of fuelling stations to 18 000 by 2020.

In September 2014, the government issued a new decree on the PEF business, which came into effect on 1 November 2014 (GOV, 2014). It detailed the business operating conditions required for importer-wholesale enterprises and other enterprises that participate in the PEF trade and distribution in Viet Nam's domestic market and their rights and duties. A notable requirement established for importer-wholesale enterprises and refineries was that they must ensure that they had a 30-day minimum stockpile equivalent available according to their level of supply and product structure. Their average daily sales in the domestic market during the previous year determines the stockpile level. This includes stockpiles for both the economy's energy security and commercial needs.

Since 2009, the government has regulated retail PEF prices based on the approval of a baseline selling price for importer-wholesale enterprises. The base price is composed of a number of price elements including: CIF (cost, insurance, freight) price of importers; government taxes and levies (import tax, excise tax, VAT, environment tax); business expenses norm; deductions for the Petroleum Price Stabilisation Fund; and profit norm.

[16] The PEF import quota is the minimum annual amount of petroleum products that an authorised enterprise can import.

The MOF regulates the calculation of each price element in the base price. Importing and wholesale enterprises can define their wholesale prices and adjust their retail prices based on the fluctuations of their actual costs compared to their approved base price. In raising prices, importer-wholesale enterprises are allowed to make adjustments equivalent to changes in their costs up to 7%, after having informed (in cases less than 3%) or received guidelines from the MOIT and MOF (in cases 3% to 7%). The Prime Minister decides on the adjustments when the increase is more than 7%. The interval between two consecutive price adjustments is set at a minimum of 15 days in the case of increasing prices and a maximum of 15 days in the case of decreasing prices.

NATURAL GAS MARKET

The government reserves the right to be the first priority buyer of all natural gas exploited and produced in Viet Nam. PVN and PVGas are the authorised buyers of natural gas from oil and gas contractors and the sellers to consumers in the Vietnamese market. According to the price law, gas prices are not subject to government regulation. All upstream sellers and downstream buyers are free to negotiate the price and other terms in the Gas Purchase and Supply Agreement (GPSA) with PVN and PVGas. The gas prices and levels are set considering the competitive position of gas against alternative fuels. This ensures a reasonable profit margin for investors in related upstream and midstream gas projects. PVN submits the GPSA, including a price formula and level, to authorised organisations and the Prime Minister for approval before the GPSA goes into effect. PVGas is responsible for planning, developing and operating gas infrastructure projects to ensure a safe and reliable natural gas supply and support gas exploration and production in Viet Nam.

COAL MARKET

Vinacomin's production and sales account for 95% of the total coal market in Viet Nam. Recently, the North-East Coal Corporation separated from Vinacomin to become an independent company and operate under the oversight of the Ministry of Defence. In addition, PVN established PV Power Coal, which is in charge of coal imports, trading and ensuring coal supply for their five new coal power plants, namely, VungAng 1, Thai Binh 2, Long Phu 1, Song Hau 1 and Quang Trach 1. The forecast for total coal demand for these power plants is about 16 Mt in 2020 and 20 Mt in 2030. As a percentage of the total coal demand for power generation, PVN's share will represent about 24% as of 2019–20 and drop to 10% by 2030.

Since July 2009, Vinacomin has set the price for local customers, except power generators, at the market price. Recently, the government has been preparing a strategy to deregulate the price of coal used for power generation. As a first step, in 2012, the government allowed the coal price for power production to rise according to the latest electricity price adjustment. Any adjustments would be no less than the coal production cost in order to ensure funding for the renovation, expansion and improvement of the capacity of the existing mines and building of new mines to meet coal demand and contribute to improvements in energy efficiency.

ENERGY EFFICIENCY

In April 2006, the Prime Minister approved the Viet Nam National Energy Efficiency Program (VNEEP) for 2006–15 (PMVN, 2006c). The program's overall objectives cover:

- community stimulation, motivation and advocacy;
- science and technology; and
- mandatory management measures for carrying out coordinated activities related to the economical and efficient use of energy in society as a whole.

The aim of the program was to save 3% to 5% of the total energy consumption over the 2006–10 period and 5% to 8% in the 2011–15 period (PMVN, 2012c).

The program includes six components:

- strengthen state management of energy efficiency and conservation by developing a management system for energy saving;
- strengthen education, disseminate information and enhance public awareness to promote energy efficiency and conservation (EE&C) as well as environmental protection;
- develop and popularise highly energy-efficient equipment by phasing out low-efficiency equipment;
- promote EE&C in industry;

- promote EE&C in building; and
- promote EE&C in transportation.

The MOIT is the focal coordinator of EE&C and is authorised to administer the implementation of the VNEEP. As part of this, the government established the Energy Efficiency and Conservation Office within the MOIT on 7 April 2006 (MOIT, 2006). The main work of the office is to develop organisations and systems for improving EE&C at the government level, from the central government to local government. According to the MOIT's report at the 7th National Conference on Energy Savings held in Tien Giang Province on 17 October 2014, a network of 14 energy conservation centres and more than 40 industrial promotion centres, counselling centres and technology transfer centres have been established across the economy.

The MOIT established a National Steering Committee chaired by the MOIT to monitor the VNEEP. The committee includes representatives from the Union of Vietnam Associations of Science and Technology and the ministries of construction; transport; education and training; culture and information (renamed the Ministry of Culture, Sports and Tourism in August 2007); science and technology; planning and investment; justice; and finance.

In order to realise targets in energy efficiency programs, the government encourages major energy-using establishments to improve their energy planning, management and auditing. Major energy-using establishments are those with the consumption of energy as follows:

- Industrial, agricultural production and transportation enterprises with a total yearly energy consumption of at least 1 000 toe; and
- Buildings used as headquarters, offices, accommodations, institutions of education, healthcare, recreation, fitness and sports, hotels, supermarkets, restaurants and stores with a total yearly energy consumption of at least 500 toe.

The MOIT, in coordination with other ministries, related sectors and localities, organises and manages the operation of these establishments. In addition, it coordinates with related ministries, the Departments and People's Committees of Central Provinces and Cities, to set up a list of these energy-intensive consumers and annually update and submit that list to the Prime Minister for approval. According to the list issued by the Prime Minister in 2013, there were 1 720 major energy-using enterprises in the economy. Cities and provinces with large numbers of such establishments are Ho Chi Minh City (241); Binh Duong (178); Hanoi (176); Dong Nai (106); QuangNinh (98); Ba Ria-Vung Tau (89) and An Giang (6). The four provinces without any major energy-using establishments are BacKan, NinhThuan, DakNong and Bac Lieu.

Phase one of the VNEEP for the period 2006–11 was successfully implemented, saving about 4 900 ktoe in total energy consumption in the period 2006–10, equivalent to 3.4% of total energy consumption. Key legal documents on EE&C were created and issued including the Law No 50/2010/QH12 dated 17 July 2010 on Energy Savings and Efficiency (effective 1 January 2011) and its regulations and guidelines by sector. By the end of 2014, the regulation and guidelines of concrete measures for enhancing energy savings and efficiency covered transport (2011), agricultural (2013) and industrial sectors (2014). In 2013, the National Technical Regulation on Energy Efficiency Buildings was revised in line with updated international trends of minimum standards for energy-efficient building exteriors and interior equipment. These standards applied as of November 2013 to all new or renovated offices, hotels, hospitals, schools, department stores and residences of 2 500 square metres (m^2) or more (MOC, 2013). In addition, Minimum Energy Performance Standards (MEPSs) were instituted from 1 January 2014 for basic household electric appliances (including tube and compact fluorescent lights, electrical and electronic ballasts for fluorescent lights, air conditioners, refrigerators, washing machines, rice cookers, fans and televisions), and as of 1 January 2015 for printers, photocopiers, computer monitors, storage water heaters, commercial refrigerators and freezers (PMVN, 2011e). The government has also issued clear regulations on vehicle life based on vehicle type, fuel quality standards and MEPSs for motorcycles and cars. Drafting guidelines on applications of economical and efficient use of energy for public means of transportation (buses) in big cities is ongoing.

Phase two's results for the period 2011–15 were discussed at a series of conferences on the five-year implementation of the National Target Program on Energy Efficiency–period 2011–15, held in 2015 Q4 by the MOIT in cooperation with Vietnam Association of Science and Technology in Energy Saving and Efficiency (VNEEP, 2015b). MOIT reported the level of energy savings at 5.96% of Viet Nam's total energy consumption during 2011–15. MOIT's report also showed progresses in application of MEPS and other measures for energy efficiency improvement. There were 29 sets of MEPS and testing methods applied for

energy labelled products issued in accordance with the energy labelling roadmap; 77 factories applied the plans for energy efficiency improvement to their operations, of which 15 businesses were qualified to obtain the certificate of the Energy Management System ISO 50001. The energy audit was implemented for 1 140 businesses in 2015; the average energy-savings was 14.6%. Awareness in society about energy savings has increased; more and more households and enterprises have proactively used energy-efficient equipment and applied saving measures. Viet Nam's annual electricity savings was between 1.4–2.5% of total power sales or 1.3–2.8 TWh per year during 2011–14 (EVN, 2015).

RENEWABLE ENERGY

In November 2015, the government issued for the first time the national strategy of renewable energy for the period through 2030, with a vision to 2050 (PMVN, 2015b). Renewable energy development in Viet Nam continues to integrate with the implementation of broader objectives of general socio-economic development, industrial and sectoral deployment. In particular, it contributes to modernisation and new rural development, fuel diversification and implementation of Viet Nam's pledge to mitigate GHG emissions increase.

The ambitious targets set include: commercial renewable energy to reach 37 Mtoe (31% of TPES) by 2020 and 62 Mtoe (over 32%) by 2030; renewable power (including large hydropower) to account for 38% of total generation by 2020 and 32% by 2030; biofuels to increase to about 5% of total transport fuel demand in 2020 (about 800 ktoe) and 13% (3.7 Mtoe) in 2030. The government expects that accelerated renewable energy growth will contribute to a mitigation of GHG emissions in energy activities of around 5% by 2020 and 25% by 2030, compared to the BAU (business as usual) plan, as well as a reduction of fossil fuel imports for energy purposes of about 40 million tons of coal (compared to the case established in the PDP7 in 2011) and 3.7 million tons of oil products by 2030. In March 2016, the Prime Minister approved the revised PDP7 to update and detail these new targets and policy measures for renewable power developments in Viet Nam to 2030.

Renewable energy (RE) remains a field with government investment incentives. Support mechanisms and policies for renewable energy development include:

- Prioritising investment and use of renewable energy in the development of the energy industry with a focus on building Viet Nam's renewable energy market;
- Supporting all organisations and individuals with a variety of ownership structures to participate in the development and use of renewable energy;
- Appling various fiscal incentives within import tax, corporate income tax and land taxes and fees, as well as credit incentives as specified in legislation, applicable to special preferential projects and preferential investment projects;
- Approved electricity prices (avoided-cost tariffs, Feed-in Tariff) for on-grid renewable energy consistent with the different locations and features of potential renewable energy projects to provide appropriate returns to investors;
- Standardized Power Purchase and Sale Contracts (20 years) for each renewable power type and an obligation for EVN/its regional electricity utilities to prioritise renewable energy in grid connection and dispatch and purchase electricity at approved tariffs;
- A Renewable Portfolio Standard (RPS) obligation for major electricity generators and traders;

RPS obligation	2020	2030	2050
Electricity generation companies greater than 1,000 MW (excluding BOT projects)	RE not lower than 3%	RE not lower than 10%	RE not less than 20%
Electricity distribution companies	RE not lower than 5%	RE not lower than 10%	RE not less than 20%

Notes: RE = renewable power sources excluding large hydropower plants (>30 MW)

- Project specific arrangements for off-grid electricity systems;
- Net-metering for electricity consumers with simplified connection arrangements;
- Environmental fees for organisations utilising fossil fuels for energy production.

The specific regulation system for renewable energy is as follows:

SMALL HYDRO POWER

The MOIT's Circular No. 32/2014/TT-BCT dated 9 October 2014 on regulation on avoided-cost tariff and power purchase agreement for small hydropower plants (MOIT, 2014b) replaces the previous MOIT's Decision No. 18/2008/QD-BCT dated 18 July 2008 on 'Regulation on avoided-cost tariff schedule and standard power purchase agreement'.

The MOIT approves and issues annually avoided-cost tariffs for small hydropower. Tariff levels are detailed by regions and vary by season and daily dispatch periods.

WIND POWER

Enacted regulations include the PMVN's Decision No. 37/2011/QD-TTg dated 29 June 2011 on 'Mechanism for supporting wind power development' (PMVN, 2011d), the MOF's circular No. 96/2012/TT-BTC dated 8 June 2012 on 'Financial mechanisms for grid-connecting wind power projects', and the MOIT's circular No. 32/2012/TT-BCT dated 12 November 2012 on 'Regulation on implementation of wind power project development, power purchase and sale contract form for wind power projects'.

Current level of the Feed-in Tariff (FiT) for wind power is equal to 7.8 US cents/kWh. The government subsidises the power price for EVN by 0.01 USD/kWh through the Viet Nam Environment Protection Fund. The FiT level for wind power is under review by the MOIT for revision.

BIOMASS POWER

Enacted regulations include the Prime Minister's Decision No. 24/2014/QD-TTg, dated 24 March 2014 on 'Support mechanism for development of biomass power projects in Viet Nam', the MOIT's Circular No. 44/2015/TT-BCT dated 9 December 2015 on 'Regulation on project development, avoided-cost tariff, and power purchase and sale contract form for biomass power projects'.

FiT for a biomass cogeneration (or CHP—combined heat and power) project is set equal to 0.058 USD/kWh. Avoided-cost tariffs apply for other biomass power projects; MOIT annually approves and issues these tariffs. Calculations are based on the generation cost of thermal coal power plants that use imported coal. The MOIT's Decision No. 942 dated 11 March 2016 promulgates the avoided-cost tariffs (excluding VAT) in 2016 for biomass power projects at 7.3–7.5 US cents/kWh.

SOLID-WASTE POWER

The Prime Minister's Decision No. 31/2014/QD-TTg, dated 5 May 2014, on 'Support mechanism for development of solid waste power projects in Viet Nam' indicates FiT levels applied for landfill gas and MSW direct combustion power projects equal to 7.28 and 10.05 US cents/kWh respectively.

SOLAR POWER

MOIT is drafting specific regulations for solar power projects in Viet Nam. It plans to submit these to the Prime Minister for approval by June 2016. MOIT has proposed FiT levels ranging at 11.2–14 US cents/kWh as a support mechanism for solar PV farm and solar PV rooftop projects (MOIT, 2016a).

BIOFUELS

Biofuels are encouraged in Viet Nam as an alternative to partially replace conventional fossil fuels, contributing to assuring energy security and environmental protection. In 2007, the government of Viet Nam announced a biofuel development scheme for the period up to 2015, with a vision to 2025, stipulating a target for building and developing biofuel production and its use nationwide (PMVN, 2007b). By 2015, the output of ethanol and vegetable oil is expected to reach 250 000 tons (enough for blending 5 million tons of E5 and B5), satisfying 1% of the whole economy's gasoline and oil demand. Moving to 2025, Viet Nam aims to build an advanced biofuel industry, applying biofuel production technology in Vietnam that will eventually reach the world's most advanced level. The ethanol and vegetable oil output is targeted to increase to 1.8 million tons, satisfying some 5% of the whole economy's gasoline and oil demand.

The MOIT, in coordination with relevant ministries, branches, organisations and individuals, assumes the prime responsibility for organising the efficient and timely implementation of the biofuels scheme. It annually reports to the Prime Minister. Enterprises that want to invest in biofuels producing projects are required to submit their plans for development to the MOIT. Biofuels traded and used in Viet Nam are required to follow the technical regulation and standards for biofuels.

In November 2012, the government announced the applicable ratio for mixing biofuels with conventional fuels for road-motorised vehicles using gasoline and diesel in Viet Nam and the road map for the implementation (PMVN, 2012d). Since 15 January 2013, Viet Nam has produced, traded and distributed biofuels for motorised road vehicles. The fuels include E5, E10, B5 and B10. As of 1 December 2014, the distribution and use of E5 for all motorised road vehicles has become mandatory in seven cities and provinces including Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho, Quang Ngai and Ba Ria-Vung Tau. It will be mandatory for the whole economy as of 1 December 2015. E10 will be mandatory in the abovementioned seven cities and provinces as of 1 December 2016 and will then expand to the whole economy on 1 December 2017. From 2015, the government will focus more on the application of economic measures and increasing incentives for players on the supply side in order to rapidly boost and sustainably develop Viet Nam's biofuel markets (PMVN, 2015a)

From 2007–15, the government classified investment in biofuel production as an area eligible for special investment incentives. As a result, biofuel production enterprises became entitled to an income tax exemption or reduction for biofuel products according to legislation on Enterprise Income Tax. They became entitled to the highest land rent and land use incentives over the next 20 years. Raw materials, components, machinery and equipment for scientific research and technological development for biofuel production are exempt from import tax. Raw materials, components, machinery and equipment used for biofuel production are eligible for the lowest import tax rate.

Since the 2007 deployment of the government's Decision No. 177/QD-TTg dated 20 November 2007 (PMVN, 2007b), investments in biofuel research and production have increased. Biofuel research focuses on biofuel technologies and applications in electricity generation and transportation use. About 58 R&D and pilot projects were implemented during 2007–15. The government has invested in domestic research capacity to advance the biofuel sector in accordance with the framework of Program 177 as well as in other economy-wide and provincial funding programs available for the scientific and technological development in Vietnam. The total state budget spent to support Program 117 was about 11.78 million USD (MOIT, 2016b). Since 2009, investments in bioethanol production projects have increased among domestic enterprises including Petrovietnam. In 2014, there were five bioethanol plants (E99.5 and above) built in Quang Nam, Dong Nai, Quang Ngai (Dung Quat), Binh Phuoc and Phu Tho, with a total installed capacity of about 500 million litres per year, enough for mixing 10 billion litres of E5 (MOIT, 2016a).

NUCLEAR

In January 2006, the Prime Minister approved the Strategy for Peaceful Applications of Atomic Energy to 2020 with the overall objective to gradually build and develop the atomic technology industry to increasingly and effectively contribute to socioeconomic development and strengthen the economy's scientific and technological capacity (PMVN, 2006a). The subsequent Prime Minister's Decisions No. 114/2007/QD-TTg (issued in July 23, 2007) and No. 957/QD-TTg (issued in June 24, 2010) detailed the government's action plans for the implementation of this strategy. In regard to nuclear power investment, the government stipulates to select proven/accredited safe and modern nuclear technologies. MOIT is responsible to formulate detail policy and road map for acquiring, mastering and developing nuclear power technologies.

The Viet Nam Power Development Master Plan for the period 2010–20, with a perspective to 2030 (PDP7) (for both approved versions in 2011 and its revision in 2016 by the Prime Minister) promotes the nuclear power development to ensure Viet Nam's electricity supply security in future, when domestic primary resources becomes exhausted. The government of Viet Nam has been actively cooperating with other governments and international organizations to accelerate the nuclear power construction and development programs. According to the PDP7 issued in 2011, the first introduction of 2 GW of nuclear power was scheduled in 2020; the capacity would gradually increase to 10.7 GW in 2030, so that nuclear power source could produce annually about 70.5 TWh, accounting for 10.1% of total power generation.

However, after the March 2011 Fukushima nuclear power plant accident in Japan, safety issues in the development and operation of nuclear power plants became a top priority in government's review agenda. With Decision No. 2241/QD-TTg dated 11 December 2014, the Prime Minister has entrusted relevant ministries, government agencies and sectors with careful reviews for revisions of nuclear power policy and regulatory framework, implementation programs, including the timeframe and the development capacity over the long term. Since 2015, the Ministry of Sciences and Technology (MOST) has leaded the review process for amending The Law on Atomic Energy 2008 (Law No.18/2008/QH12) and completing technical and environmental regulations on nuclear power infrastructure development to 2020. In March 2016, the Prime Minister approved the MOIT's revised PDP7 (PMVN, 2016), underlining that nuclear power programs must be implemented in a coherent way, in compliance with the provisions of law and ensure

safety and efficiency as the primary objectives. The revised PDP7 has postponed the operation year of the first unit in 2028 and reduced total capacity to 4.6 GW in 2030; hence, the power generation from nuclear will be 32.5 TWh in 2030, accounting for 5.7% of total power production of the national system. The government entrusted EVN as the investor for the first two nuclear power plants built in Ninh Thuan province in central of Viet Nam. As a supporting policy, the government guarantees for loans from abroad to develop nuclear power.

CLIMATE CHANGE

In an early stage of industrialisation, and only recently recognised as a lower middle-income developing economy, Viet Nam contributes only 0.5% global CO_2 emissions (GOV, 2015). In the past 50 years, however, extreme climate events such as storms, floods, droughts and saline water intrusion have increased in both frequency and intensity. Viet Nam is one of the economies that may suffer the most severe impacts of climate change and rising sea levels, according to national and international analyses of climate change scenarios to 2100.

In Viet Nam, the government exercises unified management over its natural resources and environmental protection throughout the economy. The institutional framework for environmental governance consists of the administrative hierarchy, with economy-wide representation through the National Assembly and provincial, district and community level representation through the People's Councils and Committees. More than 10 line ministries and central agencies deal with natural resources and other ministries deal with general planning responsibilities. The Ministry of Natural Resources and Environment (MONRE) plays a central coordinating role in environmental management.

Since the 1990s, the government of Viet Nam has been motivated by the serious impacts of climate change on the economy's sustainable development. Viet Nam is one of the economies most affected by climate change. It signed the UNFCCC on 16 November 1994, signed the Kyoto Protocol to the UNFCCC in 1997 and ratified it 20 August 2002. Viet Nam has fulfilled all requirements to be an Annex II economy for developing clean development mechanisms (CDMs) under the protocol.

Government agencies are progressively revising and completing the institutional framework and the system of legal documents to prevent and mitigate natural disasters due to climate change. In April 2003, the government established the CDM National Executive and Consultative Board, comprised of officials from MONRE and other ministries. In June 2003, the government designated the National Office for Climate Change and Ozone Protection (part of the International Cooperation Department of MONRE) as Viet Nam's CDM national authority.

Every five years the Vietnamese government issues its 'National Target Program to Respond to Climate Change' (NTP-RCC) to assess the climate change impact on sectors and regions over specific periods and to develop feasible action plans that can effectively respond to climate change in the short and long term in order to ensure the sustainable development of Viet Nam. In December 2008, the Prime Minister approved the National Target Program to Respond to Climate Change. It has a budget of about VND 1 965 billion.

On 5 December 2011, Prime Minister Nguyen Tan Dung issued the National Strategy on Climate Change (Decision 2139/QD-TTg). This strategy has a century-long vision and it is the foundation for all other ministerial, sectoral and local strategies, plans and programs.

Viet Nam has set a target to reduce 8–10% of its GHG emissions intensity from 2010 levels by 2020; and after 2020, to reduce GHG emissions intensity 1.5–2% per year on average (or 20% by 2030). These targets are Viet Nam's voluntary reduction. Additional international support is required for higher targets of 20% by 2020 and 30% by 2030 (PMVN, 2012a; GOV, 2015). Viet Nam's BAU scenario for GHG emissions was developed based on the assumption of economic growth in the absence of climate change policies. The BAU starts from 2010 (the latest year of the national GHG inventory) and includes the energy, agriculture, waste and LULUCF (Land Use, Land-Use Change and Forestry) sectors.

- GHG emissions in 2010: 246.8 million tons carbon dioxide equivalent (tCO_2-e);
- Projections for 2020 and 2030 (not including industrial processes):

  2020: 474.1 million tCO_2-e

  2030: 787.4 million tCO_2-e

Many international financial institutions and developed economies in the APEC region, including the World Bank and the Asian Development Bank, as well as the governments of Australia, Canada, Japan, the US and others are helping Viet Nam build specific projects aimed at reducing the impact of climate change. These include risk management for natural disasters and responses to climate change; land management for sustainable forestry under climate change conditions; the reduction of greenhouse gas emissions through efforts to combat deforestation and forest degradation; and rural development in the Cuu Long River delta to cope with climate change.

NOTABLE ENERGY DEVELOPMENTS

EVN'S STRONG INVESTMENT IN RURAL AND REMOTE ISLANDS ELECTRICITY DISTRIBUTION NETWORK EXPANSION

By the end of 2014, EVN had successfully developed a distribution network nationwide, specifically the rural and remote islands network; currently, 100% of the rural districts are able to receive electricity supply from the national grid system, next to their own local source; 99.6% of the communes and 98% of the rural households are connected to electricity; the electricity coverage for the communes and households in north-western mountainous provinces is 98% and 85%, respectively, for the central highland 100% and 96%, respectively; and for the south-western region 100% and 98%, respectively. The national grid continues to cover the island districts by overhead lines or submarine cables including Phu Quoc, Kien Hai (KienGiang province), Ly Son (Quang Ngai province) and five communes of Van Don Island district (QuangNinh province). This helps to improve the living standards of the people and local economic development, and protect national sovereignty.

The reliability indicators of power supply in Viet Nam continued to improve significantly in 2014. In general, the System Average Interruption Duration Index (SAIDI) was recorded at 3 134 minutes, down 23% compared with 2013; the System Average Interruption Frequency Index (SAIFI) was 18.1 per customer, down 25%; and the Momentary Average Interruption Frequency Index (MAIFI) was 2.63 per customer, down by 26%.

Improvements in electricity access, a more reliable power network along with power loss reduction and an increase in power usage efficiency also contribute actively to enhance the national competitiveness. (EVN, 2015)

FINANCIAL SUPPORT FOR SMALL/MEDIUM ENTERPRISES (SME) TO INVEST IN ENERGY EFFICIENCY

Since June 2015, the 'Green Investment Facility' (GIF), a 6.5 million USD financial support program under the Low Carbon Transition in Energy Efficiency Project (LCEE), funded by the Danish government, has been rolled out to guarantee loans and credit rewards for SMEs in Viet Nam to invest in energy efficiency in three sectors: brick, ceramics and food processing.

Techcombank, BIDV and SCB are three Vietnamese lending banks who cooperate to implement the GIF program.

SMEs in the three mentioned sectors, which plan to invest in projects for energy efficiency improvements with a minimum value of VND 400 million/project, can apply to participate in the GIF program. If involved in the GIF, the SMEs can receive financial assistance equivalent to 50% of their loans through a guarantee from the ANZ bank, thereby reducing half of the collateral needed when they borrow at designated lending banks. The GIF program also offers a reward mechanism based on actual energy efficiency improvements of the project. SMEs who achieve actual energy savings will receive a corresponding reward, ranging from 10–30% of their total investment costs, an additional financial source for them to use to repay the principal.

By the time of the GIF program launch in June 2015, approximately 90 SMEs had made contact with the LCEE Project for financial support. Of these, 20 companies had been instructed to complete the dossier and eight companies were under consideration for an approved loan. The GIF program expects to support 100–130 energy savings projects by the end of 2016. All information, together with GIF program progress as well as activities of the LCEE project, including applicable solutions for saving energy applied by SMEs, are reported at the website www.lcee.vn.

The GIF program presents the private sector in Viet Nam with a good opportunity for practical support in borrowing capital. In regards to Vietnamese banks participating in the GIF program, benefits may include closer links with businesses and the opportunity to become acquainted with the economic

benefits of energy efficiency. Furthermore, through these activities, the banks and businesses will contribute to raising public awareness about energy efficiency, energy saving and environmental protection.

OPERATION AT FULL CAPACITY OF THE 99.2 MW BAC LIEU WIND FARM – ASIA'S FIRST OFFSHORE WIND FARM

On 17 January 2016, the Bac Lieu wind farm, the Asia's first offshore wind farm started operation at the full capacity of 99.2 MW, with the potential to supply 320 GWh/year to the national power system (MOIT, 2016a), and recognised to offset 151 331 tons of CO_2 emissions a year. The completion of this project construction increased Viet Nam's total wind power capacity to 135 MW.

The Bac Lieu wind farm has been developed on a 540-hectare site in a submerged coastal area of Vinh Trach Dong Commune, Bac Lieu City of Bac Lieu province, in southern Viet Nam. It includes 62 wind turbines of 1.6 MW each, supplied by General Electric (GE). Each GE 1.6 MW turbine has a rotor diameter of 82.5 m and a swept area of 5 346 m^2, made of special stainless steel, weighing more than 210 tons and sitting on an 80 m to 100 m high tubular steel tower. The turbines are expected to operate at a rated speed of 1 915 rpm. The turbines use a double-fed asynchronous generator with a partial power converter system and are equipped with an electric-drive pitch control system with battery backup for efficient speed regulation.

Construction commenced in September 2010, and the first phase (ten wind turbines with a total capacity of 16 MW) was grid-connected in May 2013. Twenty-two new 110 kV-63 MVA transformer stations and approximately 30 km of 110 kV transmission lines were built to ensure power transmission to the national grid. Digital and bi-directional type electricity metre systems have been installed at the connection point to measure the export and import of electricity from the wind farm. The contracts for the construction, transportation and installation of wind turbines for the project were awarded to several domestic companies including Huy Hoang Transportation & Logistics Corporation (HTL) and Industry Construction Corporation (Descon) (Power-technology.com, 2014).

Cong Ly Construction-Trade-Tourism has invested more than VND 5.2 trillion (approximately 244.4 million USD) in the project. The wind farm is expected to have an operational life of 22 years.

The Bac Lieu wind farm is also the first project to be developed under the US-Viet Nam private sector agreement, which is part of the US-Asia Pacific comprehensive energy partnership aimed at addressing energy access and energy poverty issues in the Asia-Pacific region. The Export-Import Bank of the United States (US Ex-Im Bank) and the Vietnam Development Bank (VDB) are jointly funding the wind farm. VDB is responsible for the investment credit and foreign loan, while the US Ex-Im Bank is providing a 1.5 billion USD credit line to finance the project.

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