

APEC ENERGY
OVERVIEW
2016

Prepared by

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FOREWORD

The APEC Overview is an annual APERC publication. Its main objectives are to compile the latest data of the Expert Group on Energy Data and Analysis (EGEDA) on energy use and recent energy developments in each APEC economy, promoting the use of EGEDA data and providing useful information and insights to policy makers in the region.

The APEC Overview gives a *bird's-eye view* of the energy situation of 21 APEC economies. 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.

It gives a summary of the energy intensity improvement as well as renewable energy development in APEC. The summary indicates how APEC is progressing in achieving its aspirational goals of reducing energy intensity by at least 45% by 2035, using 2005 as a base year, and in doubling the share of renewables in the APEC energy mix, including in power generation from 2010 to 2030.

While the rates of improvement vary by economy for many reasons, most economies have followed-through on previously committed action plans to improve energy efficiency; embarked on efficiency awareness raising campaigns; increased use of renewables; promoted good energy management practices and facilitated investment in energy efficiency.

We hope that this report helps to deepen mutual understanding among APEC economies on energy issues in the region. We wish to express our deepest gratitude to the APEC-EWG and EGEDA members for their continued support to this undertaking.



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EXECUTIVE SUMMARY

In 2014, APEC population reached 2.8 billion, a sluggish growth of 0.7% from the 2013 levels. While population grew slowly, APEC economies showed significant increase of 3.8% (USD 54 811 billion, in 2010 USD purchasing power parity [PPP]) in 2014 from the 2013 GDP levels of USD 52 794 billion (2010 USD PPP). Total primary energy supply reached 7 926 million tonnes of oil equivalent (Mtoe) in 2014 which was a 0.6% expansion from the 2013 levels of 7 875 Mtoe. This rate was slower than the annual average growth rate (AAGR) of 2.7% observed between 2000 and 2014. Meanwhile, final energy consumption in APEC grew modestly by 1.1% to reach 5 244 Mtoe in 2014 from 5 188 in 2013.

Subsequent to APEC Leaders' setting the target to reduce energy intensity by 45% by 2035 (against the 2005 level), energy intensity in APEC continues to improve. Given differences in fuel mixes within APEC economies and different conversion factors from primary to final energy, the summary presented an analysis based on final energy and final energy excluding non-energy use. As regards the doubling goal, rough estimation on the possible growth rates of renewables in total final energy consumption and power generation were presented in this summary.

The final energy intensity in APEC has improved by 2.6% in 2014 from the 2013 final energy intensity level of 98.3 tonnes of oil equivalent (toe) per million USD (2010 USD PPP). The final energy excluding non-energy intensity fell to 88.5 toe per million USD (2010 USD PPP) in 2014 or 3.1% lower than the 2013 final energy excluding non-energy intensity levels. With 2005 as base year, final energy intensity and final energy excluding non-energy intensity was reduced by 14% and 14.9%, respectively in 2014. By interpolation, the energy intensity reduction goal of 45% is expected to be achieved in 2041 for final energy and 2038 for final energy excluding non-energy.

Total final energy consumption of renewables grew as fast as the total final energy consumption (TFEC) in 2010 by 9% to reach 410 Mtoe in 2014 from 377 Mtoe in 2010. Its share to TFEC however, was maintained at around 7% between 2010-14. In power generation, output from hydro and other renewables grew significantly by 30%, from 2 250 Twh in 2010 to 2 920 Twh in 2014. In terms of share, generation output from hydro and renewables accounted for 17% to 18% of the total power generation from 2010 to 2014, respectively. Assuming the annual average growth rate (AAGR) of renewables between 2010 and 2014 of around 2%, at this rate, the share of renewables in total final consumption will fall short of doubling its target share in 2030 as compared with 2010. Meanwhile, the trend to 2030 in power generation using the same estimation with 7% AAGR, will likely double the share of renewables in power generation from the 2010 levels.

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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 litres 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 by 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 (km²) comprises six states and two territories. The population of around 24 million lives mostly in major cities or regional centres along the eastern and south-eastern seaboard. The economy has maintained robust economic growth for the last 24 years and has had an average annual growth rate (AAGR) of 3.4% from 1960 to 2016 (ABS, 2016). In 2014, gross domestic product (GDP) reached USD 961.4 billion (USD 2010 purchasing power parity [PPP]), a 2.5% increase from 2012 (EGEDA, 2016). Australia has the only developed economy in APEC to have recorded no annual recessions over the last 25 years (ATC, 2016).

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

In 2014–15, Australia's primary energy production rose by 4.6% to 19 7651 petajoules (PJ) or 472 078 kilotonnes of oil equivalent (ktoe), compared with a 2.6% decrease in 2013–14 (OCE, 2016a), supported by growth in coal and gas production. Australia produces energy for both domestic consumption and export, but is becoming increasingly export-orientated. Energy exports grew by 5% compared with 2% in the previous year and accounted for 78% of domestic energy production in 2014–15 (OCE, 2016a).

Australia produces uranium for export only, while all other energy production supplies both domestic and international markets. The economy's energy production increased at an average annual rate of 1.1% from 2003–04 to 2013–14; however, it rose by 4.6% in 2014–15 (OCE, 2016c).

In 2014–15, coal accounted for 66% of Australia's primary energy production in terms of energy content, followed by uranium (15%) and gas (13%) (OCE, 2016c). Crude oil and liquefied petroleum gas (LPG) represented a further 4% of total energy production in energy content terms, and renewables represented 1.8% (OCE, 2016a). Relative to 2014–15, Australian export earnings from energy and mineral commodities decreased by 9.1% in 2015–16 to AUD 157 billion (OCE, 2016b).

As of 2013 Australia was the world's eighth-largest energy producer, accounting for around 2.4% of world energy production (OCE, 2016c). It is the world's largest exporter of metallurgical coal and the second-largest exporter of thermal 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, 2016c). 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, 2014

Key data ^a		Energy reserves ^b	
Area (million km ²)	7.7	Oil (billion barrels)	3.8
Population (million)	24	Gas (billion cubic metres)	3 738
GDP (2010 USD billion PPP)	961	Coal (million tonnes)	105 246
GDP (2010 USD PPP per capita)	40 972	Uranium (kilotonnes U)	3 472

Note: Coal reserves are defined as recoverable economically demonstrated resources of black and brown coal.

Sources: a. EGEDA (2016); b. GA (2014).

¹ As of 2016, uranium is no longer included in total Australian energy production in the Australian Energy Statistics report. For comparability with previous versions of the APEC Overview, we have included uranium in total energy production (for uranium see Table S in OCE, 2016a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014–15, Australia's total energy production was 19 765 PJ or 472 078 ktoe (OCE, 2016a). Approximately 66% of production came from coal, 4.0% from crude oil and LPG, 13% from gas, 15% from uranium and the remaining 1.8% from renewables (OCE, 2016a).

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 34 billion in 2015–16 followed by LNG (AUD 17 billion) and crude oil (AUD 5.5 billion) (OCE, 2016b). Coal is also an important component of the domestic energy supply, accounting for approximately 63% of the total electricity generation in 2014–15 (OCE, 2016a).

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 in Western Australia; the offshore Gippsland Basin in Victoria; and the onshore Cooper–Eromanga Basin, which straddles the South Australian and Queensland borders (GA, 2014). Gas production in 2015–16 of 81 billion cubic metres (bcm) was a considerable increase on the year before as coal seam gas (CSG) production in Queensland expanded to support the start of LNG exports from three new projects in Gladstone (OCE, 2016b).

The production of CSG, which occurs mainly in Queensland, more than doubled from 12 bcm in 2014–15 to over 25 bcm in 2015–16 (OCE, 2016b) and is expected to continue growing over the next few years as new LNG plants bring capacity online and continue ramping up.

Australia is a net importer of oil products, but a net exporter of LPG (OCE, 2016a). Australia's crude oil and LPG production declined by 4% in 2015–16 relative to 2014–15 largely due to its mature oil fields (OCE, 2016a). Australia's oil production is likely to continue to decline at maturing fields but will be bolstered somewhat by increasing condensate production associated with offshore gas fields being developed for LNG (OCE, 2016b).

In 2014–15, 252 359 gigawatt-hours (GWh) of electricity were generated, mostly from coal (63%) (OCE, 2016a). 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 and will account for an increasing proportion of total electricity generation over the medium to long term. Despite this, the share of renewable energy in the electricity generation mix dropped to 14% in 2014–15 from 15% the previous year, as lower rainfall led to a decline in hydro generation, particularly in Tasmania (OCE, 2016a).

FINAL ENERGY CONSUMPTION

In 2014–15, Australia's total energy consumption rose slightly, to 5 920 PJ (or 141 367 ktoe), following two years of declining demand (OCE, 2016a). In 2014–15, the electricity generation sector recaptured its place over transport as the largest energy-consuming sector at 28% of Australia's total net energy consumption. The transport sector followed at 27% and then the manufacturing sector at 19% (OCE, 2016a). This was followed by the mining (9%), residential (8%), commercial (6%) and other sectors (3%) (OCE, 2016a). By energy source, oil accounted for 38% of consumption in 2014–15, coal 32%, gas 24% and renewables 6% (OCE, 2016a). Coal and gas consumption both increased, mainly due to increased demand from the electricity generation sector, which contrasted with five years of decline for the former (OCE, 2016a). The share of renewable energy consumption has also grown over the past few years, with an increase of 2% from 2013–14. Although hydro consumption fell by 27% to 48 PJ in 2014–15, from 66 PJ in 2013–14, growth in bagasse, wind and solar significantly outweigh this decline (OCE, 2016a).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	365 711	Industry sector	24 442	Total power generation	248 299
Net imports and others	-235 083	Transport sector	31 701	Thermal	211 256
Total primary energy supply	125 199	Other sectors	22 111	Hydro	18 421
Coal	41 512	Non-energy	2 827	Nuclear	0
Oil	43 708	Total final energy consumption	81 081	Others	18 622
Gas	31 693	Coal	2 472		
Others	8 286	Oil	42 791		
		Gas	13 489		
		Electricity and others	22 327		

Source: EGEDA (2016).

ENERGY INTENSITY ANALYSIS

Australia is contributing to APEC's aspirational goal of a 45% energy intensity reduction by 2035 from 2005 levels. Australia's energy intensity has decreased consistently since the mid-1970s (OCE, 2016a). In 2014–15, primary energy intensity declined by 3.4% while final energy intensity declined by 2.5% (EGEDA, 2016). Australia's energy intensity improvements are due to developments in energy efficiency, which originate from two sources: advances in technology and the structural shift towards less energy-intensive industries, such as the commercial and service sectors (OCE, 2016a).

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	135	130	-3.4
Total final energy consumption	87	84	-2.5
Total final energy consumption excl. non-energy	84	81	-2.8

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Australia's system of government has three tiers: federal; state and territory; and local governments. The federal government or the state/territory governments own Australian energy resources, rather than private individuals. None of the tiers of government engages 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 approval process for unconventional gas exploration for their jurisdiction. However, the Australian Government, in the form of the Australian Department of the Environment and Energy, 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 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.

At a federal level, the Department of the Environment and Energy oversees energy matters. This includes energy security, international engagement, energy efficiency programs and energy markets. The Department of Industry, Innovation and Science oversees resources issues (including some related to onshore gas).

The Australian Government has committed to a set of signature economy-wide reforms that respond to rising business and household costs as outlined in the 2015 Energy White Paper. The Energy White Paper provides a coherent, integrated and efficient regulatory and policy framework that aims to stimulate sustainable growth, build community confidence in environmental safeguards and grow investments in the energy sector. (See the Notable Energy Developments section).

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 regulations 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 the Environment and Energy 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 the importation of liquid fuels from multiple 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 the economy'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 <https://www.environment.gov.au/energy/energy-security-office>.

The Australian Government has committed to present a plan to return to compliance to the International Energy Agency in mid-2016. The compliance plan comprises the introduction of mandatory reporting of Australian petroleum statistics from January 2018, a return to full compliance with the IEA stockholding obligation by 2026, the purchase of 400 ktoe of oil tickets and the establishment of an Energy Security Office. Mandatory reporting of petroleum statistics, which is currently voluntary, will be established by legislation in 2017(Environment, 2016a).

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 that 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 jurisdiction.

ENERGY MARKETS

MARKET REFORMS

Energy market reform is a priority issue for the COAG Energy Council under the energy market reform program (COAG, 2017). 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.coagenergycouncil.gov.au (COAG, 2017).

ELECTRICITY AND GAS MARKETS

The National Electricity Market (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). Western Australia is not connected to the NEM because of the state's distance from the rest of the market. The NEM comprises a wholesale sector and a competitive retail sector. All dispatched electricity is traded through the central pool, where output from generators is aggregated and scheduled to meet demand.

On 28 November 2016, the Environment and Communications References Committee of the Australian Senate released an interim report on the case for retirement of coal-fired power stations in Australia (APH, 2016). The report put forth four recommendations:

1. The committee recommends that the Australian Government adopt a comprehensive energy transition plan, including reform of the National Electricity Market rules.
2. The committee recommends that the Australian Government, in consultation with industry, community, union and other stakeholders, develop a mechanism for the orderly retirement of coal-fired power stations to be presented to the COAG Energy Council.
3. The committee recommends that the Australian Government, through representation on the COAG Energy Council, put in place a pollution reduction objective consistent with Australia's obligations under the Paris Agreement in the National Electricity Objectives.
4. The committee recommends that the Australian Government establish an energy transition authority with sufficient powers and resources to plan and coordinate the transition in the energy sector, including a just transition for workers and communities.

The report lists 24 coal-fired power plants currently operating in Australia, as well as nine plants that retired from 2010-16. Because coal is responsible for 88% of electricity-related emissions, Environment

Victoria recognises a coal phase-out that represents the earliest and largest opportunity to reduce emissions in Australia. The full report due to the Senate is expected by 1 February 2017 (APH, 2016).

The Australian gas market comprises 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 (Northern Territory) and the western gas market (Western Australia).

All three of Australia's gas markets are undergoing structural change with the development of huge amounts of new LNG supply capacity. This is being most keenly felt in the eastern gas market where the development of unconventional gas resources has underpinned new LNG plants that will, for the first time, link that market to global gas markets (the Western and Northern markets have been linked for some time). On August 2016, in response to concerns about the dynamics in the market during this transition, COAG released a gas market reform package to address four priority areas: gas supply, market operation, gas transportation and market transparency (COAG, 2016b).

In its Energy White Paper, the Australian Government and the COAG Energy Council rejected the need for government interventions such as the establishment of gas reservation (Industry, 2015b). The study and the White Paper were complemented by two reviews, the first of which is from Australia's Competition and Consumer Commission (ACCC) and the second from the Australian Energy Market Commission (AEMC). The ACCC's East Coast Gas Inquiry report, published in April 2016, addressed the effect of the three new LNG projects in Queensland on the competitiveness of the gas market in the region (ACCC, 2016). The second report, released by the AEMC in July 2016, recommended 15 key reforms to improve the efficiency of the east coast gas market in reference to trading and access to pipeline transportation (AEMC, 2016). Both of these reports helped inform COAG's gas market reforms discussed previously.

A key component of on-going energy market reforms was the establishment on 1 July 2009 of the Australian Energy Market Operator (AEMO). 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).

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 grid and the Victorian gas transmission network; economy-wide transmission planning; and establishing a short-term trading market for gas from 2010 (AEMO, 2015).

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 Electricity Statement of Opportunities and the Gas Statement of Opportunities, both of which forecast long-term supply and demand in the eastern market. It also maintains Australia's gas market bulletin board (AEMO, 2015). More recently, AEMO has taken charge of Western Australian gas and electricity markets and releases similar publications for that market (AEMO, 2016).

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 federal and state/territory (and New Zealand) energy and resources ministers, is responsible for energy policy and the legislative frameworks under which AEMO, AEMC and AER operate.

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 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 expenditures 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.

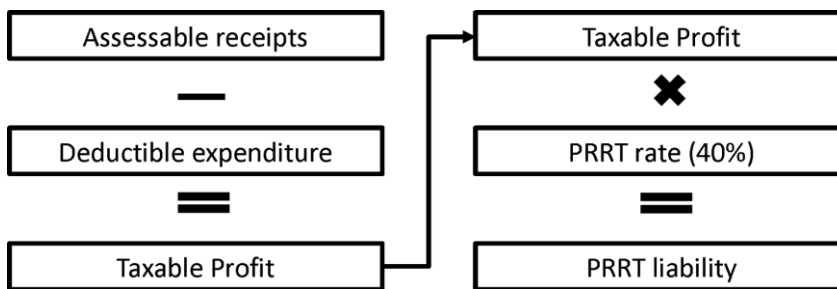
FEDERAL PETROLEUM RESOURCE RENT TAX

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 expenditures (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 expenditures are 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 2 below (ATO, 2014a).

Figure 1: Calculating a PRRT liability



Source: ATO (2014a).

The government is currently undertaking a review into the design and operation of the PRRT that is expected to be released in April 2017. More information on the review, including the report when finished, can be found at: <http://www.treasury.gov.au/ConsultationsandReviews/Reviews/2016/Review-of-the-Petroleum-Resource-Rent-Tax>.

ROYALTIES

Royalties are generally levied by the states as 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)

Effective 1 July 2014, the Australian Government introduced the EDI to encourage investments 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 expenditures 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 divided with 90% going 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 since 1 July 2012. However, the Australian Government repealed the MRRT in September 2014. Consequently, since 1 October 2014, MRRT liable entities no longer accrue further liabilities (ATO, 2014b).

INVESTMENTS

The Australian energy sector faces challenges in attracting investments over the next decade, although Australia's practical investment needs over this period will depend on long-term demand trends. AEMO's 2015 National Transmission Network Development Plan (NTNDP) identified that expenditures 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.

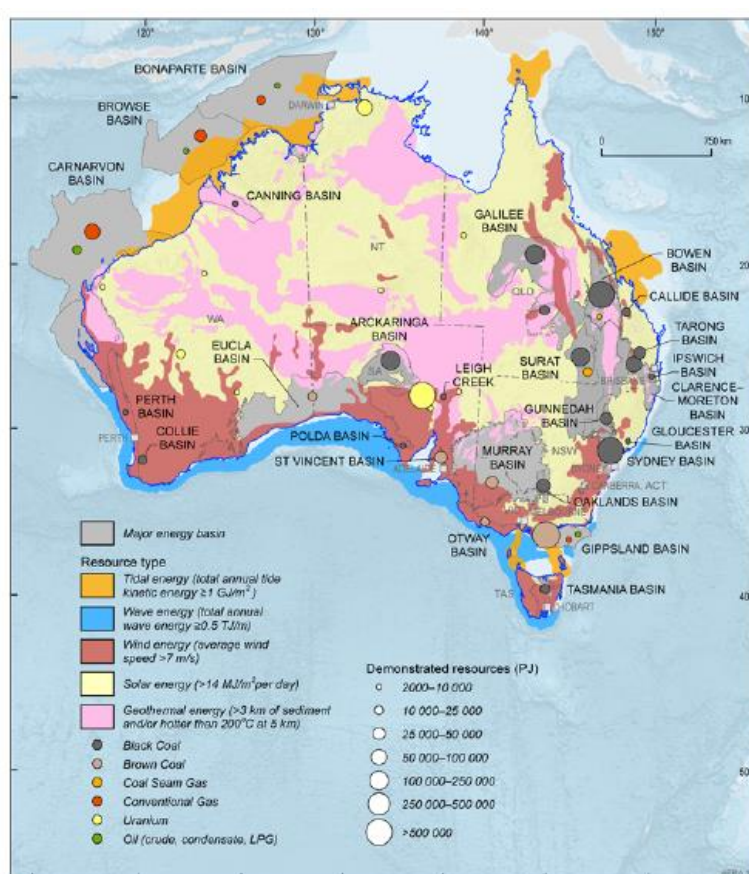
Energy productivity is a measure of the amount of economic output derived from each unit of energy consumed. Over recent years, Australia's energy productivity has improved, growing at around 1.8% per year in the last decade. Despite this, Australia still lags behind many economies and countries such 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 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 2. Solar photovoltaic (PV) generation increased by 23% in 2014–15 from 2013–14 and wind-powered electricity generation increased by 12% in 2014–15 compared with 2013–14 (OCE, 2016a). Hydro, however, decreased by 27% in 2014–15 compared with 2013–14 because of lower water availability. The contribution from hydro to electricity generation in 2014–15 was at its lowest since the mid-2000s drought (OCE, 2016a).

Figure 2: Map showing the distribution of Australia's energy resources



Source: GA (2014).

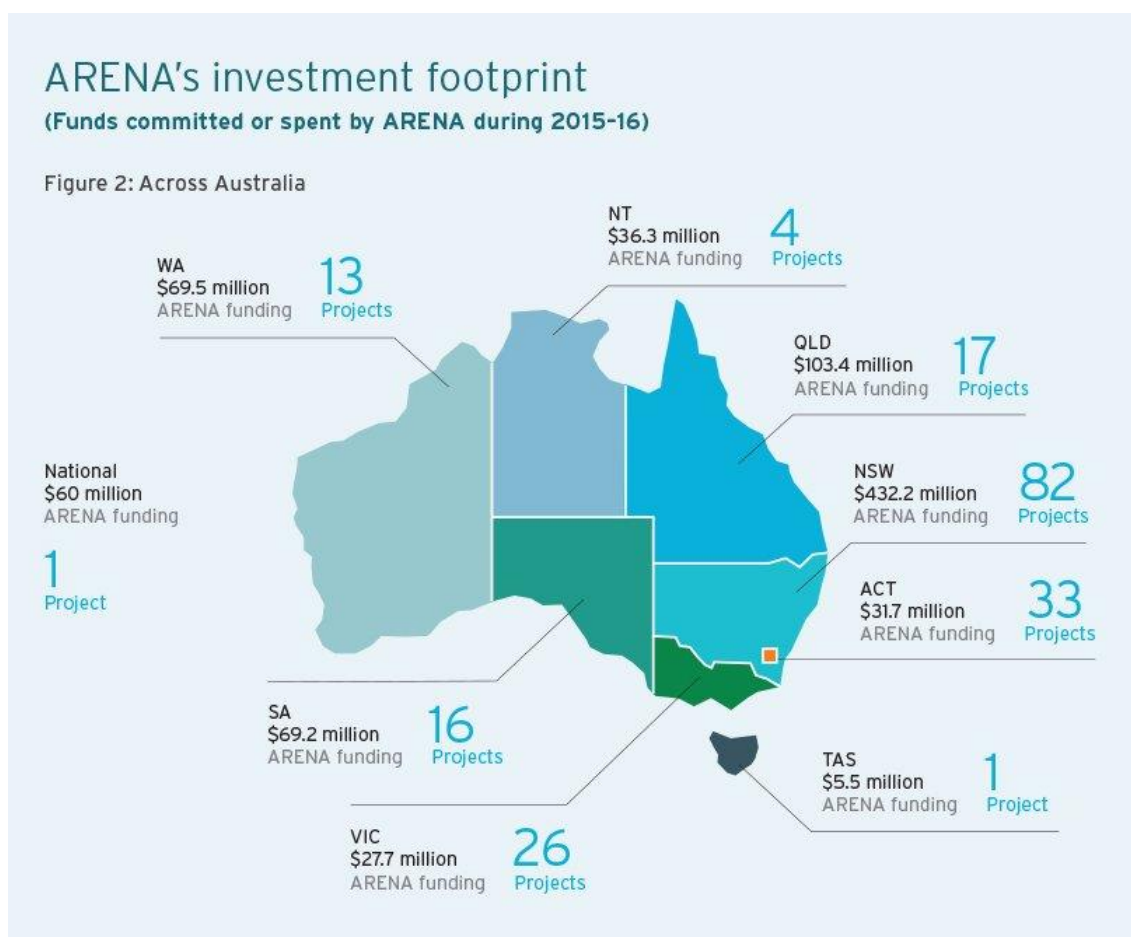
The Renewable Energy (Electricity) Amendment Act 2009 and the Renewable Energy (Electricity) (Charge) Amendment Act 2010 were passed in September 2009 and June 2010, respectively. The Renewable Energy (Electricity) Amendment Act 2009 modified the Renewable Energy (Electricity) Act 2000 to enable the 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 legislation was amended in June 2015 to reduce the LRET to 33 000 GWh of total electricity generation in 2020. The uncapped SRES provides a subsidy to small-scale technologies, such as residential solar panels and solar hot water systems.

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 to fund renewable energy projects (e.g. solar, bioenergy, marine, geothermal and enabling technologies such as storage) until 2022. 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 have 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). In 2016, the Australian Government announced its intention to retain ARENA and to expand its mandate to include energy efficiency and low emissions technologies. Under this shift, ARENA will continue to manage its existing portfolio; however, its role will evolve to more of a debt/equity provider under the Clean Energy Innovation Fund (CEIF) (ARENA, 2016). The following is a map detailing the regional use of funds committed by ARENA during 2015-16:

Figure 3: ARENA regional use of funds



ARENA's independent decision-making board consists of up to seven members appointed by the Minister for the Environment and Energy. The Board also has a CEO appointed by the Minister 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, most of these schemes have now been amended or closed.

In 2015, approximately 17% of Australian households had solar PV installed (OCE, 2016b). Consequently, total solar PV generation increased to 6 TWh in 2014–15, a 23% increase from 2013–14 (OCE, 2016a). Growth in utility-scale solar PV has mostly occurred in New South Wales and the ACT where the Nyngan (102 MW), Broken Hill (53 MW) and Royalla Solar Farms (20 MW) have been built in the last few years. Wind generation contributed 33% of Australia’s renewable generation and 5% of total generation in 2014–15. It also accounted for 33% of South Australia’s total fuel mix, up from 31% in 2013–14. Solar and wind are expected to continue growing to meet the 2020 RET target and to replace aging coal-fired plants in the generation mix.

ENERGY TECHNOLOGY AND RESEARCH AND DEVELOPMENT

In the Australian science system, the bulk of basic research occurs in the university sector. Funding delivery comes from organisations such as the Australian Research Council, which has established a range of competitive grant schemes. Furthermore, 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, 2016). 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, 2016). The Clean Energy Regulator (CER) administers the fund that 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. The fourth auction concluded in November 2016, where 47 abatement contracts were awarded to deliver 34.4 million tonnes of abatement at an average price per tonne of \$10.69 for a total of AUD 367 million (CER, 2016). Four auction rounds have awarded 356 carbon abatement contracts for 178 million tonnes of abatement (CER, 2016).

The repeal of the carbon tax by Parliament became effective on 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

BLUEPRINT FOR ENERGY SECURITY IN THE NATIONAL ELECTRICITY MARKET

On 7 October 2016, COAG Energy Ministers agreed to an Independent Review of the National Energy Market in order to develop a national reform blueprint on maintaining energy security and reliability in the market (COAG, 2016). The review’s purpose is to examine the effects of rapid technological change, increasing penetration of renewables, increasing distributed generation and changing consumer demand on the National Electricity Market. It will draw on the analysis undertaken in 2015 related to the AEMO, AEMC and AER’s work on gas market reform. A preliminary report was released for the COAG leaders’ meeting in early December 2016 and the final report is expected in the first half of 2017 (COAG, 2016).

INTERNATIONAL ENGAGEMENT ON ENERGY SECURITY

As mentioned in the Energy Security section, Australia has made policy changes in order to return to compliance with the IEA’s Agreement on an International Energy Program (IEP) Treaty. As part of this plan, Australia has introduced a mandatory reporting obligation that will apply to selected petroleum data from 1 January 2018. The Australian government currently collects data on the petroleum market using a voluntary monthly business activity survey; however, changes in the market have led to an increase in the number of businesses choosing to forego participation in this survey (Environment, 2016a). The introduction of mandatory reporting will increase the accuracy and reliability of the Australian Petroleum Statistics. Mandatory reporting legislation will be introduced in 2017 (Environment, 2016a).

In addition, Australia is required to hold oil stocks equivalent to 90 days of the previous year's average daily net oil imports under the IEP Treaty. Because of structural changes in the petroleum market, including falling domestic oil production and increasing demand, Australia has been non-compliant with the IEP Treaty since March 2012. The Government has agreed to a plan to meet its stockholding obligations by purchasing oil tickets. Australia expects to return to full compliance by 2026.

MERGER OF THE ENERGY AND ENVIRONMENT DEPARTMENTS

Under the First Turnbull Ministry, the energy and environment ministries existed separately as the Department of Environment and the Department of Industry, Innovation and Science. With the election of the Second Turnbull Ministry on 19 July 2016, the departments were reorganised and The Department of the Environment and Energy took responsibility for energy matters from the Department of Industry, Innovation and Science. In bringing energy and environment policy together under one department, the Australian government is recognising the fundamental linkages between these two policy areas and their impact on the economy (Environment, 2016b).

REGIONAL FRACKING BANS

On 14 September 2016, the Northern Territory Government implemented a moratorium on hydraulic fracturing of unconventional gas reservoirs. The NT government has stated the ban will stay in place pending the outcome of a comprehensive, independent scientific inquiry into the social and environmental impacts of fracking (NT, 2016).

The state government of Victoria introduced a bill to ban fracking in the state on 22 November 2016. The legislation will: 1) permanently ban all onshore unconventional gas exploration and development, including hydraulic fracturing and coal seam gas, and 2) extend the moratorium on conventional onshore gas exploration and development to 30 June 2020 (Premier of Victoria, 2020).

In response to community concerns regarding CSG, the state government of New South Wales has also introduced legislation that includes increased regulatory oversight, bans on certain chemicals, a number of exclusion zones and a code of practice for the industry (NSW, 2015).

NEW ENERGY PROJECTS

Chevron Australia's Gorgon LNG project began shipping LNG in March 2016. The project's facilities, located on Barrow Island, include three trains capable of processing 15.6 mtpa. While the first train came online earlier this year, the second train has been ramping up in October 2016 and train 3 modules are under construction (Chevron, 2016).

Three additional LNG projects are expected to come online in 2017/18; Inpex and Total's joint venture two-train Ichthys project, with 8.4 mtpa of capacity, Shell's Prelude floating LNG project with 3.6 mtpa capacity and Chevron's Wheatstone project with 8.9 mtpa of processing capacity (Reuters, 2016). There are a number of other projects considering FID (including brownfield expansion at current LNG plants), however, the shrinking LNG supply gap has weakened the economic case for additional projects in the medium term.

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- 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 is located on the northern coast of the island Borneo, where it shares its border with the state of Sarawak, Malaysia and faces the South China Sea in the North. The total area of Brunei Darussalam is 5 765 square kilometres and the country is divided into four administrative districts, namely Brunei – Muara district, Belait district, Tutong district and Temburong district. Its capital city is Bandar Seri Begawan, located in the Brunei – Muara district. With a population of 417 thousand in 2014 and a gross domestic product (GDP) of USD 28 billion (2010 USD purchasing power parity [PPP]), Brunei Darussalam ranks as one of the wealthiest economies in the APEC region, owing to its rich resources of crude oil and natural gas. Strategically located within a region with vast hydrocarbons wealth, Brunei Darussalam has been able to finance its development programs since the discovery of oil in 1929. Crude oil and natural gas has also dominated the economy's foreign trade, accounting for about 96% of total exports, while imports are dominated by machinery, transport equipment, manufactured goods and food.

The dependency on crude oil and natural gas exports for revenue remains high, which accounts for more than 60% of the economy's GDP. This has generated a very high per capita GDP of USD 66 538 (2010 USD PPP per capita) in 2014, which has enabled the government to continue providing the citizens of Brunei Darussalam with a high standard of living, no income tax, free health and education among other services. The government has put forth efforts to diversify the economic structure and has introduced a number of reforms focusing on new foreign direct investments (FDI).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	5 765	Oil (billion barrels)	1.1
Population (thousand)	417.4	Gas (billion cubic metres)	300
GDP (2010 USD billion PPP)	28	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	66 538	Uranium (kilotonnes U)	–

Sources: a. DEPD (2015); b. EGEDA (2016); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Crude oil and natural gas are the main energy resources in Brunei Darussalam. In 2014, the economy's total primary energy supply of 3 906 kilotonnes of oil equivalent (ktoe) in 2014 represented a year-on-year growth of 18%. Natural gas accounted for the highest percentage share of the total primary energy supply with 84%, and the remaining 16% was supplied by oil.

The majority of natural gas produced is exported as liquefied natural gas (LNG) and the main export destination in 2014 was Japan, at 74% of total LNG exports. Crude oil produced is mostly exported as term cargoes as well as used to produce petroleum products. In 2014, APEC economies took a 79% share of the total crude oil exports, while the rest were to other Asian economies. Australia was the biggest export destination in 2014, at 19% of total crude oil exports.

Brunei Darussalam's total installed electricity generation capacity of public utilities and auto producers reached 921.6 megawatts (MW) in 2014. In the same year, total electricity generated was 4 507 gigawatt-hours (GWh). Almost all of the electricity was generated by natural gas (EGEDA, 2016).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	17 601	Industrial sector	140	Total power generation	4 507
Net imports and others	-13 546	Transport sector	456	Thermal	4 505
Total primary energy supply	3 906	Other sectors	336	Hydro	-
Coal	-	Non-energy	560	Nuclear	-
Oil	612	Total final energy consumption	1 492	Others	2
Gas	3 294	Coal	-		
Others	-	Oil	624		
		Gas	580		
		Electricity and others	289		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

Brunei Darussalam's total final energy consumption in 2014 increased by 37% to 1 492 ktoe from the previous year. This was mainly due to the methanol plant that restarted its operation after several shutdowns in 2013. This led the non-energy sector to account for a large share of total energy consumption in 2014 with 38%, replacing the transport sector at 31%. The other sectors (residential, commercial and agriculture sectors combined) followed with 23%, of the economy's energy consumption. The remaining amount was for the industrial sector (9%). In terms of the energy source, oil accounted for 42% of the final consumption, followed by gas (39%), electricity and other (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, 2016).

ENERGY INTENSITY ANALYSIS

In line with APEC's overall target, Brunei Darussalam intends to reduce 45% of its energy intensity by 2035 from the 2005 level. In 2014, both primary intensity and final energy intensity experienced a large increase. A rise in consumption of natural gas for the increased activities in the non-energy sector has led the significant change, which is 187% higher than that in 2013 (Table 3). Primary intensity rose to 141 tonnes of oil equivalent per million USD (toe/million USD), up by 21%. Similarly, the economy's final energy intensity also increased from 39 toe/million USD in 2013 to 54 toe/million in 2014.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	116	141	20.7
Total final energy consumption	39	54	36.9
Total final energy consumption excl. non-energy	32	34	4.2

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Brunei Darussalam's energy policy is centred on its oil and gas industry. Following the oil production peak at 254 000 bbl/d in 1979, the government imposed a strict conservation policy on production at 150 000 bbl/d

in 1981. However, the policy was revised in November 1990 when the government removed the limit on the production ceiling. This resulted in increased production where achieved an oil production level of 219 000 bbl/d in 2006. In 2014, the economy's crude oil and condensate average production was 126 450 bbl/d (EIDPMO, 2017).

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 a level that can sustain obligations, 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.

Brunei Darussalam's energy sector has a pivotal role to play in in the realisation of Wawasan Brunei 2035 (Vision Brunei 2035), the long-term development plan of the country. The Wawasan Brunei 2035 has three (3) main goals for the next two decades, which 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 ten countries in the world; and
- To build a dynamic and sustainable economy with an income per capita among the world's top ten.

Achieving the goals of Wawasan Brunei 2035 will require a significant increase in the activity level of all economic sectors in the economy, including energy sector. In line with the aspiration to grow in a sustainable manner, Brunei Darussalam launched its first Brunei Darussalam Energy White Paper (EWP) in March 2014. The EWP describes a framework for strategic actions, which ensures sustainable energy for Brunei Darussalam's prosperity.

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 in Brunei Darussalam. EIDPMO has set four strategic goals in order to accelerate and enhance economic growth of the economy, which are:

- Strengthen and Diversify Our Economy
- Nurture Conducive Business Environment
- Ensure Safe and Secure Work Environment
- Develop Industry-Ready Local Workforce.

The above strategic goals not only encompasses goals to be achieved within oil and gas sector but also related to the development of non-oil and gas sector.

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 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 the Energy Department, Prime Minister's Office (EDPMO).

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 2016–2025 (the Action Plan). This includes flagship projects, such as the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline (TAGP) projects, among others.

UPSTREAM ENERGY DEVELOPMENT

Brunei Darussalam is the fourth-largest oil producer in South-East Asia and Brunei Shell Petroleum Company Sdn Bhd (BSP) is the main oil producer in the economy, owned jointly by the government and the Royal Dutch Shell Company. BSP has seven offshore fields and two onshore oil fields. The offshore fields are South West Ampa, Fairley, Fairley Baram (shared with Malaysia), Magpie, Gannet, Iron Duke and Champion. Champion field holds about 40% of the economy's oil reserves. It is situated in 30 metres of water about 70 kilometres northeast of Seria. Meanwhile, 13 kilometres off Kuala Belait, South West Ampa field holds more than half of the economy's total gas reserves. The other oil and gas companies that currently operate in the concession and production-sharing areas are Total E&P Deep Offshore Borneo B.V. (Total), PETRONAS Carigali Brunei Limited and Shell Deepwater Borneo Limited.

Brunei Darussalam has long-term plans to boost upstream production levels from 372 000 barrels of oil equivalent per day BOE/day in 2013 to 430 000 BOE/d by 2017 and 650 000 BOE/d by 2035. This is in accordance with the Brunei Darussalam Energy White Paper, where additional reserves totalling 3.5 billion barrels will be targeted by 2035. 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, the economy 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.

New offshore discoveries in the South China Sea are expected to prolong Brunei Darussalam's hydrocarbons production past the lifespan of its maturing fields. In a bid to develop these fields, the economy's oil and gas industry has opened tenders valued at more than USD 2.2 billion since early 2016. Calls for tender have been made for the provision of information technology, security and support services, to construction and maintenance, along with the supply of advanced technology, training, seabed sampling and other exploratory analysis. A Malaysian service operator, Icon Offshore, won a USD 27 million contract to provide offshore support vessels, while an Indonesian offshore services company namely Wintermar Offshore Marine has been awarded contracts with BSP valued at USD 5.5 million to serve coastal platforms.

The economy also aims to achieve around 100 000 BOE/d from upstream international ventures investments 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 an offshore block in Sarawak, Malaysia, and a shale gas project in Canada, thereby increasing international investments (PB, 2013).

DOWNSTREAM ENERGY DEVELOPMENT

Brunei Darussalam aims to increase the revenue from domestic downstream industries to BND 5 billion in 2035. The biggest contributor to the existing downstream industry in the economy 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 to ensure the achievement of this 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 recognises the importance of having 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 key regulatory policies and frameworks, which include, among others, 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 and to maximise local spin offs from oil and gas activities.

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 in 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

Brunei Darussalam has established Energy Efficiency and Conservation (EEC) roadmap in 2011 that specify a comprehensive EEC action plans that shall be implemented in the next 24 years until 2035. It is estimated that through rigorous implementation of energy efficiency and conservation key initiatives coupled with the deployment of Renewable Energy (RE) programs, Brunei Darussalam would be able to reduce the nation's Total Energy Consumption (TEC) up to 63%. The reduction primarily from a reduction of fossil fuel supply for inland energy use via five major sectors, namely power, commercial, residential, transportation and industrial sectors. This was announced by His Majesty the Sultan and Yang Di-Pertuan of Brunei Darussalam at the United Nations (UN) Climate Change Summit in September 2014 (RTB News, 2014). Among the key action plans which have been and will be undertaken to support the key initiatives are as follow (UNFCCC, 2015):-

- *Electricity Tariff Reform*—Electricity tariff reform for the residential sector was implemented on the 1st January 2012 with an objective to help low income citizen through the minimum charge of one cent per kWh for basic electricity consumption and concurrently to promote energy saving and to avoid energy wastage. It moves to being progressive from regressive tariff in order to enhance an element of energy saving into it. The government is also planning to formulate electricity tariff reform on other sectors accordingly.
- *Standards and Labelling Order*—EIDPMO in collaboration with Brunei National Energy Research Institute (BNERI) are currently in the process of developing the Standard and Labelling Order. The objective of the Order are to restrict or perhaps to halt the importation of the non-efficient electrical appliances and

products i.e., air conditioning into the country and concurrently to educate and encourage people to opt to a more energy-efficient electrical appliances and products.

- *EEC Building Guidelines for the Non-Residential Sector*—The EEC Building Guidelines 2015 for Non-Residential Building was launched by the Ministry of Development in May 2015. All government and new buildings are obligated to adopt the guidelines in accordance with the Energy Efficiency Index (EEI) baseline in kilowatt-hours per square metre, which has been set in the guideline. It is estimated that with the introduction of these baselines, the energy consumption of new buildings could be reduced up to 30%.
- *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 for 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 establishing a structured maintenance program.

BRUNEI DARUSSALAM ENERGY CONSUMPTION SURVEY (BDECS), 2015 FOR HOUSEHOLD

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 impact. 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. From the survey, it was concluded that the pattern of end-use energy consumption is fully dominated by cooling system followed by refrigeration, lighting and water heating. Four major policies have been identified namely, Standard and Labelling, Incentive Tariff Reform, Residential Building Energy Efficient and Intensify Campaign Awareness.

BRUNEI DARUSSALAM DOMESTIC GAS CONSUMPTION SURVEY (2016)

Surveys on consumption of domestic gas supplies at residences in Belait district was conducted in late October 2016, initiated by the Public Works Department and EIDPMO. The government has commenced the study in order to look for more efficient ways of running the direct gas supply line to reduce wastage. Approximately 10 000 households and businesses in Seria and Kuala Belait (towns in Belait district) are supplied domestic gas directly through pipelines instead of gas cylinders, which are used by a majority of the population.

RENEWABLE ENERGY

Brunei Darussalam has set a long-term target goal that requires 10% of the economy's total power generation mix in 2035 to come from renewable energy sources. 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 (R&D), and technology transfer.

Solar energy is by far the most promising renewable energy source, 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, which can power up about 200 homes with a designed installed capacity of 1.2 MW. It used to be a 3 years demonstration project from July 2010 to October 2013. After 3 years of demonstration projects, the plant managed to generate about 5 514 MWh of electricity, natural gas saving of approximately 48 302 MMBtu and avoiding about 3 939 tonnes of carbon dioxide emission.

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. Meanwhile, for other potential alternative energy sources which include wind power and hydropower may still subject to further R&D collaboration between EIDPMO, BNERI and other agencies both the government and private sectors. Deployment of these alternative energy sources will depend on the maturity of their technologies and has been integrated into the national RE Roadmap on medium-term and long-term timeline.

NUCLEAR

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 twenty-first 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 goals (UNFCCC, 2015):

- To reduce 63% of the economy's energy consumption compared to Business-As-Usual (BAU) scenario;
- To have 10% of the energy mix from the utilisation of renewable energy; and
- To reduce 40% of carbon dioxide emissions from morning peak-hour vehicle use compared with BAU scenario.

Brunei Darussalam's net greenhouse gas (GHG) emission represented a small fraction of approximately 0.016% of global emissions in 2010 (UNFCCC, 2016). Although the contribution to global GHG emissions is, and will remain relatively small, Brunei Darussalam is committed to play a part combatting adverse effects of climate change by ratifying the Paris Agreement under the auspices of the UNFCCC on 21 September 2016. The agreement entered into force on 4 November 2016.

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 3.4 billion oil refinery and aromatics cracker project to be developed by the Zhejiang Hengyi Group Co. Ltd. The project is expected to begin operation in the first half of 2019, with a production capacity of approximately 175 000 bbl/d. The project will produce paraxylene, benzene as well as refined products such as gasoline, jet fuel and diesel. In addition, a new 400 MW 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 30% through the application of combined heat and power integration or cogeneration (EIDPMO, 2017).

Meanwhile, Brunei Gas Carriers Sdn. Bhd (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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USEFUL LINKS

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

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

Brunei Methanol Company Sdn Bhd - <http://www.brunei-methanol.com/>

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

Department of Electrical Services - <http://www.des.gov.bn/Theme/Home.aspx>

Energy and Industry Department, Prime Minister's Office—www.ei.gov.bn

PetroleumBRUNEI—www.pb.com.bn

CANADA

INTRODUCTION

Canada is the world's second largest country after Russia in terms of land mass. The Canada-US border is the world's longest international border and extends from the Pacific Ocean to the west, the Atlantic Ocean to the east and the Arctic Ocean to the north. There are ten provinces and three territories in Canada with a total population of 35.1 million (StatCan, 2016c). Most Canadians reside near the southern border. In 2014, Canada's gross domestic product (GDP) grew by 2.5% to USD 1 498 billion (2010 USD purchasing power parity [PPP]) and GDP per capita grew by 1.4% to USD 42 139 (EGEDA, 2016).

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 7.3% to Canada's GDP in 2015 and indirectly contributed (through purchases of goods and services from non-energy industries) an additional 3.4% (NRCan, 2016c). In 2015, Canada exported CAD 102 billion worth of energy products and imported CAD 40 billion (NRCan, 2016a). Canada is one of the world's top four exporters of crude oil, natural gas, uranium and electricity (NRCan, 2016a).

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 172 billion barrels, of which oil sands accounted for 97% (166 billion barrels) as of May 2016 (NRCan, 2016a). The bulk of the oil sands reserves are in the province of Alberta, although the province of Saskatchewan is also rich in bitumen reserves. Conventional oil reserves exist in most Canadian provinces and territories, including Alberta, British Columbia, Saskatchewan, Ontario, Manitoba, Nova Scotia, Newfoundland and Labrador, the North West Territories (NWT) and the Yukon. However, Alberta and Saskatchewan have the largest onshore reserves, while Newfoundland and Labrador has the largest offshore reserves (NEB, 2015).

Canada has substantial proven gas reserves, which are estimated at more than 70.2 trillion cubic feet (tcf) and equal to 1.1% of global reserves in 2015 (BP, 2016). The largest concentrations of gas reserves are in Alberta and British Columbia. Saskatchewan, Newfoundland and Labrador, New Brunswick, Nova Scotia, the NWT and the Yukon also have established reserves, although significantly smaller (NEB, 2015).

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

Canada has the third largest uranium resources in the world after Australia, and Kazakhstan. As of 2015, Canada's uranium resources were estimated at 509 000 tonnes (WNA, 2016), most of which are located in the Athabasca Basin of northern Saskatchewan. This basin has the world's largest high-grade deposits (NRCan, 2014a). These resources are equal to 9% of the world's known resources, which are recoverable at a price of US\$130 per kilogram. If the price of uranium were to increase in the future, additional uranium deposits would become economically recoverable; therefore, Canada's uranium reserves would increase.

Table 1: Key Data and Economic Profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d, e, f}	
Area (million km ²)	9.9	Oil (billion barrels)	172
Population (million)	36	Gas (trillion cubic feet)	70
GDP (2010 USD billion PPP)	1 498	Coal (million tonnes)	6 600
GDP (2010 USD PPP per capita)	42 143	Uranium (kilotonnes U)	490

Sources: a. EGEDA (2016); b. StatCan (2015); c. CAPP (2016b); d. BP (2016); e. CAC (2016); f. NRCan (2014a).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Canada's domestic energy production reached 470 006 kilotonnes of oil equivalent (ktoe) in 2014. This represented an increase of 5.2% compared with 2013 (446 760 ktoe) (EGEDA, 2016). Fossil fuel dominated this production at about 83% with no major change compared with 2013. Oil, including natural gas liquids (NGL), accounted for the largest share (219 220 ktoe, 47%), followed by gas (137 536 ktoe, 29%) and coal (34 892 ktoe, 7.4%). The share of nuclear energy production was 6% (28 061 ktoe); thereby leaving a share of approximately 11% for renewables. Renewables consisted of hydro (32 901 ktoe, 7%); other renewables (bioenergy), including biomass, wood and waste (15 264 ktoe, 3.2%); and geothermal, solar, wind and ocean (2 131 ktoe, 0.5%) (EGEDA, 2016). Canada is a leading global producer of energy, as evident in its global production ranks for gas (fifth), crude oil (fourth) and hydro (second) as of 2015 (NRCan, 2016a).

Canada is a net exporter of oil, gas, coal and electricity. The economy's energy exports go mainly to the US. Between 2000 and 2014, energy exports grew at an average rate of 2.6% per year. Exports accelerated in 2014 as seen in a 4.4% increase over 2013 (EGEDA, 2016). In 2014, Canada exported 266 826 ktoe of energy, which consisted of crude oil and NGL (151 698 ktoe), petroleum products (22 950 ktoe), gas (65 349 ktoe), coal and coal products (20 603 ktoe), electricity (5 024 ktoe), and renewables (1 203 ktoe) (EGEDA, 2016). In 2014, energy exports accounted for 21% (CAD 102 billion) of domestic merchandise export revenue (NRCan, 2016a).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	470 006	Industry sector	48 703	Total power generation	656 225
Net imports and others	-183 822	Transport sector	62 619	Thermal	134 047
Total primary energy supply	281 021	Other sectors	72 284	Hydro	382 574
Coal	19 472	Non-energy	17 124	Nuclear	107 678
Oil	98 511	Total final energy consumption	200 730	Others	31 926
Gas	88 731	Coal	3 328		
Others	74 308	Oil	92 570		
		Gas	49 850		
		Electricity and others	54 981		

Source: EGEDA (2016).

CRUDE OIL

Canada's oil production has increased for the past two decades. In 2015, it was the world's fourth-largest oil producer. In 2014, Canada produced 219 220 ktoe of crude oil, including NGL. This was an increase of 7.4% from 2013 (EGEDA, 2016). Oil sands' production, which has increased by 146% from 2005-15, first surpassed conventional production levels in 2010 and has long been the main driver of growth in Canadian production (CAPP, 2016a). Production from oil sands, which are mainly located in the Athabasca oil fields in Alberta, has grown consistently since it began in 1967. In 2015, its production reached 2.4 million barrels per day (Mbbbl/D) (CAPP, 2016a), an increase of 11% over 2014 (NRCan, 2016a). Conventional oil production in 2015 was 1.3 Mbbbl/D (NRCan, 2016a), a decrease of 6.3% from 2014 (NRCan, 2016a).

Although Canada's crude oil and equivalent production is geographically dispersed, 95% of the production came from Western Canada, of which 61% was from the oil sands in 2015. The bulk of Canadian crude oil and equivalent production occurred in Alberta (80%), followed by Saskatchewan (13%), British Columbia (1.4%), Manitoba (1.2%) and the NWT (0.3%) (StatCan, 2016c). Offshore production in the Atlantic

Ocean (Hibernia, Terra Nova and White Rose) accounted for 4.4%, except for small-scale production in Ontario (<0.1%) and the Atlantic provinces (<0.1%). Pentanes plus accounted for 5.0% of total crude oil and equivalent production, (StatCan, 2016c).

In 2014, the economy's oil exports, including NGL, (151 698 ktoe) increased over 2013 by 8.6% and a 6.1% decrease of petroleum products (22 950 ktoe) (EGEDA, 2016). The main market was the US.

GAS

Canada holds seventeenth largest proven natural gas reserves in the world, but is a major producer and exporter. Canada is the world's fifth-largest producer and fourth-largest exporter of natural gas (NRCan, 2016a). In 2014, Canada's natural gas production reached 137 536 ktoe, an increase of 5.5% from 2013 (EGEDA, 2016). This increase in production extends the growth from 2013, when gas production began to ramp up again after a seven year period of decline (IEA, 2015b). In terms of exports, the volume of its gas exports was 65 349 ktoe, a decrease of 5.1% compared with 2013 (EGEDA, 2016).

Western Canada accounted for 98% of the economy's gas production in 2015, including Alberta as the largest producer (72%), British Columbia (24%) and Saskatchewan (2%) (StatCan, 2016d). Eastern Canada's gas production was mainly offshore in the Atlantic Ocean (1.3%). Gas production in Ontario has been declining, representing 0.1% of total gas production in 2015 (CAPP, 2016b).

Although conventional natural gas reserves are shrinking, 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, requiring 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. In 2015, British Columbia continued to see most of its current drilling and production activities in the northeast in the Montney and Horn River shale basins, with unconventional gas accounting for almost 80% of total gas production (NRCan, 2016b). Although Alberta's production increased by 2.2% in 2015 over 2014, it declined in all areas except the Duvernay and Montney formations (wet gas) and from shale wells (AER, 2016).

COAL

Annual coal production has experienced minor fluctuations since 2004 (BP, 2016). In 2014, Canada produced 34 892 ktoe of coal, a decrease of 0.8% from its 2013 production (EGEDA, 2016). All of Canada's coal production in 2015 took place in the Western provinces of Canada, including Alberta (43%), British Columbia (43%) and Saskatchewan (14%) (NRCan, 2016a).

Canada is a mid-size coal producer. Approximately half of its annual production of 62 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 (CAC, 2016).

Canada exported 59% (20 563 ktoe) of its coal production in 2014, a 12% decline from its 2013 exports (EGEDA, 2016). Coking coal accounted for 89% of the exports (EGEDA, 2016). In 2015, Canada exported CAD 3.5 billion of coal, of which 72% went to Asia. The remainder was exported to a number of European countries, the US, Latin America, the Middle East and Australia (ISED, 2017).

URANIUM

Canada is among the three leading producers of uranium along with Kazakhstan and Australia. Collectively, these three exporters accounted for about 72% of total global output in 2016 (WNA, 2017). Canada maintained its position as the world's second largest uranium producer in 2016. Canada produced 14 039 tonnes of uranium metal (tU) in 2015 (WNA, 2017), accounting for 22% of global production (WNA, 2016). Canada's 2015 uranium metal production increased by 46% from 2014 (WNA, 2016). Current production is entirely from the Athabasca Basin of northern Saskatchewan (NRCan, 2014a).

The mining and milling of uranium is a major industry (CAD 1.2 billion per annum) and directly employs over 3 000 Canadians at the mine sites (NRCan, 2016a). The two largest-producing uranium mines in the world are both located in Canada; that are McArthur River (6 928 tU) and Cigar Lake (6 666 tU), producing 22% of the total world output in 2016 (WNA, 2017).

NEW AND RENEWABLE

Canada is a world leader in the production and use of renewable energy. The economy has substantial renewable energy resources including bioenergy, hydro, solar, wind, geothermal and ocean energy. In 2014, the economy's total renewable production was 50 297 ktoe, consisting of hydro (32 901 ktoe), bioenergy and waste (15 264 ktoe) and solar, geothermal, wind and ocean (2 131 ktoe) (EGEDA, 2016). Production was 0.1% above the 2013 level (EGEDA, 2016). Renewables accounted for almost 11% of total indigenous energy production in 2014 (EGEDA, 2016).

Hydro is the most important source of renewable energy in Canada, supplying 58% of Canada's electricity generation in 2013 (EGEDA, 2016). In 2015, Canada's installed hydraulic capacity was over 79 232 MW (StatCan, 2016b). 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, 2016a). The installed small capacity was approximately 3 400 MW in 2016.

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 2014, bioenergy was the second most important form of renewable energy, with biofuels and renewable waste representing 5.3% of Canada's total primary energy supply (EGEDA, 2016).

Canada had 70 bioenergy power plants with a total installed capacity of 2 043 MW in 2013 (NRCan, 2015a). 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 the world's biofuel (ethanol and biodiesel) production in 2014, making Canada the fifth-largest producer after the United States, Brazil, the European Union and China (NRCan, 2015a). The federal government, alongside the provinces, has introduced regulations on renewable content to increase future production and the use of biofuels.

Wind is also an important renewable energy source whose provincial leaders are Ontario, Quebec, and Alberta (NRCan, 2015a). 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, 2015f).

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 forecast to grow at a rapid pace, given that the government initiatives are in place and 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, 2016). In May of 2015, Canada surpassed the 10 000 MW threshold to place it seventh in the world for installed capacity (CanWEA, 2016). In 2016, Canada added 21 projects that increased capacity by 702 MW to reach 11 898 MW of wind energy capacity (CanWEA, 2016).

Solar energy has also experienced continuous growth both in thermal and photovoltaic (PV) power. Cumulative PV power capacity grew to 1 843 MW in 2014 (IEA, 2015a). Ontario was the leading province in terms of solar capacity in that year (1 828 MW) (IEA, 2015a). Off-grid capacities were not reported in 2013 but were estimated at approximately 1% of the total installed capacity (IEA, 2015a). 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, 2015a).

Geothermal power has not experienced the momentum of 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, with commission planned in the 2020 timeframe. In 2010, there were over 95 000 ground-source heat

pumps with an installed capacity of about 1 045 megawatts of thermal energy (NRCan, 2015a). NRCan has financially supported the demonstration projects in British Columbia, the NWT, the Yukon and Alberta.

FINAL ENERGY CONSUMPTION

Canada's total final energy consumption (TFEC) in 2014 reached 200 730 ktoe, a slight increase of 0.9% over that of 2013 (EGEDA, 2016). This makes Canada the APEC region's fifth-largest energy consumer after China, the US, Russia and Japan (EGEDA, 2016).

The single largest consumer was the transport sector (62 619 ktoe, 31%) followed by industry (48 703 ktoe, 24%). A combination of smaller sectors, including residential, commercial and public services together with agriculture and non-specified others, accounted for most of the rest (72 284 ktoe, 36%) (EGEDA, 2016). The share of non-energy (fuels used as raw materials and are not consumed as fuel or transformed into another fuel) of Canadian TFEC was 8.5% (17 124 ktoe) (EGEDA, 2016).

Fossil fuels, excluding electricity, accounted for the largest share of TFEC (73%), consisting of petroleum products (92 570 ktoe, 46%), gas (49 850 ktoe, 25%) and coal and coal products (3 328 ktoe, 1.7%) in 2014 (EGEDA, 2016). The remainder was the share of other renewables (11 761 ktoe, 6.0%), electricity (42 075 ktoe, 21%) and heat (900 ktoe, 0.4%) (EGEDA, 2016). Factors contributing to Canada's higher consumption of energy relative to that of other industrialised countries include its cold climate, requiring 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 656 225 gigawatt-hours (GWh) of electricity in 2014, a decrease of 0.7% from the previous year (EGEDA, 2016). Renewables accounted for the largest share of this generation (63%) with hydro as the major contributor (58%). Other renewables included solar, wind and geothermal. The share of nuclear was 16%, which increased the combined share of non-emitting power generation to 80%. The share of oil, gas and coal-fuelled thermal generators was 20% (EGEDA, 2016). Coal accounted for the largest share of the latter (48%), followed by natural gas (43%) and other fossil fuels such as diesel, light fuel oil, heavy fuel, wood and spent pulping liquor (8.8%) (StatCan, 2016a).

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, 2015a).

In November 2015, Alberta followed Ontario's lead by announcing a new policy to accelerate the 2012 federal plan to phase out coal-fired power generation. Alberta's plan will force six coal-fired electricity plants to retire by 2030, rather than on the original federal schedule, which would have allowed the plants to retire according to a pre-determined schedule, ranging from 2036-61, based on the end of useful life (approximately 50 years) (Alberta Energy, 2015; Canada Gazette, 2012). The decision was announced along with a comprehensive climate change plan, discussed in more detail below under the section 'Climate Change'.

In 2016, the federal government additionally announced its plan to accelerate the phase-out of coal-fired electricity generation in Canada by 2030. Flexibility in achieving this goal will be allowed through the negotiation of equivalency agreements with the provinces (GM, 2016). For example, a deal was reached that will allow Nova Scotia to burn some coal after the deadline during periods of high-demand, in exchange for deeper sectoral reductions elsewhere in the economy (CF, 2016).

As part of the 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 began in October 2016 with one reactor, with commitments on subsequent reactors to take into account the cost and timing of preceding refurbishments and allowing for a potential discontinuation of future refurbishment plans for remaining units (PO, 2016a). Refurbishment at Bruce is expected 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 that limit the use of coal have all made Canada's electricity sector increasingly 'greener' (NEB, 2015a). Canada is the APEC region's and the world's second-largest hydroelectricity producer after China (IEA, 2015b). 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 2014, Canada exported 5 024 ktoe of electricity to the US, while importing 1 101 ktoe (EGEDA, 2016). This makes Canada APEC's largest exporter of electricity and the world's second largest after Germany (IEA, 2015b).

The bulk of the electricity trade with the US occurs between the provinces of Québec, Ontario, Manitoba and British Columbia with their neighbouring American states (NEB, 2015a). New capacity additions and low domestic electricity demand resulted in record high Canadian net exports, reaching 55 TWh in 2015 (NEB, 2016b). In 2015, the NEB received the first application for a new international power line (IPL) since 2005, the ITC Lake Erie Connector from Ontario to Pennsylvania, US (NEB, 2016b). According to public sources, four additional IPLs are under consideration with three located in Quebec and one in Manitoba (NEB, 2016b).

ENERGY INTENSITY ANALYSIS

A number of factors contribute to the energy-intensiveness of Canada's economy. These factors 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. Primary energy intensity and final energy consumption intensity fell by 0.5% and 1.8% from 2013 respectively (EGEDA, 2016). This was mainly because of a significant decrease in the energy intensity of industrial (chemicals and petrochemicals, mining and quarrying, and construction), transport (road and rail) and agricultural sectors, which registered the largest sub-sectoral reductions in their energy intensity compared with 2013. Canada experienced a decline in GDP in the first half of 2015, contributing to the decline in energy use because of job losses and production curtailments in natural resource sectors (NEB, 2016a). 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.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	187	188	0.5
Total final energy consumption	136	134	-1.8
Total final energy consumption excl. non-energy	124	123	-0.9

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Canada's federal government and those of its ten provinces and three territories all have a role in shaping the economy's energy policy. 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, 1867; NEB, 2015a).

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, 1985a; NEB,

2015a). 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 mining 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, 1985b; NEB, 2015a).

Energy policy at the federal level involves a number of government agencies that are responsible for development and implementation. Natural Resources Canada (NRCan) is the federal department that is mandated to “ensure that Canada’s resource sector remains a source of jobs, prosperity, and opportunity within the context of a world that increasingly values sustainable practices and low carbon process” (PMO 2015), . The National Energy Board (NEB) is an independent federal regulator responsible for pipelines, energy development and trade issues in the Canadian public interest. The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) is the independent joint agency of the Governments of Canada and Nova Scotia and regulates petroleum activities in the Nova Scotia Offshore Area (CNSOPB, 2017). The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect health, safety, security and the environment, implements Canada’s international commitments on the peaceful use of nuclear energy (CNSC, 2017). Other important government organizations include Environment and Climate Change Canada, Fisheries and Oceans Canada, Indigenous and Northern Affairs Canada, and Global Affairs Canada.

ELECTRICITY MARKETS

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 Canadian market is interconnected at many points with the US, forming a larger grid (NEB, 2014). 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, 2014).

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 exist 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.

In November 2016, Alberta announced the addition of a capacity market to co-exist with the current energy only market. The Alberta Electricity System Operator (AESO) had recommended the implementation of a capacity market in order to provide greater revenue certainty for generators, thereby encouraging investment in new generation capacity while maintaining the competitive market structure used to set wholesale prices (AESO, 2016). A capacity market will serve to support the recommendations of the Climate Leadership Plan as the province moves to phase out coal-fired generation by 2030 and increase the penetration of renewables generation in the electricity mix. The AESO will be responsible for designing and implementing the capacity market. This process will begin with stakeholder engagement and market design in 2017, followed by the first round of procurement in 2019 with contracts awarded by 2020-21 (AESO, 2016).

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 service (COS) plus a reasonable rate of return. There are two exceptions: in Alberta retail electricity prices are derived from a competitive wholesale market, and in Ontario retail prices are set by a combination of market spot prices and a dynamic price component (global adjustment) set to cover the costs of guaranteed rates to generators (NEB, 2013). Transmission and distribution rates across all provinces generally follow the COS operating model described above and are passed on to customers based on fixed and variable components.

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.

The fiscal regime applied to the Canadian oil and gas industry consists of a combination of corporate income taxes and royalty payments. As of 2016, for key oil and gas regions, the following general corporate income tax rates applied.

Table 4: Corporate income tax rates, 2016

CIT rates	British Columbia	Alberta	Saskatchewan	Newfoundland and Labrador	Nova Scotia
Federal	15%	15%	15%	15%	15%
Provincial	11%	12%	12%	15%	16%
Total	26%	27%	27%	30%	31%

Sources: Crisan and Mintz (2016).

Canada does not allow corporations to file consolidated tax returns; each corporation must compute and pay taxes on a separate legal entity basis. Non-capital losses (business losses) can be carried back three years and carried forward 20 years. Capital gains are subject to tax at one-half the capital gain (taxable capital gain) at regular income tax rates. Capital losses are exclusively deductible against capital gains and can be carried back three years and forward indefinitely or until the company is acquired. Non-capital losses can be deducted against taxable capital gains (EY, 2016).

Royalty regimes (or rent-based taxes) are set by the owner of the resource, typically the applicable province, but a small percentage have petroleum rights owned by surface owners (freehold land) or First Nations. The resource owner leases the land to potential developers in exchange for a fee (land sale) and royalty agreement. Parcels of crown land are auctioned off to the highest bidder for a fixed period, often with clauses tied to maintaining an active interest in the parcel (i.e. drilling or production). Royalty regimes vary both by province and by commodity and are typically paid based on a combination of well productivity and wellhead price (EY, 2016). Royalties paid are deductible for tax purposes.

Table 5 describes the basic structure of royalty regimes across Canada, as published in a report by Chen & Mintz (2012) and updated to reflect recent changes to existing structures in Crisan & Mintz (2016), both of which were published through the University of Calgary, School of Public Policy:

Table 5: Summary of regional royalty regimes, 2016

Province	Royalty	Rent-based tax
British Columbia	For conventional oil and gas, the royalty is based on gross revenue. The royalty rate differs first by product category, such as density of oil or type of gas (i.e., conservation vs. non-conservation gas) and by well age (except for heavy oil and conservation gas). Formulation of the royalty rate for a given product category differs between oil and gas. For oil, the royalty rate is sensitive mainly to productivity; for gas, it is sensitive only to price. For certain high-cost shale gas projects,	For certain high-cost shale gas projects, a newly introduced net profit royalty program with four tiers of royalty rates applies: a pre-payout of 2% royalty on gross revenue and three post-payout tiers associated with a royalty that is the greater than 5% of gross revenue and a higher rate of net revenue (i.e., 15%, 20%, or 35%, depending on the tier order). To reach each of the three tiers of net royalty, a progressive return allowance applies.

	there is a pre-payout of 2% royalty on gross revenue (refer to next column).	
Alberta <i>(Updated)</i>	For conventional oil and gas, under the new regime, the royalty rate on sales will remain price-sensitive but unrelated to volume until a threshold is reached (royalty rates decline when production drops below 194 cubic metres per month or approximately 40 barrels per day). A cost recovery allowance, sensitive to well depth but otherwise based on industry experience, will be provided instead of various drilling incentives. The new system includes a consolidation of royalty rates for fuel types produced from a well, as well as a 5% minimum royalty on sales until the cost allowance is used up. Further, the government has also announced two new programs—the Enhanced Hydrocarbon Recovery Program and the Emerging Resources Program—that will provide an allowance for eligible costs with a corresponding royalty rate of 5%. Once the cost allowance is depleted, the new royalty rates will apply.	For oil sands only, in addition to a pre-payout gross royalty, there is a net royalty of 25-40% after payout depending on the price level of the oil. The regime remained unchanged after a review in 2015.
Saskatchewan	The crown royalty and the freehold production tax (FPT) on oil and gas are determined using formulas containing parameters that are adjusted monthly by the government. Both royalty and FPT are sensitive to price and well productivity and differ by product in terms of their vintage and characteristics (for example, type of product, well and location). The FPT is lower than the crown royalty by a production tax factor (PTF), which varies by the type of product and ranges from 6.9-12.5%.	None.
Newfoundland and Labrador <i>(Updated)</i>	The province introduced a new, generic offshore-oil royalty regime in November 2015 based on the R-factor approach (revenue over accumulated cost index). The system includes a basic royalty rate ranging from 1-7.5% applied to gross revenue as the project starts producing oil, increasing as the project recovers more of its costs. After costs have been recovered, a net royalty ranging from 10-50% will be applied to net revenue varying by the R-factor, and the basic royalty becomes a credit against net royalties.	A two-tier net royalty (20% and 10%), along with a two-tier return allowance, applies after payout. Tier 1 net royalty applies after all the project costs and the basic gross royalty and the compounded Tier 1 return allowances are exhausted. Tier 2 royalty becomes payable after the payout of both gross royalty and Tier 1 net royalty along with the Tier 2 return allowance. The return allowance is 5% above LTBR for Tier 1 and 15% above LTBR for Tier 2.
Nova Scotia	The revenue-based or gross royalty is two-tiered: 2% before payout and 5% after payout. It is deductible for calculating the base for the net-revenue royalty. Note that regardless of the revenue and profit level reached, the 2%	The two-tier net royalty rate is 20% and 30%, depending on the net-revenue tier reached. Even after the net royalties become payable, only the greater rate of the 5% of gross revenue and 20% or 35% of the net revenue is

	gross royalty applies for a minimum of 24 months, and the 5% gross royalty applies for a minimum of 36 months. This implies that there is no net royalty, or rent tax payable for the first five years after the commencement of production.	payable. To reach each of the two tiers of the net royalty scheme, a progressive return allowance applies: 20% above LTBR for Tier 1 and 45% above LTBR for Tier 2.
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Sources: Chen & Mintz (2012); Crisan & Mintz (2016).

Canada has three expenditure pools that are particularly relevant to the oil and gas sector.

- Oil and gas rights expenditures are accumulated in a pool called a Canadian Oil and Gas Property Expense (COGPE) – deductible at up to 10 per cent on a declining balance bases.
- Drilling and completion expenditures are accumulated in a pool called Canadian Development Expense (CDE) – deductible at up to 30 per cent per year on a declining balance basis.
- Exploration expenditures are accumulated in a pool called Canadian Exploration Expense (CEE) – immediately deductible in the year incurred.

Although Canada does not currently export LNG, an LNG tax was conceptualised and enacted in British Columbia, which went into effect on 1 January 2017. It involves profits from an LNG source applied only to a ring-fenced set of activities from the input of feed gas to a sale from the BC coast (EY, 2016). The tax is two-tiered: a Tier 1 tax of 1.5% applies to an LNG operator's net operating income and a Tier 2 tax of 3.5% applies to net income. The Tier 1 tax is creditable against the Tier 2 tax, such that the maximum aggregate tax payable is the Tier 2 rate. This tax is not deductible under federal or provincial income tax legislation (EY, 2016). In addition, a natural gas income tax credit, 3% of natural gas purchased for operations, was introduced to reduce CIT (EY, 2016).

Indirectly, the energy sector is subject to general, provincial and harmonised sales taxes as well as climate related policies such as carbon taxes or cap-and-trade systems. However, businesses paying GST/HST are eligible to receive input tax credits (ITCs) to the extent that purchases are for consumption, use, or supply in commercial activities. Climate policies will be discussed in more detail in the 'Climate Change' section.

Private and state-owned international oil companies' investments in Canada's oil and gas sector have risen rapidly. Foreign investors are estimated to own 40–50% of the Canadian oil and gas sector as of February 2015 (TCP, 2016).

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, 2016).

Among the many existing guidelines, a 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 equivalent to natural gas combined cycle (NGCC) technology, a high-efficiency type of natural gas generation, at 420 tonnes per GWh (GOC, 2012). It also contains a caveat in order to encourage new technology for the reduction of greenhouse gas (GHG) emissions whereby units that incorporate carbon capture and storage (CCS) technology can apply to receive a temporary exemption from the performance standard until 31 December 2024 (GOC, 2012).

ENERGY EFFICIENCY

The federal and provincial governments have joint responsibility for energy efficiency, but their roles and responsibilities vary and target different aspects. 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, 1992). 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.

NRCan through its Office of Energy Efficiency (OEE) administers the Energy Efficiency Act 1992 and related efficiency issues at the federal level. 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, 2015b).

Since 2011, the federal government has committed CAD 3 million to support alternative fuels used in the transport sector (NRCan, 2015c). Federally, an additional CAD 1.5 billion of funding was available for the period 2008–17 to support the production of renewable alternatives to gasoline and diesel for the development of a competitive domestic industry (NRCan, 2015c).

Additionally, The Federal Buildings Initiative (FBI) is a Natural Resources Canada initiative, implemented in 1991, aimed at assisting federal departments and agencies to reduce the energy consumption and greenhouse gas emissions of their facilities. (NRCan, 2015d). This voluntary program provides knowledge, training and expertise that helps custodial departments through the process of undertaking energy efficiency retrofit projects in their buildings, and assists them to plan for an energy performance contract that allows major retrofits to be self-financing. No upfront capital funds are required as future energy savings pay for the investment. As of 2015, over 80 retrofit projects attracted hundreds of millions of dollars in private sector investments. These projects have resulted in an impressive 15 to 20 percent energy savings on average. Annual savings of \$44 million have been reinvested into programs for Canadians while reducing the impact of government operations on the environment. (NRCan, 2015d).

CLEAN ENERGY RESEARCH AND DEVELOPMENT

Canada is committed to the research, development and demonstration (RD&D) of clean energy technology. At the federal level, NRCan plays a central role in federal activities related to clean energy RD&D. It funds RD&D activities by stakeholders, including industry, and the national Canmet laboratories. NRCan’s CanmetENERGY and CanmetMATERIALS research centres lead in performing clean energy research and development. The federal government supports clean energy, including industry and buildings; vehicles and transportations; renewable energy such as small hydro, wind, solar, bioenergy, and marine energy; nuclear energy; cleaner fossil energy and carbon capture, utilization and storage; hydrogen and fuel cells; smart grids; energy storage; advanced materials and basic energy research. The Canmet laboratories engage in research, development and demonstration to accelerate clean energy and clean technologies towards commercialisation and self-sustainability (NRCan, 2015e).

The federal budget of 2017 provided funding for a large number of initiatives related to clean energy and clean technology. These include:

- Smart Grids (Lead: NRCan) – \$35M/4yrs to demonstrate key emerging smart grid technologies (e.g., virtual power plants, self-healing grid) essential to integrate a higher proportion of renewables onto the grid and manage expanded electrification of the economy.
- Net-Zero Buildings (Lead: NRCan) – \$64M/8yrs for RD&D to drive down the cost and create market confidence in net zero construction to enable P/T adoption of more stringent codes, starting in 2022.
- Remote Communities (Lead: NRCan) – \$60M/6yrs to demonstrate innovative clean energy solutions for northern communities and to build community capacity to integrate new energy technologies to reduce their reliance on diesel power.
- Electric Vehicle Infrastructure (Lead: NRCan) – \$30M/4yrs to demonstrate next generation electric vehicle charging technologies to improve cost/performance and accelerate commercialization and uptake.

- Energy Innovation Program Funding (Lead: NRCan) – \$210M/4yrs to continue core clean energy innovation programming.
- Clean Tech International Business Development Strategy (Lead: Global Affairs Canada) – \$15M/4yrs to develop a clean technology strategy to support Canadian firms in becoming world leaders in clean technology.
- Strategic Innovation Fund (Lead: Innovation Science and Economic Development (ISED) – \$100M/5yrs for clean technology commercialization.
- Sustainable Development Technology Canada SD Tech Fund (Lead: ISED) – \$400M/5yrs for development and demonstration of clean technologies.
- Superclusters (Lead: ISED) – \$950M/5yrs for a small number of business-led innovation “superclusters” (e.g. clean technology, clean resources, advanced manufacturing).
- Innovative Solutions Canada: Procurement (Lead: ISED) – up to \$50M, starting in 2017-18 for a new procurement program, modelled on the U.S. Small Business Innovation Research program.
- Venture Capital Catalyst Initiative (Lead: Business Development Bank of Canada (BDC) – \$400M/3yrs to support continued growth of Canada’s innovative companies with late-stage venture capital.
- Financing for Clean Tech firms (Lead: BDC/Export Development Canada) – \$1.4B in new financing equity finance, working capital and project finance to grow promising clean technology firms.
- Smart Cities Challenge Fund (Lead: INFR) – \$300M/11yrs as part of the wider Impact Canada Fund.

Nuclear energy R&D is supported by the \$76 million Federal Nuclear Science and Technology Program that supports core federal responsibilities at Chalk River Laboratories. In 2016, the federal government also committed \$800 million over five years to revitalize infrastructure at Chalk River. These investments help give effect to Canada’s participation in multilateral and bilateral collaborations on advanced nuclear technologies, including the Generation IV International Forum and bilateral partnerships with key partners such as the United States and China.

NUCLEAR POWER

Nuclear energy is an important component of Canada’s energy mix. In 2014, nuclear energy accounted for 16% of its electricity generation (EGEDA, 2016). Canadian nuclear power generation is concentrated in the provinces of Ontario (18 reactors) and New Brunswick (one reactor). In 2012, Gentilly 2, 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 (CNA, 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 1985¹ (NRCan, 2016f). They provide the framework for developing nuclear energy in Canada.

The federal government is the central body that regulates nuclear energy. However, the decision to invest in nuclear power plants for electricity generation rests with the provinces (in concert with relevant provincial energy utilities) (NRCan, 2016f). 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.

¹ The Nuclear Liability and Compensation Act (NLCA), which entered into force on January 1, 2017, repealed and replaced the previous Nuclear Liability Act of 1985. 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 increases the operator’s liability limit from CAD 75 million under the previous Nuclear Liability Act to CAD 1 billion, an amount to be phased in from CAD 650 million in 2017 to CAD 1 billion in 2020.

Investments of CAD 25 billion will be made into the refurbishment of ten nuclear reactors in Ontario: 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 began 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 scheduled 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, 2016). Climate change is a complex issue making Canada's approach multifaceted and layered at the provincial, federal and international levels. Canada's international commitments support and drive action at the federal and provincial levels. Canada is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and has also committed to fulfilling the GHG reduction target stemming from Twenty-First Conference of the Parties (COP21) in December 2015 (the Paris Agreement).

Section 91 of the Constitution Act, 1867 gives the federal government the authority to make laws on a broad range of issues. Section 92 sets out the issues for which the provinces may make laws. The environment is not explicitly listed in either section. As a result, there is often overlap and uncertainty in terms of which level of government is responsible for various aspects of the environment. Based on a number of Supreme Court of Canada decisions, protection of the environment is recognized as a matter of shared jurisdiction between the Parliament and provincial legislatures.

Since 2015, Canada has seen significant changes to its climate policy, most notably with the Pan-Canadian Framework on Clean Growth and Climate Change (the Pan-Canadian Framework), which was developed collaboratively by federal, provincial and territorial governments and with input from Canadians, including businesses, non-governmental organizations, and Indigenous Peoples.

PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE

As a first step towards implementing the commitments Canada made under the Paris Agreement, First Ministers released the Vancouver Declaration on Clean Growth and Climate Change on March 3, 2016. Through the Vancouver Declaration, working groups were established to develop options for pricing carbon pollution; complementary actions to reduce emissions; adaptation and climate resilience; and clean technology, innovation and jobs. The working group process was supported and informed by an extensive process to engage Indigenous Peoples, experts, stakeholders and the public.

As a result of these efforts, the Pan-Canadian Framework was adopted by First Ministers on December 9, 2016. It is a comprehensive plan to reduce emissions across all sectors of the economy, accelerate clean economic growth, and build resilience to the impacts of climate change. The actions, outlined in the Pan-Canadian Framework and supported by federal investments announced in Budgets 2016 and 2017, will enable Canada to meet or even exceed its target to reduce emissions to 30% below 2005 levels by 2030.

The Pan-Canadian Framework builds on the leadership of provinces and territories and the diverse array of policies and measures already in place across Canada to reduce greenhouse gas emissions in all sectors of the economy. Many of the policies and measures in the Framework are intended to be scalable to enable increasing ambition over time, and will be subject to ongoing evaluation in order to ensure that Canada is able to meet its current and future climate change commitments. Pricing carbon pollution is central to Canada's climate plan. The Government of Canada has outlined a benchmark for pricing carbon pollution that will build on existing provincial systems and expand carbon pricing across Canada in 2018. Provinces and territories may choose to implement a price-based system or a cap-and-trade system. Jurisdictions with a price-based system should have a minimum price of \$10 per tonne in 2018, rising to \$50 per tonnes by 2022. Provinces with cap-and-trade systems must have (i) a 2030 emissions-reduction target greater than or equal to Canada's 30 percent reduction target and (ii) declining (more stringent) annual caps to at least 2022 that correspond, at a minimum, to the projected emissions reductions resulting from the carbon price that year in price-based systems. Revenue generated by carbon pricing will remain in the jurisdiction of origin. The federal government plans to introduce new legislation and regulations to implement a carbon pollution pricing system – the backstop – to be applied in jurisdictions that do not have carbon pricing system that align with the benchmark.

The Pan-Canadian Framework includes commitment for a review of the overall approach to pricing carbon by early 2022 to confirm the path forward. An interim report will be completed in 2020. As an early deliverable, the review will assess approaches and best practices to address the competitiveness of emissions-intensive, trade-exposed sectors.

In addition to carbon pricing, the complementary mitigation measures included in the Framework will enable Canada to achieve emissions reductions across all sectors, both in the near-term and as part of a longer-term strategy. Expanding the use of clean electricity and low-carbon fuels are foundational actions that will reduce emissions across the economy.

To increase the use of low-carbon fuels, the federal government, working with provincial and territorial governments, industry and other stakeholders, will develop a clean fuel standard to reduce emissions from fuels used in transportation, buildings, and industry.

Using a mix of regulations and investments, Canada will also continue to drive down emissions from electricity. This will include new regulations to accelerate the phase-out of traditional coal units by 2030 and performance standards for natural gas-fired electricity. These actions will be complemented by investments to modernize Canada's electricity systems, including in smart grid and energy storage technologies, and new and enhanced transmission lines to connect new sources of clean power with places that need it.

In addition to transitioning to lower-carbon fuels and clean electricity in the built environment, transportation, and industrial sectors, Canada will take action to reduce energy use by improving energy efficiency, fuel switching and supporting innovative alternatives. In the built environment sector, this will include developing "net-zero energy ready" building codes to be adopted by 2030 for new buildings; retrofitting existing buildings based on new retrofit codes and providing businesses and consumers with information on energy performance; and improving energy efficiency of appliances and equipment.

Actions in the transportation sector include continuing to set increasingly stringent standards for light- and heavy-duty vehicles, as well as taking action to improve efficiency and support fuel switching in the rail, aviation, marine, and off-road sectors. Canada will also be developing a zero-emissions vehicle strategy by 2018 and investing in infrastructure to support zero-emissions vehicles; and investing in public transit and other infrastructure to support shifts from higher- to lower-emitting modes of transportation.

To reduce emissions from industrial sectors, Canada is developing regulations to achieve a reduction of methane emissions from the oil and gas sector, including offshore activities, by 40-45 percent by 2025. Federal, provincial, and territorial governments will work together to help industries improve their energy efficiency and invest in new technologies to reduce emissions, including in the oil and gas sector. Canada has also committed to finalizing regulations to phase down the use of hydrofluorocarbons in line with the Kigali Amendment to the Montreal Protocol.

Other actions in the Pan-Canadian Framework include protecting and enhancing carbon sinks including in forests, wetlands and agricultural lands, identifying opportunities to generate renewable fuel from waste and demonstrating leadership by reducing emissions from government operations and scaling up the procurement of clean energy and technologies. The Framework also includes support for clean technology and innovation that promote clean growth, including for early-stage technology development, establishing international partnerships, and encouraging "mission-oriented" research to help generate innovative new ideas and create economic opportunities. —Other complementary actions include support for research, development, demonstration and adoption of clean technology in Canada's natural resource sectors, an Impact Canada Fund to support clean technology and a Smart Cities Challenge.

The Pan-Canadian Framework also recognizes the importance of building climate-resilience and sets out measures to help Canadians understand, plan for, and take action to adapt to the unavoidable impacts of climate change. For example, the federal government will establish a new Canadian Centre for Climate Services and work with provinces and territories and other partners to build regional adaptation capacity and expertise that will make it easier for governments, communities, and businesses to access and use climate data and information to make adaptation decisions. Measures to build resilience through infrastructure include climate-resilient codes and standards and a fund to build natural, large-scale infrastructure projects that support mitigation of natural disasters, extreme weather events and climate resilience. A national action plan will be

developed to respond to a range of health risks caused by climate change, including extreme heat and infectious diseases such as Lyme disease.

With the understanding that Indigenous Peoples and coastal and northern regions are particularly vulnerable to climate impacts, action is also being taken to help these communities. This includes support for Indigenous Peoples to monitor changes in their communities and take action to address climate impacts, including repeated and severe flooding. In addition, targeted funding will be provided to enhance resilience in northern communities by increasing capacity to adapt and improve the design and construction of northern infrastructure.

To support these measures, the Government of Canada has announced a number of significant investments. These include:

- A \$2 billion Low Carbon Economy Fund to support new provincial and territorial actions to reduce emissions by 2030;
- \$21.9 billion to support green infrastructure, including for electricity, renewable energy, reducing reliance on diesel in Indigenous, northern and remote communities, electric vehicle charging and natural gas and hydrogen refuelling stations, new building codes, and disaster mitigation and adaptation;
- \$20.1 billion to support urban public transit; and,
- Over \$2.3 billion in funding for clean technology initiatives, including nearly \$1.4 billion in funding, dedicated to financing clean technology firms. These investments support Canada's commitment in Mission Innovation to double investment in clean energy research, development and demonstration over the next five years.

In addition, the Pan-Canadian Framework highlights specific provincial and territorial actions to reduce greenhouse gas emissions, implement carbon pricing, and accelerate clean growth as well as identifies areas to explore further federal-provincial-territorial collaboration.

PROVINCIAL

Each province develops and implements policies, regulations and initiatives in an effort to mitigate climate change by reducing GHG emissions, and support transition to clean growth. The below examples of regulations and programs focused on reducing direct GHG emissions include those highlighted in the Pan-Canadian Framework, as well as new initiatives post-adoption of the Framework.

- **British Columbia:** The province introduced a revenue-neutral carbon tax in 2008, which is applied to the purchase or use of fossil fuels within the province at a current rate of CAD 30 per tonnes of CO₂ equivalent (PBC, 2016a). In 2015, BC formed a Climate Leadership Team that reported 32 considerations for updating the current climate plan. In August 2016, the province announced 21 new measures to reduce net annual emissions by up to 25 Mt by 2050, but did not increase the price of carbon tax as recommended, citing competition with other jurisdictions. Examples of the measures adopted include a target to reduce fugitive and vented methane emissions by 45% by 2025 in infrastructure built before 2015, increasing the low-carbon fuel standard and transitioning to 100% clean energy on the integrated electricity grid by 2025 (PBC, 2016b).
- **Alberta:** In November 2015, Alberta announced the results of its Climate Leadership Plan (CLP) panel recommendations, which included a CAD 20/tonne economy-wide carbon price beginning in 2017, increasing to CAD 30/tonne in 2018 (GOC, 2016). The price will continue to increase thereafter, in real terms, as long as comparable action is taken in competing jurisdictions. The province also announced a cap on GHG emissions from oil sands production (excluding upgrading and cogeneration) of 100 Mt per year, a commitment to phase out coal-generated electricity by 2030, and a target to competitively procure 5 GW of renewable energy capacity by 2030. The CLP included provisions to address secondary impacts of the policy, including rebates for low-income earners, output-based allocations for trade-exposed energy intensive industries and transitional support for coal communities (PA, 2015). The output-based allocation system will replace the Specified Gas Emitters Regulation on large facilities.

- 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. Since October 2014, the plant has captured over 1.25 million tonnes of carbon dioxide (SaskPower, 2016). 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. In 2015, Saskatchewan announced a goal to double the percentage of renewable generation capacity to 50% by 2030 (SaskPower, 2015).
- Manitoba: Manitoba is currently developing a climate plan that is expected to include: carbon pricing, investments in clean technologies, land use and conservation measures, modifications to the building code, measures to support carbon neutrality in government and infrastructure, and measures to encourage the adoption of fuel savings technologies. An online poll was available until March 31, 2017 to consult with Manitobans (PM, 2017).
- Ontario: In 2015, Ontario announced a plan to join the cap-and-trade market currently operating in Quebec and California. Ontario's cap-and-trade system began in 2017 and covers facilities and natural gas distributors with emissions of 25 Mt or more per year, including fuel suppliers that sell more than 200 litres of fuel per year and electricity importers. Emission allowances are distributed to participants that are not a) electricity generators or involved in electricity importation and transmission, b) producing or supplying petroleum, or c) distributing natural gas. Ontario intends to link with the Quebec-California cap-and-trade system in 2018 (PO, 2016b). Ontario has also announced that it will create a green bank to finance low-carbon energy technologies to reduce pollution from buildings (PO, 2016c).
- Quebec: Quebec has an economy-wide cap-and-trade system that is linked with California. In 2015, Quebec adopted a 37.5% reduction target for emissions, below 1990 levels by 2030 (GOC, 2016).
- New Brunswick: The province has GHG emissions reductions targets that reflect a total output of 10.7 Mt by 2030 and 5 Mt by 2050. New Brunswick plans to phase out coal-fired generation as soon as possible and to establish a price on carbon, either through a carbon tax or cap-and-trade program. Revenue from carbon pricing would be allocated to a climate change fund (PNB, 2016).
- 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). In November 2016, Nova Scotia and the Government of Canada agreed to negotiate a new equivalency agreement regarding federal coal-fired electricity regulations, in light of the federal intent to accelerate the phase-out of coal-fired electricity generation by 2030. In December 2016, Nova Scotia committed to establish a cap and trade program to comply with the pan-Canadian approach to pricing carbon pollution. (PNS, 2017).
- Newfoundland and Labrador: In 2016, the province created a new fund for clean technology, funded through a form of carbon pricing on large industry (PNFLD, 2016). The *Management of Greenhouse Gas Act* passed in June 2016 and aims at reducing GHG emissions from large-emitters. Newfoundland and Labrador is in the process of developing a new climate change action plan (PNFLD 2016b).

INTERNATIONAL

Canada has been active on the international climate change stage. Prior to the Paris Agreement, Canada signed the Copenhagen Accord (2009) and committed to reducing GHG emissions to 17% below 2005 levels by 2020 (EC, 2013). Since the end of the Doha round of negotiations under the UNFCCC in December 2012, Canada has continued its engagement in the negotiations to support the establishment of a fair and comprehensive global climate change regime, leading up to signing of the Paris Agreement in 2016.

In 2015, Canada announced it would contribute CAD 2.65 billion over the next five years to help developing countries tackle climate change. The contribution supports the commitment made under the 2009 Copenhagen Accord to work to mobilise climate finance to reach USD 100 billion annually by 2020 (GOC,

2016). In addition, Canada was one of the 197 signatories to the Kigali agreement, an amendment to the Montreal Protocol, to reduce the use of factory-made hydrofluorocarbon (HFC) gases.

From September 3 to 9, 2017, Canada will host the 46th session of the Intergovernmental Panel on Climate Change (IPCC) in Montréal. Hundreds of scientists and representatives from 195 countries will gather to advance the science of climate change and to decide the scope of the sixth IPCC assessment report. This report will provide the most up-to-date international scientific knowledge on climate change, and it will play an important part in supporting the implementation of the Paris Agreement and the Pan-Canadian Framework on Clean Growth and Climate Change.

Canada has been a member of IPCC since its inception in 1988. Canada makes significant scientific contributions to the IPCC, with Canadian scientists holding leadership positions on the IPCC's scientific advisory body and Task Force on National Greenhouse Gas Inventories and serving as authors for IPCC reports.

NOTABLE ENERGY DEVELOPMENTS

LNG DEVELOPMENTS

CANADIAN LNG PROJECTS

There are twenty-seven proposed LNG export projects on Canada's west and east coast with a total export capacity of 360 million tonnes per annum (mtpa) of LNG (approximately 49 billion cubic feet per day (Bcf/d) of natural gas). To date, the NEB has issued export licences to 24 LNG projects, including three 40-year export licences to LNG Canada (May 2016), WCC LNG (October 2016), and Pacific NorthWest LNG (December 2016).

The Pacific NorthWest LNG project was approved by the Government of Canada in September 2016. On January 31, 2017, the Government of Canada, British Columbia, Lax Kw'alaams Band and Metlakatla First Nation reached an agreement on environmental monitoring. After acquiring all major required regulatory approvals, the Woodfibre LNG proponent authorized US\$1.6 billion for the project to proceed on November 4, 2016. Construction of the Woodfibre LNG project could start within 2017 and up to 2.1 million tons of LNG per year (0.3 Bcf/d) could be exported starting in 2020. The LNG Canada project is currently under the regulatory permitting phase and is expecting a final investment decision in late 2017. On March 9, 2017, Shell, one of the proponents of the LNG Canada project, reiterated that it would continue to work on the project, given the advanced stage of the project and its natural advantages.

CANADIAN LNG FACILITY REGULATORY REQUIREMENTS

The NEB federally regulates the exports of LNG and issues export licences for LNG facilities. Governor in Council approval is required before the NEB can issue a long-term export licence. When considering LNG export licences, the NEB assesses whether Canada's supply of natural gas is large enough to accommodate the economy's domestic needs and proposed quantity of LNG exports, while considering the trends in the discovery of gas in Canada. Most LNG export facility proposals require both federal and provincial environmental assessments and permits. The operation of LNG export facilities generally falls under provincial regulation. Additionally, most of the proposed LNG export facilities require new pipelines or expansion of the existing pipelines. Intra-provincial pipelines are provincially regulated, while pipelines that cross a provincial or international border are federally regulated.

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 producing reserves are far from the major refining hub on the US 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, several pipeline proposals are in the regulatory process or have recently received approval.

The federal government granted approval to two pipeline projects in 2016, the expansion of Kinder Morgan's Trans Mountain pipeline, flowing from Edmonton, AB to Vancouver, BC, and the expansion of Enbridge's Line 3 pipeline from Edmonton, AB to Superior, WI. During the same announcement, Enbridge's Northern Gateway pipeline project (greenfield construction) was rejected. Prime Minister Trudeau cited Alberta's recent Climate Leadership Plan as vital to the approval of both pipeline expansions (CP, 2016).

ARCTIC AND OFFSHORE ENERGY

Exploration and study by the oil and gas industry and the Geological Survey of Canada has long indicated a strong potential for petroleum discoveries in Canada's northern region, particularly the Arctic section. However, the costs of developing the fields and transporting oil and gas to markets 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).

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 late 2016, the federal government announced a plan to ban offshore oil and gas licensing in the Arctic, in order to protect the environment, as part of a joint announcement with the US. Currently there is no active drilling in the Canadian Arctic, due to the economic viability of these projects, and the last well drilled was completed in 2006 (TS, 2016).

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USEFUL LINKS

- Atomic Energy of Canada Ltd—www.aecl.ca
- Canada Gazette—www.gazette.gc.ca
- Canada-Nova Scotia Offshore Petroleum Board—<http://www.cnsopb.ns.ca/>
- Canadian Nuclear Laboratories—www.cnl.ca
- Canadian Nuclear Safety Association—<http://nuclearsafety.gc.ca>
- Environment and Climate Change 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. It is located in the south-west of South America and shares borders with Peru to the north and Bolivia and Argentina to the west. Its coastline runs along the Pacific Ocean for 6 435 km, with an average width of 175 kilometres (km) and a land area of 756 102 square kilometres (km²). Administratively, Chile is divided into 54 provinces and 15 regions headed by regional governors (intendente) appointed by the President. In 2014, the economy's population was estimated at approximately 18 million, with 87% living in urban areas and 40% percent of the population residing in the Metropolitan Region (RM), (INE, 2016).

Chile's economic growth is based on solid macroeconomic fundamentals, such as fiscal responsibility, an independent central bank with an explicit inflation target and a floating exchange rate system. Chile has almost tripled its gross domestic product (GDP) per capita from USD 8 175 in 1990 to USD 19 438 in 2014 (2015 USD purchasing power parity [PPP]). It is one of the fastest growing economies in South America with an average annual growth rate (AAGR) of 4.9% between 1990 and 2014. In 2014, Chile's GDP reached USD 344 billion (2015 USD PPP), which represents an increase of 1.7% from 2013 levels. Foreign direct investments, closely related to mining investments, decreased by 35% to USD 17 billion in 2014 from 2013 levels owing to lower commodity prices (UNCTAD, 2015). Chile's economic activity is highly correlated with final energy consumption, where the mining and industry sectors accounted for 45% of final energy consumption in 2014 (IEA 2015) and represented around 24% of Chile's economic activity (INE, 2016). Almost 95% 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 (DIRECON 2015).

Chile's economic activity shows a reduction in its final energy consumption, where the mining and industry sectors accounted for 35% of final energy consumption in 2015 and represented around 22% of Chile's economic activity (INE, 2016). The economy has shown a remarkable reduction in energy intensity.

Despite the diverse geography and abundant natural resources, the territory is very limited in fossil fuel resources, making Chile a net importer of fossil fuels; 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 68% of total primary energy supply (TPES) in 2014). Chile imports around 96% of its oil, 81% of its gas and 67% of its coal, but despite high oil and gas import dependence, hydro and non-conventional¹ renewables contributed about 30% of TPES in 2014 (Energy Balance 2014 CNE – Chile - <http://datos.energiaabierto.cl/dataviews/111597/-/>).

Oil production declined from 15 million barrels in 1981 to 1.1 million barrels in 2015 (Agostini and Saavedra, 2009; ENAP (2016)), 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). Exploration in natural gas during 2015 was around USD 290 million.

¹ Solar, Wind, Biomass and Biogas.

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves ^{b, c, d}	
Area (km ²)	756 102	Oil (million barrels)	150
Population (million)	18	Gas (million cubic metres)	9
GDP (2010 USD billion PPP)	354	Coal (million tonnes)	171
GDP (2010 USD PPP per capita)	19 895	Uranium (kilotonnes U)	3.7

Sources: a. EGEDA (2016); b. MEC (2014); c. EIA (2014); d. CCHEN (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

According to the Expert Group on Energy Data Analysis 2015, APEC Energy Working Group (EGEDA), Chile's TPES decreased by 6.7% from 2013 to 2014 to reach 36 061 kilotonnes of oil equivalent (ktoe). Approximately 45% of this energy volume was supplied in the form of crude oil and its by-products, 18% as coal, 10% as natural gas and the remaining 26% as other sources, particularly renewables including 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 66% of the TPES, having reduced by nearly 6% from 2010 to reach 24 293 ktoe in 2014.

In regard to fossil energy resources, Chile's proven 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 17 124 ktoe in 2014 came from imports that also included by-products such as diesel, gasoline and liquefied petroleum gas (LPG) (EGEDA, 2016). Eighty per cent of Chile's demand of 3 570 ktoe for natural gas in 2014 was met by imports and the rest by domestic production (EGEDA, 2016). Chile's domestic coal production is mainly located in the region of Magallanes, with total recoverable coal reserves estimated at 171 million tonnes. In 2014, domestic production accounted for 31% of the total supply (EGEDA, 2016).

Chile is abundant in renewable energy (RE) resources, whose contribution to the TPES is high, totalling 9 552 ktoe and representing nearly 75% of the economy's total domestic energy production in 2014 (EGEDA, 2016). Chile's primary supply of non-fossil energy in 2014 mainly consisted of biomass and hydropower.

In 2014, Chile's total net installed electricity capacity was 22 809 megawatts (MW), representing an increase of 4 209 MW (23%) from 2013, with thermal power plants representing 70% of the total capacity. The remainder was contributed mainly by hydropower (27%). 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.

In 2016, Chile's overall net installed electricity capacity was 20 868 megawatts (MW) with thermal power plants representing 56% of the total capacity, hydropower 31% and other renewables 12%. By 2016, Chile's electric system was organised around the following subsystems (CNE 2016):

- Northern Grid (SING): 4009 MW, 93% thermal (49% coal and 36% natural gas, and 8% oil and diesel), 7% renewables (5% PV, 2% wind);
- Central Interconnected System (SIC): 16695 MW, 48% thermal (16% oil, 18% natural gas and 14% coal), 40% hydro, 5% PV, 5% wind, and 2% biomass;
- Aysen Grid: 62 MW, 57% thermal (100% oil), 37% hydro and wind 6%;
- Magallanes Grid: 102 MW thermal 100% (84% natural gas and 16% oil).

During 2015, the national power generation was based on coal (39%), hydro (33%), natural gas (16%), other renewables (9%) and oil (2%).

FINAL ENERGY CONSUMPTION

During 2014, Chile's total final energy consumption was 24 857 ktoe, representing a decrease of 6.5% from the previous year.

Energy consumption was fairly balanced among the industrial (41%), transport (32%), and the residential, commercial and public sectors—jointly grouped as 'other sectors' (24%), and the remaining 3% represented non-energy use.

By energy source, around 67% of Chile's final energy consumption was met by petroleum products, which were primarily consumed by the transport and industrial sectors, followed by electricity and other sources (39%), natural gas (5%), and a marginal share of coal. Oil consumption increased by 23%, while gas and coal consumption increased by 11% and 51%, respectively, and electricity consumption decreased by 15% (EGEDA, 2016).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	12 891	Industry sector	10 395	Total power generation	73 719
Net imports and others	24 293	Transport sector	7 904	Thermal	43 070
Total primary energy supply	36 061	Other sectors	6 311	Hydro	23 099
Coal	6 723	Non-energy	247	Nuclear	0
Oil	16 215	Total final energy consumption	24 857	Others	7 550
Gas	3 570	Coal	231		
Others	9 552	Oil	16 603		
		Gas	1 267		
		Electricity and others	9 757		

Source: EGEDA (2016).

ENERGY INTENSITY ANALYSIS

Energy intensity has been declining since 2000, thus indicating a more efficient use of energy sources. The industry and transport sectors showed a reduction of 9% and 19% in energy use since 2000.

Chile's primary energy supply in 2014 was 102 tonnes of oil equivalent per million USD (toe/million USD), down 8.5% from 111 toe/million USD in 2013. The energy intensity for the final energy consumption decreased by -8.4% to 70 toe/million USD in 2014 from 77 toe/million USD in 2013. The energy intensity in the transport sector was reduced by 4.7% while the energy intensity in industry increased by 2.4%. Energy intensity was reduced by 26% in the 'others' sector, while non-energy use remains almost constant at 1.8 toe/million USD in 2014.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	111	102	-8.5
Total final energy consumption	77	70	-8.4
Total final energy consumption excl. non-energy	76	70	-0.8

Source: EGEDA (2016).

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 other 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 disruptions 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. This ministry 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 'Energy 2050: Chile's Energy Policy' to guide energy policy in the economy in the long term (MEC, 2015a). 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 has been 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 is a guide document for the current Government which contains short-term initiatives, including the design of a long-term Energy Policy. Also 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:

- To reduce the electricity marginal cost by 30% in the Central Interconnected Grid (SIC) by late 2017;
- To reduce the prices of residential electricity supply bids by 25% in the next decade;
- To 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;
- To 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;

- To set up a fuel price stabilisation system to reduce the volatility of internal fuel prices;
- To turn ENAP (National Oil Company) into a main actor to tackle the energy challenges of the member economy government; and
- To develop by 2015 a long-term energy policy that will be validated by the Chilean citizens, which has been developed and validated already.

2. Energy Road Map: This road map, realised in September 2015, is oriented to create agreements and build a shared long-term vision for the sector under the concepts of sustainability and inclusion. It was a proposal from an Advisory Committee convened by the Ministry of Energy, and used as inputs to build the Energy Policy. 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, this policy describes the four pillars of Chile's energy policy:

- Energy security and energy supply quality;
- Energy as a development engine;
- Environmental compatibility; and
- Energy efficiency and education.

Nuclear energy is not a short-term option under Energy 2050, but further research has been proposed to be considered in the next policy review.

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

Table 4: The main goals of Energy 2050 by 2035 and 2050

By 2035	By 2050
Interconnection with other Andean Region Electric Interconnection System members (Chile, Peru, Ecuador and Colombia are member countries, and Bolivia is an observer country) and with other South American economies, particularly Mercosur economies (Brazil, , Paraguay, Uruguay, Argentina, Bolivia (in the accession process) 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 OECD economies having lowest average electricity prices at residential and industrial level.	Be among the three OECD economies having lowest average electricity prices at residential and industrial level.
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.	One hundred per cent of the main categories of appliances in the Chilean sold in the market are energy efficient.
All new auctioned vehicles for public passenger transportation to be evaluated under energy efficiency standards.	Energy efficiency practiced at all levels of society.

Source: 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 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 international oil price into local currency to assess the value of the final price protection to 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

Consumers 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 programming the dispatch of energy to meet the demand at the least possible cost, which is based on the marginal cost of generation. Effective 2018, both systems will be interconnected creating the National Electric System, coordinating their activities under a unified National Electric Coordinator (NEC).

ENERGY MARKETS

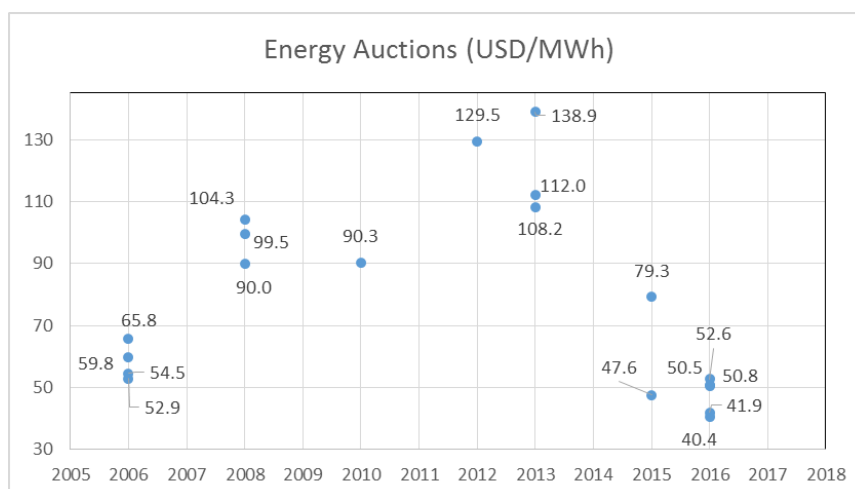
The electricity market in Chile encompasses power generation, transmission and distribution. The regulatory framework for Chile's electricity supply industry is based on the principle of competitive markets for generation and supply. Private companies wholly serve the electricity market, while the government remains a regulator, policy-maker and technical consultant to identify the requirements to meet the projected demand growth. The Ministry of Energy is the main governmental institution in charge of the energy sector in Chile. The ministry supports its actions through the National Energy Commission (Comisión Nacional de Energía or CNE) and the Superintendence of Electricity and Fuels (Superintendencia de Electricidad y Combustibles or SEC). The CNE is a technical organisation that acts as Regulator of the Chilean Energy Market, analyses prices, tariffs and technical norms that may affect energy production, generation, transport and distribution; as well as advice to the Government, through the Ministry of Energy, in any field related to the energy sector for its development. The SEC monitors the compliance of legal regulatory requirements and technical standards.

In 2016, Law 20.936, "Ley que establece un nuevo Sistema de Transmisión y crea un organismo coordinador independiente del Sistema Eléctrico Nacional" established the creation of the new electricity transmission system and created a National Electric Coordinator (NEC). The NEC is a private entity composed by generation companies supervised by the SEC. Its main function is to coordinate the operation of the National Electric System conformed by power stations, and transmission and distribution lines in the SING and SIC systems.

Generation companies are defined as those companies that own generation plants and whose energy is transmitted and distributed to final consumers. Generation companies sell their production to distribution companies, unregulated clients or other generation companies, having the option to sell their surpluses to the spot energy market. The transmission system in Chile is open access giving transmission companies the right to impose the payment of tolls over the available transmission capacity. Finally, the distribution companies operate under a 'distribution public concession regime' with service obligations and regulated tariffs for the regulated customers. Chilean regulation defines regulated customers as those with a connected capacity below 500kW. Those who have a connected capacity over 2 000 kW can negotiate the energy price directly with generation companies. Those who fall in between (500kW to 2000 kW) can choose either regulated or unregulated tariffs for periods no less than four years.

ENERGY AUCTIONS

The New Electricity Act on Energy Auctions (Law 20 805) establishes the process of open energy auctions encouraging the entrance of new players and electricity generation technologies, improving competitiveness in the auction process and promoting a better price mechanisms in favour of end users in the electricity market for regulated users. The auction winners in 2014 will start delivering energy to the grid from 2015 to 2033 while winners in the processes of 2015 and 2016 will dispatch energy from 2021 to 2040. During 2016, the average price per MW/h was USD 47.6 the lowest since 2006. The average price since 2014 has decreased from USD/MWh 108.2 to USD/MWh 47.6.

Figure 1: Energy Auctions 2005-2018.

Sources: Empresas Electricas A.G. Chile, APERC Analysis.

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 (EE) 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 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 Energy Agenda and Energy Policy.

The Energy Policy defines long-term goals by 2035 and 2050 in EE. These goals are organized in eleven alignments, described as follow:

- Forming a robust market of consultants and enterprises of energy services;
- Applying progressively energy management tools validated by competent entities;
- Using local available resources and exploit the potential energy in the productive process;
- Building efficiently incorporating EE standards in the design, construction and conditioning;
- Promoting smart control systems and own energy production in way to move along to buildings with efficient solutions;
- Strengthening the efficient edification market, moving along to more productive and efficient local markets:
- Improving energy efficiency of vehicles;
- Promoting more efficient transportation alternatives;
- Ensuring the availability of massive and clear information regarding rights and duties of consumers, including alternative energies and methods;
- Designing, implementing and tracking of an energy education strategy which joint the different initiatives developed by the Ministry of Energy and related institutions;
- Developing professional and technical human capital for the production.

The Agenda states short-term concrete activities to encourage EE, which considers measures to extend the development of EE projects, including the continuity of the Action Plan on Energy Efficiency 2020, published in 2012, 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 5: Chile's Action Plan on Energy Efficiency 2020

Industry and mining	<ul style="list-style-type: none"> • Promote energy management systems • Promote energy cogeneration • Encourage efficient technologies
Transport	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Encourage efficient technologies • Promote building labelling
End-use devices	<ul style="list-style-type: none"> • Enhance appliance labelling • Establish minimum efficiency standards • Promote minimum lighting efficiency standards
Heating	<ul style="list-style-type: none"> • 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 in 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 in late 2015, the government banned the commercialization of incandescent bulbs. New regulations on vehicle labelling, water heating and appliances have been also approved.

The Agenda also considers the implementation of programs focused on the EE with subsidies for housing conditioning, promoting efficiency in public buildings (especially hospitals), replacement of public lighting with more efficient technologies, and massive campaigns to teach to the citizenship the proper use of energy.

RENEWABLE ENERGY

In April 2008, Law 20.257 (Law of Non-Conventional Renewable Energy) was enacted. It added 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 June 2016, Chile's energy matrix had an installed capacity of 3 119 MW of NCRE, with solar and wind representing 41% and 30%, respectively. Similarly, an additional 2 336 MW is under

construction, 26887 MW worth of new projects have secured the required environmental permissions and 7149 MW are under environmental evaluation.

Table 6: Chile's NCRE capacity

March 2016	Operation (MW)	Construction (MW)	EQR-approved (MW)	Under Evaluation (MW)
Biomass	417	0	112	67
Biogas	53	0	8	0
Wind	947	477	6 500	1 949
Geothermal	0	48	120	0
Mini hydro	435	25	455	95
Solar – PV	1 267	1 676	12 038	5 434
Solar – CSP	0	110	1 085	1 270
Total	3 119	2 336	20 318	8 815

Note: EQR = Environmental Qualification Resolution.

Source: CIFES (2016).

The rising demand for electricity and policy incentives make renewables,² 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. To encourage the development of solar energy, CORFO decided to replace CIFES by the Committee for the Development of Solar Energy Industry (CDIES) in April 2017.

CDIES is a government institution that aims to strengthen the development of the solar industry, focusing in programs and projects that are part of the Energy Road Map's Solar Strategic Program.

The main objectives include:

- Supporting the implementation of the policy and plan of action contained in the Strategic Solar Program (PES).
- Promoting initiatives, such as programs, strategic projects, studies, roadmaps, and others, thrust by the Government for development of the Solar Industry.
- Proposing lines of research and development in innovation of solar energy, collaborating with the coordination of research centres in solar energy and support the association between the industry and research centres.
- Supporting the training of capacities for the development of solar energy in the country, encouraging the cooperation links with universities and technical education institutions.
- Bringing support in design of tools for development, innovation, and financing, intended to promote a technology supply local industry, and services of the solar industry with export vocation.
- Monitoring, evaluating and systematizing the results of the tools applied for development and innovation, especially those financed with public resources.

² 'Renewables' include hydro, solar, wind, geothermal, biomass and marine energy. The term 'other renewables' excludes hydropower.

- Managing requests of public and private agents related with research programs, new entrepreneurs, prototypes and solutions based in solar energy, and channelling the different requests that the Government has.

NUCLEAR

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, 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 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 faced 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 (GCH, 2012).

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. Furthermore, the report states 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 a short-term option for Chile at the present time, and its uptake depends on further research regarding security and economic rationality as well as community acceptance.

For this reason, the Chilean Nuclear Energy Commission (CCHEN) has been appointed to conduct a process for developing the required information in way that nuclear power option could be considered in next review of the energy policy, which will take place on 2020. For accomplishing this task, on March 2016 the

Strategic Development and Nuclear Power Office was created in CCHEN, and resources has been allocated for performing studies on the main relevant topics.

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 be 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 climate change on biodiversity in the four areas that are most vulnerable.

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 prepared the *National Action Plan for Climate Change 2017-22*, which is currently being updated by the Ministry of Environment, after a public consultation process developed. This document contains the following plans and objectives.

Table 7: National Action Plan for Climate Change 2017-22.

PLAN	OBJETIVES
Adaptation	Strengthening the country's capacity to adapt to climate change, improving the knowledge of its impacts and the vulnerability of the country, and generating actions to minimize negative effects and take advantage of positive effects, promoting economic and social development and, ensuring environmental sustainability.
Mitigation	Creating the enabling conditions for the implementation, compliance and follow-up of Chile's GHG emissions reduction commitments to the UNFCCC, and to contribute consistently to the country's sustainable development and low growth in carbon emissions.
Implementation means	Implementation of the transversal elements related to institutional strengthening, technology transfers, capacity-building and technical assistance, financing and international negotiation.
Climate change at regional and municipal level	Develop the elements that allow establishing the institutional, operational and necessary capacities to advance the management of climate change in the territory, through regional and municipal government, incorporating all social actors.

Source: MMA(2016b).

During 2013, greenhouse gas emissions excluding LULUF were 109 Gg tons of CO₂, increasing around 114% from 1990 levels and 19% since 2010. The main GHG emitted was CO₂ (79%) followed by CH₄ (11%). The energy sector is the main emitter (77%) primarily due to the utilization of coal in power plants and diesel in the transport sector (MMA 2016a).

The National Energy Policy 2050, launched by President Bachelet on December 2015 and implemented by the Ministry of Energy, is a State policy committed, among other issues, to adopt the necessary mitigation and adaptation actions to achieve a sustainable and clean energy sector, and to help to achieve the emissions reduction targets set in Chile's Nationally Determined Contribution. Regarding climate change, this policy is explicit in terms of setting medium and long-term goals. For instance, for 2035, it states this policy will contribute to the COP 21 commitment of reducing the intensity of GHG emissions in Chile by 30% in 2030 compared to 2007 levels and commits the implementation of a GHG Emissions Mitigation Plan for the energy sector and of a plan to adapt the energy sector to the impacts of climate change. For 2050, it states that "GHG emissions of the energy sector are consistent with international thresholds and national NDCs".

The Mitigation Action Plan for the Energy Sector (committed under the Energy Policy 2050), in elaboration by Ministry of Energy, with the support of the Partnership of Market Readiness (PMR) Policy Analysis Work Program, is intended to address the energy sector's share of responsibility in achieving the country's first NDC, by evaluating measures on relevant sectors such as electricity production, transport, industry and mining, and commercial/public/residential. This mitigation action plan ends its public consultation process in April 22 of 2017, and will be submitted for review and approval by the Council of Ministers for Sustainability and Climate Change. Ministry of Energy expected to publish the Mitigation Plan during June 2017.

Carbon pricing is of importance here since, in combination with an energy reform, it can provide important incentives for clean technology investments, and therefore for a transition to decarbonize the economy. In this regard, the National Energy Policy states the analysis of other carbon pricing instruments to internalize the environmental externalities associated to existing and future energy infrastructure. In this context, the policy explicitly notes that through the PMR initiative, in collaboration with the World Bank, economic and market-based instruments will be evaluated, such as emissions trading systems (ETS or Cap & Trade), which aim to reduce carbon dioxide and other greenhouse gases in the energy sector.

Embedded in the Energy Policy are the relevant related goals on renewables and energy efficiency that will have a great impact on reducing GHG emissions and achieving the country's commitments.

Additionally, in 2017 the Chilean government will apply a carbon tax of USD 5 per ton of CO₂ emitted affecting thermal plants with an installed capacity equal or larger than 50 megawatts. The increase in the relative price of electricity will promote the use of less contaminant energy sources, encouraging energy consumers to implement energy efficiency measures and low-carbon technologies.

NOTABLE ENERGY DEVELOPMENTS

- Chile will export energy to Argentina during 2017. The agreement between both governments establishes the export of 5.5 million cubic meters of natural gas per day to Argentina between May and September and the export of electricity from the Chilean north to Argentina, from Mejillones in Chile to Salta in Argentina. This interconnection will supply about 200 megawatts to the National Interconnected System in Argentina.
- The new law approved by the Chilean Congress maintains current gas tariff freedom but sets a cap rate equivalent to the capital cost rate plus a spread of 3%. The National Energy Commission shall review the capital cost rate every four years. When a distribution company exceeds the cap rate, tariff regulations and direct discounts to consumers will be applied. The Gas Service Act was established in 1931 and has remained in force through 2016 with some modifications. According to the Ministry of Energy, the current regulation is not adequate under the new gas scenario gas, because it does not consider:

- The pricing methodology and procedure;
- The method and procedure to assess companies' rentability;
- The method for calculating the fair capital cost rate (CCR); and
- A mechanism for dispute settlement between the regulatory agency and gas distribution companies.

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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 (km²) with diverse landscapes, which consist of mountains, plateaus, plains, deserts and river basins. Its total maritime area is 4.7 million km² and the length of its coastline is 32 000 km (NBS, 2016).

After reforming and opening up its economy in 1978, China entered a new period of high-speed growth. Its entry into 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 2015, China's merchandise exports accounted for 13.8% of the world's trade exports (WTO, 2016). In 2015, China's gross domestic product (GDP) was 19 814 billion (USD purchasing power parity [PPP]), with the primary, secondary and tertiary industries accounting for 9%, 40.5% and 50.5% respectively (World Bank, 2016; NBS, 2016).

Because of its huge population and booming economy, China plays an increasingly important role in the world's energy markets. According to BP, China's energy consumption grew by 1.5% in 2015. This was less than one-third of the ten-year average growth rate of 5.3% and the slowest annual rate of growth since 1998 (BP, 2016). However, China remained the world's largest energy consumer and accounted for 23% of global energy consumption and 34% of net global energy growth in 2015 (BP, 2016). Its per capita primary energy supply, at 2.1 tonnes of oil equivalent in 2014, is far lower than that of many developed economies and below APEC's average of 2.9 tonnes of oil equivalent (toe) (EGEDA, 2016).

China is rich in energy resources, particularly coal. According to BP statistics published in June 2016, China had recoverable coal reserves of approximately 114.5 billion tonnes, proven oil reserves of 18.5 billion barrels and proven natural gas reserves of 3.7 trillion cubic metres (tcm) (BP, 2016). 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 2014, the compound annual growth rate (CAGR) of final energy consumption was 8.7% and the CAGR of GDP was 9.8% (EGEDA, 2016).

Table 1: Key data and Economic Profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	9.6	Oil (billion barrels)	19
Population (million)	1 364	Gas (trillion cubic metres)	3.8
GDP (2010 USD billion PPP)	16 841	Coal (million tonnes)	114 500
GDP (2010 USD PPP per capita)	12 344	Uranium (kilotonnes U)	366

Sources: a. EGEDA (2016); b. NBS (2016); c. BP (2016); d. OECD-NEA (2016)

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001. This expansion was driven mainly by rapid economic growth, especially in energy consumption by heavy industry. In 2014, the total primary energy supply increased 1.4% compared with 2013, reaching 2 895 million tonnes of oil equivalent (Mtoe), including net imports and others. Most of the growth came from net imports and others, while the indigenous production remained at the same level as 2013. Coal was the dominant source, accounting for 69%, followed by oil (17.5%), gas (6%) and others (7.4%) (EGEDA, 2016).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 455 412	Industry sector	1 115 793	Total power generation	5 649 583
Net imports and others	487 112	Transport sector	240 383	Thermal	4 268 649
Total primary energy supply	2 895 788	Other sectors	397 223	Hydro	1 064 337
Coal	2 001 129	Non-energy	97 363	Nuclear	132 538
Oil	506 269	Total final energy consumption	1 850 762	Others	184 059
Gas	174 167	Coal	750 296		
Others	214 223	Oil	469 761		
		Gas	119 737		
		Electricity and others	510 969		

Source: EGEDA (2016).

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 2015, coal production fell by 2%, compared to the ten-year average growth of 3.9%. This was the second fall in coal production in China since 1998. Production of other fossil fuels grew, including natural gas by 4.8% and oil by 1.5%. Total coal consumption reached 1 962 Mtoe, 0.1% higher than in 2013 (BP, 2016).

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 2000–15, electricity generation output increased quickly from 1 356 terawatt-hours (TWh) to 5 605 TWh, of which thermal power generation accounted for 77% of the total power generation. In 2015, installed generation capacity reached 1 506 GW (NBS, 2016).

The power supply structure has diversified, with wind power and nuclear energy generation increasing rapidly. In 2015, total power generation in China was 5 605 TWh. Thermal power accounted for 73.1% (4 097 TWh) of the total generation, hydropower 19.9% (1 114 TWh), nuclear energy 3% (170 TWh) and others 4% (224 TWh) (NBS, 2016).

FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1 850 Mtoe in 2014, 2.7% higher than in 2013. The industrial sector was the largest consumer, accounting for 58% of the 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, 2016). By energy source, coal accounted for 42% of total final energy consumption, following by electricity and others (27%), oil (25%) and gas (6%).

In the Thirteenth Five Year Plan for energy development, China has set its energy consumption annual growth target at an average of 2.5% during 2016–2020, 1.1 percentage points slower than the 3.6% in 2011–15. As a result, the total energy consumption will be contained within 5 billion toe by 2020.

ENERGY INTENSITY ANALYSIS

China has reduced its energy intensity in the last two decades. The intensity of primary energy supply and final energy consumption in 2014 have been reduced by 56% and 62%, 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, 2016).

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 consumption 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, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	182	172	-5.5
Total final energy consumption	115	110	-4.3
Total final energy consumption excl. non-energy	110	104	-5.5

Source: EGEDA (2016).

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 have 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 (NDRC, 2016). It has four 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.

The Energy Thirteenth Five-Year Plan is a specification of the Master Plan for the energy sector, with more detailed targets that will better guide policymaking, government spending and project planning in the sector. The State Council approved it in December 2016 and the NEA unveiled it in January 2017 (NDRC, 2017). Clean and low-carbon energy will account for most of the newly added energy supplies during the 2016-20 period. By 2020, China expects an annual energy consumption of below 5 billion tons of coal equivalence (tce) from 4.3 billion tce in 2015. This will ensure that the average annual growth rate remains below 3% in the coming years.

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 13 departments and has an authorised staffing complement of 250 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, which originally took 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, went 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 went 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

China has been endeavouring to guarantee itself and its industries long-term access to sufficient energy and raw materials. Currently, China's energy portfolio consists mainly of domestic coal, oil and gas from domestic

and foreign sources, and small quantities of uranium. China has also created a strategic petroleum reserve, to secure emergency supplies of oil for temporary price and supply disruptions. Chinese policy focuses on diversification to reduce oil imports, which rely almost exclusively on producers in the Middle East.

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 and contains the following five major requirements:

- 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. This system is 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. This is based on China's national conditions and follows the new trend of the international energy technology revolution. The goals are guided by the principles 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 have 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 energy production is mainly domestic, the guideline sets forth 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 where 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'. This report encourages 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%.

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" in November 2015. This report 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). For 2016, the NDRC targeted a capacity cut of 250 million tons, a reduction that was met 'ahead of schedule' in late November, according to a statement by the NDRC.

OIL MARKET

China surpassed the United States as the world's largest oil importer in April 2015. According to Chinese customs data, crude oil purchases from overseas reached a new record of 7.4 million barrels per day (Mbbbl/D) in April. This is approximately 7.7% of the world's oil consumption per day and exceeds United States imports of 7.2 Mbbbl/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 Unipet 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 in Zhoushan, Zhenhai, Dalian, Huangdao, Dushanzi, Lanzhou and Tianjin, and one underground facility in 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 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 was 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

The main objectives for electricity market development in the Thirteenth Five-Year Plan are to accelerate structural reformation and innovation, transform to green energy and relax the regulations regarding electricity supplies. 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 finalised 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 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 related to the cost of building transmission lines, thereby allowing electricity consumers to negotiate directly with electricity generators (OilPrice, 2015). Also in November 2015, the NEA issued a draft document called 'Basic Rules for Electricity Market Operations',

which include calls for expansion of longer-term markets based on contracting between generators on one side, and large end-users or retail companies on the other.

In sum, electricity market reform has mainly taken the form of expanded direct trading. This is partly in reaction to pressure from large users for lower electricity prices. Coal-fired generators have also been supportive of the emphasis on direct trading, given their interest in finding use for excess capacity. Policymakers have proceeded cautiously so far, limiting the access of relatively inefficient end-users, in line with China's longstanding policies on differential pricing.

China's power sector faced a severe overcapacity problem. Slowing demand for electricity due to the economic downturn and the slashing of energy intensive industries has caused widespread under-utilisation of existing power generation capacities, which are seeing their lowest utilisation hours since 1978. The situation has prompted regulators to consider putting a two-year 'freeze period' in the Energy 13FYP for the approval of any new coal-fired power projects. The NEA promised to keep coal power capacity below 1100 GW by 2020, setting an upper limit for new coal capacity.

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 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 investments 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 indicated 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. Since October 2011, China has launched pilot carbon markets in two provinces (Hubei and Guangdong) and five cities: Beijing, Tianjin, Shanghai, Chongqing and Shenzhen. China is now preparing to roll out carbon markets on a national basis. Under the Draft National Regulation, the Chinese carbon market will be a two-tier system where the applicable central government department will be responsible for regulating and supervising the Chinese carbon market at the national level. The central government will determine GHG categories, the scope of industries, and the criteria of the companies or entities that the Chinese carbon market will cover. It will also approve, supervise and regulate the carbon exchanges. The local governments will have primary responsibility for implementation and monitoring in their jurisdictions. China is preparing for the transition to a nationwide trading scheme by 2017.

RENEWABLE ENERGY

China's renewable energy sector is growing faster than its fossil fuels and nuclear power capacity. In 2015 China became the world's largest producer of photovoltaic power, at 43 GW installed capacity. China also led the world in the production and use of wind power and smart grid technologies, generating almost as much water, wind, and solar energy as all of France and Germany's power plants combined.

China will spend 2.5 trillion yuan (USD 361 billion) on renewable power development by 2020, according to the latest strategy for the Thirteenth Five-Year Plan (2016-20). 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 it is expected to continue to grow. Since 2010, China has been the largest wind power producer in the world. In 2014, the electricity generation output of wind reached 153 TWh, making it the third most popular energy source in the economy after coal (4 269 TWh) and hydro (1 064 TWh) (EGEDA, 2016).

In 2015, China added 30.5 GW of wind power generation capacity, and generated 186.3 TWh of electricity, representing 3.3% of the total national electricity consumption. Both China's installed capacity and new capacity in 2015 are the largest in the world by a wide margin, with the next largest market, the United States, adding 8.6 GW in 2015 and having an installed capacity of 74.4 GW. By the end of November 2016, China's large-scale wind power capacity had reached 142,540 MW, which is 25.8% more than one year ago. China is forecast to have 250 GW of wind capacity by 2020 as part of the government's pledge to produce 15% of all electricity from renewable resources by that time.

However, the wind power industry faces the challenge of being abandoned 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. In the first nine months of 2016, the average utilisation hours of wind power in China was 1251 hours, down 66 hours year-on-year and the decline range narrowed 19 hours compared with the first half of the year; the abandoned wind power is 39.47 billion kWh with the average wind abandoning rate being 19% (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 significant 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 2015 was 320 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 by 2020, 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, 2016).

NUCLEAR

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 prioritises 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).

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 the total power generation. The installed capacity was 26 GW, which was approximately 1.75% of the total capacity. The year 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.

No new nuclear projects were approved for construction in 2016. However, some projects were in the process of evaluation and are considered to start construction in near-term, including the CAP1400 demonstrative project in Rongcheng City, Shandong Province, the second phase of AP1000 nuclear reactors in Lufeng City, Guangdong Province, Sanmen City, Zhejiang Province as well as Xu Dapu, Liaoning Province.

China also 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% based on 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.

In November 2016, China's Greenhouse Gas (GHG) Control Work Plan and Power Sector Development Thirteenth Five-Year Plans (FYPs) came out, while its Ecological and Environmental Protection

Thirteenth FYP was released later. Covering a comprehensive set of policies, these documents lay out benchmark goals for 2020 that will put China on track to over-achieve its 2030 Paris goals, strengthen enforcement of environmental laws and standards, and continue its transition to low-carbon energy.

NOTABLE ENERGY DEVELOPMENTS

THE THIRTEENTH FIVE-YEAR ENERGY DEVELOPMENT PLAN (2016-2020)

The year of 2016 marks the beginning of China's thirteenth five-year development period. In December 2016, the NDRC and NEA finally unveiled the Thirteenth Five-Year Energy Development Plan (2016-2020) (NDRC, 2017). It is the breakdown for the energy sector, with more detailed targets to better guide policymaking, government spending and project planning in the sector.

In the plan, China is determined to squeeze out coal's share in the country's energy mix, lowering its 2020 percentage in primary energy consumption from 62% to 58%. China is also aiming higher for renewables: installed capacity of wind energy and solar energy should reach 'more than 210GW' and 'more than 110GW' by 2020, respectively. By 2020, the proportion of non-fossil fuels should rise above 15% from 12% in 2015. Natural gas should account for at least 10% of the energy consumption.

STRUCTURAL CHANGE AND A 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.

NEW ENERGY VEHICLES

A proposal in the Thirteenth Five-Year Plan 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 ten 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.

At the end of 2016, Shanghai was the top city in the world for ownership of NEVs, according to data provided by the automobile registration department of Shanghai.

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USEFUL LINKS

Central People's Government of PRC—www.gov.cn

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

Ministry of Science and Technology—www.most.gov.cn

National Bureau of Statistics (NBS)—www.stats.gov.cn

National Development and Reform Commission (NDRC)—www.ndrc.gov.cn

National Energy Administration (NEA)—www.nea.gov.cn

National Nuclear Safety Administration (NNSA)—nnsa.mep.gov.cn

Standardisation Administration—www.sac.gov.cn

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 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 2014, the per capita gross domestic product (GDP) of Hong Kong, China was USD 51 545 (2010 USD purchasing power parity [PPP]), among the highest of the APEC economies. The GDP increased 13% in real terms after 2010 to USD 373 billion (2010 USD PPP). The service sector remained the dominant driving force of overall economic growth, accounting for 89% of the GDP in 2014 (ESTO APERC, 2016). 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, 2014

Key data ^a		Energy reserves ^b	
Area (km ²)	1 104	Oil (million barrels)	–
Population (million)	7.2	Gas (billion cubic metres)	–
GDP (2010 USD billion PPP)	373	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	51 545	Uranium (kilotonnes U)	–

Source: EGEDA (2016).

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 2014, 0.26 Mtoe higher than 2013. Coal maintained the highest share of the total primary energy supply (57%), followed by oil (22%), gas (16%) and other sources (6%) (EGEDA, 2016).

In 2015, the total installed electricity generating capacity in Hong Kong, China was 12 645 megawatts (MW) (EGEDA, 2016). 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, 2015a; 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 2014, the total final energy consumption in Hong Kong, China was 6 867 kilotonnes of oil equivalent (ktoe), an increase of 1.8% from the previous year. The residential and commercial sectors accounted for the largest share of energy used (64%), followed by the transport sector (31%) and the industry sector (5%). By energy source, electricity and 'others' made up 56% of end-use consumption, followed by petroleum products (34%) (EGEDA, 2016).

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, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	68	Industry sector	352	Total power generation	39 850
Net imports and others	27 733	Transport sector	2 114	Thermal	39 705
Total primary energy supply	14 379	Other sectors	4 402	Hydro	2
Coal	8 140	Non-energy	0	Nuclear	–
Oil	3 130	Total final energy consumption	6 867	Others	144
Gas	2 258	Coal	0		
Others	850	Oil	2 354		
		Gas	689		
		Electricity and others	3 824		

Note: 'Total' does not include electricity generated by hydro and nuclear energy facilities located in the Mainland.

Source: EGEDA (2016).

ENERGY INTENSITY ANALYSIS

In terms of primary energy or final energy consumption, the energy intensity of Hong Kong, China is the lowest among APEC economies. The primary energy intensity in 2014 was only 38.5 tonnes of oil equivalent per million USD (toe/million USD) compared with the median value of 120 toe/million USD for APEC economies, while the final energy demand was only 18.5 toe/million USD compared with the median value of 78 toe/million USD (EGEDA, 2016).

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 have been 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, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	38.8	38.5	-0.7
Total final energy consumption	18.5	18.4	-0.8
Total final energy consumption excl. non-energy	18.5	18.4	-0.8

Source: EGEDA (2016).

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 emphasises 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, China 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 programs and strengthening government energy saving efforts by appointing green managers and energy wardens, and encouraging public sector institutions to save energy; and
- Supporting community campaigns through government funding schemes, and collaborating 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, China, the Central Government of China will continue to support energy cooperation 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 the economy. 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 an additional term of 20 years from 2014. 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, 2015b, 2015c).

ENERGY EFFICIENCY

Buildings consume approximately 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 being 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 dataset 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 (for example, owners, tenants or occupants) 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 ten 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 for that ordinance.

The BEC is reviewed once every three years to meet public desire, international trends and the latest technological developments. The first comprehensive review was completed in 2015 and the new standards required a further 10% improvement in energy efficiency. It is estimated that up to 2025, energy savings from all new buildings in Hong Kong, China will be about 5 billion kilowatt-hours of electricity, equivalent to a reduction in carbon dioxide (CO₂) 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% savings in the electricity consumption of government buildings in the next five years from 2015–16 to 2019–20 under comparable operating conditions. This target uses electricity consumption from 2013–14 as the baseline.

In April 2009, the government introduced the Buildings Energy Efficiency Funding Schemes totalling HKD 450 million 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, China 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 implemented a district cooling system (DCS) in 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 is scheduled to 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 in understanding 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). The scheme also includes seven types of office equipment (photocopiers, fax machines, multifunction devices, printers, laser crystal display (LCD) monitors, computers and hot/cold bottled water dispensers) and two 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 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 electric vehicle (EV) manufacturers and dealers to encourage them to introduce EVs into Hong Kong; as a result, the economy 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 1500 different types of public EV chargers, including over 340 medium chargers and around 220 quick chargers.

The government's ultimate policy objective is to have zero emission buses running throughout 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 usage. 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, and 4 electric inverter air-conditioning systems. Additionally a ferry was retrofitted 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 CO₂ 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 CO₂ 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 CO₂ 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 solar farm at the Siu Ho Wan Sewage Treatment Works of the Drainage Services Department came into operation in December 2016, with an installed generation capacity of 1,100 kilowatts. It can generate as much as 1.1 million kilowatt-hours of electricity annually. (DSD, 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 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 cleaner and more cost-competitive energy is provided to Hong Kong, an agreement has been reached, whereby Daya Bay will increase its electricity supply from 70% of its output to approximately 80% for late 2014–18 (CLP, 2015b, 2015c).

CLIMATE CHANGE

Hong Kong, China is committed to working closely with the international community to combat climate change. The government is pursuing measures established 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 the economy'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 in the following sections.

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 towards 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 hybrids 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 twenty-first 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 ten policy bureaux and two 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 targets as well as long-term climate strategies with 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 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, China 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, almost all respondents considered that the current contractual arrangement by SCAs had mostly worked well 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 to such areas as the level of permitted rate of return, mechanism to promote energy saving and RE.
- 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

Electrical and Mechanical Services Department—www.emsd.gov.hk

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 the world's largest archipelagic state located south-east of mainland South-East Asia, between the Pacific Ocean and the Indian Ocean. Indonesia's territory encompasses 17 504 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. The economy's total land area (25% of its territory) is about 1.9 million square kilometres. The population was 254 million in 2014.

Indonesia had a gross domestic product (GDP) of around USD 2 500.88 billion and a per capita GDP of USD 9 828 in 2014 (2010 USD purchasing power parity [PPP]). Excluding the oil and gas sector, manufacturing industries accounted for the largest component of GDP in 2013 (22%), followed by agriculture, forestry and fishing with a combined share of about 14%. In terms of exports, the main export products of the economy are mineral fuels, lubricants and related materials, which together account for about 29% of total export value, followed by manufactured goods classified by materials at 13%. In 2014, Indonesia attained economic growth of 5.02%, a decrease of 0.54% from 2013 (BPS, 2016).

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 2014, oil and gas exports contributed 11% and coal exports contributed 5% of Indonesia's total exports. Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 19% of the Indonesian Government's budget in 2014 (ESDM, 2015a).

Indonesia's proven fossil energy reserves at the end of 2014 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, 2014

Key data ^a		Energy reserves ^{b, c}	
Area (million km ²)	1.9	Oil (billion barrels)	7.4
Population (million)	254	Gas (trillion cubic metres)	4.3
GDP (2010 USD billion PPP)	2 501	Coal (billion tonnes)	32
GDP (2010 USD PPP per capita)	9 828	Uranium (kilotonnes U)	6.3

Sources: a. EGEDA (2016); b. ESDM (2015b); c. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, Indonesia's total primary energy supply (TPES) was 227 117 kilotonnes of oil equivalent (ktoe) of commercial energy, consisting of oil (38%), coal (20%), natural gas (16%) and other energy (mainly hydropower, geothermal, and biomass) (27%). 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 220 920 ktoe in 2014. Total energy exports in 2014 slightly increased by 13% from 2013 (193 983 ktoe), a decrease driven primarily by a decrease in the price of exported coal.

OIL

In 2014, Indonesia produced 84 530 ktoe of crude oil and condensates; of this, 15 391 ktoe (38%) was exported, a decrease of 14% compared to 2013. 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 17 079 ktoe of crude oil and 32 608 ktoe of petroleum products in 2014 in order to meet its domestic oil requirements. This represents an increase of 3% from a total of 31 660 ktoe in 2013 (EGEDA, 2016; ESDM, 2015b).

Most crude oil is produced 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 36 383 ktoe of natural gas in 2014, an increase of 5.2% from the 34 571 ktoe produced in 2013 (EGEDA, 2016). Of the total natural gas production, 31% was converted to LNG for export. The economy produced 20 976 ktoe of LNG in 2014, a decrease of 6.1% from 22 331 ktoe in 2013. In 2014, Indonesia also exported 10 bcm of natural gas through pipelines to Singapore and Malaysia. Overall, 43.8% of Indonesia's natural gas production was exported in 2014. The balance is made available for domestic requirements (ESDM, 2015b).

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, the Masela Block in Maluku 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 23 trillion cubic feet (Tcf) (SKKMIGAS, 2014).

COAL

In 2014, Indonesia produced 269 361 ktoe of coal, an increase of 2% from 264 059 ktoe in 2013. Most of Indonesia's coal production in 2014 (224 600 ktoe, or 83%) was exported. Domestic demand (38 794 ktoe in 2014) originated from power generation (56%) and industrial uses 30 898 ktoe or (44%) (EGEDA, 2016; ESDM, 2015b).

Approximately 57% of Indonesia's total recoverable coal reserve is lignite; 27% is sub-bituminous coal; 14% is bituminous coal and less than 2% is anthracite. Most of the economy's coal reserves are in South Sumatra and East Kalimantan, with relatively small deposits in West Java and 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 53 065 megawatts (MW) of electricity generation capacity in 2014. This was held by the state-owned electricity company (PLN) and independent power producers (IPPs). In 2014, 229 terawatt-hours (TWh) of electricity were generated, of which 23% was supplied by IPPs and 1.5% was imported from Malaysia. In 2014, several types of power plants produced electricity; namely, coal-steam power plants (51%), gas power plants (combined gas-steam power plants, gas turbine power plants and gas engine power plants) (27%), renewable energy power plants (geothermal, hydro, biomass, solar and wind) (10%), and oil power plants (diesel power plants and oil-powered thermal plants) (12%) (DJK, 2015a).

FINAL ENERGY CONSUMPTION

Total final energy consumption was 167 577 ktoe in 2014, an increase of 20% from 140 029 ktoe in 2013. The share of final energy consumption by sector in 2014 was 22% for industry, 29% for transport, 39% for other sectors and 11% for non-energy use. Indonesia's economy is highly dependent on oil: final energy consumption of oil in 2014 was 76 873 ktoe (46% of the total final energy consumption) (EGEDA, 2016).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	445 176	Industry sector	36 504	Total power generation	225 565
Net imports and others	-220 920	Transport sector	47 945	Thermal	200 163
Total primary energy supply	227 117	Other sectors	65 443	Hydro	15 148
Coal	45 024	Non-energy	17 685	Nuclear	0
Oil	84 530	Total final energy consumption	167 577	Others	10 255
Gas	36 383	Coal	6 228		
Others	61 180	Oil	76 873		
		Gas	17 448		
		Electricity and others	67 028		

Note: Indigenous production excludes biomass.

Source: EGEDA (2016).

ENERGY INTENSITY

In 2014, Indonesia's primary energy intensity was 90.8 tonnes of oil equivalent per million USD (toe/million USD), a decline of 9.1% from previous year. 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 67 toe/million USD, a decrease of 14% from 2013. This was mostly driven by decreasing energy consumption in industry and transportation and other sectors.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	100	91	-9.1
Total final energy consumption	78	67	-14
Total final energy consumption excl. non-energy	75	60	-20

Source: EGEDA (2016).

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 2013.

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. 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), whose job it 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 minerals 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 upon 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 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 consequently had made it responsible for providing electricity to all parts of Indonesia.

Under the new electricity law, the industry consists of electricity business entities, which are title-holders of electricity supply business licences or Izin Usaha Penyediaan Tenaga Listrik (IUPTL). The IUPTL integrates 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 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.

GEOHERMAL 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 these areas. This situation has been a major barrier to developing geothermal electricity in Indonesia.

In order to remove the restriction to develop geothermal electricity in protected forest areas, the government 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 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 awarding 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 and successful bidders are awarded licenses. The width of the concession areas is determined according to the capacity of the individual geothermal system. 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 for the exploitation of geothermal resources for an additional 20 years per extension approval. Working areas are subject to taxes, land rentals 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 in 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 were 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 the PSCs (Johnston, 1994) and several types have since emerged internationally.

Technically, the 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

the 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 accordance with the new oil and gas law, existing TACs will not be extended. In addition, participants in the PSCs, TACs and EOR contracts may also enter into separate agreements known as joint operating agreements (JOA) and joint operating bodies (JOB).

Since 2008, a fifth generation of PSCs have been introduced. The key differences between the later generation PSC 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;
- PSC now provides 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 that 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 (for example, 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 the entire share to the international market.

UPSTREAM

In 2014, the Directorate General of Oil and Gas, the Ministry of Energy and Mineral Resources signed seven new PSC agreements. Apart from these, the PSC under the control of the upstream oil and gas implementing agency—BP MIGAS (before becoming SKKMIGAS)—numbered approximately 316 by the end of 2014. Of these 316 PSC, 81 were for oil and gas at the exploitation stage and 235 related to the exploration stage. Of the 235 PSC, 180 were for conventional oil and gas, 55 were for shale gas and 8 were terminated and 41 were involved in processing termination (SKKMIGAS, 2014).

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, 2014):

- Banyu Urip—ExxonMobil 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. From 2011 to 2013, some 6.8 million three-kilogram LPG cylinders were distributed. In 2014, the program expects to distribute 1.629 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 regards coal methane gas regulation and 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; resolution of disputes; 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 types of permits: 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 has not yet been 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 2019.

GEOHERMAL

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 and 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 or 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.

In order to implement Law No. 27/2003 on geothermal energy, the government issued Government Regulation No. 28/2016 regarding the amount and procedures for geothermal production bonuses (ESDM, 2016b)

The regulation states the following:

- Production bonus is a financial obligation for geothermal developers (geothermal license holders, holders, authorities of utilisation geothermal resources, holders of joint operating contracts of utilisation geothermal resources, and permit holders of geothermal resource utilisation of gross revenue from sales of geothermal steam and/or power from geothermal power plants) to the local governments.
- The geothermal developers are required to provide bonus for geothermal production since the first unit of commercial production to the general treasury account of local government based on the determination of the Minister of Energy and Mineral Resources.
- Production bonuses imposed amount 1% of the gross revenue from the sale of geothermal steam; or 0.5% of the gross revenue from electricity sales.

- Further provisions concerning the procedures for reconciliation and production bonus percentage producer region and assessment parameters and weights as stipulated in the regulations of the Minister.

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 recommendations 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 a possible extension).

As part of the government commitment to increase energy efficiency and conservation, the MEMR has developed an energy conservation project as one of its 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 throughout the economy. 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. In addition to 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: the 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 Programme-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 completed in 2014 but the government has continued its implementation (UNDP, 2014).

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 2016 were as follows:

- 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.

POTONG (CUT) 10% MOVEMENT

Indonesia launched a Potong (cut) 10% Movement in May 2016. The Potong 10% Movement is a movement to change people's behaviour to use an energy more wisely. The main target of this national movement is to reduce energy consumption by 10%. This campaign is intended to promote the rise of a movement such as the Public Lifestyle Change Joint Action (government, business/industry, and individual) to encourage energy savings. Nationally, it is easier and less expensive to save 10% percent than to raise the energy equivalent by the same amount (ESDM, 2016a).

The campaign will continue to illuminate ideas through the labelling of energy efficiency, formation of managerial and energy auditors, the use of energy-saving lamps, and optimising the role of energy service companies and the Nation Energy Activator (PETA). The public campaign will hold simultaneously meetings in 20 major cities, namely Medan, Pekanbaru, Batam, Padang, Palembang, Lampung, Jakarta, Bogor, Depok, Tangerang, Bekasi, Cilegon, Bandung, Yogyakarta, Semarang, Sidoarjo, Surabaya, Denpasar, Makassar and Balikpapan.

Public campaigns have been carried out comprehensively and sustainably through four scheme campaigns, namely;

- Direct campaigns in public spaces, such as schools, universities, monuments, shopping centres and city parks;
- A viral campaign through social media;
- Sustained campaigns involving 33 young communities and 35 community service officers (CSO); and
- The campaign with the Report 10% mechanism.

The overall campaign will also be accompanied by information dissemination through various media, such as public service announcements (PSAs) on national TV, branding on the train and commuter-lines, cover seat information on planes, banners on online media and appearances on talk shows on national TV. The activity will continuously post various advertisements on television, and distribute print media on trains, planes and in bus terminals.

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's 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 another fuel. This regulation 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 through Ministerial Regulation No. 12/2015 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, 2015c).

Until the end of 2014, the realisation of biofuel (biodiesel and bioethanol) utilisation was 4.1 million kilolitre (kL), an increase of 47% from 2.8 million kL in 2013.

GEOTHERMAL

In 2014, Indonesia's total geothermal capacity was 1 403.5 MW, which is 4.9% of the total geothermal potential of 28 910 MW (EBTKE, 2015). Indonesia has identified 11 705 MW of geothermal power potential from existing geothermal plants, through capacity expansion of productive geothermal resources and from new geothermal projects at 67 sites. Specifically, the latter are anticipated to produce 5 195 MW in Sumatra at 22 sites, 4 096 MW in Java at 26 sites, 1 036 MW in Sulawesi at five sites, 813 MW in the Nusa Tenggara and Bali at eight sites and 565 MW in the Maluku islands at five sites (EBTKE, 2015).

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 2015 and 2024. Under PLN's Electricity Power Supply Business Plan 2015–24 (*Rencana Usaha Penyediaan Tenaga Listrik*, or RUPITL), a further increase in geothermal capacity by 4

815 MW is expected between 2015 and 2024. Of the total capacity, 4 435 MW will be developed by IPPs, 365 MW by PLN and 15 MW by organisations with unallocated status (PLN, 2015).

HYDROPOWER

In 2014, Indonesia's total hydropower capacity was 5 229 MW (including 170 MW of micro- and mini-hydro). This was 7% of the total hydropower potential of 75 gigawatts (GW) (DJK, 2015a). Under the 10 000 MW Accelerated Development of Electricity Generation—Phase II program over 2015–22 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 2015–24 also includes the potential for an additional 9 251 MW of hydropower capacity during 2015–24 (including mini-hydro and pump-storage plants). Of this capacity, 3 668 MW would be developed by IPPs, 3 461 MW by PLN and the remainder of the project's 2 122 MW has not yet been 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 14 480 MW, or 19% 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.

Presidential Instruction No. 13 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 the Minister of Energy and Mineral Resources is the Executive Chief and both are members of the national team; 11 cabinet ministers are also members of the team. The national team is supported by the executive team, which is 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 any related 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 established a roadmap for integrating 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 are the integration of climate change into the Mid-Term Development Plan 2010–14 (Rencana Pembangunan Jangka Menengah 2010–14, RPJM) and the launching 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.

In December 2015, at the Conference of the Parties (COP) 21 of the UNFCCC in Paris, the government of Indonesia submitted its Intended Nationally Determined Contribution (INDC) in which the economy pledged unconditionally 29% GHG emissions reduction by 2030 compared to BAU, and an increase of up to 41% with international support. The BAU scenario has projected approximately 2 869 GtCO_{2e} in 2030 based on its level in 2010 (1 334 GtCO_{2e}), which has already been updated from NEP due to increasing coal-fired power plant utilisation.

In November 2016, the government of Indonesia submitted the first NDC document to the UNFCCC. The document included a target to increase the energy sector contribution from 6% to 38%. The main contribution, around 59% remaining, would come from the forestry sector including peat fire, while around 3% would be contributed from waste, agriculture, industrial processes and product use (UNFCCC, 2016).

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY

ACCELERATED ELECTRICITY GENERATION PHASE I, PHASE II AND 35 GW PROGRAM

The accelerated power development program, 10 000 MW Phase I, had completed 9 120 MW of new generation capacity by the end of December 2015. 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 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) until 2019. In the 35 GW program, 56.5% of the 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 RENEWABLE ENERGY POWER PLANTS BY PLN

On 27 January 2017, the government introduced a ceiling price mechanism under Ministerial Regulation No. 12/2017 on Utilization of renewable energy sources for electricity supply to replace the feed-in tariff (FiT) scheme, which was introduced before (Ministerial Regulation No. 22/2012 for geothermal energy, Ministerial Regulation No. 19/2015 for hydro energy, Ministerial Regulation No. 21/2016 for biomass and biogas energy, and Ministerial Regulation No. 19/2016 for solar energy). Under this new regulation, the purchase of electricity from renewable energy such as solar and wind power is carried out through the system auction based on quota capacity. Furthermore, the purchase of electricity from other renewable energy such as geothermal, biomass, biogas, municipal solid waste as well as hydro power will be conducted through the mechanism of the reference price and direct selections. This regulation also stipulates that PLN is obligated to operate renewable energy power plants with a capacity within 10 MW continuously (ESDM, 2017a).

Purchasing electricity from solar and wind power, for areas that generation cost above the average national generation cost, the purchase price of electricity is maximum 85% of generation cost on the respective local grid. Meanwhile, if generation cost in local grid equal to or below the average national generation cost, the electricity purchase price is equal to the generation cost in the local grid.

Purchasing electricity from biomass and biogas energy with a maximum capacity of 10 MW using the reference price, while more than 10 MW using the mechanism of direct selection. For areas that generation cost above the average national generation cost, the purchase price of electricity is maximum 85% of generation cost on the respective local grid. Meanwhile, if generation cost in local grid equal to or below the average national generation cost, the electricity purchase price is equal to the generation cost in the local grid.

Purchasing electricity from municipal solid waste power plant can use the technology of methane gas collection and utilization of technology with the sanitary landfill, anaerobic digestion, or the like from the landfill or through the use of heat/thermal technology using thermochemical. The developers can be given facilities in the form of incentives that will be set in separate regulation. For areas that generation cost above the average national generation cost, the purchase price of electricity is equal to the generation cost on the respective local grid. Meanwhile, if generation cost in local grid equal to or below the average national generation cost, the electricity purchase price is determined upon agreement of the parties.

Purchasing electricity from geothermal energy can only be done by PLN to electric power developers which has geothermal working areas in accordance with proven reserves after exploration. For areas that generation cost above the average national generation cost, the purchase price of electricity is equal to the generation cost on the respective local grid. Meanwhile, if generation cost in local grid equal to or below the average national generation cost, the electricity purchase price is determined upon agreement of the parties.

Purchasing electricity from hydro energy power plants performed using the reference price or direct selections. Plant with a maximum capacity of 10 MW, to be able to operate with a minimum capacity factor of 65%. While the larger capacity of 10 MW, the capacity factor depending on the needs of the system. For areas that generation cost above the average national generation cost, the purchase price of electricity is maximum 85% of generation cost on the respective local grid. Meanwhile, if generation cost in local grid equal to or below the average national generation cost, the electricity purchase price is equal to the generation cost in the local grid.

The generation cost in the electricity system that is used as the purchase price of electricity in the power purchase agreement is generation cost in the electricity system in the previous year that have been set by the Minister on the proposed PLN. The purchase of electricity is using scheme of Build Own Operate and Transfer (BOOT). Construction of the grid for power evacuation from power plant to the point of connection will be carried out between electric power developer and PLN through mechanism of business to business based.

PARTICIPATION FROM REGIONAL GOVERNMENT IN UPSTREAM OIL AND GAS BUSINESS

On 26 November 2016, the government issued Ministerial Regulation No. 37 of 2016 regarding provisions offering participating interest of 10% (PI 10%) in the working area of oil and gas. This regulation was intended to implement the provisions of Article 34 of Government Regulation No. 35 of 2004 on upstream oil and gas, which has been amended several times. The most recent amendment was by Government Regulation No. 55 of 2009 to increase the participation of regional government through the obligation for the contractor (PSC) to offer the PI 10% to the regional-owned enterprise (BUMD). BUMD was established by regional government whose administrative area includes the field which is firstly produced (ESDM, 2016c).

The regulation mandates including the following:

- Since the approval of the first plan of development (POD1), the contractor (PSC) has an obligation to offer PI 10% to BUMD;
- Onshore fields from 0 to 4 nautical miles involving BUMD districts/cities/provinces coordinated by the governor;
- The fields from 4 to 12 nautical miles for BUMD provinces;
- Onshore or offshore fields located in administrative areas of more than one province are based on the agreement among the related governors. If no agreement exists, then the Minister of EMR determines the number of PI offered to each province;
- In the period of 10 days from date of receipt of the approval of POD1, Chief of SKK Migas is obliged to submit a letter addressed to the governor to review the preparation of BUMD that will accept offer PI 10%;
- During Period 1 year, the governor delivered a letter of appointment to the BUMD that will accept the offer PI 10% indicated by the Chief of SKK Migas with a copy to the Minister;
- In case the governor did not submit a letter of BUMD appointment, it will be assumed that the party is not interested and PI offers of 10% will be declared closed;
- In case PI 10% offers for BUMD are declared closed, a contractor is required to offer it to SOEs;
- The contractor (PSC) pre-finances the amount of obligation of BUMD;
- Returns financing to contractors performed each year without interest from the production of parts BUMD while ensuring acceptance of profit sharing to BUMD;
- SOE has an obligation to finance itself appropriate of normal business practices; and
- Shareholding enterprises and 10% PI cannot be traded or transferred or pledged.

THE GROSS SPLIT SCHEME IS BREAKTHROUGH IN UPSTREAM OIL AND GAS BUSINESS

On 13 January 2017, the government issued Ministerial Regulation No. 8 of 2017 on production sharing contracts. A gross split was enacted on 22 January 2017. The gross split scheme is a breakthrough for the program in the upstream oil and gas more efficiently and effectively so as to attract the investors (ESDM, 2017b).

The regulation including the following:

- The ownership of natural resources remains in the hands of the government until the point of delivery;
- Management control operations are at SKK Migas;
- Capital and risks are borne by the contractor;
- Gross split for oil is 57% government and 43% PSC;
- Gross split for gas is 52% government and 48% PSC; and

- For gross revenue share split, especially for oil and gas development in the deep sea, which is located in the eastern part of Indonesia where its infrastructure is underdeveloped, a different split will be determined by the government.

In addition, other efforts undertaken by the Indonesian upstream oil and gas industry in order to attract investors is the simplification of licensing. The original 104 licenses have been simplified to 42 by the Directorate General of Oil and Gas. Within one to two months, it will be further simplified to just six licenses. Currently the license in upstream oil and gas industry were six licenses. To accelerate the licensing process, the Ministry of Energy and Mineral Resources in cooperation with the Investment Coordinating Board (BKPM), has launched quick service delivery and licensing related to infrastructure in the energy and mineral resources in three hours (ESDM, 2017c).

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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 (km²), 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 2014 was approximately USD 4 437 billion (2010 USD purchasing power parity [PPP]). In 2014, Japan's population of 127 million people had a per capita income of USD 34 902. The GDP decreased by 0.03% in 2014 compared to 2013. Since indigenous energy resources are modest, Japan imports nearly all of its fossil fuels to sustain economic activity. The proven energy reserves¹ included approximately 44 million barrels of oil, 21 billion cubic metres (bcm) of natural gas and 347 million tonnes (Mt) of coal.

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves	
Area (thousand km ²)	377.8	Oil (million barrels) ^b	44
Population (million)	127	Gas (billion cubic metres) ^b	21
GDP (2010 USD billion PPP)	4 437	Coal (million tonnes) ^c	347
GDP (2010 USD PPP per capita)	34 902	Uranium (kilotonnes U)	–

Sources: a. EGEDA (2016); b. C. Xu, et al. (2015); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, Japan's total primary energy supply was about 448 million tonnes of oil equivalent (Mtoe), 2.5% less than in 2013. By fuel type, oil contributed the largest share (43%), followed by coal (26%) and natural gas (24%). In 2014, the net imports of energy sources accounted for 95% of the total primary energy supply.

In 2014, Japan was the third-largest oil consumer of the world and among the APEC economies (4.3 million barrels per day [Mbbbl/D]), after the United States and China (BP, 2016), and almost all of the oil was imported. The bulk of the imports (73% in 2014) were from economies in the Middle East such as Saudi Arabia; the United Arab Emirates and Qatar (BP, 2015). In 2014, the primary oil supply was 205 Mtoe, a decrease of 6.4% from the previous year.

Japan is endowed with only limited coal reserves, 347 Mt, which is less than twice the consumption in fiscal year² (FY) 2014: 110 Mt of steam coal and 72 Mt of coking coal (METI, 2016a). It is one of the world's largest importers of coking coal for steel production and steam coal for power generation, as well as for 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 2014, and are located in the prefectures of Niigata, Chiba and Fukushima. In 2014, the domestic demand was met almost entirely by imports in the form of liquefied natural gas (LNG) (BP, 2016), from Australia (21%); Qatar (18%); Malaysia (17%); Russia (10%) and other economies. LNG imports to Japan comprised 36% of the total global LNG trade in 2014. 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 107 Mtoe in 2014, an increase of 2% from the previous year.

¹ Oil and natural gas are as of January 2016. Coal is as of the end of 2015.

² The fiscal year starts in April in Japan.

Japan has 287 gigawatts (GW) (EGEDA, 2016) of installed generating capacity and generated 1 081 865 gigawatt-hours (GWh) of electricity in 2014. Electricity is generated from thermal fuels (coal, natural gas and oil—87.6%) and hydro (7.9%). The year 2014 was the first year without nuclear generation since mid-1960s, when commercial nuclear operations started. Geothermal, solar and wind technologies produce the remainder (4.5%).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	34 559	Industry sector	113 176	Total power generation	1 081 865
Net imports and others	423 980	Transport sector	73 980	Thermal	947 441
Total primary energy supply	448 339	Other sectors	89 145	Hydro	85 544
Coal	118 187	Non-energy	3 457	Nuclear	0
Oil	192 236	Total final energy consumption	299 759	Others	48 881
Gas	107 263	Coal	33 352		
Others	30 554	Oil	151 043		
		Gas	29 167		
		Electricity and others	86 198		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

In 2014, the total final energy consumption in Japan was 299.8 Mtoe, 0.8% 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 0.8% compared to the previous year, while consumption in the transport sector also increased by 1.3%. By energy source, petroleum products accounted for 50% of the total final energy consumption, followed by electricity and others (29%), coal (11%) and gas (9.7%).

ENERGY INTENSITY ANALYSIS

In 2014, Japan's energy intensity declined in terms of primary energy as well as final consumption, contrary to the previous year, when each showed different trends. Primary energy intensity decreased to 101 tonnes of oil equivalent per million USD (toe/million USD), -2.4% from the level of the year before. Final energy intensity also dropped to 67.6%, equivalent to -0.8% from 2013. This was mostly driven by the decreasing energy consumption in the other sector, which includes buildings, and in the industry sector.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Primary energy supply	103.6	101.0	-2.4
Final energy consumption	68.1	67.6	-0.8
Final energy consumption excl. non-energy	67.3	66.8	-0.8

Source: EGEDA (2016).

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 with the Ministry of the Environment (MOE), has been 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 plus 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. The plan is required to be reviewed at least every three years and revised as necessary.

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 from 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. 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 goal. 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 government of the Democratic Party of Japan (DPJ) 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 energy 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.

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 CO₂ emissions, and aims to ensure the '3E+S' policy where 'safety' is the foremost condition.

The Outlook has three steps: 1) increase energy self-sufficiency (including nuclear as a quasi-domestic energy) to approximately 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 47% in 2012 due to the loss of nuclear generation and incremental oil-fired generation after the earthquake. Although oil's share declined to about 43% in 2014, securing its stable supply is one of Japan's major energy policy issues.

The oil supply structure of the economy is vulnerable to disruption because it imports almost all of its domestic consumption. 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 October 2016, Japan held the equivalent of 221 days of net imports, including state-owned stocks, private sector stocks and joint oil storage programs with oil-producing countries (PAJ, 2016).

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 that regulates 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 Specific Petroleum Law (provisional measures law regulating 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 in the interaction with final consumers.

The number of oil refineries in Japan decreased from 40 in 1996 to 22 in October 2016 and the refining capacity decreased from 5.3 Mbb/D to 3.8 Mbb/D (PAJ, 2016).

NATURAL GAS

Demand for natural gas has increased rapidly over the past two decades, at an annual rate of 3.8% between 1990 and 2014 (EGEDA, 2016). 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 paid 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 have sought to reduce their costs because of the deregulation of the gas and electricity markets. The utilities have been striving to secure an 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 will be 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 2014, coal accounted for 26% 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 third-largest coal importer in the world, after China and India. Japan's imports accounted for about 13% of the total global coal imports in 2014 (IEA, 2016).

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 as well as a shift in the industry structure to more services-based sectors has driven the steady increase in electricity consumption in recent years.

Since 1995, Japan has been partially liberalised to ensure fair competition and transparency: for example, introduction of independent power producers in 1995; introduction of PPS (power producers and suppliers) and partial retail competition (over 2000 kW) in 2000; and expansion of retail competition in 2004 (over 500 kW) and 2005 (over 50 kW) (METI, 2002). As of FY 2013, approximately 60% of the market, in terms of electricity consumption, was already liberalised. However, after the earthquake and the subsequent Fukushima Daiichi nuclear power accident, the Japanese electricity sector faces mounting pressure to further deregulate the market for a 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 or after the legal unbundling.

FISCAL REGIME AND INVESTMENTS

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, buildings (commercial and household), and transport sectors. Japan has improved its energy efficiency, for example, by approximately 40% in final consumption basis in 1980-2014. The Energy Conservation Law 1979 was partially amended in

May 2013. The amendment included the expansion of the top-runner program, which was introduced in 1998 to establish energy efficiency standards to curb the consumption in the residential, commercial and transport sectors. The program initially covered 11 items, including cars and air conditioners, and expanded to 31 items in 2013. In the 2013 amendments, 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 established 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 newly constructed public buildings by 2020, and all newly constructed buildings on average by 2030;
- Raising next-generation vehicles' share of new vehicle sales to between 50% and 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 FY 2016. Solar power prices were reduced from the FY 2015 levels (METI, 2016b).

Table 4: Prices for feed-in tariffs in FY 2016

Renewable Energy		Prices (JPY per kWh)	Years
Solar	Over 10 kW	24 + tax ^a	20
	Less than 10 kW	31.0/33.0 ^b	10
	Less than 10 kW (Double generation)	25.0/27.0 ^b	10
Onshore wind	Over 20 kW	22 + tax	20
	Less than 20 kW	55 + tax	20
Offshore wind		36 + tax	20
Hydro	From 1 000 kW to 30 000 kW	24 + tax	20
	From 200 kW to 1 000 kW	29 + tax	20
	Less than 200 kW	34 + tax	20
Geothermal	Over 15 000 kW	26 + tax	15
	Less than 15 000 kW	40 + tax	15

Biomass	Methane fermentation gasification	39 + tax	20
	Unused woods (less than 2000 kW)	40 + tax	20
	Unused woods (Over 2000 kW)	32 + tax	20
	General woods	24 + tax	20
	Waste (excluding woods)	17 + tax	20
	Recycled woods	13 + tax	20

Note: a. consumption tax (8%); b. 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 a suppression control system. Higher purchase prices are applied to this case.

Source: METI (2016b)

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. The surcharge for renewable energy has been calculated as follows since May 2016 (METI, 2016b):

$$\text{Surcharge for renewable energy} = \text{Monthly electricity consumption (kWh)} \times 2.25 \text{ JPY/kWh}$$

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, 2016c). Four years after the FiT's introduction, 88 209 megawatts (MW) of renewable capacity were authorised, compared to the accumulated renewable capacity at the end of June 2012, that is, before the introduction of the FiT, of 20 600 MW. This indicates that if all the authorised capacity is installed, the generation capacity based on renewable energy is more than five times since the introduction of the FiT. Non-residential solar PV has flourished in Japan. Its installed capacity and authorised capacity amounts to 30 198 MW and 80 274 MW, respectively, accounting for 95% of the newly installed capacity after the FiT introduction, and 91% of the authorised capacity. The start-up renewable capacity is 21 560 MW, a bit more than one-third of the authorised capacity.

Beginning in April 2017, the government will enforce a partial revision to the Act to facilitate the installation of authorised capacity, to revise the FiT pricing system and to oblige the general transmission companies to purchase the FiT electricity, instead of retail companies under current rules. Regarding the pricing system, the revision will allow the government to determine the purchase prices for the next several years. This new system is expected to promote renewable energy with longer lead-time, such as geothermal, wind, medium hydro and biomass, by improving the predictability of the projects. To promote renewable energy in a cost-effective manner, the revision also allows the government to use auctions for determining the FiT prices. The government plans to use the auction system for utility-scale solar PV (METI, 2016d).

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

	Installed capacity		Authorised capacity under FiT
	By the end of June 2012	Newly installed under FiT (July 2012–August 2016)	July 2012–August 2016
Solar (Residence)	4 700	4 248	5 004
Solar (Non-residence. More than 10 kW)	900	25 950	75 270
Wind	2 600	569	3 033
Medium hydro	9 600	208	791

Biomass	2 300	640	4 032
Geothermal	500	10	79
Total	20 600	31 625	88 209

Source: METI (2013, 2016c).

NUCLEAR ENERGY

There were 54 nuclear reactors in Japan in 2010, the last year before the Fukushima Daiichi nuclear power plant accident. As of December 2016, the number of reactors decreased to 43 due to the decommission of the Fukushima Daiichi Nuclear Power Station³ and six other reactors:⁴ Tsuruga Unit 1, Mihama Units 1 and 2, Shimane Unit 1, Genkai Unit 1 and Ikata Unit 1. Owners of the six reactors decided on 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 its introduction, as mentioned above. 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. In October 2016, the NRA gave the final safety approval to Ikata Unit 3, Mihama Unit 3, Sendai Units 1-2 and Takahama Units 1-4. The NEA approved a 20-year license extension for Takahama Units 1 and 2; this was the first lifetime extension under the current regulatory scheme. However, several nuclear reactors in Japan face challenges due to the decisions made by local district courts. For example, in March 2016, the Otsu district court suspended operation of Takahama Units 3 and 4, which were restarted in January and February 2016, respectively.

Regarding the nuclear fuel cycle, Japan promotes the reprocessing process and the effective utilisation of the plutonium retrieved. Although Japan continues to hold the nuclear fuel cycle policy, in December 2016, the government decided to decommission Monju, the prototype fast breeder reactor, due to repeated troubles. For future research and development of nuclear fuel cycle, the government is discussing alternative approaches, including cooperation with France in the ASTRID project (CAS, 2016).

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 exceeded this commitment by reducing emissions by 8.4%. In fact, average GHG emissions in Japan during the commitment period increased by 1.4%, from 1 261 million tonnes of CO₂ equivalent to 1 278 million tonnes of CO₂ 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).

To generate further emission reductions, Japan introduced the Tax for Climate Change Mitigation in October 2012 (MOE, 2012). This tax is levied on crude oil/oil products, gas and coal. The tax has raised in phases in April 2014 and 2016 (Table 5); the tax value is JPY 289 per tonne-CO₂ for each kind of product since April 2016. Revenue from this tax is used for implementing various measures to promote energy efficiency and renewable energy, as well as for the use of clean fossil fuels.

Table 6: 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

³ A total of six reactors. The reactor owner (Tokyo Electric Power Company) decided to decommission Units 1-4 in April 2012 and Units 5 and 6 in January 2014.

⁴ Reactor owners announced in March 2015.

Coal (JPY/tonne)	220	440	670
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Source: MOE (2012).

In July 2015, Japan submitted its (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC, 2015). The economy determined its emission reduction level based on the government's Long-term Energy Supply and Demand Outlook. Japan's INDC looking 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 CO₂ in 2030.

In the same month as Japan's INDC submission, a voluntary action plan was decided by ten former general electric power companies, J-POEWR, Japan Atomic Power Company and 23 PPSs. This action plan targets an emissions intensity of 0.37 kgCO₂/kWh in 2030, which is consistent with Japan's Long-term Energy Supply and Demand Outlook and INDC. To support the voluntary action plan, the government amended several laws, in particular, the Energy Conservation Law (conversion efficiency standards on new fossil fuel plants: 42% for coal-fired and 50.5% for LNG-fired, both in higher heating value basis) and the Act on Sophisticated Methods of Energy Supply Structure (non-fossil's share standards for retail companies: 44% in 2030) (METI, 2016a).

NOTABLE ENERGY DEVELOPMENTS

G7 KITAKYUSHU ENERGY MINISTERIAL MEETING

On 1-2 May 2016, METI hosted the G7 Kitakyushu Energy Ministerial Meeting. Energy Ministers discussed focusing on (1) energy investment for global growth, (2) energy security, and (3) energy sustainability. The meeting adopted the Kitakyushu Initiative on Energy Security for Global Growth. Key elements of the joint statement include energy investment, gas security, cybersecurity and electricity security, innovation and deployment of energy technologies, and nuclear energy and safety (METI, 2016e). At the G7 Energy Ministerial Meeting, METI also released a strategy to create flexible LNG markets.

NUCLEAR FUEL CYCLE

As mentioned in the Nuclear Energy section, in December 2016, the economy decided to decommission Monju, the prototype fast breeder reactor, due to repeated problems. Yet, the government will hold the policy to promote nuclear fuel cycle, and discuss alternative approaches for future research and development, including the cooperation with France in the ASTRID project.

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USEFUL LINKS

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

Institute of Energy Economics, Japan—enen.iecej.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 100 266 square kilometres (km²) and a population of 50 million people as of 2014. Korea's population density is very high, with an average of more than 500 people per km². Approximately 20% of the population lives in Seoul, Korea's capital and its largest city. The economy's geography consists 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 heating is required during the bitterly cold winters.

During the last few decades, Korea has become one of Asia's fastest-growing and most dynamic economies. The gross domestic product (GDP) has increased at a rate of 6.4% per year from 1980 to 2014, reaching USD 1 698 billion (2010 USD purchasing power parity [PPP]) in 2014. GDP per capita (2010 USD PPP) income in 2014 was USD 33 667, more than 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, to sustain its high level of economic growth, Korea imports large quantities of energy products. Korea imported about 87% of its primary energy supply in 2014. In the same year, it was the world's fifth-largest importer of oil, seventh-largest importer of liquefied natural gas (LNG) and fourth-largest importer of coal.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	100 266	Oil (million barrels)	–
Population (million)	50	Gas (billion cubic metres)	5.7
GDP (2010 USD billion PPP)	1 698	Coal (million tonnes)	320
GDP (2010 USD PPP per capita)	33 667	Uranium (kilotonnes U)	–

Sources: a. UN (2016); b. EGEDA (2016); c. EIA (2016); d. KEEI (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased almost sevenfold between 1980 and 2014 from 38 million tonnes of oil equivalent (Mtoe) in 1980 to 269 Mtoe in 2014. 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 5.3 toe in 2014. This increase was similar to that of Japan and most European economies.

In 2014, Korea's total primary energy supply was 269 Mtoe, a 1.7% increase from the prior year. In terms of energy source, oil represented the largest share (36%), followed by coal (30%) and gas (16%). The remaining 17% 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 2014.

The oil supply in 2014 was 96 Mtoe, a 0.2% decrease from the previous year. In 2014, the economy imported 84% of its crude oil from the Middle East. With regard to coal, the supply in 2014 totalled 82 Mtoe, a 4.9% 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 both steam coal and coking coal. The main coal imports come from Australia, Indonesia, Russia, Canada, China, and the United States.

Since the introduction of LNG in 1986, natural gas use in Korea has grown rapidly. The gas supply reached 43 Mtoe in 2014. Its share of the primary energy supply was 16% in the same year. Most of Korea's LNG imports come from Qatar, Indonesia, Oman, Malaysia, Australia, and Brunei Darussalam. 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 2014 was 551 terawatt-hours (TWh), a 1.6% increase from 2013. Generation by thermal sources, including coal, oil and natural gas, accounted for 69% of the total electricity generated, followed by nuclear at 28% and hydro and others at 2.8%.

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	49 219	Industry sector	49 813	Total power generation	550 933
Net imports and others	232 845	Transport sector	31 868	Thermal	379 353
Total primary energy supply	268 519	Other sectors	44 276	Hydro	7 820
Coal	81 697	Non-energy	44 343	Nuclear	156 407
Oil	96 332	Total final energy consumption	170 299	Others	7 353
Gas	43 126	Coal	10 883		
Others	47 365	Oil	86 907		
		Gas	22 213		
		Electricity and others	50 296		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2014 was 170 Mtoe, which is the same level as the previous year. The industrial sector accounted for the largest share at 29%, while the transport sector accounted for 19%. The remainder (52%) 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 (13%) and coal (6.4%). Natural gas consumption has increased significantly because of the economy's policy measures.

ENERGY INTENSITY ANALYSIS

The 3.3% growth of Korean GDP in 2014 resulted in a 1.6% decrease in the energy intensity of the economy's total primary energy supply. This is an economy-wide energy intensity level decrease of 2.5 tonnes of oil equivalent per million USD. With regard to final energy consumption, the energy intensity level decreased by 1.8% from the 2013 level of 102 tonnes of oil equivalent per million USD to 100 tonnes of oil equivalent per million USD in 2014. Using a per sector analysis, the other sectors registered the largest reduction in energy use per USD million of GDP from a level of 27 tonnes of oil equivalent per million USD in 2013 to 26 tonnes of oil equivalent per million USD in 2014, a fall of 3.7%. The transport sector in 2014 had a lower intensity at 19 tonnes of oil equivalent per million USD, a decrease of 1.7% from its prior year's level. The energy intensity of the industry sector rose by 0.1%, while that of non-energy declined 2% from the 2013 levels.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	161	158	-1.6
Total final energy consumption	102	100	-1.8
Total final energy consumption excl. non-energy	77	74	-3.1

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In the past, Korea's energy policy has focused on ensuring a stable energy supply 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 the following six major policy strategies:

- 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 stages of restructuring and liberalisation may evolve 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, a holding company, was owned by the Korean Government. KEPCO is still a dominant player in the electricity sector, controlling 82% of total power generation and 100% of transmission and distribution in Korea (KEEI, 2015).

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 2015, 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 2015, Korea held 228 million barrels in oil stock. 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 August 2016, it was conducting 28 projects in 17 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 9 in 1980 to 29 in 2016; however, the economy's dependency on oil imports from the Middle East remains high (84% in 2014). 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

Korea introduced natural gas-based city gas to the residential sector in the 1980s to reduce the economy's dependence on imported oil. 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 second 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 more than fourfold, 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 scheduled 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 from 22% in 2014 to 24% by 2029.

FISCAL REGIME AND INVESTMENT

In December 2009, the Korean Government approved tax reforms 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 KRW 200 million to KRW 20 billion and 10% on taxable income below 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 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, as compared to 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 government plans to replace 11% of the 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, Korea announced a new Low-Carbon, Green Growth vision aimed at shifting 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. To implement this vision 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 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

RESPONSE TO CLIMATE CHANGE

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 CO₂ 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 investments 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 MtCO₂ 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 its major mitigation measures available.

To meet its INDC, the Korean Government announced the First National Basic Plan Responding Climate Change with Basic Roadmap to National GHG Reduction in 2030 in December 2016 (Government of Korea, 2016). It provides comprehensive policy directions towards expansion of renewable energy use, increasing power generation using clean fuel, improving energy efficiency, utilisation of carbon market, increasing climate technology investment and fostering new energy-related businesses.

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USEFUL LINKS

Korea Electric Power Generation Corporation—www.kepco.co.kr/eng/

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>

Ministry of Strategy and Finance—<http://english.mosf.go.kr>

Statistics Korea—<http://kostat.go.kr/portal/english/index.action>

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

MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia and lies entirely in the equatorial zone, with an average daily temperature varying between 21°C to 32°C. It has a total territory of approximately 330 323 square kilometres (km²), covering eleven states and two federal territories in Peninsular Malaysia as well as two states and one federal territory on the island of Borneo (EPU, 2016). In 2014, Malaysia's population stood at 29.9 million, an increase of 1.5% from the 2013 level of 29.5 million (EGEDA, 2016).

Malaysia's gross domestic product (GDP) reached USD 717 billion (2010 USD purchasing power parity [PPP]) in 2014, an improvement of 6% from USD 676 billion in 2013. This represented a 4.4% improvement in GDP per capita from USD 22 945 in 2013 to USD 23 965 (EGEDA, 2016). The largest contributions to GDP were from services (53%), manufacturing (23%), agriculture (9%) and mining (9%) (EPU, 2016). In 2015, the main export products were electrical and electronic (E&E) products (approximately 36% of total exports), chemicals and chemical products (7.1%) petroleum products (7%) and liquefied natural gas (LNG) (6%) (MATRADE, 2016).

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 2016 data published by the Energy Commission of Malaysia 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 5.8 billion barrels, 40% of which is found in Peninsular Malaysia (the Malay basin). The natural gas reserves of the economy are estimated at approximately 2.8 trillion cubic metres or 100 trillion cubic feet (Tcf) in 2014. More than half of the reserves are found in the Sarawak basin. The coal reserves, assessed at 1.9 billion tonnes, are located mostly in Sarawak and Sabah (EC, 2016).

Located near the equator, where sunshine is abundant, Malaysia has huge potential to develop solar power, despite the cloudy appearance that constantly manifests itself in the region. It also has vast potential for biomass as an energy source due to the presence of palm oil plantations and industries in the economy. As of 2016, Malaysia accounted for 30% of world's palm oil production and 37% of the world's palm oil exports (MPOC, 2016). This production creates abundant agricultural residue, particularly empty fruit bunches.¹

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	330 323	Oil (billion barrels)	5.8
Population (million)	30	Gas (trillion cubic metres)	2.8
GDP (2010 USD billion PPP)	717	Coal (million tonnes)	1 938
GDP (2010 USD PPP per capita)	23 965	Uranium (kilotonnes U)	–

Sources: a. EPU (2016); b. EGEDA (2016); c. EC (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 78 626 kilotonnes of oil equivalent (ktoe) in 2014, an increase of 1.4% from the 2013 level of 77 567 ktoe. Oil contributed the largest share at approximately 41% (32 532 ktoe), followed by natural gas with 37% share (29 213 ktoe) and coal with a 19% share (15 258 ktoe). Other resources include hydro, which in 2014 provided a minimal share of approximately 2% (1 625 ktoe) to the primary energy

¹The 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).

supply (EGEDA, 2016). Among the primary energy sources, coal and gas demand decreased by 0.2% and 0.3% respectively over 2013–14. Oil demand increased by 3% and other types of fuel showed significant growth of more than 15%.

Traditionally, Malaysia has been an energy exporter of mainly crude oil and natural gas (through pipelines and in LNG form). The economy registered total energy exports of 27 867 ktoe in 2014, an increase of 2% from the 2013 level of 27 323 ktoe. Over the same period, total energy imports decrease by 8% from 26 601 ktoe to 24 544 ktoe. Most of the decrease occurred in the petroleum product sector, which saw imports decrease from 7 400 ktoe in 2013 to 5 611 ktoe in 2014 (EC, 2016). Malaysia is the third-largest exporter of LNG in the world and the second-largest producer of crude oil and natural gas in South-East Asia (EIA, 2017).

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 603 thousand barrels per day in 2014, approximately 80% of which were crude oil while the rest were condensates. In 2014, the Peninsular Malaysia yielded 42% of total oil production, followed by Sarawak with 32% and Sabah with approximately 26% (EC, 2016).

Malaysia has five oil refineries with a combined capacity of 566 thousand barrels per day (kbbbl/D) (including condensate splitter capacity). Petrolim 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 78% of total domestic sales of petroleum products in 2014 (EC, 2016).

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 known as the Pengerang Integrated Petroleum Complex (PIPC). PIPC is divided into two mega-projects: Pengerang Independent Deepwater Petroleum Terminal (PIDPT) undertaken by private companies 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). Despite challenging economic conditions and a low oil price environment, RAPID project is still on track towards achieving the overall start-up in the first quarter of 2019 (OGJ, 2016).

NATURAL GAS

Most of the gas reserves of Malaysia are offshore in Peninsular Malaysia in the eastern areas of Sarawak and Sabah. Most of the gas reserves are non-associated (84%), while the remaining reserves are associated with oil basins (16%). Sarawak hosts slightly more than half of the total reserves, followed by Peninsular Malaysia with 35% and Sabah with 14%. In 2014, the average daily natural gas production was 6 593 million standard cubic feet per day (MMscf/D), a decrease of approximately 2.0% from the 2013 level of 6 730 MMscf/D (EC, 2016). Most of the production came from Sarawak at 64%. Peninsular Malaysia had a 30% share and Sabah had a 6% share. In order to meet local demand, Malaysia sourced its gas requirements via pipelines from the Malaysia-Thailand Joint Development Area (MT-JDA) and importation from Indonesia (EC, 2013). The 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 2014, Malaysia imported approximately 2 019 ktoe of LNG, an increase of nearly 40% from 1 450 ktoe in 2013 (EC, 2016).

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 consists 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, 2015).

Malaysia has extensive LNG export facilities and contributed approximately 10% of the world's LNG exports, equivalent to 25 Mt per year. In 2016, Japan remained the largest importer of Malaysia's LNG with approximately a 62% share, followed by Korea; China and Chinese Taipei with export shares of 16%, 11% and 10% respectively (IGU, 2017).

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). Due to the aggressive exploration, Malaysian gas reserves have increased by 2%, from 98 Tcf in 2013 to 100 Tcf in 2014 (EC, 2016).

COAL

Malaysia's coal resources mostly consist of bituminous and sub-bituminous coal. Estimated reserves are approximately 1938 Mt, which are found in Sabah and Sarawak. Nearly two-thirds of these reserves have been categorised as inferred. 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, such as the Maliau Basin in Sabah, thereby prohibiting coal-mining activities. Only Sarawak allows coal-mining activity, and the areas are Mukah (the largest producing coal basin) with 2 017 747 metric tonnes of production in 2014, Kapit with 603 840 metric tonnes and Sri Aman with 66 177 metric tonnes (EC, 2016).

According to IEA Energy Statistics 2016, Malaysia ranked the ninth-largest coal importer in the world in 2015 with coal consumption reaching 24 Mt (IEA, 2016). 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, 2016).

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 jurisdiction 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) (ACE, 2015). The Sarawak grid is connected to the Kalimantan grid in Indonesia. The power transfer reached 70 MW by May 2015 (The Star, 2016).

Malaysia's total licensed installed power generation capacity in 2014 was recorded at 29 974 MW, an increase of approximately 0.6% from the 2013 level of 29 748 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 the total installed capacity was owned by the independent power producers (IPPs) and the rest by government-linked utilities, self-generation facilities and co-generation facilities (EC, 2015).

In the same year, total electricity generation was 147 461 gigawatt-hours (GWh), an increase of approximately 4% from the 2013 level. Thermal generation, mostly from natural gas and coal, accounted for 90% of total power generation, while hydropower and other fuel accounted for the remainder (EGEDA, 2016).

FINAL ENERGY CONSUMPTION

In 2014, Malaysia's final energy consumption reached 48 469 ktoe, an increase of 1.3% from the 2013 level. The transport sector was the biggest energy consumer, overtaking the industrial sector and accounting for a 43% share of the total final energy consumption or approximately 20 891 ktoe. It was followed by the industry sector with a 27% share or 13 314 ktoe, the non-energy sector with a 12% share or 5 794 ktoe, and other sectors with a share of 17% or 8 468 ktoe (EGEDA, 2016).

In 2014, in terms of fuel type, oil was still the most consumed fuel, particularly in the transport sector, accounting for approximately 56% of total energy demand. This was followed by electricity with a 23% share, gas with a 18% share and coal with a 4% share. Oil consumption increased by 0.6% to 26 991 toe in 2014 from 22 830 toe in 2013. However, natural gas consumption decreased by 1.8%, from 8 897 ktoe in 2013 to 8734 ktoe in 2014 (EGEDA, 2016).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	87 821	Industry sector	13 314	Total power generation	147 461
Net imports and others	-7 129	Transport sector	20 891	Thermal	133 153
Total primary energy supply	78 626	Other sectors	8 468	Hydro	13 388
Coal	15 258	Non-energy	5 794	Nuclear	0
Oil	32 531	Total final energy consumption	48 469	Others	920
Gas	29 213	Coal	1 708		
Others	1 625	Oil	26 991		
		Gas	8 734		
		Electricity and others	11 036		

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

Source: EGEDA (2016).

ENERGY INTENSITY ANALYSIS

Malaysia's primary energy intensity decrease from 115 toe/million USD in 2013 to 110 toe/million USD in 2014, representing a 4.4% reduction. Final energy consumption intensity also decreased at the same rate of 4.4% from 71 toe/million USD in 2013 to 68 toe/million USD in 2014. If the non-energy sector were excluded from the final energy, the final energy intensity reduction would stand at only 2.7% (EGEDA, 2016).

However, based on Malaysia's National Energy Balance 2014, final energy consumption reached 52 209 ktoe, an increase of 1.2% from 2012 (51 583 ktoe). This led to a decrease in final energy consumption intensity by 4.5% from 54 toe/million 2010 Ringgit Malaysia in 2013 to 51.56 toe/million 2010 Ringgit Malaysia in 2014 (EC, 2016).

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	115	110	-4.4
Total final energy consumption	71	68	-4.4
Total final energy consumption excl. non-energy	61	60	-2.7

Source: EGEDA (2016).

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 have been 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 2000 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 this policy was further expanded in 2001 with 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 (11GWh) 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. 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 impact 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 and created under the Petroleum Development Act of 1974. PETRONAS is vested with exclusive rights for exploration and production of petroleum whether onshore or offshore in Malaysia. It also has responsibility for the planning, investment and regulation of the upstream sector. Any foreign and private companies desiring to explore and produce petroleum in Malaysia have to enter into a Production Sharing Contracts (PSC) with PETRONAS.

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. 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 (APEREC, 2014):

- The Economic Planning Unit (EPU) sets the general direction and broad strategies for Malaysia's energy policies, such as formulation and implementation of the national policy on energy, development of oil and gas industry.
- The Ministry of Energy, Green Technology and Water (KeTTHA) oversees programs and projects in strengthening energy resources to ensure electricity supply is of quality, reliable and cost effective. It also drive the development of RE and the promotion of energy efficiency, among others. Part of the ministry's role is also to assist EPU in the formulation of energy policy.
- 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.

During the Eleventh Malaysia Plan, launched in 2016, outlines the strategic approaches that are designed to improve energy supply security. Demand-side management (DSM), a major paradigm shift, which incorporates energy efficiency and conservation measures, together with higher penetration targets of RE, will be implemented in order to ensure the sustainable management of energy resources, subsequently improved energy security.

Another measure to improve energy security is to diversify LNG supply importation. The economy is confronting the issue of the geographic disparity of the natural gas supply and demand among its regions. 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 regasification terminal (RGTs) are being constructed 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 $2 \times 13\,0000$ cubic metres and an annual storage volume of 3.8 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 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, 2016).

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 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 the following four pillars.

- 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; and
- Society: Improve the quality of life for all.

The following four sectors have been identified as the primary focus of the policy.

- Energy: The application of green technology in power generation and in energy supply-side management, including co-generation 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; and
- 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 infusion of green technology and a significant reduction of energy consumption into the 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, which 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. This 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 31 December 2016, 272 projects had been approved for loans under the GTFS amounting to MYR 2.97 billion (Green Tech Malaysia, 2017).

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, three agencies in Malaysia have been recognised as providing 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 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. 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.

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, benefit end-consumers (EPU, 2015).

In addition to IBRs, 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).

ELECTRICITY AND GAS MARKETS

Malaysia's electricity supply industry is monopolistic. It is vertically integrated whereby each utility company (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, this 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 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 proposes to remove the Special Industrial Tariff (SIT) for the industrial sector. This tariff was introduced during the Asian financial crisis in 1997–98 in order to help manufacturers stay competitive. Although launched as a temporary measure, the SIT has remained in place. The SIT will be abolished in stages and fully removed 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 2016–20 (EPU, 2015).

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. 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 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 the 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 it 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 4: 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 designs
	Retrofit 100 government buildings
	Register 70 energy service companies (ESCOs)
	Target 100 companies to implement ISO 50001 ²
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 co-generation 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)

²ISO 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 were the introduction of the RE Act in 2011 and the implementation of the Feed-in Tariff (FiT) mechanism. The Sustainable Energy Development Authority (SEDA) Malaysia, a statutory body established by the government in order to promote RE and energy demand management, set a target of 415.5 MW of additional RE capacity by 2015 (EPU, 2015). In 2016, the total installed capacity of RE (excluding hydropower with capacity above 30 MW and only covering Peninsular Malaysia and Sabah) achieving commercial operation was 420.9 MW, of which biomass was 75.4 MW, biogas 30.9 MW, small hydro 30.3 MW and solar PV 284.4 MW (SEDA, 2017).

The government identified challenges that 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 under the FiT portfolio focus on biomass, biogas, small hydro, geothermal and solar photovoltaic (PV).

Under the Eleventh Malaysia Plan, the government set a target for RE capacity to reach 2 080 MW, thereby contributing 7.8% of the total installed capacity in Peninsular Malaysia and Sabah. Strategies have also been identified to boost RE capacity. For example, studies are being conducted to identify new RE sources such as wind, geothermal and ocean energy in order to diversify the power generation mix.

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 Solar PV 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 clean electricity. This will further assist the government's effort to increase the contribution of RE in the generation mix. The NEM is regulated by the Energy Commission and implemented by SEDA and starting 1st November 2016. The total quota allocated for the 5 year period (2016-2020) is 500 MW.

Solar PV under the FiT will no longer have new quota release post 2017. As a continuation of the Government's effort to boost solar PV market in the country, the Energy Commission has been entasked to implement the large scale solar (LSS) programme in which is based on bidding process. The total quota allocated for the LSS from 2017 to 2020 is 1 250 MW³_{ac}. 250 MW_{ac} was granted direct awarded under fast track programme and these projects will achieve commercial operation in 2017. The remaining 1 000 MW_{ac} is under bidding mechanism.

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 adaptation.

At the 2015 United Nations Climate Change Conference in Paris, Malaysia's prime minister made a pledge to reduce the GHG emissions intensity of the economy's GDP by 45% 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).

Two significant policies approved in 2009 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

³ Unless specified, all PV capacities in this report are dc-rated.

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 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

PENGERANG INTEGRATED PETROLEUM COMPLEX (PIPC)

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 efficiently manage and administer 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 an 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 meet European specifications (MPRC, 2013). The project is also aimed to meet domestic demand for petroleum products and Malaysian government's future legislative requirements on the implementation Euro 5 specifications (PETRONAS, 2016).

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 by March of 2019 and that commercial operations will begin immediately thereafter (Platts, 2015b).

WORLD FIRST FLOATING LNG FACILITY

With dwindling production and maturing fields, PETRONAS has been exploring ways to develop new resources economically, which subsequently led the company to build PETRONAS Floating LNG (PFLNG), a versatile floating LNG facility consisting of several square kilometres of production, processing and offloading facilities fit-to-purpose onto a compact 300-metre long structure. PFLNG is a mega-structure that will revolutionise the landscape of LNG production. The PFLNG can be operated offshore at 200 metres water deep with a capacity of processing 1.2 million tonnes per annum of LNG (PETRONAS, 2015).

PETRONAS' first floating liquefied natural gas (LNG) facility, PFLNG SATU has achieved an industry breakthrough with the successful production of its first drop of LNG from the Kanowit gas field, offshore Sarawak on 5 December 2016. PFLNG SATU achieved commercial operations in the first quarter of 2017 and lifted its first cargo in April 2017 (PETRONAS, 2017).

BECOMING WORLD'S SECOND-LARGEST PV PRODUCER BY 2020

Malaysia aims to be the second-largest producer of solar photovoltaics (PV) in the world by 2020. Malaysia currently produces 12% of the global PV panels and aims to reach 20% by 2020. China contributed 48%, Chinese Taipei 20%, Malaysia 12% and Japan 6%. One strategy identified to achieve this target is the local adoption of green technology (The Malay Mail, 2016).

NEW TRANSPORTATION INFRASTRUCTURE AND INITIATIVES

COMMENCEMENT OF NEW MASS RAPID TRANSIT LINE

Malaysia launched the Economic Transformation Programme (ETP) in 2010 as part of its National Transformation Programme. The economy's goal is to elevate the country to developed-nation status by 2020. There are 12 National Key Economic Areas (NKEAs) under the ETP, one of which is to transform Greater Kuala Lumpur/Klang Valley into a world-class metropolis that will boast top standards in every area from business infrastructure to liveability. One of the Entry Point Projects (EPP) under the NKEA include building an integrated urban mass rapid transit system or Klang Valley Mass Rapid Transit (KVMRT) (PEMANDU, 2013).

The KVMRT project is set to be one of the most important and largest transport infrastructure projects Malaysia has ever undertaken. The KVMRT project will see the construction of three MRT lines; MRT Line 1 (51 km), MRT Line 2 (52.2 km) and MRT Line 3 (still in the planning stage) (SPAD, 2017). The MRT Line 1 begins from Sungai Buloh and runs through the city centre of Kuala Lumpur before ending in Kajang. Phase One of the MRT Line 1 (from Sungai Buloh to Semantan) was opened to commuters in December 2016, while Phase Two, from Semantan to Kajang will be operational by July 2017. The MRT Line 2 will be completed in stages and is expected to be operational by July 2021 and July 2022. The MRT Line 2 is expected to have a ridership of 529 000 passengers per day. This is expected to further improve the chronic traffic congestion currently in Kuala Lumpur.

Although no study has been conducted on how much energy, particularly oil, will be conserved due to the completion of these projects, it is nevertheless expected to contribute to the reduction of energy demand or at least stall the energy demand growth in the future and subsequently lower the emissions emitted from the transport sector.

EAST COAST RAIL LINE AND HIGH SPEED RAIL PROJECTS

In addition to the soon to be completed KVMRT project, Malaysia has embarked on two other rail projects: the East Coast Rail Line (ECRL) that will link east and west coasts of Peninsular Malaysia with a total length of 620 km (CNA, 2016) and the High Speed Rail (HSR) linking Kuala Lumpur and Singapore with a length of approximately 350 km (MyHSR, 2016).

ECRL is an electrified railway project that will connect ports on both ends and could alter regional trade routes, which are currently between the busy Strait of Malacca and the South China Sea. The construction of the project is expected to start in 2017 and it is due to be completed by 2022. As for the HSR project, a bilateral agreement that paves the way for the implementation of the Singapore-Kuala Lumpur HSR project was signed by both countries in December 2016 and the project is slated for completion in 2026. Both projects are expected to improve the public transport ridership in the future and subsequently improve energy conservation.

ENERGY EFFICIENT VEHICLES

The Malaysian government announced the third National Automotive Policy (NAP) in 2014. The NAP 2014 aims to turn Malaysia into an energy efficient vehicle (EEV) hub in ASEAN. This encompasses strategies and measures to strengthen the entire value chain of the automotive industry and will also lead to environment conservation, high-income job creation, transfer of technology and create new economic opportunities for local companies. The Malaysia Automotive Institute (MAI), which was established in 2010, has been tasked to work with the government in shaping a national industrial competitiveness in the automotive sector (MAI, 2015). Table 5 lists the EEV definition and classification set by MAI. Based on the current Malaysian car market, EEV

accounted for around 33% of the total vehicle sales in 2015 and it is expected to reach 40% in 2016 and 85% in 2020 (MAI, 2017).

Table 5: Energy efficiency vehicle definition and classification

Vehicle segment	Vehicle Type	Weight (kg)	Fuel Efficiency (L/100km)
A	Micro car	< 800	4.5
	City car	801 – 1 000	5.0
B	Super mini car	1 001 – 1 250	6.0
C	Small family car	1 251 – 1 400	6.5
D	Large family car	1 401-1 550	7.0
	Compact car		
	Executive car		
E	Executive car	1 550 – 1 800	9.5
F	Luxury car	1 801-2 050	11.0
G	Large 4 x 4	2 051 – 2 350	11.5
Others	Others	2 351 – 2 500	12.0

Source: MAI (2017)

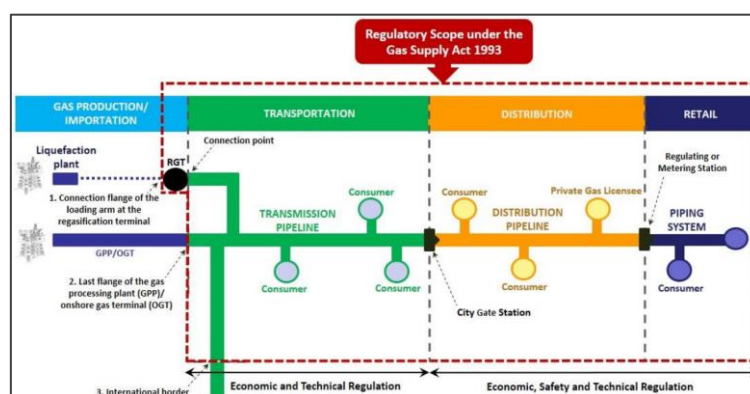
THIRD PARTY ACCESS TO GAS FACILITIES

One of the objectives of the ETP is to liberalise the gas market in Malaysia and one way to achieve such liberalisation is to create a third party access (TPA) system where third parties are able to access gas facilities that they do not own or operate. In pursuance of such considerations, the Gas Supply Act 1993 was amended in 2016 and went into effect on 16 January 2017 to provide the legal framework for the TPA system (EC, 2017).

There are three types of gas facilities that fall under the scope of the TPA: regasification terminals, transmission pipelines and distribution pipelines. There will be a 12-month grace period for existing players to apply for relevant licenses. Meanwhile, new players must apply for and be granted a licence before being able to carry out any activities specified in the Act. The Gas Supply Act 1993 is the main legal framework, which shall implement the TPA system and will be applicable throughout Malaysia, except for the state of Sarawak (EC, 2017).

The introduction of TPA is expected to help Malaysia improve the gas industry competition and at the same time improve gas supply security. With an additional receiving LNG terminal expected to be completed at PIPC in a few years, this initiative will transform the gas and energy industry into a highly competitive economic sector.

Figure 1: Regulatory scope under the Gas Supply Act 1993



Source: EC (2017).

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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 as 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 (km²). 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-2015 was more than 119 million (INEGI, 2015). Mexico City is the political capital of the economy and is one of the largest urban centres in the world. It is home to more than 20 million people, with nine million living in Mexico City proper 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 northeastern 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 2014 reaching USD 1 942 billion (2010 USD purchasing power parity [PPP]) (EGEDA, 2016).

The accomplishment of significant political, economic and energy reforms, was expected to underpin a more robust economy, but despite the prevalent environment of low oil prices since 2014, the GDP grew by 2.3% from 2013 to 2014. Despite this growth and the efforts in the last decade to improve standards of living, the growth of Mexico's GDP on a per capita basis has been small, with an annual rate of 0.7% from 2000 to 2014 (EGEDA, 2016). In addition, by the end of 2014, around 46% of the Mexican population was deemed as living under poverty conditions, with this share being roughly the same as in 2010 and 2012 (CONEVAL, 2015).

Energy, particularly oil, is a significant component of the Mexican economy, and is poised to become more relevant through the energy reform of 2013. In 2014, the value of crude oil exports represented 13% of Mexico's total exports, yet they provided 31% of the government's total revenue, from which social development and other public services are funded (Banxico, 2017). However, in 2015 this contribution dropped to around 20% due to the low oil prices, highlighting the risks of such reliance on a single resource.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	2	Oil (billion barrels)	11
Population (million)	125	Gas (billion cubic metres)	348
GDP (2010 USD billion PPP)	1 943	Coal (million tonnes)	1.2
GDP (2010 USD PPP per capita)	15 493	Uranium (kilotonnes U)	2.9

Sources: a. World Bank (2016); b. EGEDA (2016); c. BP (2016); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, the total primary energy supply (TPES) in Mexico was 187 980 kilotonnes of oil equivalent (ktoe), a decrease of 2.1% from 2013 as domestic oil production continues to wane. 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, 2016). An economy endowed with abundant fossil and renewable energy resources, by the end of 2015, Mexico's oil reserves stood at 10.8 billion barrels of crude oil (eighteenth-largest in the world) while gas reserves were around 348 billion cubic meters (bcm) and coal stood at 1.2 billion tonnes of coal (BP, 2016).

Mexico is a major oil producer, producing around 2.6 million barrels per day (Mbbbl/D) of crude oil in 2015, mostly the heavy type (BP, 2016). This volume was 2.9% 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 Mbbbl/D, constituting more than 60% of the total crude oil production in Mexico. However, its productivity has been decreasing steadily since then. By 2014, Cantarell produced less than 0.4 million barrels, representing only 15% of the economy-wide production (PEMEX, 2014).

Consequently, Petróleos Mexicanos (PEMEX), the state owned oil company, 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. This makes 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 16 Mbbbl/D in six refineries located across its territory, Mexico is a net importer of oil-based products, especially gasoline. With internal consumption increasing and production declining, net exports have decreased at an average pace of 4% per year in the last decade (PEMEX, 2016).

Mexico's significant proven natural gas reserves are under-exploited with production in 2015 reaching 181 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 is looking to boost domestic gas resources, including the development of its unconventional resources such as shale gas. However, the challenges in early shale gas development and the ready availability of cost-competitive natural gas from the US have favoured a rising volume of imports and have prevented a more accelerated domestic gas production.

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%. 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 Tamaulipas State) in its Atlantic Coast, facing the Gulf of Mexico.

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	208 271	Industry sector	33 334	Total power generation	301 496
Net imports and others	-15 087	Transport sector	51 288	Thermal	238 849
Total primary energy supply	187 981	Other sectors	28 902	Hydro	38 893
Coal	12 652	Non-energy	4 724	Nuclear	9 677
Oil	96 396	Total final energy consumption	118 258	Others	14 077
Gas	60 506	Coal	2 610		
Others	18 427	Oil	73 068		
		Gas	13 727		
		Electricity and others	28 854		

Source: EGEDA (2016).

COAL

In comparison to most other economies in the APEC region, coal is not as widely used in the primary energy supply of the economy representing less than 7% of the total supply in 2014, 12 652 ktoe (EGEDA, 2016). Most of Mexico's recoverable coal reserves of 1.2 billion tonnes are located in the state of Coahuila in the northeastern part of the 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 terawatt-hour (TWh) in 2014, mostly derived from thermal power plants (EGEDA, 2016) largely fuelled by natural gas. Mexico's electricity system is well developed and comprises a main grid covering most of its territory. This system is complemented with three other grids in the north and south of the Baja California Peninsula. The interconnection between the Baja California grid and the main grid is planned to be functional by 2021. It is expected to underpin the optimisation of infrastructure and energy sources across the Mexican territory, and it could have deeper effects on the entire system's configuration in the long term. (SENER, 2015b)

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 was developed by Comisión Federal de Electricidad (CFE), Mexico's state-owned and largest power utility, although the number of private generators has also grown over the last two decades. The capacity held by the private sector, both for the grid and self-generation, represented approximately 39% of the installed capacity in 2016 (SENER, 2016).

While CFE and private generators predominantly rely on combined cycle technologies fuelled by natural gas at this time, the use of renewable energy, particularly wind energy, has grown robustly in recent years. This growth is aligned with the government goals of electricity generation based on clean sources of 25% by 2018, 30% by 2021, and 35% by 2024

FINAL ENERGY CONSUMPTION

In 2014, total final energy consumption in Mexico reached 118 258 ktoe, a decrease of 1.1% from 2013 despite growth in transport and the 'other' sectors due to a significant drop in the industrial sector. By energy source, oil-based products accounted for 62%; electricity and others 24%; natural gas 12% and coal 2% (EGEDA, 2016). This structure remained very similar to that of the previous year. By end-use, the transport sector was the largest consumer of energy (43%) followed by the industry sector (28%), and the residential, commercial and agriculture sectors combined (24%). The remaining 4% comes from feedstock for non-energy purposes.

ENERGY INTENSITY ANALYSIS

In the last decades, Mexico has implemented initiatives to improve its energy efficiency, with a cumulative positive effect on its energy intensity levels. As shown in Table 3, from 2013 to 2014, primary energy intensity improved by over 4%, although it was only 3.3% when compared to final energy consumption. Following the unprecedented energy consumption surge due to the availability of inexpensive gas imported from the US, the industry sector showed a significant decrease of nearly 10% on energy consumption, partly due to decreased petrochemical and food and tobacco manufacturing activity. Transport intensity also decreased, while the 'other' sector registered a slight increase of 1%. Consistent with the aspirations of APEC on energy intensity, the improvement of the 2014 figures compared to 2005 amounted to 15% on a primary energy supply basis and 10% for the final energy consumption.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	101	97	-4.3
Total final energy consumption	63	61	-3.3
Total final energy consumption excl. non-energy	61	58	-3.6

Source: EGEDA (2016).

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 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 to 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.

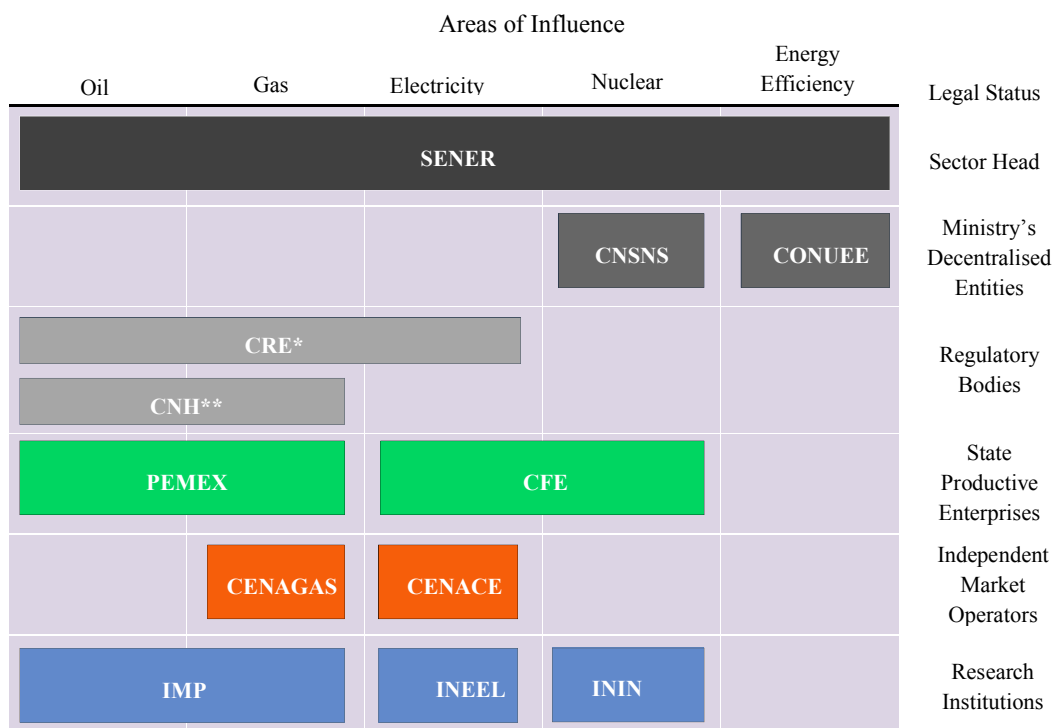
In its capacity of energy leader, SENER sets the economy-wide policies on the subject. In the oil and gas industry, it awards permits related to oil and natural gas processing. Regarding exploration and production activities, SENER selects the areas to tender and designs the technical guidelines to observe. 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 investment in the sector, private companies are now allowed to participate across the entire value chain of the oil and gas industry in a limited but significant capacity. In the electricity industry, with the exception of nuclear energy, the private sector can participate in electricity generation and marketing activities under state regulation. Concerning transmission and distribution, private parties may participate under contract with the Comisión Federal de Electricidad (CFE).

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 national economy, 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 are being used, including external audits and citizens’ participation with the aim of verifying the payments made to companies. The new institutional arrangement of Mexico’s public energy sector and its areas of influence are shown in a schematic representation 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.

Note: 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; ININ: National Institute for Nuclear Research; INEEL: National Institute for Electricity and Clean Energy.

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. The reform established four types of contracts for hydrocarbons: 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 conducts public biddings on hydrocarbons, determines winners and administers 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 for overseeing the technical issues related to all the permits awarded to maximise the economy’s rent perceived for its hydrocarbons. Consistent with the introduced competition, 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 already taking actions such as an open season to be the independent transmission gas pipelines operator.

The Mexican Fund of Petroleum for Stabilisation and Development is responsible for safeguarding, managing and distributing the revenues derived from hydrocarbon-related assignments and contracts, with the exception of taxes. The Fund consists of a trust in Mexico's Central Bank, with a technical committee made up of four independent board members and three members from the state.

ELECTRICITY

Since 1992, the private sector has participated in electricity generation in Mexico due to the industry's partial liberalisation at the time that allowed private companies to generate electricity, but it had to either be sold to CFE or used for their own purposes (self-supply). However, the 2013 Energy Reform stresses the need to expand generation and retail segments so that CFE becomes more competitive. Therefore, generators are already participating along with CFE to serve medium-sized customers under a more competitive market.

Through this reform, the state retains control over transmission and distribution activities and 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, technical and management autonomy, and budgetary self-sufficiency to carry out its duties more effectively. These duties span the regulation of the electricity industry, including the storage, transport and distribution of oil products through pipelines: in other words, the oil and gas downstream industry. Finally, the National Centre for Energy Control (CENACE) has 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.

In its efforts to meet international obligations, Mexico also enacted the Energy Transition Law in 2015, which further opens the market to the private sector in an effort to improve the sustainability of the electricity system through the increased use of clean energy. The law establishes for the first time goals for renewable generation, 35% of total generation by 2024. Energy efficiency promotion and the reduction of waste in the energy system are also key points addressed in this law.

NUCLEAR ENERGY

Mexico's experience in the development of nuclear energy to generate electricity is limited to only one plant with two nuclear reactors (Laguna Verde) operated by CFE since 1990. Mexico has not explicitly ruled out any nuclear development plans, but it is planned to expand its nuclear installed capacity by 4 GW by 2030. (SENER, 2015b) Furthermore, even with the changes introduced to promote the participation of private generators, nuclear energy development remains reserved to the Mexican State 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). The National Programme on the Sustainable Use of Energy 2014-18, frames energy efficiency actions. This program was jointly created by SENER and CONUEE with several objectives. These include the design of programs and actions conducive to optimal energy use across the energy sector; 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 the 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 abovementioned Energy Transition Law passed on December 2015. Nevertheless, the goals were largely preserved, mandating the minimum share of economy-wide electricity generation based on clean energy (renewables and nuclear) and divided into the following sub-goals: 25% by 2018, 30% by 2021 and 35% by 2024.

These targets 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 has made significant efforts to decrease the carbon intensity of its economic development, despite its emissions representing only 1.4% of the worldwide total (UNFCCC, 2015). Mexico is one of the economies most devoted to addressing climate change, having issued its first specific strategy in 2000. It was the first developing economy to have a law dedicated exclusively to this subject, which was 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.

With the structural changes achieved, Mexico 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. According to the program, the energy sector's impact on climate change is considerable, as it accounts for 61% of the mitigation commitments established. The energy sector in Mexico is responsible or reducing methane emissions by 11.3% and 36.9% of black carbon mitigation efforts.

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 formation of 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. The Agency is already performing its duties since March 2015.

RESEARCH AND DEVELOPMENT

SENER, through its Vice-Ministry for Energy Planning and Transition, is responsible for fostering research and development (R&D) policies, as explained in Figure 1, three public research bodies predominantly carry out these activities. The Mexican Petroleum Institute supports the hydrocarbons sector; the National Institute for Electricity and Clean Energy supports research and innovation on electricity and clean energies and the National Institute for Nuclear Research supports research and development on nuclear-based technology for electricity.

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 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 support the adoption, innovation and 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 in 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 five 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. 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' offered oil and gas resources to all companies willing to participate, in a series of consecutive tenders (Ronda Uno, 2015). Shortly after these offers 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, 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 26 exploratory wells with a commercial success of 50%, 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, 2016b). Additionally, CNH announced in July 2016 the start of 'Round Two', which in its first tender comprises 15 offshore oil and gas contractual areas in the Gulf of Mexico.

In order to guide the private investments in the downstream segment, CENAGAS 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). In the past 4 years, 10 new gas pipelines have started operations, adding 2 385 km to the national natural gas transport network (SENER, 2016).

ELECTRICITY

On March 2016, as stipulated by the electricity industry law, the document detailing CFE's restructuring was published on the Official Gazette (DOF). The document mandated the creation of transmission, distribution, supply and generation subsidiaries, each of which will be managed separately. The separation of the various subsidiaries is expected to allow all of CFE's generation and supply firms open access to the transmission and distribution grids. So far, CFE has created 13 subsidiaries and affiliate companies: six generation subsidiaries, CFE Transmisión, CFE Distribución, CFE Suministro Básico, CFE Generador de Intermediación, CFE Calificados, CFEnergía and CFE Internacional. (SENER, 2016).

Through the first half of 2016, sixteen power generation plants were under construction, which represent a total investment of over USD 4.5 billion. These projects are being built in different regions of Mexico and they include nine combined-cycle power plants, three internal combustion plants, geothermal plants, a cogeneration plant, and a hydropower plant. These projects are developed under different financing mechanisms. (SENER, 2016).

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 have been completed or tendered 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. In addition, for the first time in Mexico, in 2016, an actual market for the generation and commercialisation of electricity became open to competition. 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 3 400 GWh of energy during the first half of 2016 due to several efficiency programs, many of which had been implemented for a long time. Some of the programs include 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, 2016).

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.

One of the key programs in 2016 was an incandescent lighting replacement initiative that distributed around 13 million CFL lamps to approximately 2.5 million lower income households. In addition, the federal government continued implementing other initiatives and programs related to the dissemination and training of 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 an outstanding potential for renewable energy development (SENER, 2015b). Additionally, with the implementation of the Energy Transition Law, Mexico is looking to dramatically increase the supply of electricity through renewable energy. The auction held under the auspices of this law resulted in the allocation of contracts for around 4,700 MW of mostly solar and wind generation capacity. The strategy aims to have 35% of all generation coming from renewable sources by 2024.

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 from 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 micro grid 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, SENER announced the acquisition of 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, which fundamentally mandate users with an intensive use of electric power to prove that at least 5% of their demand comes from clean energy sources starting in 2018. In September 2016, Mexico ratified its Intended Nationally Determined Contribution (INDC), committing to an unconditional reduction of 22% of its GHG emissions by 2030 in comparison with its business-as-usual 2013 baseline. On a conditional basis, this share might increase to 40% if certain global measures to address climate change are put into place (UNFCCC, 2015).

In October 2015, PEMEX, along with other nine major oil companies, participated in the Oil and Gas Climate Initiative 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 the targets to promote a cleaner electricity generation operational.

INTERNATIONAL COOPERATION

Given the momentum instilled by its energy reform, Mexico was particularly active during 2015 and 2016 in several international energy events other than APEC.

In compliance with the international policy established by its Ministry of Foreign Affairs, during 2016 SENER promoted bilateral strategic cooperation initiatives with several economies across diverse energy topics. These economies were Belize, Canada, 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 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. These goals are 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 low-carbon intensity.
 - Mexico also hosted the Sixth Clean Energy Ministerial Meeting (CEM6), which aimed at complying with 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 in promoting an energy mix less concentrated on the use of fossil fuels. The report highlights that under a business-as-usual 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 2016, the Mexican Government submitted a formal 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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NEW ZEALAND

INTRODUCTION

New Zealand is an island economy in the South Pacific, comprised of two main islands, the North Island and South Island, and numerous outer islands. While its land area is between that of Japan and the United Kingdom, its low population of about 4.5 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. The economy has a mature economy with a per capita gross domestic product (GDP) of about USD 33 356 (2010 USD purchasing power parity [PPP]) in 2014.

New Zealand is self-sufficient in all energy forms except oil. It has a vast renewable energy potential, which in 2014 accounted for 80% of electricity generation, largely from hydro with increasing support from geothermal and wind. For fossil energy resources, the proven and probable (2P) reserves are more modest, including: 128 million barrels (Mbbbl) of oil and liquefied petroleum gas (LPG), 56 billion cubic meters (bcm) of natural gas and the BP Statistical Review (2016) estimates coal reserves at 571 million tonnes at the end of 2014 (BP, 2016; MBIE, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	269 652	Oil (million barrels)	100
Population (million)	4.5	Gas (billion cubic metres)	51
GDP (2010 USD billion PPP)	150	Coal (million tonnes)	571
GDP (2010 USD PPP per capita)	33 356	Uranium (kilotonnes U)	–

Sources: a. World Bank (2016); b. EGEDA (2016); c. MBIE (2016); d. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, New Zealand's total primary energy supply (TPES) was 20 500 kilotonnes of oil equivalent (ktoe), a 6.2% increase from the previous year. Geothermal, wind, solar, and others were the major contributors (40%) and the main cause for the increased geothermal capacity came online. This was followed by oil (32%), gas (21%) and coal (7%). It is worth noting that geothermal electricity generation has an efficiency of 13% in New Zealand (MBIE, 2016). As such, the geothermal share of the total final energy consumption (TFEC) is significantly smaller than its primary energy supply share. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2014 was 83%, remaining stable during the last two years, but significantly lower than in 2011 (88%) due to the waning of oil production. Since 2000, growth in New Zealand's primary energy supply has been modest, increasing at an average annual rate of 1.4% (EGEDA, 2016).

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 2014, coal production dropped 14% after the 5% decrease in 2013 on an energy-equivalent basis compared with 2012 as domestic producers struggle to compete with low coal prices (MBIE, 2016).

Oil is sourced from 19 fields in the Taranaki region in the North Island (MBIE, 2016). The production of crude oil, natural gas liquids and condensate increased by 12% on an energy-equivalent basis in 2014 compared with 2013 as the Maari field redevelopment increased production. Oil production peaked in 2008 underpinned by the coming onstream 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. Indigenous production accounted for around 33% of the domestic oil demand in 2014.

Natural gas is sourced from 18 fields currently in production (MBIE, 2014). In 2014, natural gas production increased by 12% compared with 2013 as improved recovery techniques were applied to the ageing Maui gas field, and a major expansion of the Mangahewa field. (MBIE, 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 2012, Methanex, which produces methanol with natural gas as feedstock, signed a ten-year gas supply agreement with the Mangahewa field operator ensuring increases in supply will have a secure buyer.

New Zealand has a large renewable energy potential primarily in the form of hydro, geothermal and wind. 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 2014, New Zealand generated 43 553 gigawatt-hours (GWh) of electricity, a slight decrease from 2013 (EGEDA, 2015). Hydro is the major source of electricity generation, accounting for 56% of total generation in 2014. Hydro production is affected by climatic conditions that influence the amount of rainfall to supply the hydro dams. Geothermal generation accounted for 16% (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, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	16 985	Industry sector	4 563	Total power generation	43 553
Net imports and others	4 559	Transport sector	4 699	Thermal	9 060
Total primary energy supply	20 500	Other sectors	3 765	Hydro	24 336
Coal	1 400	Non-energy	1 275	Nuclear	0
Oil	6 525	Total final energy consumption	14 302	Others	10 157
Gas	4 393	Coal	619		
Others	8 182	Oil	6 074		
		Gas	3 010		
		Electricity and others	4 599		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

In 2014, New Zealand's total final energy consumption was 14 302 ktoe, just over 7% higher than in 2013. The large increase is due to increased production of gas that was used for the production of methanol. The transport sector consumed 33% of the final energy, while the industry sector consumed 32% the other sector 26% (which includes residential, commercial and agriculture), and the remaining 9% was used for non-energy purposes. The final energy consumption was dominated by oil, accounting for 6 074 ktoe (42%), followed by electricity and others at 4 599 ktoe (32%), gas at 2 160 ktoe (21%) and coal at 619 ktoe (4%) (EGEDA, 2015).

Industrial energy consumption increased by 9% in 2014 with the increased use of gas for methanol. Industry demand has been 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. In 2014, the aluminium smelter used 12% of all New Zealand electricity and the petrochemicals sector consumed 29% of natural gas supply as a feedstock (MBIE, 2015). The pulp and paper industry meets up to half of its energy needs from wood and wood waste.

Transport energy consumption increased by 2% after also remaining relatively flat for around ten years. Transport energy consumption is dominated by 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 82% of domestic oil consumption in 2014. Consumption of oil products in the other sectors was shared between the residential, commercial, and agricultural sector (11%), and the industrial sector (7%).

ENERGY INTENSITY ANALYSIS

New Zealand's energy intensity of primary energy in 2014 was 136 tonnes of oil equivalent per million USD (toe/million USD), an increase of 2.9% from 132 toe/million USD in 2013. This is partly due to the growth in gas for non-energy use. Similarly, final energy consumption intensity grew by 4% to 95 toe/million USD. The energy intensity of the industry sector increased by 5%, while that of the transport and other sectors, which includes the commercial and residential sectors, decreased by around 1%.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	132	136	2.9
Total final energy consumption	91	95	4
Total final energy consumption excl. non-energy	86	87	1.2

Source: EGEDA (2016).

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. The economy welcomes investments 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 are 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 management 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 75% 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 are aimed at improving 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 streamlines 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 includes several stipulations for promoting 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 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, explore, and mine Crown-owned minerals. It is also responsible for effectively managing and regulating these rights and ensuring a fair financial return to the Crown for its minerals. NZP&M is instrumental in promoting investments 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 1 April 2011 (Inland Revenue, 2012). Corporations are also required to pay other indirect taxes such as payroll and fringe benefits taxes.

For petroleum production, companies must pay an ad valorem royalty of 5% (5% of the net revenues obtained from the sale of petroleum) or an accounting profits royalty of 20% (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 depends 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 between NZD 100 000 and NZD one million. For producers with net sales exceeding NZD one million, the royalty payable is either 1% of the net sales revenue or 5% of the 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 the economy is considered underexplored (Samuelson 2008). 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; and
- 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 specifications 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 noncompliance (MFE, 2014). An ongoing Phase 2 Review of the RMA takes on the more complex tasks of better aligning the Act with other environmental laws and exploring better approaches to urban planning and water management (MFE, 2015). This process is expected to be completed by 2017 (MFE, 2017a)

ENERGY EFFICIENCY

New Zealand has promoted 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 (NZECS) to replace the 2007 document. 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 follow:

- 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. New Zealand also launched a tyre-labelling program to promote low rolling resistance tyres, which increase vehicle fuel economy.
- Also on May 2016 an electric vehicle support program was announced involving tax exemptions, government/private bulk purchasing programs, information campaigns, and more (MT, 2017). More information can be found in the government sponsored website electricvehicles.govt.nz.
- 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 total housing) concluded in 2013 and a follow-up smaller program targeting at-risk households began in 2014. New residential buildings must meet more stringent insulation standards since 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 that a security of supply is maintained. The major instrument to achieve this goal is the Emissions Trading Scheme, discussed in the 'Climate Change' section (MBIE, 2012).

Hydro power 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 by government in recent years but have not been developed due to lower than expected electricity demand growth. In effect, the next 20 years of the new demand have already been approved and will be 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).

The government has also considered electric and plug-in hybrid electric light vehicles (EVs and PHEVs) as an option to increase renewables in transport. Not just as a form of demand but also as a source of electricity storage from intermittent renewable electricity generation enabling further integration of wind and solar to the electricity grid.

NUCLEAR ENERGY

New Zealand law prohibits the development and use of nuclear energy and there are no plans to revisit this stance in the 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 (ETS). The ETS places a price on greenhouse gas emissions to provide an incentive to reduce emissions. Originally, it includes all sectors of the economy and the six gases covered under the Kyoto Protocol—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (CCINZ, 2012). However, some industries like agriculture and fishing were exempted later to preserve competitiveness.

The scheme came in effect in 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, these generous allocations, 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 emissions.

The government initiated a two-stage review process of the ETS in 2015 with the objective of improving performance in view of New Zealand's ratification of the Paris Agreement. One of the key outcomes of phase one was the recommendation to phase out some of the transition measures such as the two-for-one permit surrendering deal. Phase two of this process will be completed in 2017 (MFE, 2017b).

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).

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 accounted for 12% of New Zealand's total electricity demand in 2014 (MBIE, 2015). 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.

On the supply side, the 2015 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). These closures are partly covered by the completion of the Te Miki 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, 2014).

NEW PROJECTS

Since the 2014 project mentioned above, no new generation projects have undergone construction. There are, however, several large-scale wind, geothermal and hydro projects that have regulatory and environmental consent to proceed, but 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.

In the past few years the New Zealand grid system operator Transpower 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 commissioned New Zealand's largest biofuel plant with a production capacity of 20 million litres per year. The plant began commercial operation in August 2016 (Z Energy, 2016). 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)— <http://www.mbie.govt.nz/info-services/sectors-industries/energy>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), officially the Independent State of Papua New Guinea, is a tropical country located in Oceania, South Pacific Ocean, land-bordered by Indonesia and to the north of Australia. The 600 small island economy is known as ‘the land of a million different journeys’. Achieving independence in 1975, PNG celebrated its fortieth year as an independent nation in 2015.

The mostly mountainous and covered in tropical rainforests Papua New Guinea is along the ‘Ring of Fire’ that frequently faces earthquakes, volcanic eruptions and even tsunamis. High temperatures and humidity throughout the year and wet and dry seasons are characteristics of its climate. Papua New Guinea is endowed with natural resources, such as gold, copper, rare earth elements, nickel, cobalt, chromium, molybdenum, iron and platinum (MRA website).

The population of approximately seven million is young and growing, strikingly diverse with the representation of ‘thousands of different tribes, dances, adventures, traditions and 800 indigenous languages’, more than anywhere else in the world. Population density is as low as about 16.8 thousand per km², ranked 184th in the world (World Bank, 2015).

PNG’s economy is characterised by two main sectors: the labour-intensive sector (agricultural, forestry, and fishing) and the export-earning sector (minerals and energy extraction). The country experienced strong economic growth with an annual average rate of nearly 7% between 2007 and 2010 (ADB, 2012), but due to the global economic crisis, especially in South-East Asia and the Pacific, it slowed down from 2011-2013, but has signs of regaining in 2014–2015 to 8-9%. In 2014, PNG’s real gross domestic product (GDP) was estimated at USD 19.92 billion (2010 USD purchasing power parity - PPP), an increase of 8.5% from 2013; the GDP from the previous year was 5.5% (EGEDA, 2016). PNG’s GDP per capita ranks last in the APEC economies and 180th of the world. Basic socio-economic data are provided in Table 1.

Papua New Guinea became a member of APEC in 1993, together with Mexico. Additionally, the economy is also a member of the African, Caribbean and Pacific Group of States, Non-Aligned Movement, Pacific Community, Pacific Islands Forum, United Nations and World Trade Organization (The Commonwealth, 2017).

Table 1: Key data and economic profile, 2014

Key data		Energy proved reserves (end 2015)	
Area (km ²)	462 840	Oil (million barrels)	200
Population (million)	7.5	Gas (billion cubic metres)	141
GDP (2010 USD billion PPP)	20	Coal (million tonnes)	—
GDP (2010 USD PPP per capita)	2 668	Uranium (kilotonnes U)	—

Sources: EGEDA (2016); The Commonwealth (2017); CIA (2016); WEC (2016).

ENERGY SUPPLY AND DEMAND

STAKEHOLDERS IN ENERGY SECTOR

Under Prime Minister Peter O’Neill’s government, the Department of Petroleum and Energy (DPE) is the ministerial regulatory body in charge of all energy-related issues, especially policy. Inside the department, the petroleum and energy divisions divide themselves to be respectively in charge of non-renewable and upstream activities (oil, gas); and renewable activities, concerning hydro, geothermal, solar and biomass power (Kone and Tai, 2010). The Mineral Resources Authority (MRA) is another governmental agency specialising in administration of mining activities, executed on behalf of the Government under the Ministry of Mining.

Official information related to the Departments is moderate due to limited access to their websites except for MRA (recorded until January 2017). Besides the ministries, PNG Chamber of Mines and Petroleum is an active non-profit organisation that provides a wide range of programs and projects aiming at nurturing PNG's full resource potential.

According to the Chamber, main players in the petroleum market include Talisman and its joint venture partners (active in the south-west region of the country), ExxonMobil, Oil Search (focused on the Fold Belt and the Hides/Angore/Juha gas fields), InterOil (Gulf region), Sasol, Mitsubishi plus more than 15 other stakeholders. The large mining projects in 22 current mines include Barrick Gold's Porgera gold mine, Ok Tedi copper mine, Newcrest's Lihir gold mine, Newcrest-Harmony's Hidden Valley gold mine and MCC's Ramu nickel-cobalt project (MRA, 2016). Regarding electricity industry, most thermal and hydro power stations are owned and operated by the corporatised state-owned enterprise, PNG Power Limited (PPL), formerly the PNG Electricity Commission.

PRIMARY ENERGY SUPPLY

The energy sector accounts for approximately 14% of the GDP. In 2014, PNG's total primary energy supply was 2 479 kilotonnes of oil equivalent (ktoe), an increase of 6.8% over the value in 2013. Of the total supply, crude oil and petroleum products maintain the largest share (76%), followed by gas (5.9%) and other energy sources like hydro and renewables (Table 2). Information on coal and uranium reserves are not recorded, as the country is not rich in nor has it touched upon these resources.

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, while fluctuating, production has declined to 56 600 bbl/d in 2015 (CIA, 2016), despite exploration activities that resulted in the development of additional oilfields. At this rate, crude oil reserves are expected to be depleted in ten years' time (APEREC, 2013). 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 ExxonMobil PNG Limited on behalf of six co-venture partners. It is a 6.9 million tonnes per annum integrated LNG project sourced from the Hides, Angore and Juha fields, and from associated gas from other oil fields. This PNG LNG Project¹ commenced production in April 2014 and in May 2014, PNG exported its first gas to TEPCO, one of the biggest power companies in Japan.

In 2014, PNG generated 4 176 gigawatt-hours (GWh) of electricity, a stable 5.3% increase from 2013. Four main sources for electricity generation are bio-gas, hydro, geothermal and diesel. Thermal generation contributed the largest share (66%), followed by hydro (25%) and others (11%) (Table 2, EGEDA, 2016). 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 thermal generation systems, except three hydro locations and two hybrid micro-hydro and diesel systems.

PNG 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). Still the production of electricity is not enough to meet the demand from economic development and population growth (Government of PNG, 2015).

In 2010, the International Renewable Energy Agency (IRENA) estimated that traditional biomass accounted for over one-half of PNG's energy consumption and one-third of the energy supply (IRENA, 2013).

¹ PNG LNG Project at <https://pnglng.com>.

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 well-reflected in the statistics below.

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 722	Industry sector	663	Total power generation	4 176
Net imports and others	-180	Transport sector	588	Thermal	2 734
Total primary energy supply	2 479	Other sectors	258	Hydro	1 020
Coal	0	Non-energy	0	Nuclear	—
Oil	1 882	Total final energy consumption	1 509	Others	422
Gas	147	Coal	0		
Others	451	Oil	1 194		
		Gas	0		
		Electricity and others	315		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

In 2014, total final energy consumption (TFEC) in PNG was 1 509 ktoe, an increase of 5.2% from 2013. The industrial sector witnessed an increase of 6.2% from 2013, and it was the largest end user, accounting for 44% of the total, followed by the transport sector with 39%. The other sectors, including agriculture and residential/commercial, constituted 17%. By energy source, petroleum products accounted for 79% of the total consumption, while electricity and other sources accounted for 21%, which remains roughly the same as 2013.

As electrification remains limited to the main urban areas, the 85% of the population who live in rural areas rely largely on traditional biomass to meet their energy needs. The levels of ownership of electric domestic appliances are therefore not high. For example the coverage of air conditioners in the capital city Port Moresby is only 7% (ADB, 2015a) 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 disrepair. Many locations can only be accessed through coastal or river barges. As such, transport fuel demands will be hampered once road saturation levels are reached. In 2014, transport demand grew by 9.3% from 2013 to a total of 588 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.

The industry sector with only a 3.6% increase from 2013 and 2014, is expected to show a higher 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.

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 2014 was 124.5 tonnes of oil equivalent per million USD (toe/million USD), a slight decrease of 1.6% from 127 toe/million USD in 2013, while it had just increased in the previous one year. The increase is potentially due to the increased energy consumption in the industry sector from the LNG development

The energy intensity of final energy consumption was 76 toe/million USD in 2014. The energy intensity of the industry and transport sectors remained flat at 33 and 30 toe/million USD. Regarding the 'others' sector, which includes commercial, residential and agriculture, the value continued to decrease from 2013 by 7.2% to 13 toe/million USD. The decrease of other sectors and industry (-4.5%) leads to the 3.1% decrease in the whole energy consumption's intensity, showing slight improvements in energy efficiency and usage of the population (see Table 3).

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	127	125	-1.6
Total final energy consumption	78	76	-3.1
Total final energy consumption excl. non-energy	78	76	-3.1

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Papua New Guinea is a constitutional, parliamentary democracy and a commonwealth realm. As stated previously, jurisdiction over energy matters is the responsibility of 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 (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 and sustainable 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 (at least 70% in 2030) 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 (Only 17% of households had access to electricity (Government of PNG, 2015)). These efforts are supported by ADB with some technical assistance projects and lending projects to improve electricity services in urban centers and electricity access in rural areas (ADB, 2016).

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, Rural Electrification Policy and Strategy, Geothermal Energy Policy, Renewable Energy Policy and the Electricity Industry Policy (IRENA, 2013) although not all of them have been finalised and passed by the government, such as policy for geothermal power. However, significantly, the National Energy Policy (NEP) with its accompanying plan launched in 2015 was the first governmental document to properly coordinate all energy development issues, in alignment with the Vision 2050. The NEP focuses on four aspects of sustainable development: social, economic, environment, and energy security with nine principles:

- Strengthen institutional capacity and recruit right human capital to manage the energy sector;
- Develop an integrated planning process for sustainable energy supply and utilization;
- Develop all energy resources by the State for the betterment of all citizens;
- Promote a conducive environment for long term sustainable economic solutions in the supply of all energy sources;
- Encourage involvement of the private sector in the development and provision of energy services;
- Ensure energy resources are developed and delivered in an environmentally sustainable manner;
- Promote efficient systems and safety in the energy supply in all sectors (transport, residential, commercial, industrial and agriculture; and
- Diversify the development and utilisation of energy resources for the nation's well-being and economic prosperity.

In October 2010, the PNG Government announced its Medium-Term Development Plan (MTDP) 2011–15. This plan focused on increasing access to electricity for all households in the member economy government. New investments from the private sector in solar technology were also expected during the period of the first MTDP. The succeeding MTDP 2016-2017 published in 2015, closely follows National Strategy for Responsible Sustainable Development and PNG Vision 2050. It is expected to place PNG in a better position in a long-term economic sense. Cleaner energy/electricity is highlighted to ensure less impact on the environment, while mineral and gas industries still play an important role in benefiting the development. The MTDP3 will cover year 2018-2022.

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 the 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 corporatised 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. The Third Party Access Code and the Grid Code were launched in 2013 and are governed by the Independent Consumer and Competition Commission to improve transparency in power purchasing (Kuna and Zehner, 2015).

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 during 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% (PNG Chamber of Mines and Petroleum, 2014)). PNG is also said to be the country to offer the lowest cost for LNG projects.

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). In 2015, the government started a review of the electricity tariff methodologies to improve the competitiveness of the electricity system, which was priced from US \$0.24 to US \$0.47/kWh in 2012 (ADB, 2015a).

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 expenditures.

ENERGY EFFICIENCY

Energy efficiency (EE) policies and regulations are controlled 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 in achieving the DSP 2010–30 goals. 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 by 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, 2015a). When the potential growth of PNG is considered, the level of savings would improve the possibility of meeting its targets as it significantly reduces the generation and distribution requirements.

RENEWABLE ENERGY

In addition to the Department of Petroleum and Energy, The National Institute of Standards and Industrial Technology (NISIT) and ICCC also play roles in framing the policy for 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 (for example, 15 000 MW of hydropower as stated in the NEP), 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). In 2016, PPL and International Financing Corporation (IFC) started to pursue rooftop solar projects to produce electricity (PNGfacts, 2016), which was expected to reduce the reliance on fossil fuel in the long term.

NUCLEAR ENERGY

PNG has no nuclear energy industry and there are no current plans to develop one.

CLIMATE CHANGE

The effects of climate change directly threaten PNG, 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 sources of emissions reduction besides the renewable energy target mentioned previously. 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 CO₂ 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.

In 2015, Papua New Guinea successfully submitted its Climate Action Plan, Intended Nationally Determined Contribution (INDC) before the UN climate conference in Paris in December. PNG pledges to improve energy efficiency and reduce emissions in addition to achieving 100% renewable energy in electricity generation by 2030.

NOTABLE ENERGY DEVELOPMENTS

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 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. The LNG project continues to contribute significantly to the economy. It is the largest ever private sector investment in PNG and is expected to increase

its GDP by 15% in 2015 then slowing to 5% in 2016 (ADB, 2015b). ExxonMobil is seeking to add capacity to its current project and Total is also investing in export projects. A second LNG project (Elk/Antelope) is in the process of final reviews (Government of PNG, 2015). Papua New Guinea is now in the negotiation of a USD 10 billion expansion of ExxonMobil's liquefied natural gas (LNG) project (Reuter, 2016).

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 aims to increase electrification rates from below 10% to 70% by 2030 (World Bank, 2013).

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; and
- Geothermal energy development documents 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 and hydro potential, including a very large 2.5 gigawatts (GW) potential project that includes a demand creation component.

INTERNATIONAL COOPERATION AND COMMITMENT

In the fifty-first meeting of the Energy Working Group (EWG) held in Australia in May 2016, it was reported that the development of the electricity market and the drafting of energy efficiency policies, which may lead to upgrades in lighting systems, were among the latest updates. Improving access to electricity from the three separate grids by 2017 is also part of the plan, including rural electrification programs.

In the fifty-second meeting, EGNRET officially proposed PRLCE (Peer Review on Low Carbon Energy, sixth stage) research for PNG, which was also voluntarily agreed upon and confirmed by the economy's representative. Efforts towards a clean energy economy are also shown in the announcement at the Marrakech Climate Change Conference in November of the target to adopt 100% renewable energy. In the APEC meeting in May 2016, the Prime Minister of PNG reconfirmed the hosting of APEC for the first time in 2018. The move has been criticised by the opposition leader because its expense may add to the current burden, but then reaffirmed through a media release.

Year 2016 observes a change in leadership in the Department of Petroleum and Energy, i.e. the Minister, from Hon. Ben Micah to Hon. Nixon Duban, who was previously in 2012 the Minister for Police and Internal Security and then Minister for Transport and Infrastructure. Hon. Ben Micah held the position for a brief time since the reshuffle by the Prime Minister in the beginning of 2016.

TOWARDS SUSTAINABLE DEVELOPMENT

A socio-economically sustainable development is an overall spirit shown in the newly issued key legal documents such as the National Energy Policy, Mid-term Development Plan 2 that was inherited from the ideas in Vision 2050 (Government of PNG, 2010). This Policy (NEP) is designed with Sustainable Development principles in mind and is intended to operate for a period of five years and reviewed thereafter’.

‘Hence we commit ourselves to this new paradigm of principle centred sustainable development, as set out in the MTDP2’. The energy sector is vital for PNG thanks to the economy’s abundance of precious natural resources and its great contribution to the annual GDP. However, a large portion of energy is utilised through the use of fossil fuels that might raise the concerns of climate change whilst the country is ambitiously aiming to be among the world top 50 countries in terms of the Human Development Index by 2050.

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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 (km²), 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 2014, the economy had a total population of about 30.97 million, an increase of 1.3% from the previous year (EGEDA, 2016). In 2015, approximately 22% of Peru's population was considered poor and 4.1% extremely poor (INEI, 2015a). The major population centre of Peru is the Lima region, which represents 9 million people, nearly one-third of the total population (INEI, 2015b). The urbanisation rate of Peru is 76% (INEI, 2011).

Since 1990, the economy has been driven by its internal demand, mainly private investments, exports and domestic consumption. Peru has a market-oriented economy, and in 2015, its key segments were services (49%), manufacturing and construction (18%), and mining (12%) (BCRP, 2015). Between 2000 and 2015, the average annual growth rate (AAG) was 4.8% higher than the level reached in 2014 (2.4%) due to the deceleration of emerging economies and global uncertainty. This resulted in negative growth rates in private and public investments (-4.4% and -7.5%, respectively), and a reduction in the private consumption growth rate from 4.1% in 2014 to 3.4% in 2015 (BCRP, 2015). 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, 2016). Consequently, mineral exports have consistently accounted for a significant share of the export revenue of the economy, contributing as much as 55% in 2015 (BCRP, 2015). During 2015, the energy, oil and transport sectors used around 20% of the USD 24 billion of foreign direct investments (Proinversion, 2015).

By 2014, the GDP of the economy reached USD 347 billion (2010 USD purchasing power parity [PPP]), with its GDP per capita growing at 1 to reach USD 11 220 (EGEDA, 2016). In addition, the foreign reserves reached a record USD 61 billion while the fiscal balance was 2.1% of the GDP (BCRP, 2015).

Owing to its scarce oil resources, Peru is a net importer of oil. Specifically, domestic production is insufficient to meet the economy's demands. However, 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 2014. 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, 2014

Key data ^a		Energy reserves ^{b, c, d}	
Area (million km ²)	1.3	Oil (million barrels)	1 400
Population (million)	30.97	Gas (trillion cubic metres)	0.4
GDP (2010 USD billion PPP)	348	Coal (million tonnes)	9.9
GDP (2010 USD PPP per capita)	11 220	Uranium (kilotonnes U)	1.4

Sources: a. EGEDA (2016); b. BP (2014); c. MEM (2014); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2014 was 22 788 kilotonnes of oil equivalent (ktoe), increasing 5.9% from 2013, due to the increasing production of natural gas. By energy source, in 2014, almost half (10 027 ktoe) of the TPES was from oil, 32% from natural gas (7 225 ktoe) and 4% from coal (841 ktoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others constituted the remainder at 21% (4 696 ktoe) (EGEDA, 2016).

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 its main use is to distribute natural 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. Its construction has been inactive since December 2016 and is expected to resume by the end of 2017.

The Camisea project was initially aimed at satisfying 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 2015, Peruvian LNG exports from the Melchorita liquefaction plant amounted to 8.1 billion cubic metres (bcm) (BCRP, 2015).

Peru's proven coal reserves are around 9.9 million tonnes (Mt) with about 95% consisting of anthracite and the remainder with 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 80% of its coal demand in 2014 being met by imports and 20% by domestic production (MEM, 2014).

In 2014, Peru's electricity generation totalled 45 515 gigawatt-hours (GWh), a 5.1% increase from the 43 295 GWh generated in 2013. Of that total, electricity generated from hydropower constituted the maximum share of 49% (22 196 GWh), thermal plants accounted for 49% (22 330 GWh) and the remainder was generated from other sources such as biomass and wind (EGEDA, 2016).

In the other energy sectors different 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 2015, the renewable sources used for energy supply included firewood (38%), hydropower (48%) and the remainder was from other biomass sources (MEM, 2015).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	24 082	Industry sector	4 854	Total power generation	45 515
Net imports and others	-1 186	Transport sector	7 312	Thermal	22 330
Total primary energy supply	22 788	Other sectors	5 112	Hydro	22 196
Coal	841	Non-energy	325	Nuclear	0
Oil	10 027	Total final energy consumption	17 603	Others	989
Gas	7 225	Coal	692		
Others	4 696	Oil	9 721		
		Gas	1 670		
		Electricity and others	5 520		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

The final energy consumption in Peru decreased by -0.5% in 2014, reaching 17 603 ktoe. Transportation represented 42% of the final energy consumption in 2014 and barely decreased 0.1% since 2013 to reach 7 312 ktoe. The share of the industrial sector was 28%, while the combined other residential, commercial and agricultural sectors consumed 29%. Accordingly, oil products dominated the total energy consumption in 2014 with 55%, the majority of which was consumed as diesel, gasoline and liquefied petroleum gas (LPG) (MEM, 2015). Electricity constituted 31% of the total end-use energy demand, while gas and coal accounted for the remaining 9% and 4%, respectively (EGEDA, 2016).

ENERGY INTENSITY ANALYSIS

Peru's energy intensity has been decreasing since 2011 due to the better use of energy sources. The primary energy intensity of the economy in 2014 was 66 tonnes of oil equivalent per million USD (toe/million USD), increasing by 3.5% from 63 toe/million USD in 2013. In contrast, the final energy consumption decreased in energy intensity by 2.9% from 52 toe/million USD in 2012 to 51 toe/million USD by 2014. Industry energy intensity decreased from 15 toe/million USD in 2013 to 14 toe/million USD (4%) in 2014. The transport sector also decreased its energy intensity from 22 toe/million USD in 2013 to 21 toe/million USD in 2014 (-2%).

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	63	66	3.5
Total final energy consumption	52	51	-2.9
Total final energy consumption excl. non-energy	51	50	-2.5

Source: EGEDA (2016).

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. It 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 investments 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 means 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 and satisfy 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. Additionally, Peru and Bolivia are undertaking studies in electricity to assess the potential of interconnecting their power systems to jointly supply electricity to Chile.

In energy security, during 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 for 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 northern and eastern sections 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's borders. The program intends to increase electricity coverage to cover 2.2 million people by expanding the electricity grid and 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 CO₂ 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 allows for setting electricity tariffs based on 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 demand.

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 aims to develop the natural gas industry and expand 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 approximately 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 investments 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	Conducted 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 types 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).

NATIONAL PLAN FOR RURAL ELECTRIFICATION 2016-2025

The plan was established to provide energy access to vulnerable populations in remote rural areas. Peru has a diverse geography with almost 25% of the population living in the Andes Mountain and the Amazon region. Approximately 75% of the rural population has access to electricity. These regions gather the population with the lowest income levels and as such the highest poverty rates. The plan expects to generate energy access to 3.3 million people until 2025 investing around USD 1.2 billion in transmission and distributed generation systems.

Table 8: Investments according to the National Plan for Rural Electrification

	Investment (USD MM)	Population (Thousand)
2016	346	1000
2017	230	606
2018	136	351
2019	173	538
2020	94	226
2021	41	160
2022	60	230
2023	24	87
2024	24	87
2025	24	87
Total	1 152	3 372

Source: MEM (2015)

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 a few mechanisms. These included DS–No. 034–

2008–EM on 19 June 2008 (Energy Saving Measures in Public Services), and RM No. 038–2009–MEM/DM on 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 identifies 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 be 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.

During 2016, the Ministry of Energy through the Energy Efficiency Directorate prepared the new regulatory framework for the acquisition of energy equipment for local and central governments. Under this new standard, local and central governments are obligated to utilise electric equipment and supplies with the highest levels of efficiency.

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 investing participants in electricity generation based on renewable energy (including hydro) by accelerated depreciation of their investments by up to 20% per year to improve the project's 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 (for example, 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.

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 in the first part of 2017. Additionally, during March 2016, the MEM is also scheduled to approve a project that allows the exports of electricity surplus generation to other economies. This project must be approved in the Peruvian Congress before the end of 2017.

Table 9: 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	-

Sources: a. IFC (2011) b. MEM (2014).

NUCLEAR

Although Peru does not use nuclear energy for electricity generation, a government-run nuclear program has been operational since 1975. This program involves constructing a 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.

Table 10: GHG Emissions by Activity

Activity	GHG Emissions (%) by 2012
Industrial Processes	51%
Energy	26%
Agriculture	15%
Waste	5%
LULUF	3%

Source: MINAM (2016)

Peru accounts for 0.1% of the world's GHG emissions (CAIT, 2012). Based on the Intended Nationally Determined Contribution (INDC), Peru aims 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 CO₂ equivalent, with 50% of this reduction being in the forestry sector, including land use, land use change and forestry (LULUCF) (UNFCCC, 2015).

Table 11: INDC for Reduction of GHG emissions

	Emissions Mt CO₂eq including LULUCF	Emissions Mt CO₂eq excluding LULUCF
2010 (baseline year)	170.6	78.0
2030 (target year)	298.3	139.3

Source: MINAM (2016)

In parallel to the national goals expressed in the Peruvian INDC, several sectors have presented significant advances in regulations and programs aimed to reduce carbon emissions and to foster sustainable development.

- Energy Sector: The National Energy Plan 2014-2025 projects the massification of natural gas in residential demand reducing the demand for LPG in urban areas and promoting the use of LPG instead of traditional biomass in rural regions. Additionally, the Ministry of Energy and OSINERGMIN are promoting the use of non-conventional renewable energies through annual auctions giving priority to dispatching into the national electricity grid and ensuring price stability during the contract.
- Transport Sector: promotion of the Metro System in Lima. In 2010, Line 1 of the Metro System was inaugurated. During 2014 the construction of Line 2 started with the goal of connecting 15 districts with an extension of 27 kilometres, projecting a daily demand of 665 000 passengers by 2020.
- Industrial and Fishing Sectors: the new limits of permissible emissions (LPE) for the fishmeal and fish oil industry was established. The regulation establishes that wherever natural gas connection is possible, fishmeal factories must use it instead of oil products. It is estimated that around one-third of national production is using natural gas in their industrial process because of the new regulation.
- Forestry Sector: since 2010, the forestry sector has a new regulatory framework based on the new forestry act, the forestry and wildlife policy and Law 29763. This new framework aims to reduce deforestation promoting a sustainable and efficient use of forest resources.
- Waste Management: The National Environmental Action Plan (PNAA) promotes the reuse, recycle and appropriate handling of solid municipal waste. The PNAA together with the National Plan of Solid Waste Selective Selection on the Source has been implemented in 210 municipalities recovering around 10 974 tons of solid waste per month.

Finally, Peru is designing eight nationally appropriated mitigation actions (NAMAs) as part of the National Strategy for Climate Change.

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THE PHILIPPINES

INTRODUCTION

The Philippines is an archipelago comprised of 7 107 islands with total land area of 300 000 square kilometres (km²) and coastline of about 36 289 kilometres. The economy is located in the south-eastern part of Asia and bordered by the Philippine Sea to the east and west, the Luzon Strait to the north and the Celebes Sea to the south. It has three major geographical divisions, namely: Luzon, Visayas and Mindanao islands. Manila City, located in Luzon, is the capital of the Philippines. In 2014, the economy's total population was 99.1 million, an increase of 1.6% from 2012 level (EGEDA, 2016). From the 2015 World Population ranking, it is the twelfth most populated economy in the world (WB, 2015).

The Philippines posted a 6.1% growth rate in its gross domestic product (GDP), USD 608.5 billion in 2013 to USD 645.8 billion in 2014 (2010 USD purchasing power parity [PPP]) (EGEDA, 2016), lower than the 7.1% growth achieved during the previous period. The economy was able to realise such growth despite several challenges such as a lower level of government spending (PIDS, 2015). Continuation of high growth in the past few years is necessary in the fight against poverty. Growth drivers in 2014 were household consumption and net exports on the demand side, and the industry and services sectors on the supply side. Household consumption increased by 5.4%, and exports exhibited 12% growth from 2013 levels. As for the supply side, the service sector contributed most to the growth, which accounted for almost 60% of the GDP. The industry sector had the second-highest contribution with manufacturing provided the largest share (overall industry growth) amidst the ongoing revival program of the government for the manufacturing sector. However, the agriculture sector showed slow growth in most of its sub-sectors with reductions in coconut and coffee production (Navarro, 2015). The GDP per capita also displayed a 4.5% growth, USD 6 514 in 2014 from USD 6 236 in 2013 (EGEDA, 2016).

With a better economic outlook, the government faces a great challenge on ensuring energy supply stability to meet growing domestic demand. Central to the policy of the government is the aggressive development and utilisation of indigenous energy resources for both fossil fuels and renewable energy. The government has continued the implementation of the Philippine Energy Contract Round (PECR) to attract investments in oil, gas and coal exploration. 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).

The passage of the Renewable Energy Act of 2008 (R.A. 9513) offered fiscal and non-fiscal incentives to promote and encourage more investments in renewable energy development and to expand its share in the energy mix. Under the National Renewable Energy Program (NREP), the government has set an aspirational target of more than doubling the RE-based installed capacity in power generation by 2030 from 2010 levels, or 15 299 MW (2030) from 5 542 MW (2010 level). The government likewise intends to increase RE contribution for non-power applications in the primary energy mix by 2030 (DOE, 2011).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (thousand km ²)	300	Oil (million barrels)	76
Population (million)	99	Gas (billion cubic metres)	24
GDP (2010 USD billion PPP)	646	Coal (million tonnes)	440
GDP (2010 USD PPP per capita)	6 514	Uranium (kilotonnes U)	—

Sources: a. WB (2015); b. EGEDA (2016); c. (DOE, 2015a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The economy's total primary energy supply (PES) in 2014 increased by 6.3%, from 45 564 ktoe in 2013 to 48 452 kilotonnes of oil equivalent (ktoe) in 2014. Approximately 57% of the energy requirement was produced locally, largely from renewable energy and coal. The economy's self-sufficiency level slightly increased from 56% in 2013 (EGDEDA, 2016).

Oil remained the dominant energy source, accounting for 31% of total PES. The economy's oil supply requirement grew by 9.7% in 2014, reaching 15 051 ktoe from 13 715 ktoe in 2013. The commercial and transport sectors as well as the non-energy use of oil contributed to this increase.

Coal provided the second largest share to the PES at 22%, which also exhibited an increase of 6.4% in 2014 from its 2013 level. Additionally, domestic natural gas production from Malampaya gas field (the major source of gas) went up by 5.2%. In the same period, the aggregate share of renewable energy was recorded at 40% of the PES. Among the renewables, only hydro registered a decrease in production. Solar and wind both demonstrated the largest increase in production with 1 000% and 131%, respectively (DOE, 2015b).

FOSSIL ENERGY

The economy relies heavily on fossil fuels imports, specifically oil and coal, to meet its energy demand requirement. Net imports grew by 2.6% from 20 555 ktoe in 2013 to 21 085 ktoe in 2014. Oil constituted nearly 70% of the total energy imports, while coal represented 31% and bioethanol 1%. The rise in energy imports was due to a 28% increase in oil demand for power generation, resulting in a 14% increase in oil imports.

Although coal imports escalated by 5% due to an increase in demand for power generation, net coal imports decelerated by 15% following expanded domestic coal production and growth in exports. Local coal production increased by 7.2% from 3 743 ktoe in 2013 to 4 011 ktoe in 2014. With the rise in domestic coal output, exports rose by 70%, of which a significant amount went to China. The open coalmine pit of Semirara Mining Corporation (largest coal producer in the economy) in the Antique province (Visayas Island) produced 97% of the total domestic coal output and the small-scale coalmines provided the remaining 3% (DOE, 2015c).

RENEWABLE ENERGY

Renewable energy has long been a significant contributor to the economy's energy supply requirement, providing about 40% to the PES in 2014. Among the renewables, geothermal supplied about 33% of the total indigenous primary energy supply, followed by biomass with a 28% share. The residential sector is the primary user of biomass, specifically for cooking. The industry and power sectors also utilised a portion of the biomass supply. Production from hydro slightly declined to from 9.8% in 2013 to 8.5% in 2014, due to planned and forced outages of some hydroelectric power plants, particularly in the Mindanao Island (DOE, 2015d and 2015e).

Solar and wind provided the smallest contribution, less than 1%, to the total indigenous primary supply. However, the shares from these RE resources are expected to expand in the near future with the growing number of awarded contracts issued to RE developers by the government. Wind contribution increased with the commercial operation of additional 250 MW capacity in 2014, bringing the total capacity from wind power to 283 MW. Solar generation capacity also increased (from only 1.0 MW) with the addition of 22 MW during the same period (DOE, 2015c and 2015e).

ELECTRICITY GENERATION

In 2014, the economy's total electricity generation was up 2.6%, from 75 266 GWh in 2013 to 77 261 GWh. Coal is still the dominant fuel for the economy's baseload requirement, accounting for about 43% of the total power supply in 2014. Natural gas also continued to provide a substantial share with 24%. Almost all of the natural gas power generation capacities of the economy are located in Luzon Island, supplying around 33% of the Luzon grid requirement. Meanwhile, oil-based power plants only had a modest share of 7% during the same period.

Despite the commercial operation of additional capacities from solar, wind and even biomass, the aggregate share from renewables remained at 26% in 2013 and 2014. The decline in hydro output in 2014 offset the 30% increase in electricity generation from solar, wind and biomass. Production from hydro went down by 8.8% in 2014, from 10 019 GWh in 2013 to 9 137 GWh (DOE, 2015e).

Table 2: Energy supply and consumption, 2014

Primary Energy Supply (ktoe)		Final Energy Consumption (ktoe)		Power Generation (GWh)	
Indigenous production	27 563	Industry sector	6 603	Total power generation	77 261
Net imports and others	21 085	Transport sector	8 822	Thermal	57 451
Total primary energy supply	48 452	Other sectors	12 554	Hydro	9 137
Coal	10 642	Non-energy	450	Nuclear	0
Oil	15 051	Total final energy consumption	28 430	Others	10 672
Gas	3 061	Coal	2 415		
Others	19 698	Oil	12 936		
		Gas	78		
		Electricity and others	13 001		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

The 6.1% growth of the Philippine economy in 2014 translated to a 4.4% increase in the final energy consumption (FEC), from 27 226 ktoe in 2013 to 28 430 ktoe in 2014 (EGEDA, 2016). All economic sectors posted an increase in their energy consumption during the same period with the industry sector displaying the largest growth at 4.9%, followed by the transport sector with 4.2%. The other sectors, which consist of commercial, residential and agriculture, exhibited 3.3% growth. The commercial sector expanded its energy consumption by 12%, while the residential and agriculture sectors only required 1.3% and 0.2% increase in their energy uses (DOE, 2015b).

The transport sector's energy use accounted for 31% of the FEC in 2014, more than 50% of which was diesel oil, the primary fuel used for public transport. Industry consumed 23% of the FEC with coal being the largest share (35%) of the sector. About 80% of coal use in the sector was for cement production (DOE, 2015b).

The other sectors' aggregate energy consumption was 45% of the FEC in 2014 (EGEDA, 2016). The residential sector required two-thirds of the other sectors' consumption, representing 30% of the FEC. The bulk of the energy consumption of the sector was biomass. The commercial sector demanded 26% (of the other sectors' consumption) and the remaining was shared by agriculture and non-energy use (DOE, 2015b).

Oil products continued to be the major fuel for the economy, approximately 45% of the FEC. Oil demand grew by 5.6 %, from 12 249 ktoe in 2013 to 12 936 ktoe in 2014. Electricity and biomass likewise expanded by 2.9% and 1.8%, respectively, contributing an aggregate share of 46% to the FEC (EGEDA, 2016).

ENERGY INTENSITY ANALYSIS

The economy's GDP growth rate (6.1%) in 2014 (2010 USD PPP) increased the primary supply requirement by 6.3% from the 2013 level. With a higher growth rate in the primary energy supply than the GDP, the primary energy intensity level increased a bit by 0.2%, 75.0 tonnes of oil equivalent per million USD of GDP (toe/million USD) from 74.9 toe/million USD in 2013.

However, in terms of final energy consumption, the intensity level decelerated by 1.6% from the 2012 level. All sectors, except the non-energy sector, registered decreases in intensity levels. The reduction of 11%

in the commercial sector's energy consumption triggered a large decline in the intensity level of the other sectors. The transport sector posted a decrease in intensity due to decline in gasoline demand and ethanol (blended with gasoline), as well as fuel oil demands from water transports. Vehicle owners' judicious use of fuel and the adoption of more fuel-efficient vehicles could be one of the reasons for lower gasoline demand. In the industry sector, lower growth in energy demand in some sub-sectors like non-metallic minerals and food, beverages, and tobacco pulled down the sector's intensity level.

Table 3: Energy intensity analysis, 2013

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	74.9	75	0.2
Total final energy consumption	45	44	-1.6
Total final energy consumption excl. non-energy	44	43	-2

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The government recognises the importance of energy to boost the economy's inclusive growth and development. The Department of Energy (DOE) has been at the forefront of formulating responsive energy plans and programs to address the many issues and challenges of ensuring energy supply security and expanding access to energy for the greater public to improve local productivity and fuel countryside development. The Philippine Energy Plan 2012-2030 still serves as the guidepost for the economy, outlining several measures and targets that the government and the energy stakeholders must jointly undertake to bring reliable and affordable energy services to the populace and create a sustainable future with less carbon footprints. The energy plan espouses the government policy thrusts and goals, which include:

- a. Ensuring energy security by expanding the renewable share of the total power generation capacity mix, promoting exploration and development of indigenous fossil fuels, and providing a reliable and efficient power supply;
- b. Expanding energy access by increasing household electrification levels;
- c. Promoting a low-carbon future by achieving 10% energy savings and increasing the share of alternative fuels in public utility vehicles; and
- d. Promoting a more climate change resilient energy infrastructure.

The DOE studied the possible fuel mix policy for power generation to determine a reliable long-term power generation mix model for the economy. Based on the results of the prepared fuel mix models with assistance from the Japan International Cooperation Agency (JICA) in August 2014, the proposed fuel mix should comprise 30% renewables and 30% natural gas (DOE, 2015c). In July 2015, the DOE issued Department Circular (D.C.) 2015-07-0014 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, 2105f).

ENERGY MARKETS

OIL AND GAS

In order to promote and encourage investments in the exploration 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 government has continuously implemented the Philippine Energy Contract Round (PECR). PECR is a transparent and competitive system of tending onshore and offshore oil and gas blocks for exploration that are offered to both local and foreign investors. During the fifth PECR in 2014

covering 11 petroleum potential areas, the government received three bids in 2015 and recommended the awarding of service contracts to add to the existing 25 petroleum service contracts already being monitored by the government (DOE, 2016).

The economy's existing oil and gas fields produced 3.07 million barrels (Mbbbl) in 2014, 63% higher than the 2013 output due to the production from new wells in the Galoc field. In the same year, gas production grew by 5.2% reaching 130 351 million standard cubic feet (Mmscf), almost all (99%) coming from the Malampaya gas field. Gas produced from Malampaya is mostly used to fuel three natural gas power plants (with an aggregate capacity of 2 861 MW) located in Luzon Island. Likewise, Malampaya produced 4.2 Mbbbls of associated condensate (DOE, 2015c).

COAL

The economy has 13 coal basins with an estimated total resource potential of 2.4 billion metric tonnes (Bmt). The largest coal resources are found in Semirara in Antique with a total potential of 570 million metric tonnes (Mmt). However, the economy's coal resources are a low-ranking coal; thus, there is a high dependency on imported coal (high-ranking), which is used by the coal power plants. To reduce dependency on imported coal, the government has been pursuing efforts to expand the utilisation of indigenous coal, as well as the adoption of local coal quality upgrading technologies, such as coal washing, preparation and blending to meet the environmental standards. Further, the government is exploring alternative uses of local coal through assessing the coalbed methane (CBM) potential of selected coal fields. A significant portion of local coal production is exported mostly to China.

Similar to oil and gas, the government is also promoting PECR to encourage investors to explore the coal resource potential of the economy. During the fifth PECR, the government awarded seven coal exploration contracts (COCs) to explore potential coal areas in Mindanao Island (DOE, 2016). These additional COCs could boost the coal reserves of the economy. In terms of coal production from existing COCs, a total of 7.6 Mmt (at 10 000 BTU/lb) was produced in 2014. Of the total, 97% came from Semirara, Antique, while the small-scale coal mines in Negros, Surigao del Sur, Zamboanga del Sur, Bicol and in Cebu province contributed about 0.232 Mmt or 3% of the total domestic production.

MARKET REFORMS

ELECTRICITY

The government continuously oversees the implementation of power sector reforms as mandated in the Electric Power Industry Reform Act (EPIRA) of 2001 (or Republic Act 9136). In accordance with Section 31 of the EPIRA, the government successfully commenced the full commercial operation of Retail Competition and Open Access (RCOA) in June 2013 with 275 participating competitive customers duly registered by the Central Registration Body (CRB) (DOE, 2015g). In 2015, the number of participants increased to 434 (DOE, 2016). Under the RCOA, the customers (with an average load requirement of 1.0 MW in the last 12 months) can source their electricity supply from retail electricity suppliers (RES) by allowing the use of transmission and distribution systems and associated facilities subject to the payments of transmission and distribution wheeling charges duly approved by the Energy Regulatory Commission (ERC).

The DOE has been supervising the operation of the Wholesale Electricity Spot Market (WESM) of the Philippine Electricity Market Corporation (PEMC). As of 2014, the integrated Luzon-Visayas WESM registered 229 participants comprising of 54 generating companies and 175 customers (composed of 13 private distribution utilities, 71 ECs, 79 bulk users, 5 contestable customers, and 7 wholesale aggregators). To include ancillary service requirements of the power grid in the WESM operation, the DOE issued in December 2013 a Department Circular (D.C. 2013-02-0027), 'Declaring the Commercial Launch for the Trading of Ancillary Services (through the Establishment of a Reserve Market) in Luzon and Visayas under the Philippine Wholesale Spot Market.'

The D.C. had set the commercial operation of the reserve market in March 2014 after the launching of the trial operation plan (TOP). The PEMC started the TOP in February 2014 in two phases. The first phase covered testing the protocols, procedures and interfaces for the Market Operator-System Operation and

Reserve Market Working Group, including addressing other operational issues. The second phase involved demonstration of operations of the reserve market and familiarisation of trading participants in all processes (DOE, 2015c).

However, the DOE issued another D.C. (D.C. 2014-03-0009) in March 2014, '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,' which subsequently reset the commercial operation to May 2014. To have a detailed evaluation, the PEMC conducted a reserve market forum to deliberate the results of the TOP (conducted from February to April 2016). Until June 2016, the PEMC continued to undertake activities for the reserve market, such as market participants' registration and training, and testing of enhancement on market operator and system operator procedures (DOE, 2015g).

The Reserve Market will benefit the power market with co-optimisation of energy and reserves, as well as promote greater competition among energy and reserve providers leading to more transparent and competitive energy prices. Further, the reserve market will also facilitate the entry of renewable energy in accordance with the Renewable Energy Act of 2008.

As part of the sustainable solutions for the Mindanao Island requiring additional power generation capacities, an Interim Mindanao Electricity Market (IMEM) was established, which commenced full operation in November 2013. The IMEM is intended to encourage participation of existing power generating capacities and interruptible loads,¹ and entry of new generating capacities in Mindanao. The IMEM rules were amended in May 2014 to include 'demand-side bidding and transitory arrangement' (DOE, 2015c). In 2014, IMEM market intervention was still in effect due to the continuing power supply deficiency in the Mindanao grid. The DOE held several discussions with stakeholders to resolve some issues on IMEM operations and the amendments on the market rules. Once the IMEM rules are ready for implementation, the government will lift the IMEM market intervention (DOE, 2015g).

The DOE assessed the possibility of implementing a 'demand aggregation and supply auctioning policy' (DASAP) for the electric power industry. The objective of this policy is to achieve greater transparency and reasonableness of electricity tariffs, and to encourage greater participation from the generation sector in providing adequate power supply in each franchised area served by the distribution utility. In lieu of the non-issuance of the DASAP, the DOE pursued the issuance of a Department Circular (D.C. 2015-06-0008) in June 2015 entitled 'Mandating All Distribution Utilities to Undergo CSP in Securing Power Supply Agreements (PSA)' (DOE, 2015h). The circular mandates all distribution utilities to undergo CSP, through a third party duly recognised by the DOE and Energy Regulatory Commission (ERC). In Electric Cooperatives (ECs), the National Electrification Administration (NEA) should recognise the third party (DOE, 2016).

OIL

As part of its mandate, the DOE ensures an adequate and stable oil supply in the economy through continuous monitoring of activities in the downstream oil industry, such as crude and product imports/exports and costs, local production, industry demand, inventory levels, distribution and marketing facilities, and oil price movements. The DOE still implements the minimum inventory requirement (MIR) to have a steady oil supply, specifically during emergencies like natural disasters. The MIR covers oil companies, bulk suppliers and LPG players operating in the economy. Refineries are required to have in-country stocks equivalent to 30 days, while bulk marketers must maintain 15 days' stock and LPG players 7 days' stock. As of December 2014, the average inventory was equivalent to a 46-day supply (DOE, 2015i).

The DOE entered into a memorandum of agreement (MOA) in October 2014 to develop a framework that will enable a sustainable supply of petroleum products in the event of natural disasters or emergencies. Parties to the MOA are the Metro Manila Development Authority, Office of the Civil Defense, Natural Risk Reduction and Management Council, and the members of the Philippine Institute of Petroleum (DOE, 2015c).

¹ The interruptible load program (ILP) is another measure implemented in Mindanao where customers of a distribution utility (DU) are compensated for voluntarily de-loading from the grid by using the generation facility for their 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 money will be used to pay these customers based on the Energy Regulatory Commission-approved ILP rates.

Likewise, the Mutual Product Sharing Accommodation (MPSA), established through a department circular (D.C. 2011-03-003) issued by the DOE in 2011, is part of the emergency response measures of the economy. The DOE implemented the MPSA when the economy was hit by super typhoon Haiyan in 2013. The MPSA intends to provide and stabilise oil supplies 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.

DOWNSTREAM NATURAL GAS

With depleting domestic natural gas resource, the government is now looking at the possibility of importing liquefied natural gas (LNG). The Energy World Corporation, an Australian company based in Hong Kong, is building an LNG terminal and a merchant gas-fired power in Pagbilao, Quezon province. The LNG facility is composed of two units storage tanks with a capacity of 130 000 cubic meters (Cm) each, a regasification plant, and an on-site 600 MW merchant gas-fired power plant to serve as an anchor load for the project (DOE, 2015j). In 2015, the DOE granted the Energy World Corporation a 12-month extension upon expiration of their five-year provisional permit for the completion of their LNG hub terminal facilities (DOE, 2016).

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, 2015c). JICA made a feasibility study for the entire natural gas supply chain in the economy, which covered the LNG facility, regasification facility, pipeline, and offtake facilities, among others. The PNOC availed upon the Project Development and Monitoring Facility (PDMF)² from the PPP Center to source funds in engaging the expertise of the Rebel Group International as its transaction advisor. The pipeline potential route corridors were identified by the transaction advisor. From the route analysis, the most appropriate route will be proposed to bring the natural gas from Batangas' proposed LNG terminal to the nodal gas demand located alongside the pipeline route through the Manila metropolis (DOE, 2015j).

The final draft of the Natural Gas Quality Standard was published in February 2015 and endorsed by the Bureau of Product and Standard. This standard is necessary for more efficient supply acquisition and distribution of natural gas in the economy. In November 2015, the DOE signed a memorandum of understanding (MOU) with other government agencies for the establishment of the Inter-Agency Health, Safety, Security and Environment Inspection and Monitoring Team for natural gas facilities (DOE, 2016).

The economy has not yet promulgated a comprehensive policy and regulatory frameworks to govern the development of the downstream natural gas industry. The Natural Gas Bill is still pending in both Houses of Congress.

ALTERNATIVE FUELS

The DOE drafted a MOA with the Development Academy of the Philippine for the formulation of the Alternative Fuels Roadmap to serve as a blueprint for the government in the program implementation. The DOE has been implementing policies and programs on alternative fuels as ways to diversify fuel and reduce dependence on imported fuels, and to promote a preference for cleaner fuels.

The enactment of the Biofuels Act in 2006 mandates the current 2% biodiesel blend (B2) and 10% bioethanol blend (E10) in all diesel and gasoline fuels sold in the economy. The DOE in cooperation with the University of the Philippines-Los Baños conducted a study entitled 'Economic Impact in the Increased Use of Biodiesel in the Philippines' to evaluate the effect of increasing the utilisation of biodiesel and the impact of the nationwide implementation of 5% biodiesel blend (B5) in the economy. The economy has also planned to increase biodiesel blend to 20% (B20) by 2025 and the bioethanol blend to 20% (E20) in 2020.

Under the government's program, Natural Gas Vehicle Program for Public Transport (NGVPPT), the DOE is working closely with the Department of Transportation (DOTr) and the Land Transport Franchise Regulatory Board (LTFRB) for the issuance of franchises for 169 CNG buses. In March 2015, the DOTr declared the availability of these franchises under the NGVPPT. The DOE likewise is coordinating with the

² The Philippine government, with assistance from the Asian Development Bank (ADB), has established a PDMF to fund transaction advisory services for the development of PPP projects, which include energy and social projects, such as road networks, school buildings, airports and hospitals, among others.

natural gas suppliers for the supply of CNG fuel until 2023. The DOE also directed the PNOC-Exploration Corporation (PNOC-EC) to take over the operation of the CNG refuelling station.

As for the Auto-LPG program, the DOE signed a MOA with two academic institutions in December 2014 to train proficient technicians who will be involved in the conversion from gasoline-fed to auto-LPG, including the repair and maintenance of such vehicles. The DOE has been in coordination with concerned national government agencies for the promotion and mainstreaming of auto-LPG in the transport sector to diversify the economy's fuel source.

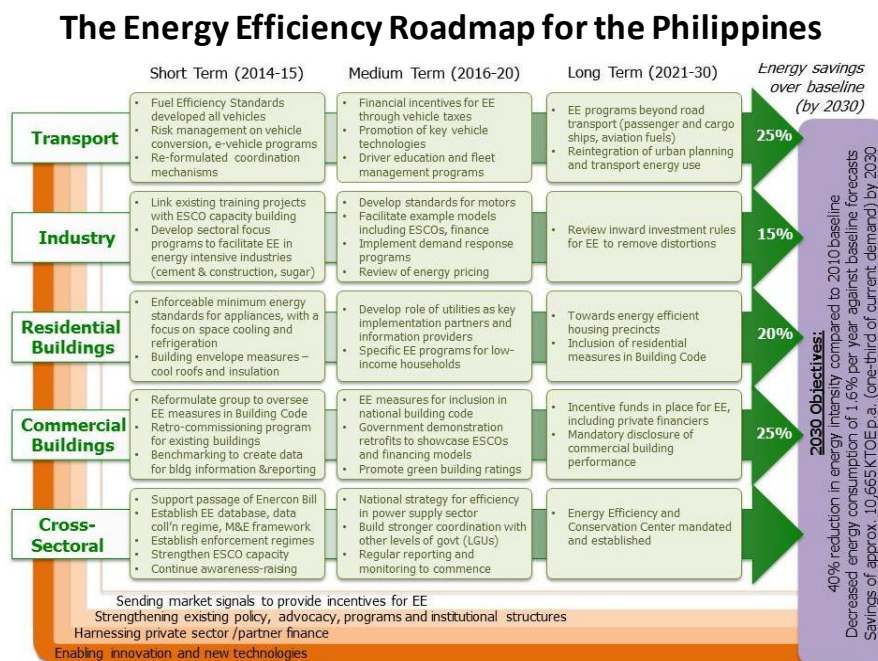
ENERGY EFFICIENCY

The government has continuously implemented the National Energy Efficiency and Conservation Program (NEECP) launched in 2004 as the banner program on the various initiatives on energy efficiency and conservation. This program includes:

- Energy Efficiency Standards and Labelling Program;
- Government Energy Management Program (GEMP);
- Energy Management Services/Energy Audits;
- Fuel Conservation and Efficiency in Road Transport (FCERT); and
- Power Conservation and Demand Management (Power Patrol), among others.

The DOE approved the implementation of the Energy Efficiency and Conservation Roadmap in July 2014, which specifies a direction towards an energy-efficient economy by 2030. The roadmap identifies short-to medium-term action plans across key energy consuming sectors with the objective of achieving 40% reduction in energy intensity by 2030 based on 2010 level. The roadmap will provide more sustainable and long-term policy directions on energy efficiency and conservation

Fig 1: Energy Efficiency and Conservation Roadmap



Source: DOE (2015c).

The DOE has pursued the accreditation of energy service companies (ESCOs) to promote emerging business industries in the economy. As of 2105, the economy had 15 accredited ESCOs to help accelerate the implementation of energy efficiency and conservation measures among the private sector. The DOE also offers audit services to manufacturing plants, commercial buildings and other energy intensive companies to evaluate the energy utilisation efficiencies of equipment, processes and operations and to recommend energy conservation measures for adoption by these companies.

The DOE has implemented the Philippine Industrial Energy Efficiency Project (PIEEP) in partnership with the United Nations Industrial Development Organization (UNIDO) and the Department of Trade and Industry (DTI). The Global Environmental Fund (GEF) provided the project funding. 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 could generate about 2 million megawatt-hours (MWh) of energy savings (DOE, 2015c).

RENEWABLE ENERGY

Government efforts to promote and expand the use of renewable energy as a clean and sustainable energy source for the public became evident with the formulation and adoption of the National Renewable Energy Program (NREP) in 2011. The NREP outlines the strategy and measures to facilitate greater private sector investment in RE development, including addressing the challenges and gaps to effect wider application and utilisation of renewables. Other policy mechanisms as stipulated in the RE Act have been implemented or are in the process of ongoing implementation, such as

- Feed-in Tariff (FiT);
- Renewable Portfolio Standards (RPS);
- Green Energy Option Program; and
- Net-Metering for Renewable Energy

Upon recommendation of the DOE, the ERC promulgated the FiT rules and FiT rates based on the set installation targets. The ERC approved the initial FiT rates in July 2012. FiT rates are subject for review and

readjustment after three years of implementation or once the DOE installation targets have been achieved. In August 2014, the DOE issued a certification for the increase in the FiT installation target for solar from 50 MW to 500 MW including lower FiT rates for the additional capacity. The FiT installation target for wind was also increased in April 2015 from 200 MW to 400 MW. The increases in solar and wind installation targets brought the total targets to 1 410 MW and are listed below:

- 250 MW Run-of-River Hydropower
- 250 MW Biomass
- 400 MW Wind
- 500 MW Solar
- 10 MW Ocean

The RPS is a market-based policy requiring mandated electric power industry participants to source a portion of electricity supply from RE resources. In the RPS, the mandated industry participants are the generators, distribution utilities and electric suppliers. The Green Energy Option Program allows the end-users the option to choose RE resources as their source of energy. 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 can be used to offset electricity provided by the distribution utilities to the end-user during the applicable period.

In 2014, the DOE awarded 220 service contracts for the different RE resources with potential capacity of 3 184.06 MW (DOE, 2015c), while the 133 service contracts awarded in 2015 have an aggregate potential capacity of 5 575 (DOE, 2016).

NUCLEAR

It has long been a policy of the government to study all possible and potential energy resources to diversify the economy's energy supply mix and to provide quality, reliable, adequate, secure and reasonably priced energy. As such, the present government administration is open to study nuclear energy as an option for power generation. In November 2016, Secretary Alfonso Cusi signed an order creating the Nuclear Energy Program Implementing Organisation (NEPIO). The NEPIO is headed by a steering committee with DOE officials at the helm, while the DOE bureaus will create technical working groups to ensure effective and timely implementation of its functions and responsibilities. In the near future, NEPIO will come up with a roadmap for nuclear power development in the economy. The NEPIO will also study the possibility of reopening the Bataan Nuclear Power Plant, which has been in 'mothballed' status since 1986 (GMA News, 2016).

Advancements in nuclear energy technology and enhancements in safety and safeguard standards, based on the lessons learned from the Fukushima incident, could encourage the economy to adopt a nuclear energy policy in the future.

CLIMATE CHANGE

In 2009, the government created the Climate Change Commission by virtue of the Philippine Climate Change Act of 2009 (RA 9729). The Climate Change Commission serves as the policy-making body under the office of the President carrying a status of national government agency. The Commission's primary functions are to monitor and evaluate programs and action plans related to climate change.

In the twenty-first session of the Conference of Parties (COP21) of the United Nations Framework on Climate Change, the Philippines expressed the intention to reduce CO₂ emissions by 70% by 2030. This is relative to its BAU scenario of 2000–30 as indicated in the economy's Individual Nationally Determined Contributions (INDC). Such commitment is conditionally based on the availability of financial resources, technology development and transfer, and capability building. Energy is one source of CO₂ reduction together with the transport, waste, forestry and industry sectors (UNFCCC, 2015).

NOTABLE ENERGY DEVELOPMENTS

POWER AND RENEWABLE ENERGY

The Access to Sustainable Energy Programme (ASEP) aims to support the Philippine government in implementing policies and programs that will generate more electricity from renewable energy and implement innovative approaches to increase access to electricity for the poor and unenergised households through reasonable and disaster-resilient energy technologies. It involves capacity building and institutional support to key agencies, such as DOE, ERC and NEA in implementing reforms in policies and programs for rural/household electrification, renewable energy development, and promotion of decentralised energy solutions for climate-vulnerable communities, particularly in Visayas and Mindanao.

The PV mainstreaming is one of the projects of ASEP providing investments for rural electrification using solar home system (SHS) for an estimated 40 500 households within the coverage areas of the participating electric cooperatives. Another project is Geographic Information System (GIS) for rural electrification and renewable energy projects. The functions of this GIS platform include:

- Maps showing the existing electricity infrastructure and the locations of non-electrified households in EC franchise areas;
- Maps showing the renewable energy potential for electricity production; and
- The possibility to compute indicators for electrification planning (screening models).

Meanwhile, the greening the grid project intends to conduct a grid integration study for variable renewable energy to identify the potential grid reliability concerns with the scaling of variable RE and the options to improve system flexibility and power system balance.

ENERGY EFFICIENCY

The DOE is finalising the Philippine Energy Standards and Labeling Program (PESLP), which will significantly contribute to the attainment of the target to reduce energy intensity by 40% in 2030. The PESLP will cover a wide range of appliances and lighting systems to include even light duty motor vehicles. Currently, PESLP only covers room air-conditioners, split-type air-conditioners, refrigerators with 5-8 cubic feet storage capacity, three types of fluorescent lamps (CFL, linear and circular), and electronic ballasts. In April 2016, the DOE issued a department circular prescribing the guidelines for minimum energy, 'Performance Standards (MEPS) and Strengthening the Philippine Energy Standards and Labeling Program (PESLP).'

PENDING ACTIONS

The DOE has been pursuing a number of legislative agenda to enhance the economy's energy policies and regulatory frameworks. The following energy bills have been filed or will be refiled in both Houses of Congress:

- 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.

Some of the energy bills are simply amendments to provide the existing framework and to provide additional fiscal and non-fiscal incentives to encourage private investments.

GOOD GOVERNANCE AND TRANSPARENCY INITIATIVES

In June 2015, the DOE, through the technical support from the United States Agency for International Development (USAID), established a web-based system called 'Energy Virtual One Shared System (EVOSS).' EVOSS is an 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 could help facilitate and streamline business processes, promote efficiency and transparency, and increase private investments.

Other government initiatives being implemented providing data and information transparency to the public include 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. The Wattmatters website provides information on energy conservation and provides data on more efficient appliances available in the market for the residential sector. The Langis website (www.langis.org.ph) gives information on factors affecting pump prices of petroleum products and international price movements.

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USEFUL LINKS

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Climate Change Commission (CCC)—climate.gov.ph/

Department of Energy, Republic of the Philippines (DOE)—www.doe.gov.ph

Department of Science and Technology (DOST)—www.dost.gov.ph/

Department of Transportation and Communication (DOTC)/Land Transportation Franchising and Regulatory Board (LTFRB)—www.dotc.gov.ph

National Power Corporation (NPC)—www.napocor.gov.ph/

National Transmission Corporation (TransCO)—www.transco.ph/

Philippine National Oil Company (PNOC)—www.pnoc.com.ph/

Wholesale Electricity Spot Market (WESM)—www.wesm.ph/

RUSSIA

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 primarily to its continental climate, which is either too cold or too dry.

From 1993 to 2008, the Russian population declined from 148 million to 143 million: however, from 2009 to 2014, there was an increase to 144 million (EGEDA, 2016). As of January 1, 2017, the population has reached 147 million, a 0.2% or 260 thousand increase compared to 2016. 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 (Rosstat, 2016).

Russia's economic growth has slowed from the 2012 level of 3.5% to 0.7% in 2014 with an average growth rate of 4.8% 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. A period of recovery (2010–13) was followed by another economic slowdown due to international sanctions from the European Union.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{b, c}	
Area (million km ²)	17	Oil (billion barrels)	102
Population (million)	144	Gas (trillion cubic metres)	32
GDP (2010 USD billion PPP)	3 223	Coal (billion tonnes)	157
GDP (2010 USD PPP per capita)	22 413	Uranium (kilotonnes U)	342

Note: NEA data is for uranium reserves recoverable at a production cost of less than 260 USD per kg.

Sources: a. EGEDA (2016); b. BP (2016); c. NEA (2016).

Russia's major industries include oil and gas production, petroleum refining, mining, iron and steel, chemicals and machinery. The economy's energy sector accounts for 27% of the GDP, 63% of the total exports and 27% of the total capital investment.

In terms of proven reserves, as of 2016, Russia holds 17% of the world's gas, 6% oil, 18% coal (BP, 2016) and about 5.8% of its reasonably assured resources of uranium (NEA, 2016).

The proven natural gas reserves in Russia, estimated at 32 trillion cubic metres, should be adequate to meet both the domestic market and export demands for the near future.

As at 2014, over 80% of Russia's oil is produced from the fields discovered before 1990, and are in later stage of development. This highlights the importance of new fields. Since 2005 the share of Western Siberia, including Khanty-Mansi Autonomous Okrug, has declined from 71% to 63%. The second largest oil-producing region is Volga-Urals accounting for 24% of production (MNRE, 2016).

At the current rate of domestic coal consumption, the reserves should be sufficient for 800 years.

The refining industry in Russia includes about 30 major refineries with a total capacity for primary processing of about 277 million tonnes (Mt) of crude oil per year (ME, 2016).

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 66.4% 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%).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Russia's total primary energy supply in 2014 was 711 million tonnes of oil equivalent (Mtoe), comprised of natural gas (52%), crude oil and petroleum products (23%), coal (15%) and others, including nuclear and hydro (10%).

By destination, the majority of Russia's total energy exports are directed to Western and Eastern Europe, including the Commonwealth of Independent States (CIS). Since 2008, Russia has been actively diversifying its export routes towards the Asia-Pacific region, aiming to deliver oil, natural gas and coal to China; Japan; Korea and South-East Asia.

Russia produced 534 Mt of crude oil and gas condensate in 2015. The oil heartland is the Ural Federal district, which accounts for 56% of the total production. Refineries consumed 287 Mt of crude oil as feedstock, producing 39 Mt of gasoline, 76 Mt of diesel, 75 Mt of fuel oil and 10 Mt of kerosene. Oil exports increased from 223 Mt in 2014 to 245 Mt in 2015 (FTS, 2015).

Natural gas production declined from 642 billion cubic metres (Bcm) in 2014 to 634 Bcm in 2015. Net exports of natural gas in 2015 accounted for 185 Bcm (FTS, 2015) (174 Bcm in 2014) or 30% of the production, which includes 21 Bcm of LNG exports (FTS, 2014).

The economy produced 372 Mt of coal in 2015, an increase of 4% compare to 2014. Coal exports reached 155 Mt declining by 0.2% (FTS, 2015). From 2000 to 2015, the share of coal for export increased from 17% to 40%, despite that the main coal-producing areas (the Kuznetsky and Kanskó-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.

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 306 126	Industry sector	125 443	Total power generation	1 066 081
Net imports and others	–570 835	Transport sector	93 491	Thermal	702 495
Total primary energy supply	711 333	Other sectors	159 364	Hydro	179 015
Coal	103 953	Non-energy	76 142	Nuclear	180 757
Oil	166 211	Total final energy consumption	454 438	Others	3 814
Gas	371 673	Coal	10 970		
Others	69 496	Oil	134 460		
		Gas	133 564		
		Electricity and others	175 444		

Source: EGEDA (2016).

Electricity production reached 1 068 terawatt-hours (TWh) in 2015, of which 66% was from thermal power plants, 16% from hydropower and 18% from nuclear energy. Russia has significant resource potential of renewable energy, such as hydro and biomass in Siberia, wind along its Arctic and Pacific shores and geothermal in Kamchatka and the Kuril Islands.

FINAL ENERGY CONSUMPTION

In 2014, the total final energy consumption (TFEC) in Russia was 454 Mtoe, an increase of 1% compared to 2013. By sector, industry accounted for 28%, transport 21%, non-energy for 17% and others for 35%. By energy source, coal accounted for 2.4% of the total consumption, oil and petroleum products 30%, natural gas 29% and electricity and others, including heat 39%.

The traditional energy-intensive industrial structure has been one of the major drivers of economic development. State and regional energy efficiency programs aim to reduce overall energy intensity up to 40% by 2020 compared to 2007. Policies are designed to attract investment in energy efficiency and realise Russia's large savings potential.

ENERGY INTENSITY ANALYSIS

The 0.7% growth of Russia's real GDP in 2014, which coincided with a 3.1% improvement in the economy's primary energy intensity, resulted in an economy-wide level of 221 tonnes of oil equivalent per million USD (toe/million USD). For final energy intensity, the indicator grew by 0.3% from the 2013 level of 140.5 toe/million USD to 141 toe/million USD in 2014.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	228	221	-3.1
Total final energy consumption	140.5	141	0.3
Total final energy consumption excl. non-energy	117.3	117.4	0.1

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Russia's Energy Strategy 2030, adopted in 2009, defines its key objective as the most efficient use of nature's energy resources and the energy sector's potential for stable economic growth, improvement in the quality of people's lives and strengthening of the economy's foreign trade (IES, 2010). The strategy sets a policy framework within which more detailed industry-oriented medium-term and short-term programs are developed.

As of early 2017, the government continued its work on the new 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, diversification of export delivery markets will be the key to better integrating Russia into the world energy markets.

Russia's nuclear energy industry remains a priority for the economy'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 a 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, which includes 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's long-term gas industry development. 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 of the Russian Federation forwarded the second phase development plan up to 2030 for the economy's gas and petrochemical industry to the Russian Government. 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 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 updated annually 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 AUTHORITIES

Main federal legislation on specific energy-related industries include laws in the following areas: subsoils (1992), functioning of the power industry (2003), power industry (2003), natural monopolies (1995), production sharing agreements (1995), energy conservation and energy efficiency increases (2009), gas supplies (1999), nuclear energy (1995), and heat supply (2010). The latter is the logical extension of the power industry law, because of the large share of cogeneration plants (CHP) where electricity and commercial heat are produced simultaneously.

As a rule, the Ministry of Energy of the Russian Federation is responsible for issuing regulations, instructions, etc., to enforce the smooth implementation of the basic energy laws and to coordinate current economic development with the long-term energy policy, except for the nuclear power industry. Other major government institutions actively participate in the development and implementation of the regulatory framework regarding the production, supply, consumption, exports and imports of energy. These include the Ministry of Natural Resources and Environment of the Russian Federation, Federal Environmental, Industrial and Nuclear Supervision Service, Ministry of Industry and Trade of the Russian Federation, Ministry of Economic Development of the Russian Federation, Federal Agency on Technical Regulating and Metrology, 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 controls 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 Russia's objectives of the Energy Strategy 2030 is to complete the full liberalisation of domestic energy markets, where at least 20% of the energy is expected to be traded on commodity exchanges.

In 2006, the simultaneous liberalisation of natural gas and electricity prices by 2011 was approved. However, the implementation was delayed and as of 2017, the electricity tariff for residential sector is still regulated by the government. Federal Antimonopoly Service is planning to launch natural gas price liberalization programme, except for industry, in three pilot regions in 2017.

The oil market in Russia has been deregulated since the 1990s, but crude oil and petroleum trading are 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, similar 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 been extended. The government will maintain control over the residential and commercial energy tariffs to gradually eliminate cross-subsidies.

OIL AND GAS

Russia's oil and gas industry was privatised in the 1990s. However, the government retained control over major oil and gas companies and crude oil and petroleum trunk pipelines, and owns 73% of the shares of Russia's biggest gas company, Gazprom.

As of 2015, the oil industry in Russia consisted of 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 is comprised of 28 large VICs, 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 Transnefteproduct, 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 remain 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 companies.

As of 2016, 192 coal enterprises were operational in the Russian coal industry (71 mines and 121 open-pit mines), with a total annual production capacity of 407.6 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 policy restrictions on coal exports; however, the cost of transportation lowers the fuel's competitiveness on external markets. Coal is the single largest commodity transported by rail, accounting for nearly 30% of its total freight volume.

ELECTRICITY

Russia started restructuring its 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, whose 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, 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 and is expected to become the major method for calculating middle-term tariffs. The methodology is 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, AtomEnergProm (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 public roads in 2015 was 1 480 817 km, 70.6% of which are paved (Rosstat, 2017). The economy has just over 30 000 km of high-speed divided highways connecting big cities. Further development of highways will be necessary to connect big cities.

Russia has a state railway system with a total length of 86 251 km, but only few cities have high-speed rail service. Extensive urban and regional bus services are available throughout Russia. Subway systems operate in seven cities.

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 251 764 km in 2015, of which 71% is gas pipeline, 22% oil pipeline and the remainder is petroleum 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 has been 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.

Beginning in 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 these 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, a preferential export duty was enacted, which, as of October 2011, was set at USD 204 per tonne. A reduced duty on crude oil was achieved by changing the formula for calculating it. According to

the norms of the '60–66', duty on crude oil was assessed 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 a priority area of the Energy Strategy 2030.

On 23 November 2009, the federal government adopted the Law on Energy Conservation and Increase of Energy Efficiency, which took effect on 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 federal law sets a legal framework and targets 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 inter-agency 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 accordance with the EE federal law and the program, all regions are required to prepare their own respective regional programs on energy efficiency improvements. Regional governments and the federal government will finance the implementation of these programs jointly.

On 22 December 2009, the government established the Russian Energy Agency, which has 70 regional branches, with the Ministry of Energy of the Russian Federation. 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 Federal Programme (FP) 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 implemented across all regions. In addition, the 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.

RENEWABLE ENERGY

Russia's technical potential for renewable energy (RE), excluding large hydro, 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 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 the economy's 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. Tenex, the state company responsible for the nuclear fuel cycle business, supplies all of the Russian, Commonwealth Independent States and Eastern European nuclear reactors. 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
- Internationalise fully with the involvement of many customer economies under the IAEA's auspices.

Russia also created a fuel bank with guaranteed reserves of low-enriched uranium hexafluoride—equivalent to two 1 000 MW reactor loads—at the IUEC available under the IAEA's control. As of 2017, the storage capacity is 120 tU as UF₆, with 2.00% to 4.95% enrichment (IUEC, 2017).

Nuclear safety is a major concern for world energy development, which has become a key agenda item following the Fukushima accident in Japan. Russia has adopted a ‘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. The expired contracts for depleted uranium hexafluoride enrichment/conversion have not been extended since 2007.

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.

Russia has chosen three core reactor technologies for nuclear energy development for the next 20 to 25 years:

- 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 have been outlined in the Climate Doctrine (Kremlin, 2009) and Fundamentals of state policy in the field of environmental development of the Russian Federation for the period until 2030 (Kremlin, 2012), and implemented in the State Environmental Protection Programme for the period 2012-2020¹. In November 2004, Russia ratified the Kyoto Protocol to the United Nations Framework Convention on Climate Change (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 on 16 February 2005.

Russia is considered the world’s largest potential host for ‘joint implementation’ projects under the Kyoto Protocol. In May 2007, the economy adopted procedures for the approval and verification of Russia-based joint implementation greenhouse gas (GHG) reduction projects. Responsibilities were assigned for establishing and maintaining the Registry of Carbon Units, which paved 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 a 50% decrease 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 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. Russia’s INDC is “Limiting anthropogenic greenhouse gases in Russia to 70-75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests” (UNFCCC, 2015).

¹ The State Environmental Protection Programme does not include the indicators related to greenhouse gas emission.

NOTABLE ENERGY DEVELOPMENTS

POWER MARKET DEVELOPMENT

The Ministry of Energy of the Russian Federation 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, Gazprom and China National Petroleum Corporation (CNPC) signed a historic 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.

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. This agreement defines the schedule for 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, Chairs 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 line with Russia's coal industry development through 2030, drafted by the Ministry of Energy of the Russian Federation, the state-controlled technology corporation Rostech 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 the 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 and results of the latest studies. It will allow Russia to participate in the elaboration of international standards as well as influence the renewable energy sector's development worldwide.

CLIMATE CHANGE

In accordance with the Decree of the President of the Russian Federation, the year 2017 was announced the Year of Ecology in Russia. In addition, during the State Council on 'The Ecological Development of Russia for the Benefit of the Future Generations', the President stressed that Russia needs to reduce harmful emissions, including greenhouse gases, by no less than 50%.

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USEFUL LINKS

OFFICIAL BODIES OF RUSSIA

- Structure of the Government of Russia—<http://government.ru/en/>
- Ministry of Energy of the Russian Federation—<http://minenergo.gov.ru/en>
- Ministry of Natural Resources and Environment of the Russian Federation —
<https://www.mnr.gov.ru/english/>
- Federal Environmental, Industrial and Nuclear Supervision Service—<http://en.gosnadzor.ru/>
- Ministry of Economic Development of the Russian Federation—<http://economy.gov.ru/en/home/>
- Federal State Statistics Service—
http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/en/main/

Ministry of Industry and Trade of the Russian Federation—<http://minpromtorg.gov.ru/>
Federal Agency on Technical Regulating and Metrology—<http://www.gost.ru/wps/portal/en>
Federal Antimonopoly Service—<http://en.fas.gov.ru/>
Federal Customs Service—<http://eng.customs.ru/>
Federal Tariff Service—<http://www.fstrf.ru/eng>

ENERGY-RELATED NON-PROFIT AND STATE-OWNED BUSINESS INSTITUTIONS

AtomEnergoProm—<http://atomenergoprom.ru/en/>
Federal Grid Company—<http://www.fsk-ees.ru/eng/>
Association NP Market Council—<http://www.en.np-sr.ru/index.htm>
Gazprom—<http://www.gazprom.com/>
Rosneft—<https://www.rosneft.com/>
RusHydro—<http://www.eng.rushydro.ru/>
Transneft—<http://www.en.transneft.ru/>
Transnefteproduct, JSC—<http://en.transnefteproduct.transneft.ru/>

STATE ENERGY-POLICY-RELATED RESEARCH CENTRES

Russian Energy Agency—<http://rosenergo.gov.ru/>
Analytical Centre for the Government—<http://ac.gov.ru/en/>
Institute of Energy Strategy—www.energystrategy.ru/
Centre for Energy Policy—<http://www.energy.ru/>
Centre for Energy Efficiency—http://www.cenef.ru/art_11207_114.html
The Energy Research Institute of the Russian Academy of Sciences (RAS)—
<https://www.eriras.ru/eng>
Melentiev Energy Systems Institute (Siberian Branch of RAS) —<http://isem.irk.ru/en/>

MAJOR ENERGY-RELATED MEDIA IN RUSSIA

Official newspaper, *Rossiyskaya Gazeta*—<https://rg.ru/>
Central Dispatching Department of Fuel Energy Complex—<http://www.cdu.ru/en/>

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 (km²) in 2014 with a population of 5.5 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 SGD 390 billion reflected growth of 3.2% from 2013. The service industry accounted for the largest GDP share (66%), with the biggest sub-sector represented by wholesale and retail trade (15%), followed by goods-producing industries (25%), with manufacturing and housing representing 19% and 5%, 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.

Table 1: Key data and economic profile, 2014

Key data		Energy reserves	
Area (km ²)	714	Oil (million barrels)	–
Population (million)	5.5	Gas (billion cubic metres)	–
GDP (2010 USD billion PPP)	426	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	77 942	Uranium (kilotonnes U)	–

Source: EGEDA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Singapore imports all its crude fossil fuel requirements. The economy's total primary energy supply (TPES) in 2014 was 29 040 kilotonnes of oil equivalent (ktoe) (EGEDA, 2016). Oil constituted the largest share (over 60%) and experienced an increase of 7.3% over 2013, from 16 528 ktoe to 17 730 ktoe. Natural gas had a 35% share (10 219 ktoe), with a modest growth (3.5%) compared to the preceding year. Coal's share increased to 397 ktoe from 2013 maintaining only a small share (1.4%) of the total (EGEDA, 2016).

Singapore's total imports of energy (crude oil, petroleum products, gas and coal) in 2014 were 162 482 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 (EGEDA, 2016). Of these imports and their produced refined products, about 53% (85 698 ktoe) were exported (EGEDA, 2016). Most of the remaining imports were used at home for marine bunkering (25%; 40 824 ktoe) and aviation bunkering (4.4%; 7 214 ktoe), signifying the role of Singapore in international shipping and aviation (EGEDA, 2016).

The economy's electricity generation in 2014 reached 49 380 gigawatt hours (GWh), showing an increase of 2.9% over 2013 (47 964 GWh) (EGEDA, 2016). The peak demand for electricity of 6 880 megawatts (MW) was slightly larger than that in 2013 (6 814 MW) (EMA, 2016a).

Thermal power plants operated by Singapore's six main power producers (46 334 GWh) accounted for the bulk of the total power generation (94%) in 2014. Auto-producers accounted for the remaining 6% (2 977 GWh) (EMA, 2016a).

The licensed power generation capacity of thermal power plants in 2014 was 12 879 MW, showing a significant increase of 17.5% over 2013 (10 964 MW). Of this, the capacity of the combined cycle gas turbine power plants was 9 708 MW, followed by steam turbine plants (2 735 MW) and open cycle gas turbine plants (180 MW) (EMA, 2016a). Waste-to-energy plants generated 601 MW of electricity (EMA, 2016a).

Adoption of solar photovoltaic (PV) systems in Singapore accelerated further in 2014, as grid-connected installed capacity of solar PV systems more than doubled from 2013. The respective shares of Singapore's residential and non-residential grid-connected solar PV system installations in 2014 were 1 MW_p and 10.8 MW_p (EMA, 2016a).

The share of natural gas in Singapore's fuel mix for power generation reached a record high of 95% in 2014, compared with 92% in 2013 with shares for petroleum products at (0.5%) and other fuels at (3.9%) (EMA, 2016a).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	650	Industry sector	5 880	Total power generation	49 380
Net imports and others	76 785	Transport sector	2 493	Thermal	47 929
Total primary energy supply	29 040	Other sectors	2 444	Hydro	–
Coal	397	Non-energy	6 677	Nuclear	–
Oil	17 730	Total final energy consumption	17 493	Others	1 451
Gas	10 219	Coal	168		
Others	694	Oil	11 914		
		Gas	1 421		
		Electricity and others	3 991		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (FEC) was 17 493 ktoe in 2014, increasing 2% from 2013. Oil accounted for the bulk of this (11 914 ktoe), with a share of about 68%, followed by electricity and others (23%, 3 991 ktoe), natural gas (8%, 1 421 ktoe) and coal (1%, 168 ktoe). In terms of sector consumption, industry was 34%, transport 14% and others 14% (EGEDA, 2016).

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, the economy 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 2011 target. Recent examples include the Energy Conservation Act 2013 (ECA), which focuses on a range of interrelated energy issues including improving energy conservation, efficiency and intensity, while reducing CO₂ emissions (GBS, 2014). The Act aims to help Singapore achieve its intensity reduction target by improving the energy performance of the economy's companies. Other initiatives, including seeking improvements in energy conservations and efficiencies, are discussed in this chapter.

Singapore experienced an increase (2.9%) in its primary energy intensity (energy consumption per unit of GDP growth) in 2014 over that of 2013. The final energy demand in 2014 rose by only 1.9% over 2013 as compared to 21% increase in the preceding year, resulting in a reduction of the total final energy consumption by 1.3%.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	66	68	2.9
Total final energy consumption	42	41	-1.3
Total final energy consumption excl. non-energy	26	25	-3.9

Source: EGEDA (2016).

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 policies are detailed below.

The Economic Strategies Committee's (ESC) Subcommittee on Ensuring Energy Resilience and Sustainable Growth released a report in 2010, which proposed 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 conducted an Intelligent Energy System (IES) pilot from 2010 to 2013. to test and evaluate smart grid technologies and related applications that will enable consumers to manage their electricity use more efficiently (NCCS, 2010a).
- **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 (E²PO) 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 continues to invest in research, development and demonstration, facilities, and work force 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 work force 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. These are detailed below (EMA, 2014e).

- 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 the determination paper:
 - Clarify the licensing requirements for IGS (Intermittent Generation Sources);
 - Simplify the commissioning procedures for solar PV installations to connect to the grid, while ensuring safety;
 - Streamline market participation and settlement to make it easier for IGS to receive payments for excess electricity exported into the grid; and
 - Streamline 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 are sufficient reserves (or backup) capacity in tandem with the growth in an IGS capacity. There will be a further study on the reserve 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 the fourth quarter of 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 established 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 the evolving energy policies 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 for 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 the economy'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 and 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 paramount importance to Singapore which imports nearly all its energy requirements. Therefore, the economy has taken steps to enhance its energy security within the framework of its geological and geographic restrictions. The latter limits its options by excluding all types of renewables apart from waste-to-energy and, to a very limited extent, solar energy. Therefore, 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 (95%) of the economy's power mix in 2015 (EMA, 2016a). Four offshore natural gas pipelines – two from Malaysia and two from Indonesia – supply Singapore's piped natural gas needs.

Keppel Gas Pte Ltd currently imports 43 million cubic feet per day [MMcf/D] of Malaysian gas while Senoko Energy Ltd imports 40 MMcf/D of piped gas from Malaysia for its power generation plant. From Indonesia, Sembcorp Gas Pte Ltd currently imports 325 MMcf/D of gas from West Natuna while Gas Supply Pte Ltd imports another 350 MMcf/D of gas from Sumatra (The Business Times, 2014).

PowerGas Ltd, a subsidiary of SP Group (formerly Singapore Power), is the gas transporter in Singapore who owns both natural gas and town gas pipeline networks. It provides open and non-discriminatory access to the gas pipeline networks. EMA licenses and works closely with PowerGas to review the natural gas transmission network plan annually.

Diversification of the gas supply has become an important issue, given its significant 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. The Singapore LNG terminal, operated by Singapore LNG Corporation ("SLNG") commenced operations 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 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) become operational (EMA, 2016b). The LNG terminal is also capable of providing ancillary services, such as LNG trucking, cool-down and break-bulks.

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 Singapore's industry competitiveness in providing additional logistic capacity for the refining and petrochemicals and oil trading sectors. The project is not yet realised as of March 2016.

Finally, in September 2014, Singapore opened the first South-East Asia's underground liquid hydrocarbon storage facility called the 'Jurong Rock Caverns'. It is located at a depth of 130 metres under the Banyan Basin on Jurong Island (TODAY Online, 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 in 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: to develop capabilities to support the clean energy sector as a key growth area; to grow a viable industry that will create jobs; and to meet 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, 2016c). Additionally, 'about \$140 million has been set aside for the Energy Innovation Research Programme' (EIRP) (EMA, 2016c).

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. Over USD 70 million was awarded to various Singapore-based institutes of higher learning, research institutes and industry. In 2015, the EIPO launched its thirteenth grant call (RFP 13) under the EIRP. 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. These included 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 $\geq 40\%$) to reduce down time and enhance availability of power plants. Domain B: Improving the energy efficiency of bio-sludge treatment process (Target $\geq 20\%$)' (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 the work force for the solar energy sector. It has attracted world-renowned talent in the field 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 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 its electricity industry in 1995 to liberalise the market and promote competition. 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 sales of electricity, separate from the natural monopoly of electricity transmission at the ownership level. The Singapore Electricity Pool was established in 1998 as a day-ahead electricity market to facilitate 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. Establishment of the NEMS represented a progression from the Singapore Electricity Pool to fully competitive wholesale and retail electricity markets.

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 MITI 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, 2016d).

GAS

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). PowerGas Ltd 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 solely a gas transporter. Under the new gas industry framework, the transportation of natural gas became regulated.

The Gas Network Code ("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. GNC 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 gas shippers (i.e. industry players who engage the transporter to convey 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 are not allowed to transport gas.

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.

In 2006, Singapore decided to import LNG to further diversify its gas supplies. On 21 August 2006, Singapore introduced controls on import of new piped natural gas (PNG) supplies 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, all new gas demand must be met through LNG imports. 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, 2016e).

TRANSPORT

Singapore promotes the use of public transport as part of its efforts for fuel efficiency and energy conservation. Towards this end, the economy has initiated innovative policies to discourage car ownership and usage, such as a vehicle quota system and electronic road pricing. In 2001, the government introduced the Green Vehicle Rebate (GVR) program which offers rebates for the purchase of green vehicles such as hybrid, compressed natural gas and electric cars. In 2013, the GVR was replaced by a targeted Carbon Emissions-based Vehicle Scheme (CEVS) which offers rebates or imposes surcharges according to a vehicle's carbon emission.

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 the 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 upfront costs. In December 2014, the EDB and the LTA announced the next phase of the EV test-bed, which will focus on vehicle fleets such as EV car sharing and E-taxis (LTA, 2014). As part of this second phase of the EV test bed, HDT Singapore Taxi Pte. Ltd also launched a fleet of electric taxis in late 2016 (The Straits Times, 2016). Singapore will launch an electric vehicle (EV) car-sharing programme in collaboration with Bolloré Group by mid-2017. EVs will be deployed in every single Housing & Development Board (HDB) town by 2020, to allow as many residents as possible to enjoy car-sharing facilities (LTA, 2016).

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 went into effect in 2013.

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 energy efficiency. The economy 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). These energy efficiency efforts are targeted at various sectors, such as power generation, industry, transport, buildings and households.

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 CO₂ 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 this tax plan, which is a capital allowance on qualifying equipment costs that allow a deduction against chargeable income.
- Design for Efficiency Scheme (DfE): Introduced in 2008, this initiative 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 in 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 Awards.

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 and a green vehicle rebate to encourage more fuel-efficient vehicles and trials of green technologies such as diesel hybrid buses and electric vehicles.

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 have to pay a surcharge. Replacing the green vehicle rebate (GVR), the results of CEVS have 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 30 June 2017 before it is reviewed.
- **Fuel Economy Labelling Scheme (FELS):** As of 2009, passenger cars and light goods vehicles that are sold in Singapore must have a fuel economy label affixed. 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 is expected to double to 278 km. The objectives of the green mark for the RTS framework are to promote sustainable and environmentally friendly RTS designs 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. These vehicles 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:** 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: This plan allows people who have vehicles to park them 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.

BUILDINGS

Singapore has plans to improve the energy efficiency of the building sector. A main consideration is achieving a sustainable environment as a key factor towards 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 this plan 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: These 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 (for example, 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 (for example, Green Mark Platinum or Green Mark Gold^{PLUS}) 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 (E²PO, 2015a). The Building Control Act's Chapter 29 Part IIIB—Environmental Sustainability Measures for Existing Buildings 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 CO₂ emissions. Accounting for about one-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 have an energy label affixed. 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:** Established 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, 2016a). Due to such constraints, Singapore is pursuing growth opportunities in waste-to-energy and, to the extent possible, solar for power generation. The economy 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. These projects are detailed in the following sections.

Singapore's modern, electricity-generating incineration plants make use of renewable waste-to-energy technologies, annually consuming about 2.7 million tonnes of waste. This 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, 2016a).

Singapore has embarked on R&D and test-bedding initiatives to help companies and researchers advance the development of the required technologies for solar energy. 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. In that regard, 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 a total capacity of 33 MWp, comprised of 226 residential (2.3 MWp) and 410 non-residential (30.8 MWp) installations (EMA, 2016a). The HDB will install solar panels over 900 HDB blocks and eight government buildings by the end of 2017 through a tender (EMA, 2016f).

The HDB has been investing substantially in solar R&D. Under its USD 31 million Solar Capability Building Program, the government agency has been test-bedding different solar capabilities to build expertise on solar installations. It has also helped to promote data sharing with other government agencies and 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, 2016f). 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 (NCCS, 2014). 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, 2016g). This threshold covers power generation from renewables that vary for natural reasons (sunshine in the case of solar) and require fossil fuel-fired generators as a backup.

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, started its 800 000 tonnes per year renewable diesel refinery in Singapore at the cost of EUR 550 million¹. 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. This plan 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 the reduction of consumption, recycling, reuse of all materials, and the adoption of greener practices by businesses (MEWR, 2015). The objective is to turn Singapore into a 'hub for the cutting-edge business of sustainable development' and 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 CO₂ emissions account for less than 0.2% of global emissions. The economy has made major progress in reducing its CO₂ emissions, although its options

¹ Started the operation in Nov 2010 and opened in March 2011.

for non-CO₂ 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 0.4332 kg CO₂/kWh in 2013 to 0.4313 kg CO₂/kWh in 2014 (EMA, 2016a).

Singapore is also intensifying efforts to promote more efficient energy use to decrease its CO₂ 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, 2016h). The document's rationalisation 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 their 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 issue 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, 2016i). This was part of its plan to catalyse the 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 competitive Request-for-Proposal (RFP) process to appoint up to two importers to supply Singapore with LNG beyond the first 3 Mtpa from Shell (previously BG Singapore Gas Marketing Pte. Ltd.). The RFP was conducted in two stages and concluded in October 2016, with Pavilion

Gas and Shell Eastern Trading (Pte) Ltd being appointed as the next LNG importers for Singapore. Both companies were each awarded with an exclusive right to import and sell LNG in Singapore up to 1Mtpa each, or for a period of 3 years, whichever is earlier. (EMA, 2016j)

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, 2015c). 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 collaborated 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 commercialisation (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. In November 2015, EMA awarded two projects under Phase 2 for energy storage and real-time monitoring of the micro grid's performance. These two projects will tap on the existing micro-grid as 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).

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, 2015d). 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 Merlimau 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 of 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 owns two co-generation power plants in the Tembusu sector of Singapore's Jurong Island. The total power generating capacity is 1,215MW (Sembcorp, 2014).

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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Temasek Holdings—www.temasekholdings.com.sg

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 coast of Japan. With an area of 36 193 square kilometres (km²) (Executive Yuan, R.O.C., 2016), 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 perennial growth of fruit and vegetables.

In 2014, Chinese Taipei's gross domestic product (GDP) was USD 1 020 billion, and its per capita income was USD 43 536 (2010 USD purchasing power parity [PPP]). Its GDP grew on average at a rate of 3.8% from 2000–14. 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 64% of the GDP, followed by industry (35%) and agriculture (1.8%) in 2014 (BOE, 2016a). 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 0.3% in 2014 compared with 2013 (EGEDA, 2016).

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 2.4 million barrels of oil reserves (EIA, 2016). 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, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	36 193	Oil (million barrels)	2.4
Population (million)	23	Gas (billion cubic metres)	N/A
GDP (2010 USD billion PPP)	1 020	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	43 536	Uranium (kilotonnes of U)	–

Sources: a. EGEDA (2016); b. Executive Yuan R.O.C. (2015); c. EIA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

As mentioned earlier, Chinese Taipei relies heavily on overseas energy resources for its needs. In 2014, energy imports accounted for 98% of the total primary energy supply (TPES) in Chinese Taipei (BOE, 2016b), indicating a low energy self-sufficiency rate as well as a 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 108 280 kilotonnes of oil equivalent (ktoe) in 2013 to 110 854 ktoe in 2014, an increase of 2.4%. Regarding the composition of the TPES, fossil fuels continue to be the dominant fuel consisting of 88% of the total supply. By fuel type, oil contributes the largest share (39%), followed by coal (33%), natural gas (15%) and other fuels (12%) (EGEDA, 2016).

In 2014, Chinese Taipei imported 315 million barrels of crude oil, 6.5% higher than the 296 million barrels imported in 2013. The Middle East is the major supplier, accounting for 83% of total oil imports, followed by Angola (8.4%) (BOE, 2017). To prevent supply disruption, the Petroleum Administration Act 2001 requires Chinese Taipei's refiners to maintain stocks of more than 60 days of sale volumes.

With regard to coal, Australia and Indonesia are the major suppliers, respectively, accounting for 45% and 40.4% of total coal imports totalling 56 million tonnes in 2014. 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 2014. The total LNG import in 2014 was 13.2 million tonnes (Mt), 5.8% higher than the 12.5 Mt imported in 2013 (BOE, 2016a).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power Generation (GWh)	
Indigenous production	13 903	Industry sector	22 484	Total power generation	260 040
Net imports and others	101 416	Transport sector	11 911	Thermal	202 467
Total primary energy supply	110 854	Other sectors	12 073	Hydro	7 439
Coal	36 851	Non-energy	22 363	Nuclear	42 389
Oil	43 186	Total final energy consumption	68 830	Others	7 746
Gas	17 150	Coal	6 990		
Others	13 666	Oil	38 780		
		Gas	3 007		
		Electricity and others	20 053		

Source: EGEDA (2016).

In 2014, electricity generation in Chinese Taipei reached 259 957 gigawatt-hours (GWh). Of the total electricity production, the hydropower generated by the Taiwan Power Company (TPC) comprised 2.8%, thermal power 48% (25% coal, 2.5% oil and 21% LNG), nuclear power 16%, wind power 0.27%, cogeneration 16% and independent power producers (IPPs) 16%. In terms of the generating capacity, the TPC dominates Chinese Taipei's electric power sector with 65% and IPPs account for 18% 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, 2016a).

FINAL ENERGY CONSUMPTION

The final energy consumption in Chinese Taipei was 68 830 ktoe in 2014, 0.5% higher than in 2013. The industrial sector consumed 33% of the total energy used, followed by the transport sector (17%). The other sectors, including residential and services, consumed 18% of the total energy used. By energy source, petroleum products accounted for 56% of total final energy consumption, followed by electricity (29%), coal (10%) and gas (4.4%). In comparison with 2013, the energy consumption in 2014 was 0.5% higher (EGEDA, 2016).

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 1.5%, declining from 110 tonnes of oil equivalent per million USD (toe/million USD) in 2013 to 109 toe/million USD in 2014. The improvements also show in the final energy consumption intensity, a reduction of 3.3% from 70 toe/million USD in 2013 to 68 toe/million USD in 2014, which was mainly attributable to the industrial sector.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	110	109	-1.5
Total final energy consumption	70	68	-3.3
Total final energy consumption excl. non-energy	47	46	-3.6

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Bureau of Energy (BOE) was established in 2004 and is responsible for formulating and implementing Chinese Taipei's energy policy. There are two 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). Secondly, to cope with the worldwide energy challenges, in 2012 the BOE released the *Guideline on Energy Development*. Given that it is based on the Energy Administration Act, which safeguards 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 two fundamental energy policies mentioned above encompass the specific acts for each energy market and its management, including the Energy Administration Act, the Electricity Act, the Petroleum Administration Act, the Natural Gas Enterprise Act and the Renewable Energy Development Act. These acts aim to supervise energy enterprises, plan energy supply and demand, establish energy information systems, promote energy saving measures, and 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 that clearly set carbon-reduction targets, build monitoring and follow-up mechanisms to regularly review the effectiveness and performance of the action plans, and 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 (CO₂) 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.

Secondly, 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 new energy technologies. However, high costs and stability of supplies 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).

In addition to the two energy policies stated previously, the new government, which was elected in May 2016, introduced the New Energy Policy with five objectives (BOE 2016c):

- Establish low-carbon and sustainable, high quality, stable and economically efficient energy systems;
- Halt the fourth nuclear power plant, stop extending the first, second and third nuclear power plants, achieving zero nuclear homeland plants by 2025;
- Develop green energy, renewable energy generation of total power generation reaching 20% in 2025;
- Foster the construction of the third LNG terminal, enlarge natural gas use, reducing pollution and carbon emissions from current thermal power plants;
- Complete amendments of the Electricity Act, providing energy market structure and a regulation basis for energy transition.

ENERGY SECURITY

Since Chinese Taipei relies heavily on energy imports, the government has been striving to enhance an overseas security supply. To stabilise the oil supply, the Petroleum Administration Act requires refiners and importers to 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 lasting more than 25 days be maintained (BOE, 2016b).

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 2015, this cooperation extended to 25 fields spread over 8 economies.

Within Chinese Taipei, the CPC completed 2D seismic surveys over 75 km in Pingtung Plain, a precise gravity survey of the Fongshan mud structures and geological surveys of 66 km², and repaired three production wells in 2015. There are currently 35 oil and gas producing wells in southern and south-west Chinese Taipei, yielding 370 million cubic metres of natural gas and 9 500 kilolitres (kL) of condensate annually.

CPC’s future strategic deployment involves maintaining their efforts with international cooperation and M&A in exploration to boost autonomously controlled oil and gas reserves by acquiring mid-to-small oil and gas fields, especially those with low risk, and extending contracts with producing fields, as well as seeking opportunities for investment in overseas assets during times of low oil prices (CPC, 2016).

ENERGY MARKETS

ELECTRICITY MARKETS

The government of Chinese Taipei aims to secure a total electricity supply with a reserve capacity of 15% (BOE, 2016b) 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

2014, the TPC provided 65% of the total installed capacity, sourcing 18% from IPPs and 17% from cogeneration plants (BOE, 2016a).

In order to enhance the stability of the electricity supply, the TPC continues to improve its transmission and distribution systems. As of the end of 2014, Taipower had 603 transmission (sub) stations along 17 286 km of transmission lines and 356,428 km of distribution lines. In 2014 the average power interruption duration per customer was 17.496 minutes per year (down from 18.25 minutes per year), a good performance and a record for Taipower. The average power interruption frequency was 0.264 times per customer per year (better than the target of 0.29 times per year), which was the same as 2013 and better than 2012. On both parameters, performance exceeded the set targets, which was highly beneficial to the quality of power supply service. (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 (BOE, 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 industrial sectors, 17% for the transportation sector, 18% 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, 2016b; EGEDA, 2016).

The major activities and achievements of Chinese Taipei with regard to energy intensity reduction and attaining government targets included the following (BOE, 2016a).

- Successful completion of energy audits of major energy users and providing assistance in establishing internal energy auditing systems and reporting the results to the government: A total of 4 701 high-energy users (3 274 manufacturers and 1 427 non-manufacturers) were audited by the government in 2015. The audits showed that major energy users made energy savings of about 475 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 1 701 companies were visited in 2015, amounting to a potential energy savings of up to 535 mloe.
- Promotion of voluntary accreditation of high energy-efficient products and an energy labelling system since 2001: A total of 47 product categories were included in the energy labelling system, and 320 manufacturers and 7 473 brands gained accreditation by the end of 2015.
- 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, and humidifiers, fluorescent lamps, gas stoves and instantaneous gas water heaters. These accounted for 71% of the total household energy consumption in summer.

- Promotion of a series of demonstration projects pertaining to light-emitting diodes (LEDs) from 2008: By 2013, nearly 300 000 mercury vapour streetlights had been replaced by LEDs, saving an estimated 120 GWh of electricity. In 2014, the Executive Yuan planned to invest NTD 5.5 billion to foster all local governments to replace mercury vapour streetlights with LEDs by 2016. The estimated savings is 600 million kWh and 0.32 million tonnes of carbon dioxide per year.
- 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. There have been 131 institutions implementing ESCO projects between 2006 and 2015, saving an average of 25 mtoe per year.

RENEWABLE ENERGY

The three main renewable energy (RE) industries in Chinese Taipei are photovoltaic (PV) power, wind power and bioenergy. In 2016, total renewable energy generation was 12 692 GWh (about 4.8% of total electricity generation). Furthermore, in 2016, Chinese Taipei set a target of reaching a renewable energy generation of 20% of the total power generation by 2025. The government's major efforts to promote RE industries in 2015 included the solar, wind and bioenergy sub-sectors, as detailed below (BOE, 2016a; 2016c).

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 October 2016, the total installed capacity of solar PV reached 1 GW milestone. Bureau of Energy has proposed two targets, short-term target and long-term target. For short-term target, installed capacity of roof-top type and ground-top is expected to reach 910 MW and 610 MW respectively. For long-term target, it is expected to reach 6.5 GW and 20 GW in 2020 and 2025 respectively.

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 2016, Chinese Taipei has installed 682 MW of on-shore wind turbines and 8 MW of demonstration offshore wind turbines. The target for onshore wind turbines is to promote feasible plan in priority while excluding application barriers via administrative coordination. For offshore wind turbines development, Chinese Taipei will establish sustainable investment environment to help facilitate offshore development. The installed capacity target is to reach 1.32 GW in 2020 and 4.2 GW in 2025 respectively.

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 primarily uses waste cooking oil as its raw material (BOE, 2016b). 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.

NUCLEAR ENERGY

Currently there are four nuclear power plants in Chinese Taipei, of which three are operational and one is sealed off. In 2015, the total installed capacity of the three operational nuclear power plants was 5 144 MW with an output of 36 471 GWh accounting for 14% of the economy's total power generation mix, 3% lower than in 2013.

In 2011, the nuclear disaster at Fukushima led to public fears of nuclear safety in Chinese Taipei. The government at the time released an energy policy aimed at steadily reducing nuclear dependence by lowering electricity demand and peak loads, and by promoting alternative energy sources to ensure a stable power supply. In 2016, the newly elected government released “New Energy Policy,” reassuring a nuclear-free homeland in 2025. This policy prohibits life-span extensions for existing nuclear plants and outlines a decommissioning plan 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.

CLIMATE CHANGE

GREENHOUSE GAS EMISSIONS

Chinese Taipei produces CO₂ 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 consequently 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.

In order to promote carbon dioxide reduction, Chinese Taipei set up an Executive Yuan Energy Conservation and Carbon Reduction Service Team in 2009, which was renamed the Executive Yuan Green Energy and Low Carbon Committee in 2014. The committee acts as the highest authority with regard to the state energy conservation and carbon reduction projects. It is chaired by the Vice Premier of the Executive Yuan with members from each ministry. In May 2010, relevant ministries worked together to build the Master Plan on Energy Conservation and GHGs Emission Reduction, covering all aspects of energy and climate policies. In May 2014, the master plan was renamed the Green Energy and Low Carbon Master Plan, covering ten landmark programs (BOE, 2014a).

Chinese Taipei has followed the U.N. Framework Convention on Climate Change as well as its domestic Basic Environment Act and Greenhouse Gas Reduction and Management Act (referred to hereafter as the Greenhouse Gas Act) in proposing its Intended Nationally Determined Contribution (INDC) to cutting GHG emissions. This has demonstrated Chinese Taipei’s ambition to actively and steadily reduce its carbon emissions and use of nuclear energy (Executive Yuan, 2015).

The government’s INDC goal is for Chinese Taipei’s 2030 GHG emissions to be 50% lower than they would be if it conducted business as usual and 20% lower than its 2005 total. This should pave the way for meeting the ultimate target stipulated by the Greenhouse Gas Act: reducing annual GHG emissions to less than half of the 2005 levels by 2050 (Executive Yuan, 2015).

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 global competition, 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 DEVELOPMENTS

ELECTRICITY ACT AMENDMENT

BACKGROUND

To become a nuclear-free economy and achieve the goals stipulated in Greenhouse Gas Reduction and Management Act by reducing greenhouse gas emissions to 50% below 2005 levels by 2050, the Ministry of Economic Affairs formulated a two-stage plan to amend the Electricity Act.

First-stage amendments promote liberalization of the green energy market and open access to the power transmission and distribution grids. Second-stage amendments will follow after first-stage operational schemes and mechanisms have matured. It is expected to gradually complete power industry liberalization with step-by-step power industry reform and transformation of energy model, while promoting the renewable energy development in Chinese Taipei (Executive Yuan, R.O.C, 2017).

KEY AMENDMENTS

- As a matter of principle, the power generation market shall give precedence to the adoption of green energy sources. The first step is to allow sales of green energy to users via wheeling, direct supply, and renewable energy sales firms.
- The power transmission and distribution industry will be a state-run operation that ensures fair, public access. The electricity sales mechanism will give users freedom of choice, and allow them to purchase power from public power sales, renewable energy generation, and renewable energy sales enterprises.
- The competent authority of the central government will designate a regulatory agency to manage and supervise the market for electrical power, stipulating that electricity rates charged by public power sales enterprises be subject to regulatory controls, and establish an energy price stabilization fund to minimize price volatility.
- To maintain the enterprise integrity of Taiwan Power Company (Taipower) and provide a stable supply of electrical power, after the company is divided into two major functional lines, Taipower may become a parent holding company and set up two separate enterprises under its corporate jurisdiction, one for power generation, and one for power transmission and distribution.

GOALS OF ELECTRICITY ACT AMENDMENT

- **Diversifying supply**
After the amendments to the Act are passed, communities, water conservancy associations, agricultural groups, county and municipal governments, and renewable energy vendors will be allowed to jointly establish renewable energy enterprises, creating a localized, decentralized, community-based electricity industry. As the first-stage amendments have been passed, all public power sales enterprises are subject to carbon emission controls. So in addition to initiating investments in renewable energy, Taipower may also cooperate with renewable energy firms and form partnerships. Going forward, this transformation of Taipower and the energy industry as a whole will give Taiwan a far more diversified energy supply.

- Fair use
The electric power transmission and distribution industries will still be state-run. Power dispatching will be conducted based on principles prescribed by the regulatory authority to ensure that the electric grid is operated on a fair use basis for all power enterprises, and the relevant fees, including wheeling and dispatching fees, will be collected based on approved rate schedules.
- Freedom of choice
All users of electric power will have the right to choose their power provider, selecting from public power sales, renewable energy generation, and renewable energy sales enterprises. After second-stage amendments to the Act are passed, in addition to Taipower, users will be permitted to purchase electrical power from private-sector power plants.

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USEFUL LINKS

Bureau of Energy, Ministry of Economic Affairs—www.moeaboe.gov.tw

Chinese Petroleum Corporation—www.cpc.com.tw

Directorate General of Budget, Accounting and Statistics, Executive Yuan—www.dgbas.gov.tw

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 is 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 has an area of 513 120 square kilometres (km²) and a population of about 67.7 million in 2014. Its GDP that year reached USD 994 billion (2010 USD purchasing power parity [PPP]), a 0.8% increase from USD 986 billion in 2013. In the same period, the GDP per capita increased 0.4%, from USD 14 613 (2010 USD PPP) to USD 14 673 (2010 USD PPP). The largest contributors to its GDP were services (53%) and industries (37%) (UN, 2016).

Thailand has limited energy resources. At the end of 2013, Thailand had proven reserves of 405 million barrels of oil, 220 billion cubic metres of natural gas, and 1 239 million tonnes of coal. Based on its production rate in 2014, it will deplete its domestic supply very soon—oil resources within three years and natural gas in six years (BP, 2016). Most coal in Thailand is lignite, which is a low ranking coal with high emissions. Notwithstanding its resources, Thailand is highly dependent on energy imports, particularly oil, with about 82% of its oil and 22% of its gas supply coming from imported stock in 2013 (DEDE, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	513 120	Oil (million barrels)	405
Population (million)	68	Gas (billion cubic metres)	220
GDP (2010 USD billion PPP)	994	Coal (million tonnes)	1 239
GDP (2010 USD PPP per capita)	14 673	Uranium (kilotonnes U)	–

Sources: a. UN (2016); b. EGEDA (2016); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Thailand’s total primary energy supply in 2014 was 133 727 kilotonnes of oil equivalent (ktoe), which represented a decrease of 0.7% from 2013. Oil accounted for 38% of the total primary supply, while gas, coal and others accounted for roughly 31%, 10% and 21%, respectively. As most of Thailand’s proven coal reserves are lignite coal with lower calorific values, imported stock is needed to meet the energy demand for both the power and industry sectors. In 2014, coal supply was 13 039 ktoe, down 15% from the previous year.

Natural gas supply in 2014 was 41 800 ktoe, a 13% decrease from 48 002 ktoe in 2013. 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 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 2014, total electricity generation was 175 428 gigawatt-hours (GWh). Thermal generation, mostly from natural gas and coal, accounted for nearly all of its power generation (92%), 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, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	80 813	Industry sector	20 998	Total power generation	175 428
Net imports and others	58 755	Transport sector	22 859	Thermal	161 827
Total primary energy supply	133 727	Other sectors	27 100	Hydro	5 323
Coal	13 039	Non-energy	11 416	Nuclear	0
Oil	51 140	Total final energy consumption	82 373	Others	8 278
Gas	41 800	Coal	4 629		
Others	27 747	Oil	34 410		
		Gas	8 212		
		Electricity and others	35 121		

Source: EGEDA (2016).

NATURAL GAS

Thailand's proven 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 proven 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 4 073 million standard cubic feet per day (MMscfd), accounting for 80% of Thailand's gas. The remaining 20%, 843 MMscfd was imported from Myanmar and 182 MMscfd was imported in the form of LNG 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 proven reserves of oil and condensate reserves stood at 387 million barrels (Mbbbl), of which 326.5 Mbbbl came from the gulf and 60 Mbbbl from onshore. The total proven reserves fell by 53.9 Mbbbl (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 proven 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 comes 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 import has increased continuously because domestic lignite concessions have begun to expire and coal is inexpensive compared with other energy prices (EPPO, 2015a).

ELECTRICITY

EGAT has maintained its position as the sole power producer in Thailand for some time until 1994 when the government promoted the private sector's role in power generation in order to encourage competitiveness in the power generation business. Since then, a number of independent power producers (IPP) and small power producers (SPP) have taken part in the power supply industry, creating an improvement in power generation and service quality. Moreover, the use of renewable energy in power

generation has recently been promoted, resulting in a growing number of very small power producers (VSPP) using renewable energy as the main fuel to supply power to the grid. Thus, in the last decade, Thailand's overall electricity capacity has gradually 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, the economy'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 2014 was 82 373 ktoe, an increase of 11% from the previous year. The transport sector was the largest energy-consuming sector, accounting for 22 859 ktoe, or 28% of total final energy consumption. The second largest energy consumer was the industrial sector, which consumed 20 998 ktoe in 2014, a decrease of 18% from 2013. Beside the energy-consuming sectors, non-energy products, which are mostly used in the industry sectors, such as feedstock, account for 14% of the total final energy consumption, or 11 416 ktoe. By fuel type, electricity and others accounted for 43% (35 121 ktoe) of total energy consumption in 2014, followed by oil (42%), gas (10%) and coal (6%).

Natural gas consumption increased by 3.6%, from 7 928 ktoe in 2013 to 8 212 ktoe in 2014. In contrast, oil consumption decreased significantly by 34%, from 51 960 ktoe in 2013 to 34 410 ktoe in 2014. Coal consumption also decreased significantly by 17%, from 5 563 ktoe in 2013 to 4 629 ktoe in 2014. Domestic electricity and other energy consumption in 2014 increased by 30% from 26 925 ktoe in 2013 to 35 121 ktoe in 2014. The shrink in consumption in 2014 was mainly due to decreased consumption in the industry sector and non-energy products.

ENERGY INTENSITY ANALYSIS

Thailand's energy intensity (energy consumption/GDP) of its primary energy in 2014 was 135 tonnes of oil equivalent per million USD (toe/million USD), which decreased by 1.5% from 137 toe/million USD in 2013. The energy intensity of final energy consumption decreased 12%, from 94 toe/million USD in 2013 to 83 toe/million USD in 2014. The energy intensity of the industry and transport sectors decreased by 18% and 0.3%, respectively, while the energy intensity of the others sector, which mainly includes the commercial and residential sections, increased significantly by 27%. The energy intensity of the non-energy products sector decreased significantly by 50%. When excluding non-energy products, the energy intensity of the final energy consumption increased 0.9% from the previous year.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	137	135	-1.5
Total final energy consumption	94	83	-12
Total final energy consumption excl. non-energy	70.8	71.4	0.9

Source: EGEDA (2016).

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 supply 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;

- supporting energy research and development domestically and internationally while simultaneously protecting the environment and mitigating climate change; and
- structuring the energy database centre to systematically consolidate and standardise Thailand's energy related information.

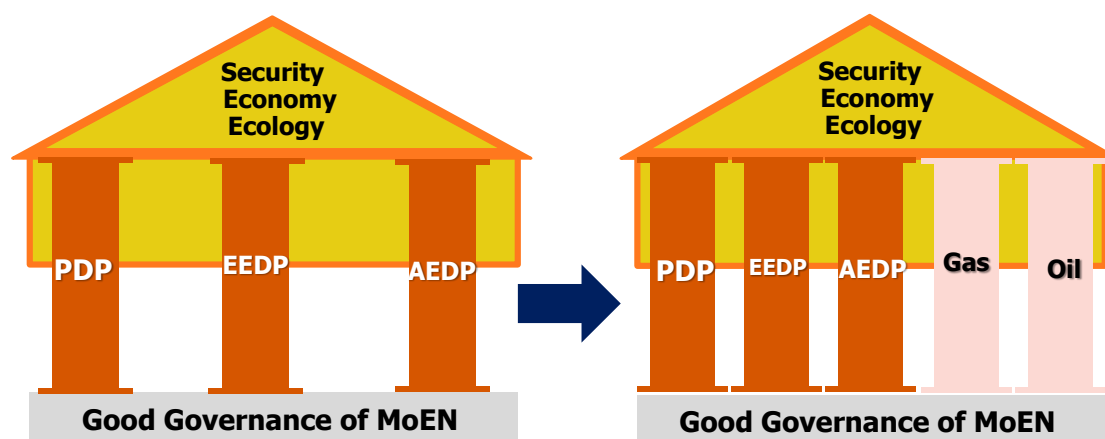
The Ministry of Energy is the main government institution responsible for energy policy in Thailand. Under the Ministry, there are six departments and four state enterprises, which are listed below.

- 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 (DOEB)—regulates energy quality and safety standards, environment and security, and improves the standards to protect consumers' interests;
- Department of Mineral Fuels (DMF)—facilitates energy resource exploration and development;
- Energy Policy and Planning Office (EPPPO)—recommends economy-wide energy policies and planning;
- Electricity Generating Authority of Thailand (EGAT)—the state power generating enterprise;
- PTT Public Company Limited (PTT) and the Bangchak Petroleum Public Company Limited (BCP)—two autonomous public companies;
- The Energy Fund Administration Institute (EFAI)—a public organisation; and
- Energy Regulatory Commission (ERC) and the Nuclear Energy Study and Coordination Office (NESC) —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 will be reformed to reflect actual costs and taxes for different types of fuels and different groups of consumers. This reformation 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 offshore. 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) (EPPPO, 2015b) based on the three principles of economy, ecology and security. The blueprint consists of five long-term plans including the Power Development Plan (PDP2015) (EPPPO, 2015c), the Energy Efficiency Development Plan (EEDP2015) (EPPPO, 2015d), the Renewable and Alternative Energy Development Plan (AEDP2015), the Gas Plan 2015 and the Oil Plan 2015. All the proposals have been updated and synchronised to cover the same time period of 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 towards 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 to be less natural gas dependent, less electricity import dependent and setting reserve margins at a minimum of 15%. The PDP2015 has already included energy savings from the EEDP2015, which identifies 89 672 GWh of electricity savings. The largest share of savings is expected to be delivered through a variety of compulsory measures such as building energy codes, factory and service 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, PTT 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) and the first stock of imported LNG was delivered to Thailand in January 2015. In addition, PTT has been in negotiation to acquire 1 million tonnes of LNG per year from Shell Eastern Trading (PTE) Ltd. and another 1 million tonnes of LNG per year from BP Singapore PTE. Limited. 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 INVESTMENTS

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 a transparent and justifiable 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 monitoring 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 be reasonable in comparison to those in neighbouring economies. The government is supervising the pricing policies and price structures of oil, LPG and NGV 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 Thailand Board of Investment, 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 exploration and production.

ENERGY EFFICIENCY

The first long-term energy policy on energy efficiency, namely the EEDP, was launched in 2011 with a target of reducing energy intensity (EI) by 25% in 2030 from 2010 levels, or equivalent to a reduction in final energy consumption of 20% by 2030 (38 200 ktoe). 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 5 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 ten-year R&D master plan for energy efficiency to guide R&D directions in line with the EEAP and EEDP framework.

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 7 641 ktoe of electricity (or 89 672 GWh) and 44 059 ktoe of heating in addition to what has already been achieved through 2013 at 4 442 ktoe. It also equates to a 30% reduction in BAU energy consumption in 2036 (EPPO, 2015d).

The EEDP2015 set the targets of energy reduction for four major economic sectors: 1. industry 2. commercial and governmental buildings 3. residential and 4. transportation in three strategic areas with ten specific measures. The approaches and measures are as follows:

COMPULSORY PROGRAM

- Enforce the Energy Conservation Promotion Act B.E. 2550 (2007), which would put in effect an energy management system based on energy consumption reporting and verification imposed on 7 870 designated buildings and 11 335 factories with the transformer sizes of 1 000 kW (1 175 kVA) and up;
- Impose mandatory energy efficiency evaluations for the newly-built and renovating buildings such as building energy codes (BEC), leadership in energy and environmental design (LEED) and Thailand's rating of energy and environmental sustainability (TREES);
- Enforce high efficiency performance standards (HEPS) and minimum efficiency performance standards (MEPS) for equipment/appliance labelling to provide options for consumers to buy or use highly energy-efficient equipment/appliances;
- Implement energy efficiency resource standards (EERS) or minimum standards for large energy businesses, including power producers and distributors, to implement energy conservation measures, encouraging their customers to use energy efficiently, which would be an important mechanism for providing both technical and financial assistance to small and medium enterprises (SMEs).

VOLUNTARY PROGRAM

- Support the operation of ESCO companies using financial tools such as EE revolving fund, tax incentives, soft loan and grants to alleviate the technical and financial risks of entrepreneurs wishing to implement energy conservation measures;
- Promote the wider use of LEDs for street lights and households through public relations campaigns and price mechanisms;
- Promote energy conservation programs in the transportation sector by setting up effective pricing structure, economising automobile engines, increasing efficient infrastructure and logistics systems, and launching electric vehicle fleets to replace inefficient older generation cars;
- Promote research and development (R&D) that improves energy efficiency and reduces technological costs for equipment/appliances, production processes and materials;

COMPLEMENTARY PROGRAM

- Support the development of professionals in energy conservation fields so that they will have the ability to be responsible for energy management and operations, verification and monitoring, consultancy, engineering services; as well as for the planning, supervision and promotion of the implementation of energy conservation measures;
- Introduce measures that will have a wider impact in terms of fostering public awareness and changing energy consumption behaviour related to the energy consumption of consumers.

The breakdown of this target is shown in Table 4.

Table 4: The EEDP's Targets by 2036

Energy Efficiency Measures	Saving Targets in 2036, ktoe
Compulsory Program	10 972
1. Enforcement of Energy Conservation Promotion Act B.E. 2550 (2007).	5 156
2. Energy efficiency evaluations for buildings (BEC, LEED, and TREES).	1 166
3. Enforcement of HEPS and MEPS for equipment/appliances.	4 150
4. Implementation of EERS for energy businesses.	500
Voluntary Program	40 728
5. Support of ESCO companies using financial tools.	9 524
6. Promote the wider use of LED for street lights and households.	991
7. Promote energy conservation programs in transportation sector.	30 213
8. Promote R&D to improve energy efficiency and technological costs.	-
Complementary Program	-
9. Support the development of professionals in the energy conservation field.	-
10. Introduce measures that foster public awareness.	-
Total Program	51 700

Source: DEDE (2015).

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 that 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 investments, such as the Fund for Energy Services Companies, which acts as a special-purpose vehicle for renewable energy development projects; additional investment grants are available from the Energy Conservation Fund. Some of the previously successful self-working measures, such as the revolving fund, which 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 a renewable energy share of 30% of the total final energy consumption by 2036. This target is equal to 39 388 ktoe, which can be divided into power generation of 19 684 MW (5 588 ktoe), heating of 25 088 ktoe and biofuels of 8 712 ktoe. The breakdown of this target is shown in Table 5.

Table 5: 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	2 906	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 (for example, geothermal, pyrolysis gas, etc.)	10	ktoe
Biofuels	8 712	ktoe
1. Biodiesel	14	million litre/day
2. Ethanol	11.3	million litre/day
3. Pyrolysis-Oil	0.5	million litre/day
4. Compressed biogas (CBG)	4 800	tonne/day
5. Others (for example, bio oil, hydrogen, etc.)	10	ktoe
Renewable Energy Consumption	39 388	ktoe

Sources: AEDP2015, DEDE (2015b).

NUCLEAR ENERGY

Nuclear power is recognised as an alternative energy resource that provides low emissions and inexpensive 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 revised 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 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 the total generation capacity. The 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 an important issue 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 achieves climate-resilience 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 a significant milestone in accordance with the government's policy to ensure domestic energy security. It has established a comprehensive energy plan, namely the TIEB, based on 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 environmental working group (EWG) members in December 2015. There are 48 recommendations to Thailand on energy efficiency in transportation, covering the following six key issues: 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.

THAILAND'S ENERGY 4.0

In addition to TIEB, the Ministry of Energy has launched an Energy 4.0 policy to promote the high-value energy innovations to support TIEB. The objective was set to transform the economic structure to have diverse energy sources for electricity generation, energy conservation in the industrial and business sectors and alternative energies with the applications focused on the development of electric vehicles, energy storage systems, smart cities and small power plant hybrid.

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USEFUL LINKS

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- Department of Mineral Fuels (DMF)—www.dmf.go.th
- Electricity Generating Authority of Thailand (EGAT)—www.egat.co.th
- Energy Policy and Planning Office (EPPA)—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 second largest economy with a GDP of USD 16 trillion (2010 USD purchasing power parity [PPP]) in 2014 (EGEDA, 2016). The US spans 9.9 million square kilometres (km²) and has a population of 318 million people. The economy's population growth rate has declined from a recent high of 1.2% in 1997 to 0.8% in 2014 (EGEDA, 2016).

The US enjoyed economic expansion from 1990 to 2000, recording growth of 3.4% in real terms, which then slowed to 1.7% from 2000–14. In 2014, economic growth increased, from 1.5% to 2.4%, compared with 2013 (EGEDA, 2016).

The US is the second-largest producer and consumer of energy in APEC. It is rich in energy resources. In 2014, the US had 55 billion barrels of proved oil reserves, 10.4 trillion cubic metres (tcm) of natural gas reserves and 237 billion tonnes of coal reserves (BP, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	9.9	Oil (billion barrels)	55
Population (million)	319	Gas (trillion cubic metres)	10
GDP (2010 USD billion PPP)	16 157	Coal (billion tonnes)	237
GDP (2010 USD PPP per capita)	50 662	Uranium (kilotonnes U)	138

Sources: a. Census (2010); b. EGEDA (2016); c. BP (2016); d. NEA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in the US in 2014 was 2 215 million tonnes of oil equivalent (Mtoe). In terms of fuel type, 35% of the supply came from crude oil and petroleum products, 28% from natural gas, 19% from coal and the rest from other sources such as nuclear energy, hydropower and geothermal energy. Only 12% of the economy's primary energy requirements in 2014 were from net imports. The share of net energy imports declined from a peak of 33% in 2005 (EGEDA, 2016).

The economy's total primary energy supply in 2013 increased by 1.4% compared with the 2013 level of 2 184 Mtoe. The increase resulted mainly from a 3% increase in gas supply, a 2% increase in other sources and an increase in the supply of oil of 1%. Likewise, a substantial reduction in the net imports, 17% from the previous year, was recorded in 2014. The United States has shown constant reduction in import dependency since 2005, recording an average annual decline of 11% over the last nine years (EGEDA, 2016), as crude oil production increased in North Dakota and onshore Texas, mainly from shale and other tight (having very low permeability) formations (EIA, 2016k). In 2014, the US was the world's largest crude oil, natural gas liquids and condensates producer, ahead of Saudi Arabia and the Russian Federation. Production averaged 11.7 million barrels per day (bbl/d), a 17% increase from the previous year (BP, 2016).

The US primary natural gas supply totalled 624 Mtoe in 2014. While the economy's natural gas supply has grown modestly from 1990 to 2014 with an annual growth rate of 1.5%, the primary natural gas supply (including net imports in 2014) grew by 2.9% from the 2013 level (EGEDA, 2016). In recent years, 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 (EIA, 2016c).

Table 2: Energy supply and consumption, 2014

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 013 158	Industry sector	268 663	Total power generation	4 339 210
Net imports and others	256 203	Transport sector	622 091	Thermal	2 913 787
Total primary energy supply	2 215 156	Other sectors	565 463	Hydro	281 527
Coal	431 685	Non-energy	81 028	Nuclear	830 584
Oil	780 272	Total final energy consumption	1 536 874	Others	313 312
Gas	624 001	Coal	21 835		
Others	379 199	Oil	778 750		
		Gas	355 206		
		Electricity and others	381 083		

Source: EGEDA (2016).

The US held about 5.6% of the world's natural gas reserves in 2014 (BP, 2016). As of 2014, the economy's natural gas pipeline transmission network was more than 485 000 kilometres (km) long (PHMSA, 2016). In 2014, approved major pipeline projects amounted to 686 km and 0.3 billion cubic metres (bcm) per day (FERC, 2016a). In 2014 the 400 active underground storage fields in the United States had a working gas capacity of 134 bcm. On 7 November 2014, gas in storage peaked at 102 bcm; the 2016 peak was on November 11 at a record 115 bcm (EIA, 2016a, 2016b).

Since the mid-2000s horizontal drilling combined with hydraulic fracturing spurred the economic production of unconventional gas, largely from shale formations. Shale gas production in the US has increased rapidly, from about 8% of gross withdrawals in 2007 to 44% in 2014 (EIA, 2016d, 2016e). Proved unconventional gas reserves, including shale gas and coalbed methane, are estimated to be 5.3 tcm or more than half of the total reserves as of year-end 2014 (EIA, 2016f), and thus, further increases in shale gas production are anticipated.

Abundant supplies and relatively low prices have led to several liquefied natural gas (LNG) export projects. On 24 February 2016, the first shipment of LNG produced in the lower 48 States left Sabine Pass, Louisiana (EIA, 2016g). By about 2020, 72 million tonnes per year of exporting capacity are expected to be added if all the export terminals currently under construction are completed (FERC, 2016c). The newly expanded Panama Canal will considerably reduce voyage times for LNG from the US Gulf Coast to markets in northeast Asia (EIA, 2016h).

The primary energy supply of coal in the United States totalled 432 Mtoe in 2014. In 2014, the primary coal supply was virtually unchanged from the previous year (EGEDA, 2016). US coal reserves are concentrated east of the Mississippi River in Appalachia and in several key western states (EIA, 2015).

In 2014, the United States was the fourth-largest coal exporter in the world, behind Indonesia, Australia and Russia. In 2014, coal exports amounted to 97 million short tons, a 17.3% reduction from 2013. Coal imports have declined from a peak of 36.3 million short tons in 2007 to 11.4 million short tons in 2014 (EIA, 2016i). More than 60% of exported coal is metallurgical, with the rest being steam coal. Europe is the largest importer of coal from the US, accounting for more than 45% of net exports (EIA, 2016j).

In 2014, the US produced 4.3 million gigawatt-hours of electricity, 67% of which came from fossil fuel plants, 19% from nuclear power and 14% from renewable energy and other sources (EGEDA, 2016).

The US generates more nuclear power than any other economy (EIA, 2016i). In 2014, the average utilisation rate of the economy's 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, 2016l). On October 19, 2016, Watts Bar Unit 2, the first new US nuclear generating unit in 20 years, entered commercial operation in Tennessee (TVA, 2016).

A few days later, on October 24, the economy's smallest commercial reactor, Fort Calhoun in Nebraska, shut down permanently (NRC, 2016c). Currently, four commercial nuclear reactors are under construction (EIA, 2016m). Many nuclear plants have applied to the Nuclear Regulatory Commission (NRC) for 20-year extensions of their operating licences, enabling them to operate for 60 years. In late 2016, the NRC had approved licence extensions for 83 operating nuclear reactor units and had applications for another 9 extensions under review, while another 5 units had informed the Agency of their intention to seek extensions between 2017 and 2022 (NRC, 2016a).

Total renewable energy production in the US in 2014 was approximately 242 Mtoe or 10% of the total primary energy supply. Production from non-hydro sources increased 6.6% from the previous year, recording an average annual growth rate of 8.2% since 2005. By consumption of renewable energy type in 2014, biomass, as a whole, represented 50% of the total; hydroelectric power, 26%; geothermal energy, 2%; wind, 18% and solar photovoltaic, 4%. There has been a particularly rapid expansion of wind power; between 2000 and 2014, wind power recorded an average annual growth rate of 28.1% (EIA, 2016l).

FINAL ENERGY CONSUMPTION

In 2014, the total final energy consumption in the US was 1 537 Mtoe, an increase of 1.8% from the previous year. The transport and other sectors accounted for 40% and 37%, respectively, of the total demand with the remaining share consumed by the industrial sector (17%) and non-energy sector (5.3%). In terms of fuel, petroleum accounted for 51% of the final consumption, while electricity and natural gas accounted for 25% and 23%, respectively. Coal contributed a modest 1.4% (EGEDA, 2016).

ENERGY INTENSITY ANALYSIS

US energy intensity improved in 2014. (Energy intensity is the amount of energy an economy uses or consumes for every dollar of GDP it produces.) Primary supply intensity in 2014 improved by 10% from the previous year's value of 139 tonnes of oil equivalent per million USD (toe/million USD). Final energy consumption improved by 0.6% compared with the previous year's energy consumption level. Final energy consumption intensity excluding non-energy improved by 0.4% (Table 3).

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	139	137	-1.0
Total final energy consumption	96	95	-0.6
Total final energy consumption excl. non-energy	90.4	90.1	-0.4

Source: EGEDA (2016).

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 mainly under the auspices of the Department of Energy (DOE). The Federal Energy Regulatory Commission (FERC) oversees the interstate transmission of energy, and the Environmental Protection Agency (EPA) regulates the environmental impact of energy transformations throughout the economy. The Department of Transportation (DOT) also plays an important role as the regulator of vehicle fuel economy.

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 set the rules for energy markets. Since the 1970s, several major legislative packages have defined the economy's energy policies.

The Energy Policy Act of 2005 (EPAct) was the first major piece of energy legislation passed since the Energy Policy Act of 1992 (GPO, 2005; US House, 1992). This was followed shortly thereafter by the Energy Independence and Security Act of 2007 (EISA), the last piece of comprehensive energy legislation passed by the US Congress (GPO, 2007). The American Recovery and Reinvestment Act of 2009 (ARRA) also dramatically increased funding for many federal energy programs (DOE, 2012). Key elements of these recent acts are described below.

ENERGY SECURITY

Among the APEC economies, the United States has the lowest exposure to oil supply disruptions, according to a recent composite index (APEREC, 2015). Oil import dependence, measured as net imports as a percentage of product supplied, peaked at 60.3% in 2005. By 2015, US import dependence had fallen to 25.2% by the same measure (EIA, 2016l).

Nevertheless, the United States is a member of the International Energy Agency (IEA) and in 1975 established a strategic oil stockpile, called the Strategic Petroleum Reserve (SPR). The SPR consists of 60 storage caverns in underground salt dome formations located at four sites in Texas and the Louisiana Gulf Coast and is the largest government-owned stockpile in the world (DOE, 2016b). Some 695 million barrels of crude oil are currently contained in the SPR, the equivalent of 148 days of net imports, based on the average 2015 levels (EIA, 2016l).

With the oil in the SPR exceeding the IEA's 90-day coverage requirement, in December 2015 Congress passed the Bipartisan Budget Act of 2015 and the Fixing America's Surface Transportation (FAST) Act. In December 2016 Congress passed the 21st Century Cures Act authorising further sales. These laws mandated the sale of an estimated 190 million barrels of crude oil between 2017 and 2026 and approved the funding of an SPR modernisation program through the sale of up to an additional \$2 billion worth of oil (DOE, 2016b; EIA, 2016n).

In addition to the SPR, in 2000 DOE established a 2 million barrel Northeast Home Heating Oil Reserve and in 2014 a 1 million barrel Northeast Gasoline Supply Reserve. These would provide consumers with supplemental sources of home heating oil and gasoline in the event of supply shortages (DOE, 2016b). The US Government does not hold strategic reserves of natural gas.

In December 2015 growing US crude oil production also prompted Congress to pass the Consolidated Appropriations act of 2016 lifting a 40-year-old ban on the export of crude oil (BIS, 2016).

FISCAL REGIME AND INVESTMENT

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 9.6 billion in royalty and other payments in Fiscal Year 2015 (ONRR, 2016). 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 approximately 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.

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. Although 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 17 laboratories as well as the research conducted at 300 universities across the US. Currently supported research ranges from particle physics to pilot projects for carbon capture and sequestration (CCS) (DOE, 2016f). Total government spending for energy-related R&D peaked in FY09 at USD 3.79 billion with the passage of the ARRA, a one-time economic stimulus. After FY09, US federal funding for energy R&D slid to USD 2.29 billion in FY 13 before increasing to USD 3.17 billion in FY 15 and an estimated USD 3.46 billion in FY 2016 (NSF, 2016a). State governments spent an additional USD 312 million on energy R&D in FY15 (NSF, 2016b). 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 energy R&D (AEIC, 2015).

ENERGY MARKETS

In 2013, American consumers spent an estimated USD 1.4 trillion on energy purchases (EIA, 2016l). 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 the Interior's (DOI) Bureau of Land Management (BLM) administers more than 2.8 million km² of onshore underground mineral estates, of which about 130 000 km² is currently leased for oil and gas development (BLM, 2017). The Bureau of Ocean Energy Management (BOEM), another office of the DOI, leases another 70 000 km² of offshore oil and gas resources (BOEM, 2017). The BLM and BOEM also lease more limited onshore 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, 2012). State and federal governments share regulation of upstream development. State oil and gas commissions prevent the waste of resources and protect public safety in state territories (IOGCC, 2004). In the federal offshore territory, the offices of the DOI exercise similar responsibilities.

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 (GPO, 2005).

The EPA regulates waste from crude oil and natural gas exploration and production under the Resource Conservation and Recovery Act (RCRA), and many states also regulate these wastes (EPA, 2016c). In particular, concerns about the impact of hydraulic fracturing on drinking water led EPA to conduct an extensive study over the past few years. In December 2016, EPA concluded that hydraulic fracturing can affect drinking water under some circumstances (EPA, 2016d). Despite EPAct, BLM has proposed to regulate

hydraulic fracturing on federal lands. The rule was struck down by the US District Court in Wyoming in June 2016, but is being appealed to the Tenth Circuit Court of Appeals in Denver (BLM, 2016).

NUCLEAR ENERGY

The US Government supports the nuclear industry through various means, including legislative and financial measures. 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. It also introduced loans to cover costs incurred by legal or regulatory project delays (GPO, 2005). In February 2014, 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, 2016d).

DOE is responsible for the development and promotion of nuclear energy, while the NRC is 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 (NRC, 2016b). However, a suitable site remains to be found. The partially completed waste depository project in Yucca Mountain, Nevada was abandoned in 2010, and since then, there has been no viable permanent storage option for nuclear waste (NRC, 2015).

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 United States. One of the subsequent major activities was the NRC's comprehensive review of its processes and regulations, leading to the release of a report by its Near-Term Task Force, 'Recommendations for Enhancing Reactor Safety in the 21st Century'. This report consisted of 12 recommendations covering short- and long-term actions, followed by an additional three NRC orders in March 2012. The orders 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, 2014).

- 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.

RENEWABLE ENERGY

In June 2016 the United States, Canada and Mexico set a goal of generating half their electricity with clean power by 2025 (Obama WH, 2016a). With 14% of electricity generated by renewables and 19% generated by nuclear in 2014, this would require a doubling of renewables by 2025, assuming little growth in nuclear (EGEDA, 2016). Incentives to promote renewables have been established at the federal, state and local levels for utilities and homeowners. At the utility level, the federal renewable electricity PTC is an inflation-adjusted per-kilowatt-hour (kWh) tax credit for electricity generated by geothermal, wind, biomass, hydroelectric, municipal solid waste, landfill gas, tidal, wave, and ocean thermal systems. Wind PTCs extend through 2019, while the others end in 2016. Utilities may elect an ITC in lieu of the PTC. A related individual tax credit is available for residential solar electric system expenditures without cap through 2021, as are similar tax credits for small residential wind and geothermal systems through 2016. Several federal loan and loan guarantee programs also exist to encourage the development of renewable energy and other advanced energy facilities (DSIRE, 2016). The DOE Loan Program Office manages a portfolio of about USD 13.5 billion of loan guarantees covering more than 20 renewable projects (DOE, 2016d).

Many state and local governments have established financial measures that complement federal incentives for renewable investment. In addition to subsidies, state legislation has also provided significant indirect incentives for renewable 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. Twenty-nine states had enacted the RPS legislation with varying degrees of stringency by early 2016. Hawaii has the most ambitious goal: 100% renewables generation by 2045 (LBNL, 2016). Other measures have also been introduced to support renewable development, such as net metering, generation disclosure rules, mandatory utility green power options, green power purchasing policies and the use of public benefit funds (DSIRE, 2016).

Biofuels have received strong policy support in the transportation sector. In 2007 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. This included the increase in advanced biofuels usage (other than that derived from corn) to 79 billion litres (21 billion gallons) by 2022 (CRS, 2007). Since this law was passed, US 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 US gasoline contains 10% ethanol. EPA mandated that more than 19 billion gallons of biofuels overall be blended into the fuel supply for 2017, still short of the 24 billion gallons envisioned by Congress in 2007 (EPA, 2016e).

ELECTRICITY AND GAS

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 use 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. Sixty-four per cent of retail customers are served by regulated, investor-owned utilities, 14% by public power systems and 13% by cooperatives (EIA, 2016o). State regulators ensure that these providers serve their customers at rates that are 'fair, reasonable and non-discriminatory' (NARUC, 2017). 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 2015, 21 states allowed some customers a choice of electricity service provider, while 8% of electricity customers are served by energy-only providers (EIA, 2016o).

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 sets natural gas pipeline rates. DOE regulates the import and export of natural gas. The DOT's Pipeline and Hazardous Materials Safety Administration regulates gas transmission pipelines to ensure they are operating safely. The pricing and safety of natural gas distribution networks are regulated by state agencies (FERC, 2016b; EIA, 2009; DOE, 2016c). The Department of Health and Human Services subsidises the natural gas bills of low-income families through the Low Income Home Energy Assistance Program. This subsidy was more than USD 3 billion in 2016-2017 (HHS, 2016).

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 \$500 of the cost of a residential efficiency measure from 2011 through 2016. Homeowners can also obtain loans from the federal government to finance energy-efficiency measures in new or existing homes (DSIRE, 2016). The US Department of Energy sets minimum energy conservation standards for more than 60 categories of appliances and equipment, including clothes washers, dishwashers, refrigerators/freezers, dehumidifiers, ceiling fans, water heaters, lighting, furnaces, boilers, heat pumps, air conditioners, and motors (EIA, 2016p).

At the state level, 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). In 2016, 32 states had current or pending efficiency targets that require electric and/or gas utilities to meet energy reduction targets over time (EIA, 2016p). At the local level, cities often use building codes to mandate building efficiency improvements (DSIRE, 2016).

CLIMATE CHANGE

On 3 September 2016, the United States alongside China formally joined the COP21 Agreement on Climate Change. The United States stood with China in a joint climate announcement, the ‘US-China Climate Cooperation Outcomes’ (Obama WH, 2016b). The agreement 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.’ 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. This is consistent with a straight-line reduction of emissions by 80% or more by 2050 (UNFCCC, 2016).

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. Although Congress has not passed specific legislation to control greenhouse gases, the EPA has authority to regulate them under existing legislation. State and local governments have developed their own goals and action plans. Several state and regional initiatives incorporate a price for carbon emissions (for example, the plans implemented in California and north-eastern United States).

FEDERAL REGULATION

Principally, the EPA proposed to limit CO₂ emissions in the power sector. One proposed standard restricts CO₂ 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. In addition, the EPA attempted to set CO₂ emission limits for existing generating units. Accounting for each state’s energy mix, the Clean Power Plan (CPP) was published in October 2015. However, 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, 2016a). 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 sets limits on sulfur dioxide and nitrogen oxide emissions through the Cross State Air Pollution Rule (CSAPR) and on mercury and toxic pollutants through the Mercury Air Toxics Standard (MATS). Under CSAPR, power plants in 27 states in the eastern United States must limit sulfur dioxide and nitrogen oxide, which are precursors of fine particulates (soot) and ozone (smog). Implementation of the regulations began in 2015, with further modifications starting in 2017 (EPA, 2016h). The MATS regulates acid gases and mercury from coal-fired plants of 25 megawatts or greater. Under MATS mercury emissions must be 90% below their uncontrolled levels. The EPA issued its final finding in April 2016 (EPA, 2016b).

In 2015, the Obama Administration set a goal of reducing methane emissions from the oil and gas sector by 40–45% below 2012 levels by 2025 (UNFCCC). Methane is a key constituent of natural gas and has a global warming potential more than 25 times greater than carbon dioxide. In 2016 the EPA issued a final standard to significantly cut methane emissions from new, reconstructed, and modified processes and equipment, including hydraulically fractured oil wells (EPA, 2016f). The EPA also issued a final rule in 2016 that requires new and existing landfills to reduce methane emissions by one-third from the current requirement (EPA, 2016g).

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, modernise the grid, and increase energy efficiency to combat climate change and reach greenhouse gas targets while growing low-carbon economies in North America (DOE, 2015).

STATE- AND CITY-LEVEL CLIMATE CHANGE INITIATIVES

In addition to federal actions to reduce GHG emissions, regions, states, and cities have undertaken their own initiatives. Nine states in the northeast and Mid-Atlantic US are members of the Regional Greenhouse Gas Initiative (RGGI), which focuses on reducing CO₂ emissions from the power sector by 45% of 2005 levels by 2020. Using a cap-and-trade system, the states sell emission allowances through auctions and spend the proceeds on energy efficiency, renewable energy and other consumer benefit programs. RGGI has conducted 34 auctions thus far and is now considering further emissions cuts after 2020 (RGGI, 2017). The 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 and 35–45% below 1990 levels by 2030 (NEG & ECP, 2015).

California set a new target of reducing greenhouse gas emissions to at least 40% below 1990 levels by 2030 in legislation signed by the governor in September 2016 (CAGov, 2016a). It builds on the Global Warming Solutions Act of 2006, which sets a mandatory state-wide GHG emissions cap equal to 1990 levels by 2020 (ARB, 2014). The California Air Resources Board (ARB) has already developed a draft implementation plan to reach the 2030 goal, through a 50% renewable portfolio standard by 2030, adding 4.2 million zero-emission vehicles, a 20% cut in greenhouse gas emissions from refineries, etc. (ARB, 2017). The governor also signed legislation in 2016 to spend USD 900 million from an ARB-run emissions cap-and-trade program to public transit, housing, communities, and high-speed rail (CAGov, 2016b).

California leads a global effort by cities, states, and countries to limit greenhouse gas emissions to 2 tons per capita or 80–95% below 1990 levels by 2050. The Under 2 Coalition was formed in 2015 by the states of California and Baden-Wurttemberg, Germany. The coalition represents 167 jurisdictions with more than 1 billion people and more than one-third of global GDP, including ten US states (Under2, 2017).

Municipal governments have undertaken other GHG initiatives, notably the US Mayors' National Climate Action Agenda, formed in 2014 by the mayors of Los Angeles, Houston, and Philadelphia. Each of the 68 cities in the coalition, comprising more than 37 million people, has definite greenhouse gas reduction targets (MNCAA, 2016). The earlier Climate Protection Agreement, launched in 2005 through the US Conference of Mayors, had 1 060 signatories by 2016. The goal of these mayors is to reduce carbon dioxide emissions to below 1990 levels (USCM, 2017).

VEHICLE EMISSION STANDARDS

In July 2011, a new US combined car and light truck (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). The program is estimated to save 4 billion barrels of oil and reduce greenhouse gas emissions by the equivalent of about 2 billion metric tons over the lifetimes of the 2017–2025 model year vehicles (EPA, 2012). A mid-term evaluation for setting 2022–25 standards was also established (NHTSA, 2016a).

Unlike light-duty vehicles, which have been subject to fuel economy standards since the 1970s, the EPA and DOT's National Highway Transportation Safety Administration (NHTSA) are completing the first phase

(2014-2018) of standards for heavy-duty vehicles. These are expected to reduce the fuel consumption of heavy-duty vehicles by 10–20% between 2014 and 2018, save 530 million barrels of oil and reduce carbon emissions by 270 million metric tons (EPA, 2011). EPA and NHTSA released final standards for Phase 2 (2018-2027) in August 2016, which apply to semi-trucks, large pickup trucks and vans, and all types of buses and work vehicles. These standards reduce fuel consumption by 8–24% compared with model year 2017 vehicles, cut greenhouse gas emissions by about 1 billion metric tons, and save about 1.8 billion barrels of oil (NHTSA, 2016b).

In addition to the EPA vehicle standards, California is the only state with the right to enact its own emissions standards for new engines and vehicles, which are often more stringent than EPA standards. To date, nine other states have fully adopted California Air Resources Board (CARB) advanced clean cars program standards. In July 2014, CARB issued a new rule for its zero emissions vehicle (ZEV) program for model year 2018 and later, including battery electric and hydrogen fuel cell vehicles.

The ZEV sales requirement for large manufacturers is 4.5% starting in model year 2018 and increasing to 22% by model year 2025 (CARB, 2014). In July 2016 the White House announced that up to USD 4.5 billion would be available for new types of electric vehicle charging stations, along with plans for electric vehicle charging corridors, plans for more government electric vehicles, and more research (DOE, 2016e). The number of electric vehicle charging stations rose to almost 31 000 in 2015, up 21% from 2014. Hybrid vehicle sales declined to about 384 000 in 2015, down 15% from the year before and 22% from the 2013 peak. Plug-in vehicle sales were about 115 000, down 3% from the year before (ORNL, 2016).

NOTABLE ENERGY DEVELOPMENTS

PRESIDENTIAL ELECTION

Donald J. Trump was elected President of the United States on 8 November 2016. Although his inauguration speech did not specifically mention energy, the White House immediately posted ‘An America First Energy Plan’. It said that the Trump Administration ‘will embrace the shale oil and gas revolution’, is ‘committed to clean coal technology, and the reviving America’s coal industry’, and ‘to achieving energy independence from the OPEC cartel.’ It also noted that the President is committed to eliminating the Climate Action Plan (White House, 2017).

CLIMATE CHANGE

On 3 September 2016, President Obama signed the Paris Agreement on climate change on behalf of the United States (Obama WH, 2016a). As part of this effort, the White House delivered to the United Nations a ‘United States mid-century strategy for deep decarbonization’. The strategy includes a vision for 2050, and plans to decarbonise the US energy system, store carbon, reduce emissions in US lands, and reduce non-CO₂ emissions (UNFCCC).

ELECTRICITY SYSTEM MODERNISATION

On 6 January 2017, the Department of Energy released the second installment of the *Quadrennial Energy Review*. The document is a broad review of the nation’s electricity system, including electricity transmission, storage, and distribution infrastructure. It offers 76 recommendations for modernising and securing the electricity grid, including recommendations for increased research and development, support for nuclear power, and support for small utilities (DOE, 2017). Early in 2016 DOE announced grid modernisation funding of up to USD 220 million for 88 projects over three years for DOE’s national laboratories and their partners. DOE said its grid modernisation initiative is designed to ‘solve the challenges of integrating conventional and renewable sources with energy storage and smart buildings, while ensuring that the grid is resilient and secure to withstand growing cybersecurity and climate challenges’ (DOE, 2016a).

NATURAL GAS

On 25 February 2016, the United States exported its first shipment of liquefied natural gas (LNG) produced in the lower 48 states. (LNG has been shipped from Alaska since 1969.) Later in the year on July 25, the Maran Gas Apollonia became the first LNG vessel carrying US natural gas to transit the newly-expanded Panama Canal. The expanded Panama Canal will significantly reduce the voyage time from the US Gulf Coast to

markets in northern Asia and South America. Between February and the end of June, 15 LNG cargoes were shipped from the Sabine Pass liquefaction terminal (EIA, 2016q).

On 23 October 2015, Southern California Gas Company discovered the largest methane leak from a natural gas storage facility in US history at its Aliso Canyon Storage Field in Los Angeles County. The leak continued for nearly four months until it was permanently sealed, releasing about 90 000 metric tons of methane. In April 2016, the federal government formed an interagency task force to address the leak. In October the task force made 44 recommendations, including that storage operators should evaluate their facilities and phase out single-point-of-failure designs; preparation for possible leaks and coordinated emergency response; and better understanding by power system operators of the potential risks of gas storage disruptions (Gas Storage Task Force, 2016).

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USEFUL LINKS

- Database of State Incentives for Renewables and Efficiency—www.dsireusa.org
- Department of Energy—www.energy.gov
- Department of Interior—www.doi.gov
- Energy Information Administration—www.eia.gov
- Energy Star—www.energystar.gov
- Environmental Protection Agency—www.epa.gov/energy
- Federal Energy Regulatory Commission—www.ferc.gov
- Fuel economy—www.fueleconomy.gov
- Nuclear Regulatory Commission—www.nrc.gov

VIET NAM

INTRODUCTION

Viet Nam is an S-shaped country located in the centre of South-East Asia. It is bordered by China to the north, Laos and Cambodia to the west, and the East Sea (Bien Dong) 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 affected by the East Sea, Viet Nam has warm weather, abundant solar radiation, high humidity and generous seasonal rainfall. The country joined APEC in 1998 as part of the last batch to become members of the 21-economy organisation.

Viet Nam is a dynamic, emerging economy with a population of about 91 million (34% live in cities and 66% in rural areas) (GSO, 2015) and a gross domestic product (GDP) of USD 447 billion (2010 USD at purchasing power parity [PPP]) in 2014 (See Table 1). Over the past 30 years, Viet Nam has transformed 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 between 1990 and 2008, at an annual rate of over 7%. The GDP decreased to 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 62% of the economy in the early 1990s to 73% in 2015. Major exports have diversified with more manufactured products, such as electronics, machinery and vehicles (28% of total exports in 2014) as well as 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).

As of 2017, Viet Nam's business environment ranking has risen nine levels and is now the eighty-second in the world, in part due to improved possibility of electricity, trading across borders, and protecting minority investors (World Bank, 2017). 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, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	330 967	Oil (billion barrels)	4.4
Population (million)	91	Gas (billion cubic metres)	600
GDP (2010 USD billion PPP)	477	Coal (million tonnes)	150
GDP (2010 USD PPP per capita)	5 262	Uranium (kilotonnes U)	1

Sources: a. GSO (2015); b. EGEDA (2016); c. BP (2016); d. NEA-IAEA (2016).

Viet Nam is endowed with diverse energy resources, such as oil, gas and coal, as well as renewables. Fossil energy potential is 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 2014, 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. OECD estimates the identified recoverable resources of uranium at about 3 900 tonnes yet has not been produced. Surveys and assessment for renewable energy's potential are somewhat covered (APERC, 2016), especially for large hydropower. The economic and technical potential of large hydro is estimated at 95–100 terawatt-hours (TWh)/year or 25 gigawatts (GW), of which the technical potential of small hydropower (less than 30 megawatts [MW]) is about 7 GW (MOIT, 2015e). 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, 2016b), biomass 2 GW and municipal solid wastes (MSW) 320 MW (MOIT, 2015e). The energy sector is important in

attracting significant foreign investments 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 2014 was 65 232 kilotonnes of oil equivalent (ktoe), which is a considerable increase of 9.5% from the 2013 level and almost triple the 2003 level (Table 2). By energy source, 31% of the supply came from coal, 28% from oil, 14% from natural gas and 28% from other sources (mostly biomass).

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 of potential coal resources as of 2010 (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 its 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, 2016b).

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 will have 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 barrels per day Dung Quat refinery, began operation during that period.

NATURAL GAS

Viet Nam is self-sufficient in terms of natural gas supply. There are four 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, Malay-Tho Chu and Red River Delta to shores in the south-east and south-west regions of Viet Nam.

Viet Nam's natural gas supply in 2014 was about 10 bcm (PVGas, 2015). 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, 2016b, 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, 2015b).

POWER GENERATION

Vietnam Electricity (or EVN) is a state-owned company who has the control over the entire national power transmission and distribution. As of the beginning of 2016, EVN owned approximately 61% of the total 38 553 MW capacity of electricity in Viet Nam (EVN, 2016). Total power generation in 2014 was 143 216 gigawatt-hours (GWh), an increase of 12% from its 2013 level. Of this total electricity output, about 58% came from hydro and almost 42% from thermal energy (Table 2). Only a very small insignificant portion of is made up by other renewable sources such as wind and biomass. The installed hydropower capacity has tripled from 4.4 GW to 14 GW since 2005, reflecting an average annual growth rate (AAGR) of 13%. As a result, total renewables' share increased from 38% in 2005 to 42% in 2014.

Among thermal power sources which grow as high as 18%, 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 28% in 2014 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 21% in 2014. The share of oil power plants decreased substantially, from 6% to 2.6% 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 marginal in its economy's power system during 2008–14.

Table 2: Energy supply and consumption, 2014¹

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	68 188	Industry sector	22 655	Total power generation	143 216
Net imports and others	-2 277	Transport sector	10 721	Thermal	83 217
Total primary energy supply	65 232	Other sectors	17 649	Hydro	59 841
Coal	19 957	Non-energy	1 224	Nuclear	0
Oil	18 316	Total final energy consumption	52 248	Others	158
Gas	8 937	Coal	11 456		
Others	18 022	Oil	15 592		
		Gas	1 458		
		Electricity and others	23 741		

Source: EGEDA (2016).

¹ Note: The numbers differ greatly from last year's report as the database were recalculated and updated for the whole time series so that biomass resources could be reflected in the 'others' section.

FINAL ENERGY CONSUMPTION

In 2014, Viet Nam's total commercial final energy consumption (TFEC) was 52 248 ktoe, up 3.3% from 2013 (Table 2). By fuel source, electricity and others contributed to the largest share (45%), followed by oil (30%), coal (22%) and gas (3%). Although the component 'others', referring to biomass (fuelwood and wood waste) decrease year by year, that electricity consumption increase in association with higher electrification rates makes this number rank on top. The consumption of coal substantially grew at 8.5% and oil at 4.2%, for the first time in five years since 2009. By contrast, during the same period, gas consumption shows the first signals of decline.

Industry is an important sector in GDP growth and represents the largest segment of TFEC at a constant 43%. This sector consumed coal at 44%, electricity at 26%, biomass at 16%, petroleum products at 7% and natural gas at 6%. The transport sector was also a big energy-consuming sector, accounting for 21% of TFEC. It remained the main consumer of petroleum products at up to 70% of the economy's total requirement. In the other sectors (residential, agricultural and commercial as a whole) consumption represented 34% of TFEC. In this sector, biomass accounted for the largest amount at 51%, electricity 29%, petroleum products 11% and coal 8.6%. All of the biomass and most of the coal volumes were consumed by the residential sector. 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 2014, Viet Nam's energy intensity was about 137 tonnes of oil equivalent per USD million GDP (toe/million USD), which is an increase of 3.3% from 132 toe/million USD in 2013, yet still lower than all levels from 2005–2012. There were, however, slight improvements in energy efficiency from end-use sectors except industry, the sector with the highest level of energy intensity. The residential sector (in others) recorded a significant decline in energy intensity at 9.2% as a whole in 2014 while transport was at 3.9% decline.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	132	137	3.3
Total final energy consumption	112	109	-2.6
Total final energy consumption excl. non-energy	108	107	-1.1

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Industry and Trade (MOIT), which formed in 2007, oversees all energy industries. It drafts laws, policies, development strategies, master plans, economy-wide target programs, technical-economic programs and important projects for all energy sectors and submits to the government and the Prime Minister for issue or approval.

The Ministry administers the implementation of these laws, policies and plans. It takes 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. GDE (PMVN, 2011a) focuses on formulating law, policy and planning, and generally

managing all energy sectors; while ERAV (PMVN, 2008) specialises in regulatory activities in the electricity sector in order to ensure a safe and high-quality supply of electricity for the economy.

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. 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).

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 viewpoints, key objectives, major policies and measures to be realised up to 2020 in the energy industries. In addition, through the formulation and subsequent issuance of development strategies and or master plans by energy subsectors, detailed sectoral targets and policies for each five-year planning period correspondingly adjust to updated assessments. During 2015–16, the Prime Minister approved a number of new or revised strategies and master plans for the development of oil and gas, renewable energy, coal and electricity sectors. They include Oil and Gas Development Strategy to 2025 and Orientations to 2035 (PMVN, 2015b); Renewable Energy Development Strategy to 2030, with a vision to 2050 (PMVN, 2015c); The Revised Coal Development Master Plan to 2020, with a perspective to 2030 (PMVN, 2016a); and the Revised Power Development Master Plan for the period 2010–20, with a perspective to 2030, also known as PDP7 revised (PMVN, 2016b).

These versions continue to confirm the persistent viewpoints of Viet Nam:

- To develop energy sectors in close association with the national socio-economic development strategy and planning;
- To establish national energy security in open market conditions, effectively entering into regional and global cooperation while ensuring to firmly preserve the national security;
- To synchronously and rationally develop an energy system with diversified sources, consisting of electricity, oil, gas, coal, and new and renewable energies; efficiently use and conserve domestic resources; pay attention to develop clean energies and prioritise the development of new and renewable energies;
- To, step by step, develop functioning energy markets, striving to put an end to the pursuit of social policies through energy prices;
- To apply achievements of the knowledge economy in order to enhance productivities and effectiveness in energy businesses. To attach importance to investment in energy conservation technologies, so as to reduce the wastage; and
- To develop energy in close association with preserving the ecological environment, ensuring sustainable energy development.

Below is the summary of some of the main targets for energy development in Viet Nam over the next 5–15 years:

- To ensure a sufficient and high quality supply of energy to meet the demands of socio-economic development, with average GDP growth rates expected to be 7%–7.5% per year during 2011–20 and 6%–6.5% during 2021–30 (PMVN, 2015c);
- To strive to increase petroleum reserves at 25–30 Mtoe per year during 2016–20 and 20–28 Mtoe per year during 2021–30, and to produce 11-14 million tons of crude oil and 11-14 bcm of gas annually during 2016-20, and 5-12 million tons of crude oil and 15-21 bcm for the period 2021-30 (MOIT, 2015d);
- To expand oil refining and petrochemical capacities, aiming to satisfy demands of domestic markets and export of oil and petrochemical products. To ensure domestic production to meet 60–70% of

Viet Nam's demand for petroleum products and 50% of the economy's demand for petrochemical products over the period 2020–30 (MOIT, 2015d);

- To ensure total oil stockpiling (including crude oil and petroleum products) adequate for 90 net-import days from 2015 (PMVN, 2009);
- To strive to reach coal production of 47–50 million tons by 2020 and 55–57 million tons by 2030. To start exploitation in the Red River Delta coal basin in the period 2021–30 with a targeted commercial coal yield of 0.5–1.0 million ton per year by 2030 (PMVN, 2016a);
- To achieve a share of renewable energy (including large hydropower) in the total primary energy supply of 31% (or 37 Mtoe) in 2020, 32% (62 Mtoe) in 2030 and 44% (138 Mtoe) in 2050. To develop renewable power (including large hydro and pumped-storage hydropower) of about 24 GW in 2020 and 49 GW in 2030 (PMVN, 2015c); and
- To complete 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 (PMVN, 2007a).

In a meeting between APERC and IE in 2016, the National Energy Master Plan through 2035 is thought to be under preparation and likely completed by mid–2017.

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 (annual coal export limited to 2–3 million tons per year up to 2020); 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 characterised 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 Viet Nam's power sector, EVN is entrusted to manage the development and operation of the national power transmission system. In 2015, the electricity generation structure by ownership was as follows (EVN, 2016):

- EVN's power plants accounted for 61.2% of the total 38.5 GW installed capacity;

- PVN's power plants accounted for 11.5%;
- Vinacomin's power plants accounted for 4.6%; and
- BOT and other investors' power plants accounted for 22.7.

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 considered 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 2005 and amended 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 Road Map (PMVN, 2013a), stating the three phases of a competitive market 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 regulations.

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 the third quarter of 2014, 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 at the time.

The first actual pilot year of the competitive wholesale power market started in January 2016, according to MOIT's conceptual and detailed design of the Viet Nam Wholesale Electricity Market (VWEM) issued during 2014–15 (MOIT, 2014c and 2015c). 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 plans firmly in place (ERAV's Decision No. 79/QD-DTDL in 2015).

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.

EVN is allowed to increase retail tariffs only when (PMVN, 2013b):

- 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.

Current application of retail electricity tariffs by user categories and wholesale prices for electricity retailers follows the MOIT's regulations (MOIT, 2014a and 2015a) of purchasing and selling prices of

electricity from the national electricity system. The average retail tariff (exclusive of value added tax [VAT]) is VND 1 622.01 per kilowatt-hours (kWh).

CRUDE OIL MARKET

Players in the upstream oil sector in Viet Nam include PVN and its subsidiary PVEP, 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 cases, foreign contractors have the right to sell their profit oil at international prices.

The Dung Quat refinery built in Quang Ngai province has a refining capacity of 6.5 Mt of crude oil per year (or 148 000 barrels per day). It has been operated by the Binh Son Refining and Petrochemical Company Limited (BSR) since 2009 and is the only crude oil consumer in Viet Nam. Currently BSR is a 100%-owned PVN subsidiary; however, PVN announced in 2015 a plan for BSR's equitization, inviting domestic and foreign investors. Over the last seven years, BSR has bought crude oil mainly via the Petrovietnam Oil Corporation (PVOil), a subsidiary of PVN. The sweet crude oil supply to Dung Quat refinery has mainly come from domestic sources, including about 60% from Bach Ho field and 40% from others offshore Viet Nam; imports remain a negligent contribution.

Viet Nam's crude oil market and imports are anticipated to further increase together with existing expansion plans of refining capacity towards 2030. At present, a 10 Mt refinery and petrochemical complex—PVN's Nghi Son project is under construction; commercial operation is scheduled for 2017.

PETROLEUM ENGINE FUEL MARKET

'Petroleum engine fuel' (PEF) is the general term used in Viet Nam to refer to products of the crude oil refining process, which are used as fuel, including gasoline, diesel, jet fuel, kerosene, fuel oil, biofuels (E5 and E10) and other engine fuels, excluding liquefied petroleum gas (LPG) and natural gas products.

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 (GOV, 2014).

The government regulates wholesale prices of fuel oil and retail prices of other PEFs based on the approval of a baseline selling price for PEF suppliers. The base price for PEFs (excluding E5, E10) 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 expense norms; deductions for the Petroleum Price Stabilisation Fund; and profit norms. Exchange rates also affect the base price. In regard to the E5, E10 base price, the calculation takes into account not only the abovementioned price elements but also the monthly average price of fuel ethanol (E100) domestically produced and imported to Viet Nam and the blending percentage of fuel ethanol (5% for E5 and 10% for E10) by its volume with unleaded gasoline RON 92. The MOF takes the leading role in the calculation of each price element in the regulated base price.

NATURAL GAS AND LPG 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, natural 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 natural gas prices and levels are set considering the competitive position of natural gas against alternative fuels. This ensures a reasonable profit margin for investors in related upstream and midstream natural 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 infrastructure projects to ensure a safe and reliable natural gas supply and support natural gas exploration and production in Viet Nam.

Business activities, especially trading and distribution of LPG, and natural gas products are, however, open for competition among all domestic and foreign investors. In 2016, the government promulgated regulations (GOV, 2016a,b) on detailed conditions and investment procedures for conducting LPG, CNG and LNG businesses. By the end of 2016, there were 7 LPG import-export trading companies and 23 LPG distribution companies operating in Viet Nam. PVGas (51%), Bitexco (39%) and TG Asia (10%) have jointly invested and created the first LNG company in Viet Nam, the LNG Viet Nam, operating since August 2016.

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 at the market price, except for power generators. 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 the 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, 2006b). 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 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 (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.

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 and 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.

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 (NAVN, 2010) 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 (m²) 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). As of 1 January 2015 the list of equipment was expanded to include 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 the fourth quarter of 2015 by the MOIT in cooperation with the 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.

RENEWABLE ENERGY

In November 2015, the government first issued the national strategy of renewable energy for the period through 2030, with a vision towards 2050 (PMVN, 2015c). 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 the increase in GHG emissions.

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; and 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 business as usual (BAU) plan. Additionally, 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 is expected. 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 investments 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;
- Applying 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;

- Standardised 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.

Table 4: Renewable portfolio standards

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 lower than 20%
Electricity distribution companies	RE not lower than 5%	RE not lower than 10%	RE not lower than 20%

Notes: RE = renewable power sources exclude large hydropower plants (>30 MW). Source: PMVN (2015c)

- Project specific arrangements for off-grid electricity systems;
- Net-metering for electricity consumers with simplified connection arrangements; and
- Environmental fees for organisations utilising fossil fuels for energy production.

Policies of RPS and net-metering are newly mentioned in renewable strategy but yet to be implemented by 2016. The specific regulation system for renewable energy is as follows:

SMALL HYDRO POWER

The MOIT's Circular No. 32/2014/TT-BCT on regulation on avoided-cost tariff and power purchase agreement for small hydropower plants (MOIT, 2014c) is the latest relevant policy document. The MOIT annually approves and issues 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 the Mechanism for Supporting Wind Power Development (PMVN, 2011d); the Financial Mechanisms for Grid-connecting Wind Power Project (MOF, 2012); and the Regulation on Implementation of Wind Power Project Development, Power Purchase and Sale Contract Form for Wind Power Projects (MOIT, 2012).

The 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, 'Support Mechanism for Development of Biomass Power Projects in Viet Nam' and the MOIT's Circular No. 44/2015/TT-BCT dated 9 December 2015, '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 (excluding VAT). 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, '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 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. The government classified investment in biofuel production as an area eligible for special investment incentives. According to biofuel development scheme for the period up to 2015, with a vision towards 2025 (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, the economy aims to build an advanced biofuel industry, applying biofuel production technology in Viet Nam 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 entire economy's gasoline and oil demand.

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 (PMVN, 2015a). However, more efforts should be made to realize those targets.

Since the 2007 deployment of the Scheme on Development of Biofuels up to 2015 with a Vision to 2025 (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. In 2014, there were five bioethanol plants (E99.5 and above) built in Quang Nam (Dai Tan), Dong Nai (Tung Lam), Quang Ngai (Dung Quat), Binh Phuoc and Phu Tho (Tam Nong), with a total installed capacity of about 500 million litres per year, enough for mixing 10 billion litres of E5 (MOIT, 2016a). It is projected that in 2016-2017 the number is roughly about 16 plants nationwide.

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 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 nuclear power development to ensure Viet Nam's electricity supply security in the future when domestic primary resources becomes exhausted. 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.

In March 2016, the Prime Minister approved the MOIT's revised PDP7 (PMVN, 2016b), 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 Viet Nam.

Ultimately, however, in November 2016, the National Assembly decided to halt the Ninh Thuan nuclear power plants based on updated assessments of capital requirements and general conditions of Viet Nam's economy.

CLIMATE CHANGE

Viet Nam submitted its new climate action plan Intended Nationally Determined Contributions (INDC) in 2015 including a mitigation and an adaptation component. In the early stages of industrialisation, and only recently recognised as a lower middle-income developing economy, Viet Nam contributes only 0.5% global CO₂ 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.

Viet Nam signed the UNFCCC in 1992 and ratified it in 1994 and signed the Kyoto Protocol (KP) in 1998 and ratified it in 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.

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 land use, land-use change and forestry (LULUCF) sectors.

- GHG emissions in 2010: 246.8 million tons carbon dioxide equivalent (tCO₂-e);
- Projections for 2020 and 2030 (not including industrial processes):
 - 2020: 474.1 million tCO₂-e
 - 2030: 787.4 million tCO₂-e

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY DEMAND AND SUPPLY OF 2015-2016

According to EVN (Electricity Vietnam, the largest state-owned power company in Viet Nam), Viet Nam is successfully maintaining energy self-sufficiency in line with the growth of the gross domestic products at 6.68% in 2015. In terms of installed capacity, the Viet Nam power system stepped up to the second rank in ASEAN (from the third by the end of 2014) with approximately 38.5 GW, including newly added 3 314 MW at the beginning of 2016. Electricity coverage stays high at 99.85% in the communes and 98.88% in rural households. Export and import activities have slowed since 2014, while energy demand has not stopped growing for a single year since 2010.

This growing demand, contributed mostly by industry/construction and residential area, has been met by more prevalent use of coal-fired power whose share reached 33%, compared to 26% in 2014. In response to increasing sales, EVN is considering importing more primary fuel (coal) or LNG alongside with investing

in more advanced technology for power project development. The World Bank (2017) in its most recent report credits Viet Nam for reducing the time required for getting electricity connection by reducing delays and increasing efficiency in approving connection applications and designs for connection works.

HALT TO NINH THUAN NUCLEAR POWER PLAN PROJECT

During the last quarter of 2016, the National Assembly decided to halt the Ninh Thuan Nuclear Power Plant project in southeast Viet Nam, which was approved seven years prior in cooperative projects with Japan and Russia. According to the announcement made by the Government Office at the government's press conference on 22 November, two main reasons were mentioned in addition to the need for nuclear power and technology safety. Firstly, the unfavourable economic situation and the need for a more modern infrastructure together with the challenges of climate change presented a hurdle to the continuity of the already doubled VND 400 trillion projects.

Secondly, during the seven years since the project began, many changes in energy prices and technology development have occurred. The supply shortage equal to anticipated combined capacity of 4 000 megawatts due to this halt can be filled up by purchasing power from neighbouring countries and exploitation of renewable energy, especially wind and solar power as well as enhancing thermal power deployment. From now until 2030, Viet Nam will consider replacing the Ninh Thuan nuclear with a thermal power plant; and from 2030 forward, it is assumed that coal-fired power and LNG as well as renewable energy will be the primary source (GOV, 2016c).

ACTIVE MOVES TOWARDS RENEWABLE ENERGY

The loss of 5.7% in electricity output caused by cancellation of nuclear projects is expected to be recovered by accumulating more coal and renewable resources. This will require great effort from the government, in spite of the economy's commitment to FFS reductions to restore fossil fuels to market prices during APEC EWG 51th meeting in Australia. Year 2015-2016 witnessed the launch of important key policy documents such as

- No. 2068/QĐ-TTg of the Prime Minister (November 2015): This is the first comprehensive strategic legal document on the development of renewable energy to 2030 with a vision toward 2050. The document regulates responsibility of power companies to purchase all renewable energy, the price of power as well as distributed sources that are not connected to the grid. Hydropower is emphasised as the main source, expected to increase to 96 billion kWh in 2030.
- No. 428/QĐ-TTg of the Prime Minister (March 2016), a revision to the national power development plan (PDP7) that attached more support to sustainable development. Under this decision, renewables as a percentage of the total generation capacity as well as renewables output will increase over time. By 2030, it is expected to account for 21.0% of the total generation capacity and RE output will account for 10.7% of the total power output.
- No. 403/QĐ-TTg, in which the Prime Minister approved the adjusted master plan for development of Vietnam's coal industry through 2020, with prospects towards 2030. The consecutive revisions started by oil and gas industry will continue in other sectors onwards.

Besides, The Ministry of Industry and Trade issued regulations related to feed-in tariffs for biomass power projects (March, 2016) after decisions on wind (2011), biomass (2014), solid waste (2014) power development support. Scheme of FiT support for solar power is now in the final draft stages.

The government's efforts in promoting renewable energy were also evident in international forums. The fifty-first meeting of the APEC Energy Working Group (EWG) was held in Canberra, Australia in May 2016. Viet Nam delegates confirmed that the new power master plan was revised to strengthen energy security and sustainability, including a roadmap. The strategy for renewables was expanded to 2030–2050 with new goals established, revising supporting mechanisms that included wind and solar development with the aid of feed-in tariffs. In terms of energy efficiency, energy labelling and energy saving of electric equipment were stressed and state-owned companies will become more efficient by 2020.

As Viet Nam relies on coal and thus produces relatively high GHG emissions, it has established cooperation with Japan towards a wider adoption of super critical coal technology. The economy actively cooperated with APERC in the peer review on low-carbon energy policies endorsed by the APEC Energy Ministers at the 2010 Energy Ministerial Meeting to publish a thorough research on alternative energy sources

as well as peer review to be held soon. By the end of October 2016, the government ratified the Paris Agreement of the United Nations Framework on Climate Change (Resolution No 93/NQ-CP) In the Marrakech Climate Change Conference in November, Viet Nam, as one of the 48 countries most exposed to the impact of climate change, announced the adoption of a 100% renewables target.

On the practical side, RE projects are actively been supported. On 17 January 2016, the Bac Lieu wind farm, 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 CO₂ 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 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. In early responses to policy of promoting solar energy, a number of small-scale grid-connected PV plants have recently been developed (ADB, 2015), including:

- 212 kW Big C Supermarket in Di An;
- 200 kW Intel factory in Saigon High-Tech Park; and
- 100 kW power project near Ho Chi Minh City.

Larger projects are expected in the near future, such as the ones in Quang Binh, Khanh Hoa, and Ninh Thuan.

Following these, Phu Lac 1 windrower (24MW) is scheduled for September 2016, and the new Phuoc Thai solar farm project (200MW) will follow. The year 2016 is also when biofuel E10 will be introduced in major cities after December, according to Decision 53/2012/QD-TTg. Additionally, in its annual report for 2016, EVN has committed itself to the feasibility study of several RE projects and strong investments in rural and remote islands electricity distribution network expansion.

In an effort to tackle climate change, Viet Nam identifies in its INDC the GHG reduction pathway for the 2021–2030 period, during which time GHG emissions will be reduced by 8% by 2030 compared to the BAU. The abovementioned contribution could be increased up to 25% with international support.

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