

APEC ENERGY
OVERVIEW

2013

Prepared by

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FOREWORD

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

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

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

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

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



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ABBREVIATIONS AND SYMBOLS

| Abbreviation | Term |
|---------------------|--|
| B/D | barrels per day |
| Bcf | billion cubic feet |
| bcm | billion cubic metres |
| Btu | British thermal units |
| GW | gigawatt |
| GWh | gigawatt-hour |
| kL | kilolitre |
| km | kilometre |
| km/L | kilometres per litre |
| ktoe | kilotonne of oil equivalent |
| kV | kilovolt |
| kW | kilowatt |
| kWh | kilowatt-hour |
| Mbbl/D | thousand barrels per day |
| ML | million litres (megalitre) |
| 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 |
| EDMC | Energy Data and Modelling Center, 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 | 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 |
| TVDKB | true vertical depth below kelly |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| US | United States |
| VAT | value added tax |

CURRENCY CODES

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

AUSTRALIA

INTRODUCTION

Australia is the world's largest island economy and the world's sixth largest economy in land area. It lies in the southern hemisphere between the Indian and Pacific oceans. Its total land area of nearly 7.7 million square kilometres is divided into six states and two territories. The population of more than 22 million lives mostly in major cities or regional centres along the eastern and south-eastern seaboard. Australia has maintained robust economic growth for the last 21 years, averaging 3.5% over the period 1960–2013 (ABS 2013). In 2011, Australia's GDP reached USD 696.74 billion (USD 2000 PPP), a 2.4% increase from 2010.

Australia has abundant, high-quality energy resources that are expected to last for many decades at current rates of production. The Australian energy industry is a significant contributor to the economy (ABS, 2013).

In 2011–12, Australia's energy production was 17 460 petajoules. Australia produces energy for both domestic consumption and export. Net energy exports accounted for 65% of domestic energy production in 2010–11, while domestic consumption accounted for the remaining 35% (BREE 2013c). In 2011 Australia was the world's ninth largest energy producer, accounting for around 2.7% of world energy production (BREE 2013a). Given its large energy resources, Australia is well positioned to continue its role as an important supplier of world energy needs, while maintaining domestic energy supply.

Australia produces uranium for export only, while all other energy production supplies both domestic and international markets. Australia's energy production increased on average at a strong rate of 18% between 2001–02 and 2011–12 (BREE 2013c).

In 2011–12, coal accounted for 60% of Australia's primary energy production, in energy content terms, followed by uranium (20%) and gas (13%) (BREE 2013c). Crude oil and LPG represented a further 6% of total energy production in energy content terms, and renewables 2% (BREE 2013c). Relative to 2011–12, Australian mine production increased by 4.1% in 2012–13, underpinned by 6.1% and 1.9% increases in the output of energy and mineral commodities respectively (BREE 2013b). Australia's energy and mineral commodity export earnings totalled AUD177.4 billion in 2012–13, a decrease by 8.3% relative to 2011–12 (BREE 2013b).

Australia is the world's ninth-largest energy producer, the 2nd largest exporter of coal and a major exporter of uranium and liquefied natural gas (LNG). Given Australia's large energy resources and geographical proximity to burgeoning markets in the Asia–Pacific region, it is well positioned to meet a significant proportion of the world's growing energy demand, as well as its own domestic needs.

Table 1 Key data and economic profile, 2011

| Key data ^a | | Energy reserves ^b | |
|------------------------------------|--------|---|---------|
| Area (million sq. km) | 7.69 | Oil (billion barrels) | 4.2 |
| Population (million) | 22.3 | Gas (billion cubic metres) | 3 822.8 |
| GDP (USD (2000) billion at PPP) | 696.7 | Coal (million tonnes recoverable EDR of black and brown coal) | 93 400 |
| GDP (USD (2000) per capita at PPP) | 31 210 | | |

Sources: a. IMF (2013) b: GA (2012a) & GA 2010.

Source: 2013 Australian Identified Mineral Resources, Geoscience Australia. Figure quoted is for Economic Demonstrated Resources (EDR).

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011–12 Australia’s total primary energy supply was 147 910 kilotonnes of oil equivalent (ktoe) (BREE 2013c). Around 34% of supply came from coal, 39% from oil, 23% from gas and the remaining 4% from renewables (BREE 2013c).

Australia accounts for around 6% of the world’s black coal production and is the fourth largest producer after China (51%), the United States (16%) and India (9%) (GA 2012b). Australian coking and steaming coals are high in energy content and are low in sulphur, ash and other contaminants. Around 87% of Australia’s black coal production is destined for export (BREE 2013a). Coal is Australia’s second largest commodity export (BREE 2013b), earning AUD 38.6 billion in 2012–13. It is also an important component of domestic energy supply, accounting for approximately 70% of total electricity generation (BREE 2013a).

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 Australian conventional gas is sourced from three basins: the Carnarvon Basin offshore Western Australia, the Gippsland Basin offshore Victoria and the onshore Cooper–Eromanga Basin that straddles the South Australia and Queensland boundary (BREE 2013a). Production of coal-seam methane (CSM), which is produced only in New South Wales and Queensland, has expanded rapidly from a share of 2% of total production in 2002–03 to 12% in 2011–12 (BREE 2013a). CSM production is expected to continue to grow, and a number of projects are under development. In 2012–13, gas production increased by 5.7%, relative to 2011–12, to 59 billion cubic metres (BREE 2013b).

Australia is a net importer of crude oil and petroleum products, but a net exporter of liquefied petroleum gas (LPG). Around 78% of crude oil and condensate production is exported, while approximately 85% of Australia’s refinery feedstock was imported in 2011–12 (BREE 2013a). This is because a large proportion of Australia’s oil production is based off the north-west coast, which is closer to refineries in Asia than to domestic refineries on the east coast (BREE, 2013a).

In 2011–12, 254 000 gigawatt-hours (GWh) of electricity were generated, mostly from coal (69%) (BREE 2013c). Given its abundance, coal is expected to remain the most commonly used fuel in electricity generation. However, a large number of wind energy projects, are planned or underway, and are expected to account for an increasing proportion of total electricity generation over the medium to long term.

FINAL ENERGY CONSUMPTION

Australia’s final energy consumption in 2011–12 was 147 941 ktoe (BREE 2013c). In 2011–12 the transport sector accounted for 38.2% of the total, the industry sector 38.6% the agricultural sector 2.4%, and the other sectors, which include residential, commercial and other, 20.8% (BREE 2013c). By energy source, petroleum products accounted for 38.9% of consumption in 2011–12, coal 34.2%, gas 22.6% and renewables 3.4%. (BREE 2013c).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|----------|---------------------------------|--------|------------------------|---------|
| Indigenous production | 296 246 | Industry sector | 23 263 | Total | 254 634 |
| Net imports and other | –179 201 | Transport sector | 30 119 | Thermal | 227 052 |
| Total PES | 122 858 | Other sectors | 24 170 | Hydro | 16 807 |
| Coal | 48 193 | Total FEC | 77 551 | Nuclear | – |
| Oil | 41 380 | Coal | 2 985 | Other | 10 775 |

| | | | | | |
|-------|--------|-----------------------|--------|--|--|
| Gas | 27 028 | Oil | 40 047 | | |
| Other | 6 258 | Gas | 13 007 | | |
| | | Electricity and other | 21 511 | | |

Source: EDMC (2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Australia's system of government has three tiers: the federal government; the six state governments and two territory governments; and the local governments. Australian energy resources are owned either by the federal government or the state/territory governments rather than private individuals. None of the tiers of government is engaged 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'). The approvals process for unconventional gas exploration is overseen by each responsible state government, with the Australian government considering aspects of national environmental significance under the Environment Protection and Biodiversity Conservation Act 1999. In this process each state/territory assesses applications from proponents looking to explore in their area, and then declines or grants access. Similarly, the assessment of safety requirements and environmental regulations for the coal industry is carried out by the state/territory each project is based in.

Following a change in government on 7 September 2013, the government announced a number of energy policy changes and reviews. These include the repeal of the Carbon Tax; the introduction of the Direct Action Plan for reducing carbon emissions; a review of the Renewable Energy Target; and the development of an Energy White Paper. In addition, the former Department of Resources, Energy and Tourism has been amalgamated into the Department of Industry.

The Australian Government has committed to a set of signature economy-wide reforms to respond to rising business and household costs, including a new Energy White Paper. The Energy White Paper will outline a coherent, integrated and efficient regulatory and policy framework, stimulating sustainable growth, building community confidence in environmental safeguards and growing investment in the energy sector. See also the 'Notable energy developments' section.

The Council of Australian Governments' (COAG) Standing Council on Energy and Resources (SCER) is responsible for pursuing issues of national significance in the energy and resources sectors. It is also in charge of advancing the key aims of the former Ministerial Council on Energy (MCE) and former Ministerial Council on Mineral and Petroleum Resources.

The standing council aims to:

- promote the consistent upstream petroleum administration and regulation standards
- address issues affecting investment in resources exploration and development
- develop a nationally consistent approach to clean-energy technology
- promote efficiency and investment in generation and networks
- build on Australia's resilience to energy-supply shocks (Industry 2013).

On 13 December 2013, COAG agreed that its Council system should be streamlined and refocused on COAG's priorities. SCER will be replaced in early 2014 with a new Council on Energy. The terms of reference for the new Council are currently under development and will be agreed by COAG.

ENERGY SECURITY

In 2009, the Australian government released the first National Energy Security Assessment (NESA), which assessed the challenges that could affect Australia's current and future energy security. Energy security was defined as the adequate, reliable and affordable provision of energy needed to support the functioning of the economy and social development: 'adequate' is the provision of enough energy to support economic and social activity; 'reliable' is the provision of energy with minimal supply disruptions; and 'affordable' is the provision of energy at a price that does not affect the competitiveness of the economy and encourages investment in the sector.

Using the same definition of energy security, the second NESA in 2011 found that energy security does not depend on Australian energy independence, or the ability to be self-sufficient. Australia's overall energy security was expected to remain adequate and reliable; increasingly being shaped by both the level of new investment going forward and the price of energy, which are both materially influenced by global trends (Industry 2011d). Work has commenced on the third NESA, with release planned for late 2014. The updated NESA web page link is: <http://www.industry.gov.au/Energy/EnergySecurity/nesa/Pages/default.aspx>.

UPSTREAM ENERGY DEVELOPMENT

The Australian government's approach to developing the economy's energy resources is guided by the following basic principles:

- The efficient commercial development of its energy resources should be promoted to provide the highest-value return for the community
- Energy resource development should be safe and sustainable, and consistent with all relevant national environmental and health and safety standards and obligations
- The development of Australia's energy resources should contribute to its ongoing domestic energy security
- The development of its energy resources should enhance Australia's international competitiveness
- The energy resource development framework should interface appropriately and effectively with other relevant markets or regulatory frameworks 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 acreage 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 jurisdictions.

ENERGY MARKETS

MARKET REFORMS

As mentioned above in the Energy Policy Framework section, COAG established the Standing Council on Energy and Resources (SCER); for more information on the SCER's role and function, please see above.

ELECTRICITY AND GAS MARKETS

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

The Australian Gas Market can also be separated into three distinct regional markets defined by the pipeline transmission infrastructure—the Eastern Gas Market (including the Australian Capital Territory, New South Wales, Queensland, South Australia, Tasmania and Victoria), the Northern Gas Market and the Western Gas Market. The Government has recently released a study on the Eastern Gas Market which will inform its Eastern Australian Gas Supply Strategy to 2020, more information of which is discussed below in the ‘Notable Energy Developments’ section.

A key component of the ongoing energy market reforms was the 1 July 2009 establishment of the Australian Energy Market Operator (AEMO). The AEMO is 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.

The AEMO’s functions include operating the NEM and the retail and wholesale gas markets in eastern and southern Australia; overseeing the system security of the NEM electricity grid and the Victorian gas transmission network; economy-wide transmission planning; and establishing a short-term trading market for gas from 2010 (AEMO 2009).

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

The AEMO oversees Australia’s energy market governance in cooperation with the Australian Energy Market Commission (AEMC), as the rule-making body, and the Australian Energy Regulator (AER), as the regulating body. The Standing Council on Energy and Resources, comprising energy and resources ministers from all Australian governments, 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 earning an income in Australia are subject to corporate income tax, which is imposed at a rate of 30%. Project ring-fencing does not apply, and 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.

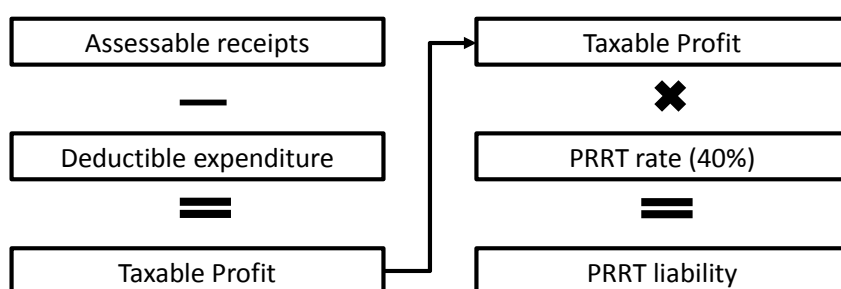
FEDERAL PETROLEUM RESOURCE RENT TAX

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.

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. To ensure that only the economic rent generated from a petroleum project is captured by the PRRT, deductions are provided for all allowable expenditure (together with indexation of carry forward losses). Furthermore, where other layers of resource taxes are applicable (such as State and Territory royalties and Federal crude oil excise), these expenditures are creditable against the liabilities of PRRT projects. This ensures that petroleum projects are not subject to double taxation.

PRRT applies at a rate of 40 per cent 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. As 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 a number of conditions. PRRT payments are deductible for income tax purposes, and a PRRT liability is calculated as per Figure 1 below.

Figure 1: Calculating a PRRT Liability



ROYALTIES

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

For 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 is exempt from crude oil excise.

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;
- A 40% non-refundable tax offset for aggregate turnover equal to or greater than AUD 20 million per year.

JOINT PETROLEUM DEVELOPMENT AREA

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

MINERALS RESOURCE RENT TAX (MRRT)

The MRRT regime, which applies to iron ore and coal mining in Australia, commenced on 1 July 2012.

Following the 2013 election, the new Government announced that it will seek to repeal the MRRT from 1 July 2014. It released an exposure draft of the Minerals Resource Rent Tax Repeal and Other Measures Bill 2013 and an Explanatory Memorandum (Treasury 2013) for a consultation process, which has now been completed. On 20 November 2013, the Bill passed the House of Representatives. On 14 November 2013, the Senate referred the provisions of the Bill to the Senate Economics Legislation Committee for inquiry and report. The Committee reported on 2 December 2013, recommending that the Bill be passed.

INVESTMENT

The Australian energy sector faces a significant investment challenge over the next decade, although investment needs beyond this will depend on long-term trends around demand. The AEMO's 2013 National Transmission Development Plan (NTNDP) forecasts AUD 32 billion for new generation and electricity transmission assets will be required over the next 25 years (AEMO 2013).

ENERGY EFFICIENCY

Australia has a number of programs and regulatory measures that promote energy efficiency. The National Strategy for Energy Efficiency (NSEE), released in July 2009, is an overarching programme of work for promoting energy efficiency in Australia. The NSEE is a coordinated approach to accelerating energy efficiency efforts that helps households and businesses reduce their energy costs and prepare for the emissions reduction measures and targets.

The NSEE incorporates and builds on measures already agreed on by COAG and the SCER through the National Framework for Energy Efficiency (NFEE). All NFEE projects and activities now form part of the NSEE. The NSEE is a 10-year strategy containing measures across all sectors—commercial and residential buildings, appliances and equipment, industry and business, government, transport, skills, innovation, advice and education. The NSEE addresses barriers that prevent the optimal uptake of energy efficient opportunities, such as information failures.

The Department of Industry is working to develop the Energy Savings Initiative (ESI), a market-based tool for driving economy-wide improvements in energy efficiency.

The Energy Efficiency Opportunities (EEO) program is designed to address organisational barriers to efficient energy use by building the energy management capacity of companies. The program requires participant firms using more than 0.5 petajoules (PJ) of energy per year

(equivalent to the energy used by about 10 000 Australian households) to undertake rigorous assessments to identify and evaluate cost-effective energy savings opportunities. Firms are not required to implement savings measures, but the requirements for public reporting on the business response approved by their Boards encourage senior managers to carefully consider energy use in a strategic business context. More than 300 businesses are currently registered with the programme, accounting for more than 60% of the total energy used by business and around 55% of all energy used in Australia. Results from reporting to date indicate that corporations plan to implement energy savings equivalent to about 1.5% of Australia's energy end use or AUD 800 million per year (Industry, 2011c).

BREE's *Economic Analysis of End-Use Energy Intensity* (2012a) analysed energy intensity and energy efficiency in Australia. Changes in energy consumption are broken down into the activity effect, which is based on changes in the output or level of activity; the structural effect, which is based on changes in the composition of activity; and the efficiency effect, which is based on changes in energy intensity.

The aggregate energy-GDP ratio in Australia declined at an average rate of 1.3% a year over the past twenty years.

The transport sector accounts for the largest share of final energy consumption of the sectors analysed, followed by the manufacturing sector. Energy intensity in each of these two sectors declined over the period 1989-90 to 2009-10.

RENEWABLE ENERGY

Australia has abundant and diverse clean energy resources with significant potential for future development. Solar energy use increased by 20% between 2010-11 and 2011-12, which was the largest growth among renewable sources (BREE 2013c). This was partially driven by the Small-Scale Renewable Energy Scheme (SRES), which is mentioned below. Wind-powered electricity generation increased by 5% in 2011-12 relative to 2010-11 (BREE 2013c).

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 allow the government to replace the Mandatory Renewable Energy Target (MRET) with the expanded Renewable Energy Target (RET) from 1 January 2010.

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 SRES and the Large-scale Renewable Energy Target (LRET).

The enhanced RET aims for at least 20% (or around 60 000 GWh) of electricity supply to be provided by renewable energy sources by 2020. This includes a target of 45 000 GWh of new renewable electricity generation, on top of the 15 000 GWh of existing renewable electricity generation. The LRET will deliver the majority of the 2020 target (41 000 GWh), providing investment certainty for large-scale projects. The uncapped SRES provides a subsidy to small-scale technologies, such as residential solar panels and solar hot water systems. The Australian Government will undertake a RET Review in 2014.

The Australian Renewable Energy Agency (ARENA) is an independent agency established by the Australian government on 1 July 2012. It manages AUD 2.5 billion to fund renewable energy projects and support research and development activities, along 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 Centre for Renewable Energy and the Australian Solar Institute has been incorporated into ARENA.

ARENA's independent decision-making board, also referred to as the 'Board', consists of up to seven members appointed by the Minister for Industry and has a CEO appointed by the

Minister for Industry, on the recommendation of the Board. Membership of the Board reflects the skills required to meet the objectives of ARENA.

For more information: 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, but all of these schemes have now been amended or closed.

Over the long term, renewables will play a more important role in the Australian energy system. Solar energy use in Australia is projected to increase by 7.8% per year from 11 PJ in 2010–11 to 236 PJ in 2049–50. Wind energy use in Australia is projected to increase by 4.7% per year to 282 PJ in 2049–2050 (BREE 2012b).

ENERGY TECHNOLOGY AND RESEARCH AND DEVELOPMENT

In the Australian science system, the bulk of basic research is conducted in the university sector. Funding delivery occurs through organisations including the Australian Research Council, which has established a range of competitive grants schemes. 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 per cent below 2000 levels by 2020. The Direct Action Plan is the government's strategy to meet this target. Legislation for the Direct Action Plan is being developed and will be introduced into Parliament in 2014.

Central to the Direct Action Plan is an Emissions Reduction Fund with a capped funding allocation of \$1.55 billion over the forward estimates. The fund is intended to identify and purchase verified emissions reductions from businesses and industry at lowest cost.

The Government released a green paper in December 2013 to invite comment on design options for the Emissions Reduction Fund. A white paper outlining the final design of the fund will be released early in 2014. It is intended that the fund will commence operation on 1 July 2014.

Other elements of the Direct Action Plan include the One Million Solar Roofs program, the Twenty Million Trees program, and the Solar Towns and Solar Schools initiatives.

NOTABLE ENERGY DEVELOPMENTS

EASTERN AUSTRALIAN GAS SUPPLY STRATEGY TO 2020

Australia's gas markets are projected to undergo major changes in the period to 2030, with the development of new unconventional gas resources seeing an expected tripling of domestic gas production over this period in response to strong international and steady domestic demand growth. In response to concerns about the dynamics of the eastern Australian gas market as it makes this transition, on 3 January 2014 the Australian Government released the joint Eastern Australian Domestic Gas Market Study. The objective of the Study was to inform policy makers of the demand supply situation in the eastern Australian gas market and barriers to domestic gas supply over the period 2012–2023, as well as canvassing opportunities to improve market

efficiency. The Study findings will help to inform the Government's Eastern Australian Gas Supply Strategy to 2020 and the Energy White Paper, both of which are being developed in 2014.

ENERGY WHITE PAPER 2014

On 5 December 2013 the Australian Government released the terms of reference for the Energy White Paper and the Issues Paper was released on 17 December 2013. A Green Paper is expected in May 2014, followed by the White Paper in September 2014. The Energy White Paper will set out an integrated and coherent Australian Government position on energy policy and will consider the supply and use of Australia's energy resources to deliver security of supply, increases in new energy sources to ease demand/supply constraints, regulatory reform to put downward pressure on prices, and improved energy productivity. Downward pressure on prices will help relieve cost-of-living pressures and improve business competitiveness. The Issues Paper provides an overview of the energy issues facing Australia. They include: energy supply security, regulatory reform and the role of government, growth and investment, trade and international relations, workforce productivity, driving energy productivity, and alternative and emerging energy sources and technology.

NEW ENERGY PROJECTS

Australia's production and infrastructure capacity will be expanded in the future through the completion of new projects. BREE's *Electricity Generation Major Projects* provides a list of major electricity generation facilities under development, including renewable and non-renewable sources (BREE 2013d).

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USEFUL LINKS

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- Australian Energy Market Commission—www.aemc.gov.au
- Australian Energy Market Operator—www.aemo.com.au
- Australian Energy Regulator—www.aer.gov.au
- Australian Government—www.australia.gov.au
- Australian Government Department of Industry—www.industry.gov.au
- Bureau of Resources and Energy Economics—www.bree.gov.au
- Commonwealth Law—www.comlaw.gov.au
- Energy White Paper—www.ewp.industry.gov.au

BRUNEI DARUSSALAM

INTRODUCTION

Brunei Darussalam, whose name means “Brunei the Abode of Peace,” is located on the north-west coast of the island of Borneo. It covers a total land area of around 5 765 square kilometres and has a 161-kilometre coastline along the South China Sea. It is bordered on the north by the South China Sea and on all other sides by the Malaysian state of Sarawak, which divides the economy into two parts. Brunei Darussalam has four districts: the eastern part is the Temburong District, and the western part consists of the Brunei-Muara, Tutong and Belait districts; and its capital, Bandar Seri Begawan, is located in the Brunei-Muara District. Brunei Darussalam is a small economy with a population of around 393,372 in 2011 and is characterized by a mixture of foreign and domestic entrepreneurship, government regulation, welfare programs and traditional village economies.

In 2011, Brunei Darussalam’s GDP was USD 16.46 billion, and its GDP per capita PPP was USD 40 492. Since their discovery in 1929, oil and gas have dominated Brunei Darussalam’s economy. Accordingly, the oil and gas sector is the economy’s main source of revenue and constitutes around 95% of Brunei Darussalam’s export earnings and around 68% of its GDP. To further sustain and strengthen the oil and gas industry, the government is actively pursuing the development of new upstream and downstream activities.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|---|--------|--|-----|
| Area (sq. km) ^a | 5 765 | Oil (billion barrels) ^c | 1.1 |
| Population (thousand) ^b | 410 | Gas (trillion cubic metres) ^c | 0.3 |
| GDP (Billion US\$) ^b | 16.46 | Coal (million tonnes) ^c | – |
| GDP (USD (2005) per capita at PPP) ^b | 40 492 | | |

a. DEPD (2011).

b. EDMC (2012).

c. Proven reserves at the end of 2012 BP (2013, p.6 and 20).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply of Brunei Darussalam in 2011 was 3 394 kilotonnes of oil equivalent (ktoe). Natural gas represented about 77% of the total primary energy supply and oil 23%. Oil and gas production was 20 766 ktoe in 2011. As a major oil and gas exporter, Brunei Darussalam exported 83% of its oil and gas production in 2011.

Brunei Darussalam’s proven oil reserves in 2012 amounted to 1.1 billion barrels, and its natural gas reserves reached 0.3 trillion cubic metres (BP, 2013). In 2011, crude oil and condensate production averaged 160,690 barrels per day (Mbbbl/D), the majority of which was exported (93%). The main export destinations for Brunei Darussalam’s oil and condensate in 2011 were Korea, the ASEAN economies, Australia, India, China, New Zealand and Japan. Gas production was around 32 million cubic metres a day, most of which was exported as liquefied natural gas (LNG) to the major markets of Japan and Korea (DEPD, 2012, p.148).

Brunei Darussalam’s total installed electricity generation capacity reached 894 megawatts (MW) in 2011. In the same year, total electricity generated was 3,723 gigawatt-hours, with almost all of the electricity generated being supplied by natural gas (DEPD, 2012, p.156).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|-----|------------------------|-------|
| Indigenous production | 20 766 | Industrial sector | 179 | Total | 3 725 |
| Net imports and other | -17 215 | Transport sector | 431 | Thermal | 3 723 |
| Total PES | 3 394 | Other sectors | 305 | Hydro | – |
| Coal | – | Total FEC | 915 | Nuclear | – |
| Oil | 773 | Coal | – | Geothermal | – |
| Gas | 2 621 | Oil | 624 | Others (Solar) | 2 |
| Others | – | Gas | 27 | | |
| | | Electricity and other | 264 | | |

Source: EDMC (2012).

FINAL ENERGY CONSUMPTION

Brunei Darussalam's total final energy consumption in 2011 reached 915 ktoe. The transport sector topped the economy's energy demand at 431 ktoe, or 47.1% of the total amount. The other sectors (residential, commercial and non-energy) consumed 33.4% of the total energy used and the industrial sector 19.6%. In terms of energy source, oil was the fuel most consumed, accounting for 68.2% of final consumption, followed by electricity and other sources (28.8%) and gas (3%). Natural gas accounted for 99% of the fuel used to generate electricity. The other 1% was generated by diesel fuel (EDMC, 2012).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Brunei Darussalam's energy policy is centred on its oil and gas industry. In 1981, the Oil Conservation Policy was introduced after oil production had peaked at 261 000 barrels per day (Mbbbl/D) in 1979. The policy aimed to extend the life of the economy's oil reserves. As a result, oil production gradually declined to around 150 Mbbbl/D in 1989. In November 1990, the government reviewed the policy and removed the production ceiling, resulting in production of 219 Mbbbl/D by 2006. By 2011, crude oil and condensate production averaged 165 Mbbbl/D. In 2000, the Brunei Natural Gas Policy (Production and Utilization) was introduced. The policy aimed to maintain gas production at year-2000 levels in order to adequately satisfy export 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 electric power generation.

In January 2002, the Brunei National Petroleum Company Private Limited (PetroleumBRUNEI) was empowered to manage Brunei Darussalam's commercial interests in the oil and gas sector. PetroleumBRUNEI has been granted all mineral rights in nine petroleum exploration blocks, nominee shareholder status in the Brunei Methanol Company Private Limited, and one of its subsidiaries, PB Logistics, is a shareholder in Brunei Methanol Tanker (BMT).

On May 24 2005, His Majesty the Sultan and Yang Di-Pertuan of Brunei Darussalam created the position of the Minister of Energy and with it, the Energy Division at the Prime Minister's Office. The Energy Division was responsible for formulating the economy's energy policy as well as presiding over matters related to energy. The Petroleum Unit, which oversaw the development of Brunei Darussalam's natural gas and oil sector, and the Department of Electrical Services, which is tasked with managing and developing its electricity sector, also come under the purview

of the Minister of Energy. In 2011, the Energy Division and the Petroleum Unit merged to become the Energy Department, Prime Minister's Office.

Brunei Darussalam has implemented a series of five-year economic development plans known as the National Development Plan. Currently, the tenth National Development Plan (RKN 2012-2017) is in force. This is the second five-year plan under the long-term development plan, Vision Brunei 2035, which states that the economy's major goals for the next three decades are economic diversification and strengthening of the oil and gas sector. The latter is to be achieved by expanding the economy's oil and gas reserves through on-going exploration in both existing and new areas.

ENERGY SECURITY

As an active member of the Association of South-East Asian Nations (ASEAN), Brunei Darussalam supports the implementation of strategies relating to energy security, diversification of supply, energy efficiency and conservation among the regions. The government is working to achieve the targets set under the ASEAN Plan of Action on Energy Cooperation 2010–15 (the Action Plan). The Action Plan includes a call for more concrete and action-oriented programmes and for more focus to be put on results through regular measurement of the progress of programmes and activities using the agreed-to key performance indicators (KPIs) and targets.

Cognizant of its role in the success of the Action Plan, Brunei Darussalam is poised to accelerate its exploration activities. The economy will implement advanced recovery methods and technology to rejuvenate maturing oil and gas fields. It is also exploring plans to diversify its energy mix and to promote alternative energy sources for power generation. The potential of non-conventional energy resources and power transmission interconnection for energy exchange or power transactions will need to be exploited fully to create the additional power generation capacity required. It is hoped the economy's venture into renewable energy, along with its work to upgrade and expand existing electricity-generating facilities, will contribute to its energy security.

Brunei Darussalam is also formulating an Energy White Paper with the aim of securing the future of its energy sector. Three strategic goals have been set to drive the energy sector forward and realize the National Vision. The goals are:

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

UPSTREAM ENERGY DEVELOPMENT

Brunei Darussalam's existing and potential oil and gas reserves lie within the economy's northern landmass and extend offshore to the outer limits of its exclusive economic zone. Most of the existing oil and gas production is located in scattered sites around 70 kilometres offshore. While its oil and gas reserves are expected to last for at least several decades, several areas onshore and offshore have been opened up for exploration.

Most of Brunei Darussalam's oil and gas fields are considered mature. Intensive exploitation of oil resources for about 80 years and of natural gas resources for over 40 years has required the industry to move from primary recovery to secondary and pilot projects on tertiary enhanced oil recovery. Despite its status as a net exporter of oil, Brunei Darussalam imports about half of the refined petroleum products it consumes since it has limited domestic refining capacity. In 2009, the first phase of a 3D seismic survey officially launched Brunei Darussalam's first large-scale onshore exploration project in 20 years.

Brunei Darussalam also has excellent long-term prospects for natural gas and LNG development. In addition to intensifying the development of conventional gas, the economy will continue to explore the availability of unconventional sources of gas, such as coal bed methane. The Brunei LNG plant has been in operation since 1972 and ships more than 7 billion cubic metres of LNG annually. In 2000, Brunei LNG Sdn. Bhd. embarked on the Asset Reference Plan, which includes 25 key rejuvenation projects designed to stretch the plant's lifetime until 2033 and improve efficiency to achieve higher production capacity. The rejuvenation projects include replacing the main cryogenic heat exchangers, upgrading the cooling water system, replacing the steam-powered generation plants with a co-generation power plant, constructing new LNG storage tanks, replacing relief valves and control valves and upgrading the obsolete Distributed Control System (DCS).

DOWNSTREAM ENERGY DEVELOPMENT

Besides exporting its natural gas, Brunei Darussalam looks forward to its utilisation for the development of domestic petrochemicals and energy-intensive industries. To this end, 28.3 billion cubic metres of natural gas have been allocated for domestic downstream activities over an estimated 20-year span (FGE, 2010). Plans are underway to develop export-oriented petroleum industries, including oil refining, petrochemicals, and associated downstream industries. The economy's first petrochemical plant, Brunei Methanol Company Sendirian Berhad (BMC) is a joint venture company between Mitsubishi Gas Chemical Company, Inc., PetroleumBRUNEI and Itochu Corporation, and was officially opened on 25th May 2010. In 2011, 625,000 metric tonnes of methanol was exported (Brunei Times, 2012). ASEAN economies, Chinese Taipei, Korea and China were Brunei Darussalam's largest methanol importers (DEPD, 2012, p.99).

ENERGY MARKETS

The government regulates the energy market in Brunei Darussalam, but no dedicated energy regulator currently exists in the economy. While energy prices are subsidised, an increase in the smuggling of fuels to neighbouring economies has prompted the government to institute considerable price increases for gasoline (Premium 97) and diesel for vehicles and vessels not registered in Brunei Darussalam. Concerned about the increasing cost of maintaining fuel subsidies, the government began a Subsidy Awareness Campaign in 2008 to inform the public of the scale of the energy subsidies in the economy.

ELECTRICITY MARKET

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

ENERGY EFFICIENCY

Brunei Darussalam is actively promoting energy efficiency and conservation in various sectors in the economy. The government's economy-wide target is to reduce its domestic energy intensity by 45% by 2035, with the 2005 level as the base line. This target will be Brunei Darussalam's contribution to the APEC target revised at the 19th APEC Economic Leaders Meeting.

Brunei Darussalam has identified a number of measures in the generation, residential, industrial, government, commercial and transportation sectors. The plan is to improve the energy efficiency performance of these five areas over the period between 2010 and 2035. Brunei Darussalam's immediate plans for the improvement of energy efficiency and conservation are detailed below.

- Revision of the residential sector electricity tariff structure to encourage the use of high-efficiency appliances, avoid waste and provide subsidies to the right groups of people. This was accomplished on 1 January 2012 when the domestic tariff rate was revised from a regressive structure. Under the new structure, a reverse block rate was implemented that keeps the cost for the first 600 kWh low, and then becomes progressively higher as consumption increases, thus incentivizing energy savings in residences.
- Improvement of overall power sector efficiency through the implementation of energy-saving technology such as utilising combined-cycle gas turbines instead of open-cycle gas turbines, reducing partial load operation, installing smart meters and upgrading the transmission and distribution network.
- Formulation of a national standard and labelling regulation for air conditioning systems and lighting.
- Facilitation of energy management exercises in government buildings in order to increase awareness and build capacity in the area of energy management and audit.
- Promotion of energy-efficient vehicles through the introduction of 100 hybrid and electric vehicles into the market, replacement of main government cars with hybrid cars and installation of a minimum of five electric charging bays across the economy.

The economy is also enhancing its human capacity through seminars and workshops on energy management and energy audits, and through energy education in schools. The Energy Management Guide and the Basic Energy Audit Guide are available to give practical help to those carrying out energy efficiency and conservation measures in the government and private sectors.

To build an energy efficient and conservation culture at the grass-root level, the Ministry of Education and the Energy Division collaborated to introduce into the school curriculum material on the importance of using energy wisely and responsibly. Energy saving tips were printed and distributed to all Brunei Darussalam schools. In 2009, the Energy Clubs in Schools program was launched to encourage students to act as energy ambassadors to promote energy efficiency and conservation measures in their schools and at home. By the end of May 2013, 20 Energy Clubs had been established.

RENEWABLE ENERGY

Solar energy is by far the most promising renewable energies, 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 or TSB. TSB is connected to the national power grid and is designed to produce 1344 Mwh of electricity annually, saving 340 kilolitres of crude oil and avoiding 940 tonnes of CO₂ emissions annually. The actual electricity recorded in 2010 was 808 Mwh, i.e. saving an equivalent 205 kilolitres of crude oil and avoiding 566 tonnes of CO₂ emissions into the atmosphere.

Another renewable project that is currently being evaluated by the economy is a 24 MW waste-to-energy power generation system utilising municipal waste. Research on other renewable sources of energy, such as wind, is being conducted by researchers in the local universities.

NUCLEAR

Brunei Darussalam does not have a nuclear energy industry.

CLIMATE CHANGE

Brunei Darussalam recognises the importance to its economic growth of energy security and environmental sustainability. Environmental policy directions are embedded in the 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
- 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 (UNFCCC) in 2007 and subsequently to its Kyoto Protocol in 2009. Brunei Darussalam also associated itself with the Copenhagen Accord in 2009. At the 18th session of the Conference of the Parties (COP18) to the UNFCCC, Brunei Darussalam pledged to continue integrating environmental dimensions into its national development projects. Some of the proposed steps include (UNFCCC, 2012):

- Introducing Environmental Impact Assessment (EIA) in the planning and implementation of projects
- Optimising land use by introducing vertical development in national housing schemes
- Conserving carbon sink resources by maintaining 50% of total land area under forest cover and apportioning a percentage of built-up areas as green areas
- Promoting environmentally sound technology and products
- Enhancing awareness of environmentally friendly lifestyles and resource efficiency
- Promoting green building initiatives
- Increasing the utilization of renewable energy to reach 10% of the energy mix by 2030

NOTABLE ENERGY DEVELOPMENTS

ENERGY INFRASTRUCTURE PROJECTS

The government of 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 the Vision Brunei 2035 is to designate industry cluster-specific sites with supporting

infrastructure 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.

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 (BEDB, 2012). The anchoring project will be a USD 2.5 billion oil refinery and aromatics cracker project to be developed by the Zhejiang Hengyi Group Co. Ltd. The project is expected to begin operations in 2015, with a production capacity of approximately 135,000 barrels per day. The first phase will consist of the production of petroleum products such as gasoline, diesel and jet A-fuel, as well as paraxylene and benzene, which is used mainly in textile production (BEDB, 2012). The feedstock for this plant will be crude oil and condensate.

In the power sector, a Memorandum of Understanding was signed between the Brunei Government, Brunei LNG and Brunei Shell Petroleum Company to expand the Lumut Co-Generation Power Station to an installed capacity of 246 MW, an increase of 66 MW. This is to 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 of greater than 60% through the application of combined heat and power integration or cogeneration (EWG, 2012).

BRUNEI NATIONAL ENERGY RESEARCH INSTITUTE (BNERI)

Brunei Darussalam's newly established energy research centre, the Brunei National Energy Research Institute (BNERI), is now fully operational. This centre aims to be an international centre of excellence in energy and will focus on developing innovative solutions for using fossil fuels, for energy efficiency and conservation, and for renewable energy.

THE US-ASIA PACIFIC COMPREHENSIVE ENERGY PARTNERSHIP (USACEP)

At the 7th 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 U.S.-Asia Pacific Comprehensive Partnership (USACEP). The United States has made available up to USD 6 billion in financing for this venture.

Under the auspices of USACEP, a new Renewable and Alternative Power Generation (RAPG) Work Stream was established as part of the EAS Energy Cooperation. The main aim of this RAPG Work Stream is to spur 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 so as to elevate the role of renewable energy in the region.

The first activity under the RAPG Work Stream was a workshop on "Policies, Feed-in Tariff Frameworks and Best Practices for Grid-Connected Solar PV Projects," which was held in Brunei Darussalam from 8-10 September 2013. With over 70 participants, the workshop aimed to provide useful recommendations and policy guidance to EAS member countries that would allow for the promotion, development and deployment of renewable energy technologies.

APEC PEER REVIEW ON ENERGY EFFICIENCY PHASE 4

Brunei Darussalam volunteered to undertake the APEC Peer Review on Energy Efficiency (PREE) from 11-15 June 2013. Based on their findings, the PREE Review Team has set out 47 recommendations for improving Brunei Darussalam's energy efficiency performance in terms of institutional context; energy efficiency goals, targets and strategies; energy data collection and monitoring; policy measures for residential, commercial, government and industrial sectors; policy measures for transport sector; policy measures for electricity sector; and policy measures

for appliances and equipment. The final report was endorsed by the APEC Energy Working Group at the 46th EWG Meeting in November 2013.

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USEFUL LINKS

Brunei Economic Development Board—www.bedb.com.bn
 Brunei LNG Sdn Bhd—www.blng.com.bn
 Brunei Shell Petroleum Company Sdn Bhd—www.bsp.com.bn
 Energy Department, Prime Minister’s Office—www.energy.gov.bn

CANADA

INTRODUCTION

Canada is a North American economy with vast natural resources, including large reserves of fossil energy and a significant potential for non-fossil energy whose land area is the world's second largest after Russia. Canada's population in 2011 was about 34.48 million, the majority of whom live in its southern part bordering the United States of America, with approximately three-quarters living in the provinces of Ontario (38.39%), Quebec (23.61%) and British Columbia (13.14%) (Statcan, 2013a). Canada's gross domestic product (GDP) in 2011 grew 2.53% from 2010, amounting to USD 1 078.98 billion, and, in per capita terms (with 2000 as a base), increased 1.47%, amounting roughly to USD 31 289 (both in 2000 USD price and PPP) (EDMC, 2013). On average, the Canadian population has high energy demands, both to meet their high living standards but also due to the prevalent cold temperatures, the long distances between major cities and the energy-intensive nature of the activities that support the economy. These factors, in combination with Canada's low population density, contributed to a final per capita energy consumption level in 2011 that was the highest among the APEC economies, at nearly 5.93 tonnes of oil equivalent (toe), way ahead of other large developed APEC economies, namely the United States (4.86 toe), Australia (3.4 toe), Russia (3.23 toe), the Republic of Korea (3.22 toe) and Japan (2.49 toe) (EDMC, 2013).

Canada is also one of the world's top energy producers, drawing on its vast oil and gas reserves estimated at 622.5 million cubic meters (mcm), which is equal to about 174 billion barrels and 1 700.9 mcm, respectively (Statcan, 2013b; Statcan 2013c; CAPP, 2013a). Due to its huge oil reserves of which the bulk (about 97%; 169 billion barrels) is unconventional (oil sands) (CAPP, 2013a), Canada was a major oil producer (174.119 Mtoe) and exporter (118.761 Mtoe) in 2011, and particularly, the largest source of oil imports for the United States, i.e., 2 729 000 barrels per day (bpd), equal to 23.86% of its 2011 imports (11 436 000 bpd), a significant increase from the previous year (2 535 000 bpd equal to 21.49% of its total import of 11 793 000 bpd) (EDMC, 2013; USEIA, 2013). In the same year, Canada produced 132.386 Mtoe of gas of which 76.853 Mtoe was exported to the United States (EDMC, 2013). The economy is well known for its rich supply of indigenous energy resources, with abundant reserves of oil, natural gas, coal and uranium in its western provinces, and large hydropower resources in its provinces of Quebec, British Columbia, Newfoundland, Ontario and Manitoba. It also holds significant offshore oil and gas reserves near Nova Scotia and Newfoundland (NEB, 2011a). Accordingly, energy production is important to the Canadian economy. In 2011 its contribution to Canada's GDP and export revenue was 6.9% and 25.4% (equal to CAD 113.7 billion), respectively (NEB, 2013a). Canada is the world's 3rd largest gas producer, 6th largest oil producer and 5th largest energy producer (CAPP, 2013a).

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|---|----------|--|--------|
| Area (million sq. km) | 9.98 | Oil (billion barrels) | 174 |
| Population (million) | 34.48 | Oil sands (billion barrels) | 169 |
| GDP (USD 2000 price and PPP) | 1 078.98 | Gas (trillion cubic metres) | 1.7009 |
| GDP (USD 2000 price and PPP per capita) | 31 289 | Uranium (thousand tonnes of uranium metal) | 468.7 |

Source: EDMC (2013); Statcan, 2013c; CAPP, 2013b; WNA, 2013.

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Canada's domestic energy production reached 409.840 Mtoe in 2011 with a predominance of fossil fuels (EDMC, 2013). Oil (174.119 Mtoe; 43.41%), natural gas (132.386 Mtoe; 32.30%) and coal (33.658 Mtoe; 8.21%) accounted for the bulk of Canada's primary energy production, while the remainder was made up by hydropower (32.319 Mtoe; 7.88%), other renewable sources (3.426 Mtoe; 0.83%) and nuclear (8.130 Mtoe; 1.98%) (Ibid.). However, since a large proportion of the energy produced was exported, Canada's primary energy supply in 2011 totalled 252.587 Mtoe, equivalent to 61.63% of its production reflecting the growing role of Canada as an energy exporting economy (Ibid.).

Canada's natural gas marketable production in 2011 was 144.448 billion cubic metres (bcm), which was almost the same as its 2010 production (144.506 bcm), a significant decline from the peak year of 2002 (172.2 bcm) (Statcan, 2011; Statcan 2013d). The continuity of a lower production in 2011 was the outcome of various factors, including increasing capital and labour costs, the recession of the previous decade and the United States' rapid expansion of its shale gas production to decrease Canada's gas exports to its southern neighbour.

As a result of the American shale gas boom, net natural gas exports from Canada have followed a declining trend. This trend continued in 2011 as Canada exported 76.853 Mtoe of gas to the United States, its only gas market, compared to 79.151 Mtoe in 2010 (EMDC, 2013).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|----------|---------------------------------|---------|------------------------|---------|
| Indigenous production | 409 840 | Industry sector | 56 757 | Total | 639 000 |
| Net imports and other | -158 531 | Transport sector | 59 754 | Thermal | 145 006 |
| Total PES | 252 587 | Other sectors | 88 065 | Hydro | 375 797 |
| Coal | 19 600 | Total FEC | 204 567 | Nuclear | 93 589 |
| Oil | 82 724 | Coal | 2 757 | Other | 24 608 |
| Gas | 83 593 | Oil | 92 581 | | |
| Other | 66 670 | Gas | 55 928 | | |
| | | Electricity and other | 53 300 | | |

Source: EDMC (2013).

In 2011, Canada's production of crude oil was 174.119 Mtoe, an increase of about 6% from 2010 when it produced 163.916 Mtoe (EDMC, 2013). The bulk of this production (118.761 Mtoe; 68%) was exported mainly to the United States (EDMC, 2013). Given the fact that the output of oil sands has been increasing, Canada's total oil production is expected to increase in the future. Canada is also a net exporter of petroleum products and natural gas liquids (NGLs), predominantly to the United States. Total natural gas liquids and liquefied petroleum gases produced in 2011 was 31 472.3 cubic meters (cm), of which 700.2 cm was exported (Statcan, 2013e). While their production was slightly larger than the 2010 production (31 255.3 cm), their exports were slightly lower than that of the previous year (730.8 cm) (Statcan, 2013f).

Canada generated 639 terawatt-hours (TWh) of electricity in 2011, registering an increase of about 5% of the previous year (608 TWh) (EDMC, 2013). Hydropower plants were the largest contributor (375.797 TWh) followed by thermal (145.006 TWh) and nuclear (93.589 TWh) plants. Comparatively, the share of renewables other than hydro of the total production was small (24.608 TWh), but it reflected a significant increase from their 2010 share (17.953 TWh). Their production has been growing at a significant rate as was evident in 2011 when wind, tidal and

solar energy, for example, generated 10.4 TWh of electricity, an increase of over 8% from 2010 (9.6 TWh) and a phenomenal increase of about 274% from 2008 (3.8 TWh) (NEB, 2013b).

Canada is the world's third largest hydroelectricity producer after China and Brazil, with roughly 25 GW of additional capacity in various stages of project development that will be completed by 2030 (Irving, 2010). Moreover, if nuclear power is included, nearly 77% of Canada's electricity generation does not emit greenhouse gases. Canada's electricity flows are actively traded with the United States through the interconnection of the two networks in both economies. In 2011, Canada exported 51.077 TWh of electricity to the United States and imported 14.394 TWh from the United States, making Canada the world's third largest exporter of electricity after France and Paraguay (NEB, 2011b; IEA, 2013a). This indicated a significant increase in exports and a significant decrease in imports of electricity compared to 2010 when Canada exported and imported 43.6 TWh and 18.8 TWh of electricity, respectively (NEB, 2010).

Canada produced 19.6 Mtoe of coal in 2011, a substantial decrease of about 11.1% from its 2010 production (EDMC, 2013). The share of coking coal, steam coal and lignite of its production was 29.45%, 27.93% and 9.73%, respectively (IEA, 2013b).

Canada uses more than half of its coal production domestically for electricity generation and various industrial applications, and exports the rest while also importing coal, primarily for electricity generation, as well as for metallurgical applications (Ibid). Coal consumption has taken a declining trend in Canada due to various reasons, particularly environmental ones. This is evident in a sharp decrease of about 38% in its production from 31.6 Mtoe in 2000 to 19.6 Mtoe in 2011 (MEDC, 2013). Canada has 8.7 billion tonnes of proved coal reserves of which 6.6 billion tonnes are currently recoverable using the existing technology. The recoverable resources will last about 100 years at today's production rate (NRCan, 2013a).

Canada is among the three leading producers of uranium along with Kazakhstan and Australia, accounting for roughly 64% of total global output in 2011 (WNA, 2013). With nearly 9% of identified global uranium resources and reserves of nearly 468 700 tonnes of uranium metal (tU) in 2013, the economy's output totalled 9145 tU in 2011 equal to about 17% of the global uranium production, a decrease of about 6.5% from the previous year's production of 9783 tU (WNA, 2013). The economy retained its rank as the world's second largest uranium producer after Kazakhstan in 2011. Canada's uranium production is mostly located in northern Saskatchewan and involves two of the world's largest uranium-producing companies as well as the world's largest high-grade uranium mine, which operates at full capacity (NRCan, 2009a; NEA, 2012).

Other non-hydro renewable energy sources are growing quickly in Canada, but their share in Canada's total primary energy supply is small. This was evident in 2011 when all types of non-fossil energy consisting of renewables and nuclear energy accounted for 66.670 Mtoe, which is equal to about 26.39 % of the economy's total primary energy (252.587 Mtoe) (MEDC, 2013). Of this, the share of all renewables was 45.504 Mtoe, the bulk of which was hydro (32.309 Mtoe) (IEA, 2013c).

However, in light of Canada's abundant natural resources, there are promising expectations for certain renewable sources such as wind, the use of which has grown rapidly in recent years. The contribution of wind energy to electricity generation is expected to grow steadily. Canada is currently ranked ninth in the world in terms of totalled installed wind energy capacity, which is 6500 MW (CanWEA, 2013). The Canadian wind industry, which installed a record level of over 936 MW in 2012, is expected to install 1500 MW of wind capacity annually during the next few years to reach the total installed capacity of 12 000 MW by 2016; Canada's Provinces of Ontario and Quebec will lead the instalment (CanWEA, 2013).

FINAL ENERGY CONSUMPTION

Canada's total final energy consumption in 2011 was 204.567 Mtoe, an increase of about 2.58% in comparison to the previous year (199.425 Mtoe) (EDMC, 2013). Within this context, the single largest consumer was the transport sector (59.745 Mtoe; 29.20%) followed by industry (56.757 Mtoe; 27.74%), demonstrating the continuity of the pattern of consumption of 2010 (EDMC,

2013). Excluding the share of the non-energy sector of Canada's final energy consumption (23.996 Mtoe; 11.73%), the residential (32.786 Mtoe; 16.02%), commerce and public services (26.467 Mtoe; 12.93%) and agriculture (4.816 Mtoe; 2.35%) sectors accounted for the remaining consumption (Ibid.).

While the transport and industry sectors' consumption remained almost at the 2010 level in absolute terms (59.501 Mtoe and 56.595 Mtoe, respectively), the other sectors, namely residential, commerce and public services, and agriculture (64.069 Mtoe), registered an increase of about 6.4% in energy consumption compared to the previous year (respectively, 30.808 Mtoe, 25.144 Mtoe and 4.231 Mtoe) (EDMC, 2013).

Following the 2010 pattern, fossil fuels accounted for the bulk of Canada's total final energy consumption, i.e., petroleum products (92.581 Mtoe; 45.25%), gas (55.928 Mtoe; 27.33%) and coal (1.697 Mtoe; 0.82%), followed by electricity as the largest non-fossil source of energy (44.625 Mtoe; 21.81%) (EDMC, 2013). In 2010, the share of the latter of Canada's total final energy consumption (199.425 Mtoe) was respectively (91.711 Mtoe; 45.98%), (52.178 Mtoe; 26.16%), (1.703 Mtoe; 0.85%) and (43.512 Mtoe; 21.81%) (Ibid.).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Canada's energy policy, including resource development policies, is market-based. However, if necessary, it also provides for targeted intervention in the market process to achieve specific policy objectives, including health and safety (e.g., pipeline regulation) and environmental sustainability, through various means, including regulation (NRCan, 2013b). Certain agreements and accords frame the economy's energy policy. They include the Western Accord and the Agreement on Natural Gas Markets and Prices (two agreements between the Governments of Canada, Alberta, Saskatchewan and British Columbia on oil and gas pricing and taxation), the Atlantic Accords (an agreement with Newfoundland and Labrador and with Nova Scotia, including the establishment of jointly managed Offshore Boards) and the Free Trade Agreement, which is a Canadian-American agreement followed by the North American Free Trade Agreement (NAFTA). NAFTA is the cornerstone of Canada's energy policy with regard to trade, which emphasizes the importance of competitive market behavior and encourages investment in Canada's energy markets (Ibid.).

Various decisions of the Canadian federal government have contributed to Canada's energy policy, including the creation of three entities (NRCan, 2013b). These are the National Energy Board (NEB) mandated with promoting safety and security, environmental protection and efficient energy infrastructure and markets in its regulation of pipelines, transmission lines, energy development and trade; the Canadian Nuclear Safety Commission (CNSC) in charge of regulating all aspects of the nuclear power industry in Canada; and the Atomic Energy of Canada Limited (AECL) tasked with fostering the advancement of nuclear energy and nuclear technology. The mentioned decisions also include the funding of the Program on Energy Research and Development to support the development of energy technologies (Ibid.).

The economy's energy policy incorporates a mix of domestic and foreign-owned companies. As per the Canadian Constitution, the Canadian provinces are the jurisdictional owners and managers of their energy resources (except for uranium), while the Canadian federal government is responsible for the control of international and interprovincial trade. In addition, the Constitution mandates provincial or territorial regulation of mining activities on publicly owned mineral leases, and hence there is separate mining rights legislation for each of the 13 Canadian jurisdictions except for Nunavut (the northern and eastern portions of the former Northwest Territories). As for off-shore mineral rights, those are usually owned by the Canadian Federal Government.

Through Natural Resources Canada (NRCan), the NEB and other government agencies, including Environment Canada, Fisheries and Oceans Canada, Indian and Northern Affairs Canada, and Foreign Affairs and International Trade Canada, the federal government works with provincial governments to implement economy-wide development programmes and to honour international agreements. In particular, as an independent federal regulator, the NEB is in charge of pipelines, energy development and trade issues in the Canadian public interest.

Even though Canada has an abundant and diverse supply of energy sources, improving the sustainability of the economy's energy supply to ensure its long-term viability is a governmental priority. As a consequence, energy policies are simultaneously centred on promoting economic growth, encouraging the sustainable development of resources and limiting environmental impact.

In this regard, the NRCan is involved in the oversight of the areas in which the market does not adequately meet these policy objectives. For that matter, it emphasizes regulation to protect the public interest and promote health and safety, and policies and programmes to encourage scientific and technological research, promote energy efficiency, and support the development of renewable and alternative energy sources.

ENERGY MARKETS

OIL AND GAS MARKETS

Wellhead oil and natural gas prices in Canada 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. Oil and gas pipeline networks continue to be regulated as natural monopolies (NRCan, 2009b; NEB, 1996).

As a federal regulatory body reporting to Parliament through the Minister of Natural Resources, the NEB has the primary responsibility for regulating international and interprovincial transport networks, as well as exports (Minister of Justice, 2009a). Provincial authorities have the main responsibility for regulating local and regional distribution networks. Under the Canada Oil and Gas Operations Act, the NEB continues to develop and maintain regulations for exploration and development activities in non-Accord Frontier Lands (Minister of Justice, 2009b).

ELECTRICITY MARKETS

The structure of the Canadian electricity markets gives the provinces and territories jurisdiction over generation, transmission and distribution of electricity within their boundaries, including restructuring initiatives and electricity prices. In turn, the federal government is responsible for electricity exports, international and designated inter-provincial power lines, and nuclear safety, which is especially important since the economy-wide market is interconnected at many points with the United States to form a larger grid (NEB, 2012a).

In most provinces, the electricity industry is highly integrated with the bulk of generation, transmission and distribution services provided by one or two dominant utilities. While some of these utilities are privately owned, many are Crown corporations owned by the provincial governments and, although independent power producers also exist, they are rarely in direct competition with a Crown corporation. Exceptions include the provinces of Alberta, which has moved to full wholesale and retail competition, and Ontario, which has established a hybrid system with competitive and regulated elements. Retail electricity prices vary across the provinces, in terms of both their levels and the mechanisms by which they are set, with the provinces with an abundant supply of hydro-electricity having the lowest prices. In most provinces, prices are set by the regulator according to a formula that determines the cost of generation plus a reasonable rate of return. While retail electricity prices in Alberta are more market-based than in other provinces and territories and the remaining regulated price plan is

gradually being phased out, in Ontario, both regulated and deregulated price plans are offered (NEB, 2009).

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

NUCLEAR POWER

Nuclear energy is an important component of Canada's energy mix accounting for 14.64% (93.589 TWh) of the economy's total electricity generation (639 TWh) in 2011 and reflecting a slight increase in its share compared to that of 2010 (14.5%; 90.658 TWh) (EDMC, 2013).

Canada's nuclear energy falls within the federal government's jurisdiction. Added to licensing, the government's role covers certain issues, including Research and Development (R&D) and the regulation of all nuclear materials and activities (NRCan, 2013c). Concerned with health, safety, security and the environment in relation to nuclear activities in Canada, the federal government has put in place a comprehensive legislation framework for protecting the latter, which is comprised of the Nuclear Safety and Control Act (Regulation), the Nuclear Energy Act (Nuclear Research and Development), the Nuclear Fuel Waste Act (Waste) and the Nuclear Liability Act (Liability) (Ibid.). The federal government and the provincial governments have certain rights and responsibilities with respect to the economy's nuclear energy sector. The federal government regulates the development and application of nuclear energy in Canada, in addition to the other previously mentioned responsibilities, and the provincial governments decide whether they should embark on nuclear energy projects and operate nuclear energy plants through the provincial energy organizations or private utility companies (Ibid.).

Canada's nuclear energy sector consists of 22 reactors (20 in Ontario, 1 in Quebec and 1 in New Brunswick) operated by public utilities and private companies of which 17 are in operation, two are shut down and three are being refurbished (NRCan, 2013d).

There are two organizations which report through the Minister of Natural Resources to the Parliament of Canada that play key roles in the Canadian nuclear energy program: the Atomic Energy of Canada Limited (AECL) and the Canadian Nuclear Safety Commission (CNSC) (NRCan, 2013c).

The AECL, which is wholly owned by the Canadian Government, is the economy's premier nuclear and science organization, and it has been mandated to develop peaceful applications of nuclear energy. It has two distinct roles, namely a public policy role and a commercial role. With respect to the former, it conducts nuclear research and development, producing medical isotopes, and the management of legacy and historic nuclear wastes. Regarding its commercial role, the AECL designs, develops, deploys and refurbishes nuclear reactors based on Pressurized Heavy Water Reactor technology, i.e., Canada Deuterium Uranium Reactors (CANDUs) (Ibid.). As a result, AECL delivers research and development support and services, such as consulting and maintenance, to nuclear utilities and Candu Energy Inc., the private-sector designer and builder of the CANDU reactors. In 2006, the Government of Canada launched the five-year, CAD 520 million start-up phase of a long-term strategy to safely and cost-effectively deal with legacy radioactive waste and decommissioning liabilities at AECL sites, based on sound waste management and environmental principles (AECL, n.d.). In 2011, the Government of Canada

renewed this Nuclear Legacy Liabilities Programme with a three-year extension worth CAD 439 million. AECL is currently reviewing and updating its estimate of the liability for nuclear decommissioning and waste management (AECL, 2013).

The CNSC is an independent agency of the Government of Canada tasked with regulating the use of nuclear energy and materials to protect health, safety, security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy (NRCAN, 2013c).

ENERGY EFFICIENCY

Energy Efficiency Act

The Energy Efficiency Act, which took effect in 1992 and was amended in 2009 to expand its scope and effectiveness, provides for the creation and enforcement of regulations on the energy efficiency of products, and supports the pursuit of an energy market transformation in Canada through the replacement of the least efficient products with high-efficient, cost-effective ones. Provincial governments are also major contributors to the energy efficiency in their respective provinces through the establishment of energy-efficient building codes, equipment standards, etc.

End-Use Efficiency

At the federal level, energy efficiency issues are addressed by the NRCAN through its Office of Energy Efficiency (OEE), with the vision to improve the utilisation of energy by “leading Canadians to energy efficiency at home, at work and on the road” (NRCAN, 2011a). The OEE delivers the ecoENERGY Efficiency program to improve energy efficiency for a cleaner environment and reduced greenhouse gas emissions (GHG), while saving Canadians money and making the most of Canada’s natural resources (NRCAN, 2011b). Running until 2016, the ecoENERGY Efficiency program targets energy efficiency improvements in all end-use sectors, making the housing, building and equipment stock more energy-efficient, energy performance more visible, and industry and vehicle operations more efficient.

Specific areas of work include a more stringent model energy code for buildings, a next generation energy rating system for homes, project financing tools, transportation, product regulation, industrial energy management standards and integrated community energy solutions. These efforts support a July 2011 commitment by Canada’s Federal, Provincial and Territorial Energy Ministers to work on a Collaborative Approach to Energy.

The OEE also delivers ecoENERGY for Biofuels, which supports the production of renewable alternatives to gasoline and diesel, and encourages the development of a competitive domestic industry, and ecoENERGY for Alternative Fuels, which supports the diversification of energy used in the transportation sector through education and outreach activities, and codes and standards development for natural gas.

In addition to coordinating these programs, the OEE is mandated to strengthen and expand Canada’s commitment to energy efficiency to further support the Government of Canada’s policy objectives and programs. Informing key decision-makers in government, industry and the non-profit sector about Canada’s energy conservation and energy efficiency efforts is a major focus of the OEE.

CLIMATE CHANGE

As energy production and consumption contribute significantly to Canada’s greenhouse gas (GHG) and air pollutant emissions, the Canadian government policies are aimed at promoting energy efficiency and cleaner technologies, boosting renewable energy supplies and reducing GHG emissions. Since 2006, the Government of Canada has invested more than CAD 10 billion to reduce GHG emissions and build a more sustainable environment through investments in green infrastructure, energy efficiency, clean energy technologies and the production of cleaner

fuels. As part of the Copenhagen Accord, Canada pledged to set a goal to reduce emissions by 17% from 2005 levels by 2020. This was endorsed again through the Cancun Agreement and is in line with the US goals in this regard.

The federal government is pursuing a number of actions to reduce emissions and the environmental impact of the energy sector for the benefit of Canadians. One of the most significant policies, the Clean Air Agenda, aims to minimise the energy sector's impact on sustainability and the environment mainly through the reduction of GHG emissions. After reviewing a proposal for a Comprehensive Air Management System developed over a two-year period, the Canadian government agreed in 2011 to finalise the system's major elements, with the aim to implement it by 2013 (Treasury Board, 2012).

Canada has continued its engagement in the UNFCCC negotiations to support the establishment of a fair and comprehensive global climate change regime since the end of the Doha round of negotiations under the UNFCCC (United Nations Framework Convention on Climate Change) in December 2012. In this regard, it has significantly increased its climate change-related financial support to "accelerate global progress and effective action by all countries with an overall commitment of \$1.2 billion in new and additional climate change financing for the fiscal years 2010-2011, 2011-2012 and 2012-2013" (Government of Canada 2013).

Another component of the Clean Air Agenda relates to the promotion of a cleaner transportation sector, for which the government decided to issue three new emissions regulations for new vehicles and engines, aligned with the U.S. Environmental Protection Agency (EPA) standards. In addition, the Clean Air Agenda activities included the tracking of the new U.S. labelling regulations for new light-duty vehicles in order to develop a matching policy measure in Canada. The energy sector's engagement with the Clean Air Agenda is centred on increasing energy efficiency, renewable energy supply and the facilitation of the commercial availability of new technologies to minimise the environmental impact of energy use (Treasury Board, 2012).

Additionally, Canada has sought to strike a balance between its energy requirements and environmental considerations to make its energy consumption environmentally sustainable by decreasing the adverse environmental impact of energy-related activities. As part of this policy, the NEB conducts an environmental assessment for any energy project falling within its mandate, which is a review of the environmental effects likely to be associated with an energy project. This assessment is to be completed before the NEB makes a decision on whether or not to approve an application for an energy project (NEB, 2013c). Other NEB's related activities include its introducing new pipeline performance measures to promote continual improvement in the management of pipelines. These measures are meant to help prevent pipeline accidents leading to environmental damages and harming public safety (NEB, 2013d).

In the power sector and in spite of its lower GHG emissions, the Canadian government announced in 2012 stricter regulations concerning coal-based electricity generation, with new standards applicable for new and old power plants that have reached the end of their economic life. The standards, which will be in force by July 2015, are expected to result in a cumulative reduction in GHG emissions of about 214 mega tonnes, which is equal to removing some 2.6 million personal vehicles per year from the road (Canada Gazette, 2012).

Thus far, these policies have shown that the primary complexity in addressing climate change lies in strengthening the energy sector's competitiveness while achieving adequate flexibility in adjusting priorities and meeting international commitments on the subject. This is particularly important in the case of the jurisdiction and regulatory status of the United States, which Canada follows closely, as the close economic and energy ties between the two economies create an intrinsic need to harmonize.

NOTABLE ENERGY DEVELOPMENTS

NEW CLEAN ENERGY TECHNOLOGY INVESTMENT

The Canadian Government's policies are aimed at sustaining and improving the competitiveness of the economy and stimulating job creation while also minimising environmental impacts.

Stemming from the Economic Action Plan and in connection with the ecoENERGY energy efficiency programmes, Canada has boosted research and development to support energy technology innovation capable of producing and utilising energy in a more sustainable way. To do so, the ecoENERGY Innovation Initiative was created and funded in the Budget 2011, to focus on the following strategic areas:

- Energy efficiency
- Clean and renewable electricity
- Bioenergy
- Electrification of transportation
- Unconventional oil and gas.

Unlike mainstream trends in which sustainable energy efficiency, renewable energy and alternative technologies are considered the only environmentally-friendly sources, Canada's policy also applies to hydrocarbons, an approach derived from Canada's role as a major global oil and gas supplier and the consequent impact of energy production on its economy (NRCan, 2012). To amplify the scope and results of the ecoENERGY Innovation Initiative, it is divided into two funding streams, one for research and development projects and one for demonstrative projects. While a portion of the funding from the programme is to be provided to federal researchers and laboratories as continued support for their activities, candidates for funding also include both for-profit and non-profit Canadian organizations, such as electricity utilities, gas utilities, private sector firms, industry associations, research associations and academic institutions at any provincial, territorial, regional or municipal government level (Canada's Economic Action Plan, 2011).

OIL SANDS

Canada has the world's largest oil sands resources (NRCan, 2013e). Accounting for 97% (169 billion barrels) of Canada's oil reserves (174 billion barrels) (CAPP, 2013b), these resources have secured Canada the third rank only after Venezuela and Saudi Arabia in terms of oil reserves (CAPP, 2013a). Oil sands are a solid, extra-heavy type of crude oil composed of a mixture of natural bitumen, sand, water and clay, with the largest known deposits located in the Athabasca oil fields in Canada's Province of Alberta. Production from oil sands in Canada has grown continuously since its beginning in 1967. It reached 1 744 000 barrels per day (bpd) in 2012 when Canada's conventional oil production was 1 310 000 bpd, accounting for about 57% of Canada's total oil production of 3 054 000 bpd in that year (Ibid.).

In recent years, the run-up in oil prices and technological advancements have dramatically improved the economics of oil sands production and resulted in a boom going into the 2009 recession. Oil sands production is projected to reach 3 000 000 bpd by 2015 (NEB, 2013e).

Rapid development of Canada's oil sands for mainly exports to the USA will likely continue in the foreseeable future. However, its growth rate and sustainability will depend on achieving a balance "between the opposing forces that affect the oil sands" (NEB, 2013e). Thus, on the one hand, certain factors contribute to its development, namely "high oil prices, international recognition, stable investment climate, global growth in oil demand, size of the resource base and proximity to the large U.S. market, and potentially access to other markets" (Ibid.). On the other, there are factors that could hamper its development, including its "water use, air emissions, local

infrastructure and services, labor requirements, natural gas costs and the light/heavy oil price differential” (Ibid.).

Moreover, apart from the large investments required to develop the potential of oil sands, the role of technology in increasing the sustainability of oil sands production will be critical in determining oil sands’ future contribution to the Canadian oil industry. As a reference, technology has enabled a 26% reduction in carbon emissions per barrel of oil sands produced in 2012 compared to 1990 levels (IPIECA, 2012) and this trend is expected to continue. In addition, the Canadian federal and provincial governments alike are investing in such new technologies as carbon capture and sequestration technology in order to utilise this strategic resource in a more sustainable way. This will lead to new technologies that are targeted at reducing both environmental impact and the cost to federal and provincial governments for financial support of such projects (NEB, 2011a).

LNG TERMINAL PROJECTS

The Canaport LNG terminal in Saint John, New Brunswick that began gas-importing operations in 2009 was Canada’s only operating LNG facility (regasification) for some years. However, the NEB during the period October 2011 to February 2013 approved certain LNG export licenses for exporting Canadian LNG to primarily the Asia-Pacific market, for which the respective companies would build LNG export terminals in the Province of British Columbia (BC). They include its awarding a 20-year export licence to KM LNG Operating General Partnership (October 2011) for exporting LNG from the proposed Kitimat LNG Terminal to be located at Bish Cove, near the Port of Kitimat in BC, and another to BC LNG Export Co-operative LLC (February 2012) for exporting LNG from a proposed LNG terminal to be located on the Douglas Channel near Kitimat. In February 2013, the NEB awarded a 25-year export licence to LNG Canada Development Inc. for its LNG exports from a terminal to be located at Kitimat (NEB, 2012b; NEB 2013f).

Among many other requirements for their approval, the NEB ensures that the proposed volume of gas exports does not exceed the surplus needed to meet estimated domestic demand. In the case of the Kitimat LNG terminal approved in 2013, for example, it will be able to export as much as 670 million tonnes of LNG (equivalent to 0.93 trillion cubic metres of natural gas) over a 25-year period, with a maximum annual output of 24 million tonnes of LNG, approximately equivalent to 914.6 million cubic metres of natural gas per day (NEB, 2013f).

As of 2013, Canada does not have any operational LNG export facilities, but at least five such facilities have been proposed as follows: Douglas Channel LNG (Kitimat/BC), Kitimat LNG (Kitimat/BC), LNG Canada (Kitimat/BC), Pacific Northwest LNG (Prince Rupert, BC) and Prince Rupert LNG (Prince Rupert, BC) (NRCan, 2013f).

OTHER PROJECTS

In an effort to expand Canada’s current oil pipeline infrastructure given the growth in oil production, in December 2011, the NEB approved the Bakken Pipeline project. The pipeline will extend from Saskatchewan to Manitoba, connecting to Enbridge Pipelines Inc.’s mainline system, and will serve as a continuous, long-term source of light crude oil supply to the central Canadian and US mid-west markets to maintain the long-term competitiveness of refineries in those regions (NEB, 2011c). Additionally, in February 2012, the NEB authorised the expansion of the Northwest Mainline, a project to build and operate three new natural gas loops in northern British Columbia and northwest Alberta totalling 111.2 kilometres, with an associated investment of CAD 324 million. The project aims to connect the natural gas supply from the Upper Peace River in British Columbia with market demand in Canada and the United States (NEB, 2012c).

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USEFUL LINKS

Atomic Energy of Canada Ltd—www.aecl.ca
 Canadá Gazette—www.gazette.gc.ca
 Canadian Association of Petroleum Producers —www.capp.ca
 Canadian Nuclear Association—www.cna.ca
 Environement 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 its three Latin American member economies. Located in South America, it shares borders with Peru to the north, Bolivia to the north-east and Argentina to the east; to the west, its coastline runs 6 435 kilometres along the Pacific Ocean. It occupies a long, narrow land area of nearly 756 102 square kilometres that is 4 300 kilometres long and on average only 175 kilometres wide. Administratively, Chile is divided into 15 regions that are further subdivided into 53 provinces. In 2010 the economy's population was above 17 million, most of them living in urban areas, with the three largest urban regions alone (Santiago-metropolitan, Bío Bío and Valparaíso) concentrating roughly 40.3%, 11.9% and 10.3% of the total population respectively (INE, 2012). Given the size and shape of its territory and its number of inhabitants, Chile's general population density is low, with less than nine inhabitants per square kilometre in 2010 on average, although in such metropolitan areas as Santiago and Valparaíso it is much higher, having respectively as much as 446 and 107 people per square kilometre (INE, 2011).

Chile's economic growth has been remarkable. In 2011, Chile's gross domestic product (GDP) reached USD 231.73 billion and in per capita terms amounted to USD 13 388 (USD 2000 at PPP) that represented respective increases of 5.9% and 4.9% from 2010 levels. Since 1990, the Chilean economy has almost doubled in per capita terms and has been one of the fastest growing economies in Latin America. In terms of Chile's GDP composition, roughly 17.8% was accounted by the joint agriculture, fishing and mining sectors, manufacturing and industry represented 21.8%, and the services, transport and communications made up the remainder 60.4%. In particular, copper stands as one of Chile's landmarks, being as a significant driver for private investments as its output is mainly oriented to exports; in 2012, this activity accounted alone for nearly 90% of the mining GDP (BCL, 2013).

In order to attract direct investment inflows to sustain its economic growth, the Chilean government has focused on keeping its economy open through liberalisation, free trade and regulatory stability. By 2012, Chile had signed a variety of trade agreements, not all of which were full free agreements. The 60 economies with which it has agreements include: the European Union, Mercosur (a regional trade group comprised of Argentina, Brazil, Paraguay, Uruguay and Venezuela), India, China, Japan, Korea, Mexico and the United States. These agreements grant Chile preferential access to markets that represent the majority of Chile's total trade volume.

Furthermore, and in spite of its diverse geography and abundant natural resources, which are favourable to renewable energy, the territory is very limited in fossil fuel resources, making Chile a net energy importer for which one of its mainstay priorities revolves around a steady energy supply.

Table 3 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|----------------------------------|---------|---|-----|
| Area (sq. km) | 756 102 | Oil (million barrels) ^a | 13 |
| Population (million) | 17.31 | Gas (billion cubic metres) ^a | 10 |
| GDP (USD 2000 billion at PPP) | 231.73 | Coal (million tonnes) ^b | 155 |
| GDP (USD 2000 per capita at PPP) | 13 388 | | |

a. Proved developing reserves at the end of 2011 (MINERGIA).

b. Total recoverable reserves at the end of 2008 (EIA, 2012).

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

According to EDMC (2013), Chile's total primary energy supply (TPES) increased 8.5% from 2010 to 2011 to reach 33 545 kilotonnes of oil equivalent (ktoe). Approximately 47.2% of this energy volume was supplied in the form of crude oil and its by-products, 15.9% as coal, 13.6% as natural gas and the remaining 23.4% as other sources, particularly biomass and hydropower. Given its limited endowment of hydrocarbons, Chile is a net importer of primary energy, especially of fossil fuels, with its net primary energy imports having grown 12% from 2010 to reach nearly 25 000 ktoe, which represented nearly three-quarters of its TPES. Despite its small contribution to TPES, Chile's energy output from non-fossil sources increased 14.3% from 2010 to 2011; while biomass and hydropower accounted for most of this volume, wind energy has grown very rapidly in recent years.

In regards to fossil energy resources, Chile's proved crude oil reserves amounted to 10 million barrels by the end of 2012, with most of it located in the southern Magallanes region. In the light of the low domestic production, nearly all of Chile's crude oil supply of 15 820 ktoe in 2011 came from imports that also included by-products such as diesel, gasoline and LPG (EDMC, 2013). As for natural gas, Chile's demand was met by three-quarters of imports and the rest by domestic production in 2012 (MINERGIA, 2012a).

Chile's domestic coal production is mainly located at Isla Riesco in the Magallanes region. Total recoverable coal reserves are estimated to be roughly 155 million tonnes (EIA, 2012) but as of 2012, domestic production accounted for less than 6% of the total supply (MINERGIA, 2012a).

In 2011, Chile's total installed electricity capacity was 17 549 MW, including public service suppliers (93.2%) and self-suppliers (6.8%). This represented an increase of 595 MW (3.5%) from 2010, with thermal power plants maintaining their share of two-thirds of the total capacity (self-suppliers included), and the remainder contributed by hydropower, the share of which has been declining since 1998, when it reached 48%, to about 33% in 2011 (MINERGIA, 2012a). According to EDMC (2013), in step with the strong economic growth seen in 2011, electricity generation in Chile during that year increased 12.1% in comparison to 2010 and reached 67 724 gigawatt-hours (GWh), of which 59% came from thermal plants, 31% from hydropower plants and the remaining 10.4% from plants with other renewable energy technologies.

Owing to Chile's abundance of renewable energy resources, in particular of water resources, their contribution to TPES is high, totalling 7 022 ktoe and representing more than three-quarters of the economy's total domestic energy production in 2011 (EDMC, 2013). Chile's primary supply of non-fossil energy in 2011 was mainly made up of biomass and hydropower.

FINAL ENERGY CONSUMPTION

Chile's total final energy consumption expanded 9.3% from 2010 to reach little more than 26 000 ktoe by the end of 2011. Energy demand was fairly balanced between the industry (37.4%), residential, commercial and public—jointly grouped as “other”—(32.7%) and transport (29.9%) sectors. By energy source, more than half of Chile's final energy demand was met by petroleum products (52.8%) primarily consumed in the transport and industrial sectors, followed by electricity and other sources (38.4%), natural gas (7.6%) and a marginal share of coal (1.2%). Energy consumption for each of these sources diverged from 2010 levels, rising 13.7% and 11.5% respectively in the cases of oil and electricity, given their pervasiveness into Chile's economic activities, while it dropped nearly 17% for coal and gas alike (EDMC, 2013).

Table 4 Energy supply & consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|--------|------------------------|--------|
| Indigenous production | 9 881 | Industry sector | 9 728 | Total | 67 724 |
| Net imports and other | 24 947 | Transport sector | 7 784 | Thermal | 39 693 |
| Total PES | 33 545 | Other sectors | 8 498 | Hydro | 21 009 |
| Coal | 5 323 | Total FEC | 26 009 | Nuclear | - |
| Oil | 15 820 | Coal | 324 | Others | 7 022 |
| Gas | 4 566 | Oil | 13 734 | | |
| Others | 7 837 | Gas | 1 970 | | |
| | | Electricity and other | 9 982 | | |

Source: EDMC (2012).

ENERGY POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Chile has embarked on the development of an economy based on international trade and the rules of the free market since the 1980s, when the economy started to grow significantly. From that time to 2011, Chile has almost doubled its income per capita and has been one of the fastest-growing economies in Latin America. In addition, it provides a supportive business environment for foreign investments with streamlined administrative processes and simplified tax payments. The Chilean economy is highly integrated, as demonstrated by its participation in free trade agreements and its vigorous development of further trade opportunities. Chile has evolved from an economy dependent on copper exports to a diversified participant in a free market, trading products of higher added value.

In line with these foundations, Chile's energy policy is based on the development of a free market economy and oriented towards enhancing its economic efficiency and energy security by reducing its vulnerability to supply shocks and high dependence on imports, taking into consideration its increasing energy demands. To strengthen the organisation of its energy sector, the Chilean Parliament approved the creation of a Ministry of Energy in November 2009. In February 2010, the new Ministry of Energy started operations. It centralises the functions of developing, proposing and evaluating public policies in this area, including the definition of objectives, the regulatory framework and strategies to be applied, and the development of public policy instruments.

In early 2012, the Chilean government through its Ministry of Energy released the National Energy Strategy 2012-2030 (ENE in Spanish) to guide the economy's long-term energy policy. ENE's main objective is to guide the energy sector and set its policies and objectives for the long term. On electricity issues, the document looks ahead to the goal of supplying clean, competitively-priced and reliable energy to Chile in the coming decades in order to support economic development and growth. To do so, the ENE has established the following six priorities (MINENERGIA, 2012b):

- Economy-wide promotion of energy efficiency
- Promotion of non-conventional renewable energy
- Expansion of hydropower generation to reduce dependence on energy imports
- Introduction of new schemes for electricity transmission
- Modifications to the electricity market to make it more competitive

- Development of energy integration with neighbouring economies.

FISCAL REGIME AND ENERGY PRICES

Since 2000, Chile's fiscal policy has been developed in accordance with a structural surplus rule that emphasises medium-term fiscal responsibility. 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.

In Chile, prices for petroleum-based fuels are set by market conditions 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, LPG and CNG). Although Chile does not employ direct energy subsidies, it has a current price stabilization mechanism that was introduced in February 2011 to reduce uncertainty about domestic prices for oil products. This is the government's Consumers' Protection System for Volatility in International Oil Prices (SIPCO). Under this system, a price band is determined around the average price of a fuel over the previous months; 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 minimized.

Chile's Economic Development Agency (CORFO) is administratively dependent on the Ministry of Economy. Its mission is to promote the economy's economic development by supporting production companies. CORFO handles subsidies for studies at the pre-investment stage and long-term credits for financing. It also helps consortiums to develop biofuels projects and solar energy pilot projects.

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. The electricity market is wholly served by private companies, while the government remains a regulator, policy-maker and technical consultant in such efforts to identify the requirements to meet the projected demand growth. The principal state organisation involved in the regulation of the electricity industry in Chile is the Ministry of Energy, which is supported by the National Energy Commission (*Comisión Nacional de Energía*, or CNE) and the Superintendence of Electricity and Fuels (*Superintendencia de Combustibles y Electricidad*, or SEC).

Due to the ENE's goals issued in 2012, the electricity market in Chile will face a number of changes in the near future to improve competition and transmission infrastructure and foster interconnection with its neighbouring economies. To succeed in its goals, ENE has defined several operational strategies that, with the passing of the Concessions Law in late 2013, will streamline electricity projects and strengthen the economy's infrastructure, including the electricity dispatch centres' autonomy, improvements to supply schemes, regulatory modifications involving transmission and sub-transmission issues as well as the introduction of net billing for residential customers (MINERGIA, 2012b).

Most of Chile's oil and gas sector has been liberalised and is privately owned, although its National Oil Company (*Empresa Nacional del Petróleo* or ENAP) is also a major participant in oil production activities and controls its refining in the economy. Additionally, and to offset its limited hydrocarbon resources, ENAP carries out exploration and production activities abroad, in places such as Ecuador, Argentina and Egypt. Over the last decade the government has been encouraging the participation of private companies in exploration activities to boost domestic production. This led to the signing of nine Oil Operation Special Contracts (CEOPs) in 2007 for blocks in the Magallanes area and of five additional CEOPs in 2011 for blocks in Tierra del

Fuego. In several of these blocks, ENAP participates as a partner. As for coal, the Isla Riesco project in the south of the economy is expected to increase significantly the domestic supply, with an annual output of approximately 6 Mt of coal (Mina Invierno, 2012).

ENERGY EFFICIENCY

Energy efficiency is among Chile's priorities as it works toward achieving its key goal of enhancing its energy security. As per the ENE issued in 2012, the government's approach in recent years has been focused on increasing the electricity generation from nonconventional renewable energy sources, with efforts also encompassing the stabilization of demand growth through energy efficiency efforts. In the ENE, the Ministry of Energy has established a main energy efficiency goal consisting of a 12% reduction in the energy demand forecasted for 2020.

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 hinges on 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 explore opportunities in the field of energy efficiency; and develop energy efficiency marks to recognize and reward leading energy-efficiency companies.

RENEWABLE ENERGY

In April 2008, Law 20.257 (the Law of Non-Conventional Renewable Energy) was enacted, which was added to previous modifications introduced through Law 19.940 (2004) and Law 20.018 (2005). It establishes the requirement that electricity companies include a percentage of non-conventional renewable energy (renewable energy 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 from electricity generators that obtain energy from electric systems with an installed capacity greater than 200 MW be guaranteed to come from non-conventional sources. The required level of non-conventional energy sources rises by 0.5% annually to reach 10% of the total energy production by 2024. Since 2005, the Ministry of Energy has implemented, through the CORFO, a mechanism used to finance feasibility studies for NCRE projects for up to 40% of the total study with a UF 1,000 cap.

Due to the ENE's goal of promoting NCRE, which defines non-conventional renewable energy in terms of all renewable sources with the exception of hydropower plants larger than 20 MW, it is expected that in the near future the share of this type of energy will be increased in the Chilean electricity matrix. To achieve this goal, the ENE has applied several strategies, including improvements to bidding mechanisms; development of a geo-referenced atlas to provide accurate information to support investment projects; financing schemes; and the development and implementation of differentiated policies to account for the specific technical and economic issues that each technology presents (MINERGIA, 2012b). Currently, there are two on-going public contests: the first will subsidise the implementation of a Concentration Solar Power plant; and the second will fund NCRE pilot projects. In addition to the above, the ENE's goal of expanding hydropower generation to reduce dependence on energy imports will also contribute to power generation in favour of carbon-free, renewable technologies.

The Chilean government also enacted the Law to Promote the Expansion of Renewable Energy, which 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 introduces the obligation of the Ministry of Energy to conduct annual public procurement of energy blocks generated from non-conventional renewable energy, which will serve to fulfill the required NCRE quotas.

NUCLEAR

In 1964 Chile created its Commission on Nuclear Energy (*Comisión Chilena de Energía Nuclear*, or CCHEN) to address the operation and regulation of two nuclear reactors located in the Santiago metropolitan region, which up until now have been used only for research 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. In order to consider any program and make any decision in the future, the ENE stresses the need to maintain its ongoing efforts so as to understand the potential advantages and disadvantages of the use of nuclear energy for electricity generation purposes (MINERGIA, 2012b).

CLIMATE CHANGE

Chile is a signatory to the United Nations Framework Convention on Climate Change (1995) and ratified the Kyoto Protocol in 2002. In 2006, the government published a National Strategy on Climate Change to promote action in that area. In December 2008, to complement the strategy, 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). In addition, Chile is involved in the Partnership for Market Readiness Initiative by the World Bank, a grant-based, capacity-building trust fund that provides funding and technical assistance for the collective innovation and piloting of market-based instruments for greenhouse gas emissions reduction. Under this initiative, Chile will evaluate and design an Emissions Trading Scheme (ETS), along with other market instruments that result in mitigation actions in relevant sectors of the economy. More recently, with the publication of the ENE in early 2012, the Chilean government stressed its commitment to the economy's long-term sustainable development through the development and use of energy in a way that preserves the environment.

Since 2012, Chile has been working in a participative multi-actor project named Mitigation Actions Plans Scenarios—MAPS Chile. The main objective of this project is to estimate mitigation scenarios and their economic impacts for 2020, 2030 and 2050 using such tools as energy and macroeconomic quantitative models.

While Chile's contribution to global carbon emissions is very low, at around 0.2% of the global carbon dioxide emitted in 2009 (UNStats, 2012) 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, and where adaptation would be required.

NOTABLE ENERGY DEVELOPMENTS

All energy sector public services are now integrated and under the oversight of the Ministry of Energy, including the CNE, the SEC, and the Commission on Nuclear Energy. These institutions are charged with applying, clarifying and interpreting macro policies, technical analysis, tariffs, rules and regulations, along with enforcement. On the implementation side, the Government is supported by the Renewable Energy Centre and the Chilean Energy Efficiency Agency. The activities of these agencies are integrated with other government agencies, and involve public and private sector cooperation.

ENERGY EFFICIENCY

In order to enhance energy efficiency across the economy, the following are some of the milestones that have been achieved during 2013:

- **Launch of the Action Plan of Energy Efficiency (PAEE20):** establishes a series of concrete measures to be implemented in the period 2012 - 2020, with the aim of achieving a 12% reduction in the final energy demand projected for 2020.
- **Vehicular labeling:** The vehicular labeling aims to provide objective information to the public on fuel consumption and CO2 emissions of new vehicles. It only applies to the first sale of light vehicles, with a gross vehicle weight of up to 2700 kg and which are used for the passengers transport, except those designed primarily to carry cargo such as trucks and vans.
- **En.lighten Initiative:** For the transition to efficient lighting, Energy Efficiency Division coordinated this initiative to develop a policy for the transition to more efficient lighting in the residential sector. This involves the development of MEPS, the implementation of support programs, improving the technical capacity for the quality assurance of the products on the domestic market and ensuring a sustainable transition. This forms part of a global initiative and is promoted by the United Nations Environment Program (UNEP), which selected Chile as a pilot country.
- **MEPS for non-directional lamps for general illumination:** In December, the Ministry of Energy released the first energy efficiency standard. As a result, lamps with an energy efficiency index greater than 80% may not be sold. The restriction on sales will be gradual over time.
- **Launch of the Energy Efficiency Label for companies (Sello de Eficiencia Energética in Spanish):** The label is a recognition that identifies and rewards the leading companies in the development of national energy efficiency initiatives that have allowed them to reduce their energy costs, increase their competitiveness and reduce their emissions. In December 2013, 40 companies are recognized with the Energy Efficiency Label.
- **Energy efficiency rating system for the residential sector:** The Energy Rating of Dwellings is a tool for voluntary use, which rates the energy efficiency of a new home in its use stage, considering requirements for heating, lighting and hot water.
- **Creation of the Inter-Ministerial Committee for Energy Efficiency (CIEE):** To strengthen coordination between ministries and agencies, the Inter-Ministerial Committee for Energy Efficiency (CIEE) was created with the mission to advise the President on the coordinated development of public policies, plans, projects and to guide the development of EE in the public sector.
- **Incentive Program for the production and trade of dry firewood:** A program for the construction and implementation of collection centers and drying firewood began in 2013, through a competitive nonrefundable fund for producers and traders in the region of Araucanía, Los Lagos, Aysén and Los Ríos, executed by the Technical Cooperation Service (SERCOTEC).
- **Communicational Campaign "Rock the Future: Energy efficiency is the energy of the future":** (November to December 2013). The media campaign consisted of a mini series of four chapters, developed with the aim of creating consciousness about the correct use of energy in homes. It was primarily focused on young persons between the ages of 15 and 35, a generation that is considered to be a major factor of change in our society.

Also the Chilean Energy Efficiency Agency (AChEE) has worked on implementing energy efficiency specific programs in the areas of Industry and Mining, Transport, Buildings, Education, Monitoring & Verification and Business Development.

RENEWABLE ENERGY

With the aim of promoting a more accelerated development of renewable energy, in March 2013 Chile's Ministry of Energy released a new regulation for geothermal projects that grants holders of exploration permits the right to exploit the resources they find through an exploitation permit. By the same date, 76 exploration permits and six exploitation permits had been granted, setting a more favourable outlook for the development of this energy source (MINERGIA, 2013b).

In January 2013 the Tambo Real solar power plant with a capacity of 1.2 MW in the Central region of Chile came online and in July 2013 the El Águila solar power plant with an installed generating capacity of 2 MW started operations. The El Águila plant is located in Arica at the north of Chile, the plant supports Chile's mission to diversify its power generation portfolio and strengthen non-fossil power generation in order to reduce its vulnerability and enhance its environmental sustainability. Moreover, these projects will pave the road towards more ambitious efforts entailing larger solar capacity (MINERGIA, 2013a). Other significant achievements in renewable energy are as follows:

Award Tender Concentration Solar Power

The Government of Chile and CORFO grant a subsidy of \$20 million and access to additional funding from major players worldwide, for over U.S. \$500 million for the construction of the first Concentrated Solar Power (CSP) in Latin America. The contest was awarded to Cerro Dominador project, belonging to the company Abengoa Solar Chile. The concentrating solar plant to be built considered an output of 110 MW and 17.5 hours of thermal storage, allowing for an operation with a higher plant factor of 80%. The initiative will be located in the commune of María Elena, Antofagasta Region and the estimated investment amounts to approximately U.S. \$1,000 million. For its operation, the plant must precisely align its 10,600 mirrors with an area of 140 square meters each, distributed in a circular area of about two and a half miles, to reflect the sunlight that strikes them toward the top a 243 foot-high central tower.

Tender "Innovation in Non Conventional Renewable Energy"

The Ministry of Energy, announced the results of the contest "Innovation in Non-Conventional Renewable Energy" initiative to support the development of pilot projects for energy self-sufficiency based on renewable sources. The competition received 34 proposals, of which 10 were selected, for a total investment of \$5,400 million, of which this program will co-fund 33% (approximately \$ 1,800 million). The selected initiatives developed different technologies: solar, biomass and mini-hydro, for different industries, such as salmon, mining, retail, fruit, wine, dairy, fishing, sports and education.

Applied Research and Development in Solar Energy

Fraunhofer ISE has benefited from being part of the new "Applied Research Centres and Development" that operate in Chile. The Fraunhofer Institute for Solar Energy (ISE), perform applied R & D in solar energy. It has funding support from the Ministry of Energy for 8 years for a total amount of 13 million dollars.

Applied Research and Development in Marine Energy

On January 6th, the Ministry of Energy in conjunction with InnovaChile launched a call for International Centres of Excellence for R & D in energy of the seas. This initiative will be open until 8 April 2014. The Ministry of Energy will devote a fund of \$13 million over 8 years to finance the activities of the research center.

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USEFUL LINKS

- Chilean Energy Efficiency Agency (AChEE)—<http://www.acee.cl>
- Chilean Energy Efficiency Agency—www.acee.cl
- Economic Load Dispatch Centre Norte Grande Interconnected System—www.cdec-sing.cl
- Economic Load Dispatch Centre of Central Interconnected System—www.cdec-sic.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 Energy Commission (CNE)—www.cne.cl
- National Institute of Statistics (INE)—www.ine.cl
- National Oil Company (ENAP)—www.enap.cl
- Nuclear Energy Chilean Commission (CCHEN)—www.cchen.cl
- Superintendence of Electricity and Fuel (SEC)—www.sec.cl

CHINA

INTRODUCTION

China is one of the world's important emerging economies. It is located in north-east Asia and bordered by the East China Sea, the Yellow Sea and the South China Sea. Its population of 1.34 billion is roughly one-fifth of the world's population. It has a land area of about 9.6 million square kilometres, with diverse landscapes consisting of mountains, plateaus, plains, deserts and river basins. Its total maritime area is 4.73 million square kilometres, and the length of its coastline reaches 32 thousand kilometres (NBS, 2012).

After reforming and opening up its economy in 1978, China entered a new period of high-speed growth. Its entry to the World Trade Organization in 2001 further contributed to its prosperity in the first 10 years of the twenty-first century. China's proportion of total imports and exports in the world increased from 4.0% in 2001 to 9.9% in 2011 (WTO, 2012). In the previous year, China overtook Japan to become the world's second-largest economy, ranking after the United States. Its gross domestic product (GDP) was 8845 billion (USD 2000 at PPP), with the primary, secondary and tertiary industries accounting for 10.0%, 46.6% and 43.3%, respectively (EDMC, 2013; NBS, 2012).

Due to its huge population and booming economy, China plays an increasingly important role in the world's energy markets. Some statistics have reported that China was the world's largest energy consumer in 2012 and accounted for 21.9% of global primary energy consumption in 2012 (BP 2013). However, its per capita primary energy supply, at 1.89 tonnes of oil equivalent (toe) in 2011, is far lower than that of many developed economies and below the world's average. It is almost one-fifth of the per capita energy consumption of the United States (EDMC, 2013).

China is rich in energy resources, particularly coal. According to recent estimates, China had recoverable coal reserves of around 114.5 billion tonnes, proven oil reserves of 17.3 billion barrels and proven natural gas reserves of 3.1 trillion cubic metres (tcm) at the end of 2012 (BP, 2013). In addition, China is endowed with 400 gigawatts (GW) of economic hydropower potential, more than any other economy. Coal and oil resources have been utilized more extensively than natural gas and hydro for power generation and industrial development.

In terms of its energy reserves per capita, China is not so well endowed. 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 1978 to 2011, the average annual growth rate of primary energy consumption in China was 5.6% and the average annual growth rate of GDP was 9.9% (NBS, 2012). China essentially achieved its goal of a quadrupling of GDP supported by only a doubling of energy consumption.

Table 5 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|------------------------------------|-----------|------------------------------|--------|
| Area (sq. km) | 9 600 000 | Oil (million barrels) | 17 335 |
| Population (million) | 1344.1 | Gas (billion cubic metres) | 3 096 |
| GDP (USD (2000) billion at PPP) | 8845.33 | Coal (billion tonnes) | 114.5 |
| GDP (USD (2000) per capita at PPP) | 6581 | | |

a. Proven reserves at the end of 2011 (BP, 2013).

Source: EDMC (2012).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001, driven mainly by rapid economic growth, especially in energy consumption by heavy industry. In 2011, the total primary energy supply increased 10.3% compared with 2010, reaching 2 536 million tonnes of oil equivalent (Mtoe), including net imports and other. Of this, coal was the dominant source, accounting for 74.3%, followed by oil (17.8%), gas (4.8%) and other (3.0%) (EDMC, 2013).

Table 6 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|-----------|---------------------------------|-----------|------------------------|-----------|
| Indigenous production | 2 223 366 | Industrial sector | 876 017 | Total | 4 713 019 |
| Net imports and other | 381 251 | Transport sector | 182 516 | Thermal | 3 806 136 |
| Total PES | 2 536 205 | Other sectors | 393 889 | Hydro | 698 945 |
| Coal | 1 885 584 | Total FEC | 1 452 421 | Nuclear | 86 350 |
| Oil | 451 986 | Coal | 559 002 | Other | 121 588 |
| Gas | 121 866 | Oil | 413 902 | | |
| Other | 76 769 | Gas | 82 394 | | |
| | | Electricity and other | 397 123 | | |

Source: EDMC (2013).

China has provided significant political and financial support for the development of its abundant indigenous coal reserves to ensure the security of its energy supply. In 2011, China's total energy production reached 2223 Mtoe, of which coal accounted for 82.2%, followed by oil (9.13%), gas (4.3%) and other (4.3%) (EDMC, 2013). Since the 1990s, Chinese authorities have been encouraging fuel switching (for example, from coal to cleaner fuels), introducing energy-efficiency initiatives to reduce pollution and emissions from energy use, and optimising 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 2012, coal production reached 1825 Mtoe, 3.5% higher than the previous year. Total coal consumption reached 1873 Mtoe, 6.1% higher than the previous year and 50.2% of global coal consumption in 2012 (BP, 2013).

In 2012, China's domestic crude oil production reached 207.5 million tonnes (mt), rising 2.0% compared to 2011. At the same time, crude oil imports reached 271 mt. Since 1993, China has been a net oil and oil product importer, and net oil and oil product imports increased to 327 mt in 2012. Total oil consumption reached 483.7 mt, 5.0% higher than the previous year and 11.7% of global oil consumption in 2012 (BP, 2013).

China's proven gas reserves and gas production have expanded rapidly. Gas reserves have grown from 1400 billion cubic metres (bcm) in 2001 to 3100 bcm in 2012. Since 2001, gas production in China has grown 12.2% a year, on average, to reach 107.2 bcm in 2011 (BP 2013). The expansion of natural gas pipelines has also been rapid (NBS 2012). At the same time, China imported 20.0 bcm of liquid natural gas (LNG) and 21.4 bcm of pipeline gas in 2012. Total gas consumption reached 143.8 bcm, 9.9% higher than the previous year and 4.3% of global gas consumption in 2012 (BP, 2013).

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, which were major consumers of electricity. Subsequently, however, a power supply shortage developed as a result of rapid economic expansion after 2001. Between 2001 and 2005, installed generation capacity increased steadily at an annual average rate of 9.8%; since 2005, installed generation capacity has increased steadily at an annual average rate of 13.6%. In 2010, installed generation capacity reached 962 GW, an increase of 10.1% compared with 2009 (EDMC, 2013).

The power supply structure is becoming more diversified, with wind power and nuclear energy generation increasing rapidly. In 2011, total power generation in China was 4713.02 terawatt hours (TWh). Thermal power accounted for 80.8% (3806.14 TWh) of total generation, hydropower 14.8% (698.95 TWh), nuclear energy 1.8% (86.35 TWh) and other 2.6% (121.59 TWh) (EDMC, 2013).

FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1452.42 Mtoe in 2011, 7.1% higher than in the previous year. The industrial sector was the largest consumer, accounting for 60.3% of total final energy consumption, followed by the transport sector (12.6%) and other sectors, including residential, commercial and agriculture, totalling 27.1% (EDMC, 2013).

Power generation increased 12% to 4713 TWh in 2011, compared to the previous year (EDMC, 2013). Demand rate growth was, as in previous years, based mainly on increased consumption in the commercial and residential, transport and industrial sectors. In 2011, the industrial sector accounted for the majority of electric power consumption (69.6% or 231.00 Mtoe), followed by the residential and commercial sector (25.6% or 84.94 Mtoe, including non-specified), agriculture (2.6% or 8.71 Mtoe) and transport (2.1% or 7.30 Mtoe). In terms of growth, electric power consumption in the transport sector in 2011 increased by 15.5% compared with the previous year, the industrial sector by 12.3%, the residential and commercial sector by 11.4%, and the agriculture sector by 3.7% (EDMC, 2013).

Coal consumption, excluding coal consumption to generate electricity, was 559 Mtoe in 2011 (EDMC 2013). The electric power generation sector was the biggest coal consumer, followed by the metallurgical sector, the building materials sector, the chemical sector and other. Coal consumption in the residential, commercial and agriculture sectors showed little growth.

In 2011, total final oil consumption was 414 Mtoe. The industrial sector was the largest oil-consuming sector, accounting for 38.8% of total final oil consumption, or 160.4 Mtoe. The transportation sector was the second largest in terms of consumption and accounted for 38.7% of total oil consumption or 159.99 Mtoe (EDMC, 2013).

The market for gas is moving to the north and east of China with the completion of the Shaanxi–Beijing and West–East gas pipelines. With the larger-scale utilization of gas, residential and commercial consumption grew from 5.19 Mtoe in 2000 to 29.12 Mtoe in 2011. However, the industrial sector was still the largest sector in total final gas consumption, accounting for 47.1% or 38.79 Mtoe (EDMC, 2013).

Based on changes in its electricity mix and energy consumption in end-use, China's primary energy structure is being continuously optimised, and the proportion of low-carbon energy has increased significantly. In 2011, the proportion of coal used was 68.4% (compared to 76.2% in 1990), the proportion of oil and natural gas used rose from 18.7% in 1990 to 23.6%, and hydropower, nuclear energy and wind power rose from 5.1% in 1990 to 8.0% (NBS, 2012).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

China's energy consumption has grown rapidly, in line with robust economic development and accelerated industrialization. Energy has become an important strategic issue for China's economic growth, social stability and security. A low-carbon society is a goal for China. The structural transformation of energy is considered the key to economic restructuring, which is also seen as 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.

In March 2011, the National People's Congress approved the Twelfth Five-Year Plan for National Economic and Social Development (the Twelfth Five-Year Plan), which clarifies the national strategic intent, the government's focus and the people's common programme of action during the five year period starting from 2011. The plan emphasizes that China will continue to give priority to thrift, rely on domestic resources, encourage diverse patterns of development, protect the environment, increase international cooperation for mutual benefit, adjust and optimise the energy structure, and construct a modern energy industry with the merits of safety, stability, economy, and cleanliness. Some targets related to energy are also published in the plan, including increasing the proportion of non-fossil fuel usage in total primary energy consumption to 11.4%, and reducing the energy consumption per unit of GDP by 16% and carbon dioxide emissions per unit of GDP by 17% by 2015, compared to 2010.

ORGANISATION

To coordinate the overall energy policies, China has established a high-level coordinating body, the National Energy Committee. The committee, chaired by the Premier, is in charge of drawing up China's energy strategy and deliberating on major issues in energy security. In March 2008, the National Energy Administration (NEA) was formed, under the administration of the National Development and Reform Commission (NDRC). In March 2013, the State Electricity Regulatory Commission (SERC) was merged into the NEA. The NEA currently is composed of 12 departments, with an authorized staff size of 240 civil servants. It is responsible for developing and implementing energy industry planning and industrial policies and standards and for administering the energy sector, including coal, oil, and natural gas; power including nuclear energy, and new and renewable sources of energy. It 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 policy development.

In 2009, the National Energy Conservation Centre was formed directly under the NDRC to provide technical support to the government in implementing 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

There are a series of laws related to energy in China today, such as the Coal Law, the Electricity Law, the Renewable Energy Law, the Energy Conservation Law and the Environmental Protection Law. A comprehensive legal basis for the energy sector, the Energy Law, is currently under consideration. The amended version of the Renewable Energy Law was endorsed by the Standing Committee of the National People's Congress on 26 December 2009 and came into effect on 1 April 2010. It more clearly defines the responsibilities of the power grid and power generation enterprises and emphasizes 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 will receive all of the revenue generated from the surcharge on retail power tariffs, and it sets a minimum target for the amount of electricity the grid companies must buy from renewable energy projects.

The Oil and Natural Gas Pipeline Protection Law was endorsed by the Standing Committee of the National People's Congress on 25 June 2010 and came into effect on 1 October 2010. The law requires that oil and pipeline companies take safety measures while constructing pipelines, ensure the quality of construction materials, have regular patrols of pipelines and promptly eliminate any hazards.

The Regulation on the Administration of Urban Gas was approved by the State Council on 19 November 2010 and became effective 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.

FISCAL REGIME

China has implemented a series of reforms covering energy investment, government regulation, market adjustment and the management of state-owned energy companies. The economy encourages investment diversification in the energy sector, offers autonomy to businesses and seeks to attract foreign capital and advanced technology to China's energy industry.

The Chinese energy tax regime includes resource taxes, royalties, mineral resources compensation, consumption taxes and other levies. Since 1 October 1984, China has collected a resource tax on oil, natural gas and coal. The levying scope was expanded in 1994, and after that the tax was levied according to the volume of production as well as the circumstances of the various resources. In September 2011, the Provisional Regulations on Resource Taxes were amended by the State Council. From 1 November 2011, the assessment base for resource taxes on crude oil and natural gas was changed from production amount to sales value, with the tax rate ranging from 5%–10%. Coking coal and rare earth ores were singled out from coal and nonferrous metal ore resources respectively. Correspondingly, their tax rates were raised to CNY 8–20 per tonne and CNY 0.4–60 per tonne, respectively.

The collection of royalties is limited to offshore and onshore oil and gas exploitation. Since 1989, production of up to 1 mt of crude oil in offshore exploitation has royalties levied at a rate of 2.5%–4%. Similarly, production of up to 2 bcm of natural gas has royalties levied at a rate of 1%–3%. For onshore exploitation, the collection of royalties has depended on the annual production of each oil field or gas field since 1990. The rate ranges from 1%–12.5% for production of up to 50 000 tonnes of crude oil and 100 million cubic metres of natural gas. All royalties can be paid in kind. Since 1 April 1994, China has levied mineral resources compensation on mining operators. The rates differ between mineral resources, ranging from 0.5%–4%. There are 13 kinds of energy-related products, including gasoline and diesel that incur a consumption tax.

On 25 March 2006, the State Council decided to collect a Special Oil Gain Levy from oil companies that obtain excess income from sales of domestically produced crude oil when the crude oil price exceeds a certain level. The cut-off point is USD 40 per barrel and the levy rate is progressive, with five categories ranging from 20% to 40%.

ENERGY SECURITY

“More coal, less oil and gas” is statement that characterises China's energy resources. The most efficient use of available resources is accepted as a necessary guiding principle for the economy. China has also strengthened the security of its oil supply through building and supporting bilateral cooperation with new trading partners and through the globalisation of its oil and gas assets. The trend toward energy diversification in China, in terms of the fundamental energy system, energy structure and regional energy development, is considered important for the formation of a secure energy base.

A backdrop of rapidly rising oil needs and faltering domestic production have resulted in China turning to secure oil internationally while speeding up the build-out of its strategic petroleum reserve (SPR).

China has been trying to increase the security of its oil supply by encouraging Chinese companies' upstream investment activities abroad, through cooperation with international and/or local companies. After 16 months of construction, the China–Russia crude oil pipeline was completed in September 2010. This is designed to transport 150 mt of crude oil per year from 2011 to 2030. On 10 September 2010, construction began on domestic engineering of the China–Myanmar oil and gas pipeline in Yunnan province. In 2009, the first phase of China's SPR projects was completed and in operation. In 2010, a second round of SPR projects began construction, and a third round of SPR locations went through the site selection process. According to the China Petroleum and Chemical Industry Federation (CPCIF), with the addition of the second and third rounds, China's SPR capacity will reach 350 million barrels by the end of 2015 (CPCIF 2011).

In order to secure the energy supply, the NDRC and the Ministry of Finance decided to set up a strategic coal reserve base in major coal production areas and import ports in 2011. The first round of reserves with capacity of 5 mt is expected to be completed by the end of 2012. China will continue to look for new locations for a second round of strategic coal reserves with another 10 mt capacity, and expects to finish by the end of 2013 (CEN, 2011).

ENERGY MARKET

Actively promoting the reform of the energy market and uniformly allocating the necessary resources to accelerate development are among China's major concerns. The Government of China announced that the entire range of projects included in the National Energy Plan will be open to private investment, except those that are 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," which 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.

China has stressed that reform is a strong driving force in accelerating the transformation and diversification of energy. China intends to continue pushing firmly ahead to reform the energy field, strengthen top-level design and overall planning, accelerate the establishment of institutional mechanisms for the development of energy technology, improve the environment for energy development and promote a revolution in energy production and application to secure the economy's energy supply in line with demand (Reuters, 2012).

Coal market

Coal is the major primary energy source for China, contributing about 70%, and this is expected to remain the case for the foreseeable future. Due to efforts by the State Council and enforcement of policies regarding coal industry development during the period of the Eleventh Five-Year Plan (2006-2010), the coal industry has made quite promising progress (CEN, 2011).

- The coal reserve was about 1341 billion tonnes (bt) in 2010, up 300 bt from 2005. More than 90% of the increase in reserves comes from the western area of China. It also has the potential to create another economic development opportunity for that region.
- Great progress has been observed in production technology through the introduction of new technology and equipment and with the merger of existing coal companies. Total production was 3.24 bt in 2010, an increase of 0.89 bt compared with 2005. Fifty-eight percent of production came from 661 sites with annual production of more than 1.2 mt. There were 40 coal mines with annual production capacity of over 10 million tonnes, producing 560 million tonnes of coal in 2010.

- Significant progress has been made in the construction of large coal production bases. There are 14 major coal production bases with a total annual production greater than 2.8 bt, contributing 87% of total production in China.
- Small coal production sites have been retired or closed. By 2010, 9,616 sites were closed and fewer than 10 000 sites with annual production of less than 300 000 tonnes remained. This has led to improvements in coal production safety and a reduction in the industry death rate from 2.81 deaths per million tonnes of production in 2005 to 0.749 in 2010, 0.564 in 2011, and 0.374 in 2012.
- The coal industry continues to be opened up to private investment. By the end of 2010, 35 coal companies had raised a total of CNY 169 billion in the stock market.

In March 2012, the NEA announced its Twelfth Five-Year Plan for Coal Industry Development and set an overall target for annual coal production to reach 3.9 bt by 2015. The Plan calls for the industry to:

- Continue to push for the formation of large coal companies. It is expected that 10 companies that produce 100 mt/year and 10 companies that produce 50 mt/year will be formed and that these 20 companies will contribute more than 60% of production in China.
- Continue to improve the safety of coal production, reducing deaths per million tonnes of production by more than 28% in 2015 compared to 2010.
- Adjust the balance between production and demand, strengthen the railway and shipping transportation system, reduce the long-distance road transportation of coal, and establish an emergency coal reserve system, improving emergency response capabilities.
- Strengthen the development of coal bed methane. This is expected to result in the creation of 36 sites with annual production of coal bed methane in excess of 100 million cubic metres. Encourage the application of coal bed methane in district power generation and for household use through the construction of a district pipeline network.

Since 2011 the central government has begun requesting that large coal and power enterprises establish coal reserves in the major collection and distribution centres, consumption regions and key transport hubs, so as to be able to respond to supply disruptions or serious shortage of coal due to natural disasters or other emergencies. The central government grants a subsidy to the stakeholders for their costs in relation to the reserves and instructs them to use the reserves when it is necessary.

Oil market

In December 2008, China instituted an oil product tax and price reform plan. Based on the Highway Law and other relevant regulations, the NDRC, the Ministry of Finance, the Ministry of Transport and the State Administration of Taxation jointly drafted a proposal on a fuel tax reform programme. The programme was approved by the State Council and took effect from 1 January 2009. The main aim of the reform is to standardize government fees and charges, and it includes two aspects. First, it abolishes all fees related to road maintenance, waterway conservation, road transport management, road passenger and freight surcharges, water management and water transport passenger and freight surcharges, as well as government approval of road charges on secondary loans. The changes will be made gradually and in an orderly fashion. Second, the reform raises the gasoline consumption tax from CNY 0.2 a litre to CNY 1 a litre for gasoline and from CNY 0.1 to CNY 0.8 for diesel, with similarly increased unit taxes on other oil products. For gasoline and diesel oil, the aim is to implement a fixed-amount consumption tax rather than an *ad valorem* tax.

Prices for oil products continue to be the mandated or guided by the government depending on the product type. When the average oil price in the related international market varies by greater than 4% for more than 22 consecutive working days, the government may adjust domestic oil product prices accordingly. From December 2008 to March 2013, the price has been adjusted 25 times: it has risen 15 times and fallen 10 times. In March 2013, the NDRC revised

the oil pricing mechanism to closely reflect global price movements. The new plan shortened the 22-working day price review period to a 10-working day period and removed the 4% fluctuation limit, which means the government will adjust domestic oil product prices based on international market fluctuations every 10 working days (NDRC, 2013).

When the National Standardisation Technical Committee for the Oil and Natural Gas Industry was set up on 9 May 2008, standardisation of China's oil and natural gas industry entered a new stage of development. The committee is mainly responsible for petroleum geology, oil exploration, oil drilling, logging, oil and gas field development, gas production, storage and transportation of oil and gas, oil and gas measurement and analysis, oil pipes, offshore oil engineering, production safety and environmental protection.

Natural gas market

Natural gas can be considered a high quality and relatively clean energy source, with high conversion efficiency, lower environmental cost, low investment cost and short construction periods. There is an increasing global trend to actively develop natural gas resources, and China's energy industry is now rapidly expanding in this area. The industrial chain from production, transmission and application of natural gas is expanding, while diversification in natural gas consumption is also increasing. On 14 October 2012, China released the new Natural Gas Utilisation Policy (2012 Gas Policy). The 2012 Gas Policy addressed some important issues such as balancing gas supply and demand, promoting economical and efficient use, intensifying the pricing reform and classifying gas users (NDRC 2012).

In 2010, China's natural gas demand reached 107.6 bcm, making it the world's fourth-largest natural gas market. Demand is expected to reach 230 bcm by 2015. This will require extensive infrastructure construction and the creation of extensive domestic natural gas distribution and storage facilities in a short time. It will also require ensuring an adequate supply source, which means that the price of natural gas should be kept at a reasonable level to attract more suppliers (CEN, 2011).

In order to regulate natural gas prices, the Chinese Government has been accelerating the establishment of a market-based pricing mechanism for natural gas products. The disadvantages of a government-controlled natural gas price are becoming apparent, with the domestic price of natural gas well below the international price of natural gas and alternative energy prices. The price of natural gas has also varied among domestic regions. On 31 May 2010, the NDRC issued a notification to increase the benchmark price of domestic onshore natural gas, which took effect from 1 June 2010. It aims to create an appropriate increase in the domestic natural gas price and to improve related policies concerning natural gas prices and supporting measures (NDRC 2011). In view of carbon reduction concerns and expansion of the energy distribution system to some of the economy's remoter regions, the NDRC, the Ministry of Finance, the Ministry of Housing and Urban-Rural Development and the NEA jointly issued an Instruction for Developing a Distributed Energy System based on Natural Gas in September 2011. From 2011–15, China will construct about 1000 distributed energy systems based on natural gas projects, along with about 10 demonstration areas with typical distributed energy system features. Distributed energy systems will be promoted in the more prosperous cities, with total installed capacity expected to reach 50 000 MW by 2020 (NDRC 2011).

China has estimated technically recoverable shale-gas resources of 36.1 tcm, which is in theory enough to meet China's gas needs for the next two centuries (EIA, 2012). It has launched a five-year plan (2011–2015) for the development of shale gas, aiming for 6.5 bcm/year of shale gas production by 2015, the equivalent to 2–3% of projected Chinese gas production in 2015, and 60–100 bcm/year of shale gas production by 2020. Geological conditions are complex, however, and will pose great technical and investment challenges. In order to secure more natural gas supply through domestic shale gas, China and the United States signed a working plan of action on shale gas resources during the second round of their strategic and economic dialogue in May 2010. They agreed that, based on the US's experience in unconventional natural gas development and in accordance with relevant Chinese laws and regulations, both sides will

strengthen cooperation in shale gas resource evaluation and exploration and in the development of technology and related policies.

Electricity market

In addition to the energy-related legislation listed earlier, these laws also regulate the electricity industry in China: the Electricity Law, the Energy Conservation Law, the Renewable Energy Law, the Regulations on Electric Power Supply and Consumption, and the Basic Operating Rules for the Electric Power Market.

The State Electricity Regulatory Commission (*SERC*), formed in 2003, was another administrative agency for the electricity industry, in addition to the NDRC and the NEA. However, according to a plan of institutional restructuring and functional transformation of the State Council, approved by the National People's Congress, the SERC was merged into the NEA in March 2013. This is considered a significant change for China's power industry. The restructuring has eliminated the overlapping of functions and responsibilities between the original NEA and the SER and endowed the new NEA with greater administrative and regulatory power over the energy sector.

In 2011, thermal power plants, particularly coal-fired power plants, were under pressure both from the move towards carbon reduction and from operational deficits. The southern provinces experienced the worst power shortages since 2004. This situation was caused by the contradiction that existed between coal-fired power plants and the price for supplying coal, which resulted in a “the more power generated, the greater the deficit” dilemma for existing coal-fired power plants. In order to solve this problem, the NDRC announced the decommissioning of coal-fired power plants with a capacity of less than 100 MW by the end of 2011, and proposed a mechanism for creating a linkage between the price of electricity and coal prices. In 2011, China adjusted the tariff for electricity three times. The last adjustment, at the end of 2011, was more comprehensive, and included CNY 0.008/kWh in subsidies. In this regard, while price adjustments may ease the losses incurred by thermal power enterprises, reliance on temporary administrative adjustments makes it impossible to solve the problems of China's electric power system (CEN, 2011).

Another phenomenon that can be observed as a result of operational difficulties at thermal power plants is that some coal production enterprises have gradually expanded their business into the thermal power industry. This gives rise to two concerns. One is the continued growth of coal-fired power plants. The other is that rising coal prices will bring greater revenue for the coal industry. These will create disadvantages in terms of efforts to reduce carbon emissions. However, the integration of power generation companies with coal production companies can also help avoid the risk of coal price fluctuations and enhance the stability of the electricity supply (CEN, 2011).

According to the SERC, the average power tariff in 2010 was CNY 384.6 per thousand kWh, a 0.67% increase from 2009. By plant type, the average gas turbine power tariff was CNY 610.8 per thousand kWh, nuclear energy CNY 432.2 per thousand kWh, and thermal power CNY 394.8 per thousand kWh; while hydropower, at CNY 291.2 per thousand kWh, was the lowest (SERC, 2011).

Nuclear

The development of nuclear energy has become an option for optimising China's energy structure, ensuring energy security and improving environmental protections. The Medium- and Long-Term Nuclear Energy Development Plan (2005–20), issued in 2007, called for total nuclear energy installed capacity to reach 40 million kW by 2020, and for annual power generation by nuclear energy to reach 260–280 billion kWh. An additional 18 million kW of installed capacity is expected to be under construction at the end of 2020.

Since 2008, China has accelerated its development of nuclear energy. As of the end of 2011, 15 nuclear power generating units were in operation, with a total installed capacity of 12.54 million kW. Another 26 units, still under construction, were designed with a total installed

capacity of 29.24 million kW, leading the world. According to the Twelfth Five-Year Plan for Energy Development, the installed capacity of nuclear power is expected to reach 40 million kW by 2015.

A draft Regulation on Nuclear Energy Management is being developed. This will mainly focus on construction planning, nuclear energy development, rights and obligations of parties involved, nuclear energy power plant operation supervision and technical standards issues. The Management Approach for National Energy Storage of Natural Uranium is also being developed. Documents that came into effect in 2008 included the Regulation on Supervision and Control of Civil Nuclear Safety Equipment, and the Rules for Personnel Qualification Management for Non-destructive Testing of Civil Nuclear Safety Equipment. At the same time, the NEA also issued the Reporting System for Construction of Nuclear Energy Projects and the Reporting System for Nuclear Power Plants in Operation. To support the development of nuclear energy, in April 2008 the Ministry of Finance and the State Administration of Taxation jointly issued a notice about taxation policy for the nuclear energy industry (Tax 2008, no. 38). According to the notice, after the month that commercial nuclear energy generating units are put into operation, taxation of the sale of electric power generation products follows a unified policy of reimbursement after levying value-added tax. The return is 75% of the total tax in the first five years, 70% in the second five years and 55% in the third five years.

Since the crisis at Japan's Fukushima Daiichi nuclear plant early in 2011, China has been paying more attention to the safety of nuclear energy. Some measures were determined immediately, including carrying out comprehensive safety checks and enhanced management of existing plants, reviewing the construction of nuclear energy plants against the most advanced safety standards, and working on a nuclear safety plan. Until the plan is approved, all new nuclear energy power plants, including pre-construction projects, will be suspended. On 25 October 2012, the Chinese Cabinet approved new safety rules, adopting the world's most rigorous reactor safety standards for nuclear power plants, and announced an end to the freeze on nuclear power projects instituted after the Fukushima accident in Japan. The Chinese government has said that it will approve a small number of plants along the coast in accordance with new stricter safety rules. However, it insists that no nuclear plants will be built in inland areas during the period of Twelfth Five-Year Plan (2011-2015) (SCC, 2013).

RENEWABLE ENERGY

The development of renewable energy in China is seen as inevitable and of benefit to the sustainable development of society and the economy. China plans to vigorously develop renewable energy and nuclear energy, with the aim of achieving a 15% share for non-fossil fuels in its primary energy consumption mix by 2020.

China announced the Medium- and Long-term Development Plan for Renewable Energy in September 2007. The general goal of the plan is to steadily raise the share of renewable energy in overall energy consumption. It also aims to promote the development of renewable energy technologies and industries so that essential renewable energy equipment can be produced domestically by 2010, and local manufacture can be based mainly on homegrown intellectual property rights by 2020. The target for power from renewable energy is 300 million kW of hydropower, 30 million kW of wind power, 1.8 million kW of solar power, 30 million kW of biomass energy and 0.1 million kW of tidal power by 2020. The plan also encourages the application of solar thermal technologies to build a total of 300 million square metres of solar water heaters and promotes household biogas and livestock farm biogas with the goal of achieving annual use of 44 billion cubic metres by 2020.

In the Twelfth Five-year Plan for Energy Development, China confirms its ambitious targets for renewable energy. By the end of 2015, installed wind power generation capacity is expected to reach 100 GW, and the capacity of installed solar power plants is expected to be more than 21 GW.

After the enactment of the Renewable Energy Law in 2005, China has doubled its installed capacity every year for renewable energy. In 2010, the thermal power supply accounted for 79.2

of total power generation capacity, hydro for 17.2% and (grid connected) wind power for 1.1%. The Renewable Energy Law was revised in April of 2010 to force the grid companies to guarantee the purchase of a minimum amount of electricity from renewable energy to solve the issue of balance between power generation and grid connection.

Among the various options for renewable energy, China is pursuing wind energy development with the same vigour it has shown for hydropower. China's approach in increasing wind power has come to be known as "Three Gorges on the Land," a reference to a massive scale of development comparable to that of the Three Gorges Dam. In 2009, China added 13 GW to total capacity, of which 5.5 GW was installed in Inner Mongolia, and was on par with Germany with the world's second largest installed wind power capacity. The Chinese capacity surpassed that of the United States in 2010, when the country became the world's largest wind power capacity holder. A recent national wind resources survey conducted by the China Meteorological Administration (CMA) showed that wind power potential is 2380 GW onshore and 200 GW offshore – about 100 times the current installed capacity. The survey confirms the likely further concentration of mega wind farms in northern China in the future. The geographic mismatch between electricity demand and supply in China will thus become increasingly evident. This will create great challenges for the development of wind power due to the concentration of wind farms construction in the north and northeast (where the wind resources are among the richest), a great distance from the main demand centres (IEA, 2012).

In August 2011, the NEA published a large wind power grid design specification, which put forward clear requirements for wind power unit performance. It will be useful for improving grid safety when the grid takes on wind power.

In 2010, photovoltaic (PV) cell production in China reached 10 million kW, accounting for more than 50% of the global market share, of which five local enterprises ranked among the world's top 10 PV cell manufacturers. The price per PV module fell from CNY 40/W in 2005 to about CNY 6–7/W in 2010. The power generation cost has also fallen from CNY 4/kWh before 2009 to about CNY 1/kWh in 2010. This marked significant progress in technology development and production capability in China (NEA, 2012).

China is also developing a feed-in tariff policy for PV systems to encourage the construction of solar farms in the western region to connect with the local grid system. The Golden Sun Demonstration Project was also implemented to provide financial subsidies for the construction of photovoltaic power generation systems on the demand side. At the same time, photovoltaic power generation systems are widely used in areas without any other electricity supply, as well as in solar traffic signals, solar street lights, and in the fields of communications, weather, railways, and petroleum. By the end of 2010, the total installed PV capacity reached 860 000 kW, including large-scale grid-connected photovoltaic power plants generating 450 000 kW and Building Integrated Photovoltaic Systems (BIPVs) generating 260 000 kW (NEA, 2012).

NEA also announced guidelines for continued PV development, including:

- Gradually expand the range of solar power applications, especially distributed PV power generation systems, to create a market for the PV industry. Meanwhile, adhering to the mechanism of market competition, accelerate technological progress, reduce the cost of solar power systems and improve market competitiveness to create conditions for large-scale development of solar power systems.
- Promote large-scale PV power stations in the western region to take the advantage of abundant solar and land resources and to increase the local electricity supply. Promote rooftop or BIPV systems in the central and eastern region to take advantage of abundant solar resources while compensating for the shortage of land resources. This will create different opportunities and development approaches to fulfil the varying requirements in different regions.
- Encourage investment in solar power generation applications and innovation in technology and construction. Establish a diversification policy mechanism for different

application patterns to create a broader market and establish a positive environment for the development of the solar power industry.

- Strengthen international cooperation in advanced technology to advance and upgrade China's solar power technology and industry in order to promote China's solar power equipment and products in the international supply chain. Enhance the global competitiveness of China's solar power generating equipment and other products in order to establish a pattern for balanced development in both domestic and foreign markets.

Based on the above guidelines, China has established targets for solar power development: 21 GW of solar power capacity (10 GW for solar farms, 1 GW for solar thermal power and 10 GW for distributed solar power) in 2015, and 50 GW (20 GW for solar farms, 3 GW for solar thermal power and 27 GW for distributed solar power) by 2020 (NEA, 2012).

The generation price for biomass power, solar power and other sources of renewable energy power is a mandated price. On 18 July 2010, the NDRC published a Notification about the Ideal Pricing for Power Generation Using Agriculture and Forestry Biomass, which came into effect on 1 July 2010. The notification requires the implementation of a benchmark electricity price policy for power generation projects using agricultural and forestry biomass. The benchmark electricity price for biomass power is uniform at CNY 0.75 per kWh (including tax). On 24 July 2011, the NDRC published another Notification about the Ideal Pricing for Solar Photovoltaic Power Generation, which came into effect on 1 August 2011. The notification set the benchmark electricity price for solar photovoltaic power at CNY 1.00 or CNY 1.15 per kWh (including tax), depending on the location and commissioning time.

ENERGY EFFICIENCY

China's energy consumption per unit of GDP is much higher than the global average. Energy-intensive industries are backward in technology. The share of energy consumption by the secondary industries is too high a percentage of the country's total. Four major energy-intensive industries—steel, non-ferrous metals, chemicals, and building materials—account for 40% of the total energy consumption. Low energy efficiency results in high-energy consumption for every unit of GDP.

In 2011, the State Council released the Comprehensive Work Plan on Energy Conservation and Emission Reduction during the Twelfth Five-Year Plan Period. This plan proposed the major objectives and key actions in the fields of energy conservation and emission reduction during this period. China aims to establish a "reverse coercion mechanism" through the dynamic integration of its efforts in lowering the intensity of energy consumption, reducing the total emissions of major pollutants, and rationally controlling total energy consumption. The reverse coercion mechanism helps promote the strategic restructuring of the economy, push forward the optimization of the industrial structure, and strengthen all aspects of energy utilization management in industry, construction, transportation and public organizations, as well as in the fields of urban and rural construction and consumption (SCC 2012a).

To promote energy conservation activities in the industry sector, the central government has issued catalogues of advanced and applicable technologies in the fields of energy conservation and emission reduction for key industries such as iron and steel, petrochemicals, non-ferrous metals and building materials. It has established and improved a mandatory standards system of quotas for energy consumption per unit product in key industries and strengthened the energy-saving evaluation and supervision system. It has undertaken key energy-saving projects, including combined heat and power (CHP), recycling of industrial by-product gas, construction of enterprise energy-control centres, and fostering of energy-saving industries, so as to increase its enterprises' energy utilization efficiency. The government also encourages energy service companies (ESCOs) through financial and tax incentives. ESCOs provide a total energy efficiency solution (finance, technology, operation, maintenance, etc.) for industrial energy users. From 2005 to 2010, the number of ESCOs increased from 80 to over 800, the number of

employees in this sector increased from 16 000 to 180 000, and revenues from the energy service industry grew from CNY 4.7 billion to CNY 84 billion (USD 740 million to 13.2 billion) (APEREC, 2012).

In the transport sector, the government is committed to improving public transport, developing intercity rail transportation, and encouraging green commuting. China has implemented some of the world's most advanced fuel economy standards for automobiles and popularized energy-saving and environmentally-friendly vehicles. It is speeding up the elimination of old automobiles, locomotives and ships. Some efforts are being made to optimize the transportation structure and develop green logistics. According to the Development Plan for Energy Saving and New Energy Automobile Industry (2012–2020), China will focus on electrically powered cars (EVs and FCVs) to increase energy efficiency and reduce carbon emissions. It will also push the economy's automobile industry to upgrade its technology and encourage local car manufacturers to speed their efforts in the development of electrically powered vehicles. Production and sales of electrically powered vehicles are expected to total 500 000 units by 2015, and more than 5 million units with a 2 million unit production capacity by 2020. Subsidies and tax exemptions are provided for electrically powered vehicles (SCC, 2012b). The construction of supporting facilities, such as electricity charging facilities is also included. More than 2000 charging stations with 400 000 quick chargers for EVs will be provided by 2015. The economy is harmonizing charging methods to promote electrical-driven vehicles. Electrically powered cars (EVs and FCVs) and hybrid vehicles will be gradually introduced into the domestic market for both energy conservation and environmental protection (IEEJ, 2012). Another effort by China is to carry out a vehicle fuel consumption testing and management scheme from March 2011 to enhance and strengthen vehicle energy efficiency management. In this scheme, China published a list of vehicle models that satisfy the fuel consumption standards (CAA, 2011).

Promoting energy conservation in buildings is another target for the government. It sets and improves the standards for green buildings and implements rating and identification of green buildings. It actively promotes energy-saving renovation of existing buildings, sets quotas for energy consumption by public buildings and publicizes their energy efficiency rates. It has set up a management system for the life cycles of buildings and exercises strict control over demolition of buildings. China has also made and implemented an energy-saving plan for public institutions and strengthened the establishment of a supervisory system for energy conservation in public buildings. It carries forward heat metreing and energy efficiency renovations on existing residential heating systems in the northern regions of China, builds energy-saving greenhouses, improves the old heat-supply network, and practices metreed heat-supply charging and energy consumption quota management (SCC 2012a).

China has also been promoting energy conservation among all citizens. The government will intensify efforts in energy saving education and publicity. It works hard to bring into being a green mode of consumption and green lifestyle among urban and rural residents and to strengthen the public awareness of the importance of resource conservation. It has launched a project to promote energy-efficient products for the benefit of the people and has promoted high-efficiency lighting products and air conditioners, energy-efficient motors and other energy-efficient products by providing government subsidies. The central treasury has appropriated subsidies to support the production and promote the use of some 360 million high-efficiency lighting products, 30 million high-efficiency air conditioners and one million energy-efficient motor vehicles, which have realized an annual energy-saving capacity of 20 billion kWh. The government has established a preferential procurement system for energy-efficient products, released a government procurement list of energy-efficient products and ordered the mandatory procurement of nine kinds of energy-efficient products, including air conditioners, computers and lighting products. By the end of 2010, the market share of high-efficiency lighting products had reached 67%, and that of high-efficiency air conditioners, 70%.

CLIMATE CHANGE

In 2008, the Chinese Government published a White Paper on China's Policies and Actions for Addressing Climate Change. In that paper, it described the policies and actions the economy had

adopted to address climate change and the progress it had made. Follow-up annual progress reports have been issued at the end of every year since 2009. In addition, nearly all the provinces of China have developed province-level programmes to address climate change, most of which are under implementation. China is fully aware of the complexity and impacts of climate change and of the difficulty and urgency of the task of addressing climate change. It has addressed climate change as a major issue in its mid-term and long-term planning for economic and social development. In 2006, China set the goal of reducing its per-unit GDP energy consumption in 2010 by 20% from that of 2005. In 2007, China became the first developing country to formulate and implement an economy-wide program to address climate change. In 2009, China set a goal of action to reduce per-unit GDP greenhouse gas emissions in 2020 by 40%–45%, compared to those of 2005 (IOSC, 2011).

The importance of China's participation in a global climate treaty increases with each year, as its population, economy and energy use continue to grow rapidly. From 2000 to 2010, China's energy use grew 130%. That's up from growth of just 50% in the previous decade. With a growing, wealthier population, China has become the world's largest energy consumer — and with it, the world's greatest source of greenhouse gas emissions. China's share of global energy-related CO₂ emissions has increased in just eight years from 14% in 2000 to 22% in 2008. Eighty percent of those emissions came from coal, making China the consumer of about half the world's coal in 2011. In order to reduce carbon emissions, China is on a path toward doing something about its rapidly escalating energy use and emissions. It has recently announced it will be testing a pilot cap-and-trade programme in select major cities in 2013 and plans to make the programme national by 2015. In fact, if taken by China alone, the change would reduce global temperature by only about 0.1 degree Celsius in 2020. However, the efforts by China to impose a national cap-and-trade system could force other economies to follow, including the US (MIT news, 2012).

During the Eleventh Five-year Plan period, China accelerated the transformation of its economic development mode and achieved remarkable results in controlling greenhouse gas emissions by optimizing industrial structure, promoting energy conservation, developing low-carbon energy, controlling non-energy-related greenhouse gas emissions, increasing carbon sinks and promoting low-carbon development in some localities.

At the same time, China strengthened scientific research in evaluating the impact of climate change, improved relevant laws and policies, and enhanced the capability of key sectors to adapt to climate change, so as to reduce the negative impact of climate change on economic and social development and on people's lives. The key sectors include agriculture, water resources, marine resources, public health and meteorology.

China plays a constructive role in international climate change negotiations. The economy insists on the double-track negotiation mechanism of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol and upholds the principle of “common but differentiated responsibilities” in promoting the progress of international climate change negotiations. In its latest white paper, China adheres to the following five principles. First, China upholds the basic framework of the UNFCCC and Kyoto Protocol, and strictly follows the Bali Road Map. Developed countries should undertake to achieve substantial emissions reduction targets for the second commitment period under the Kyoto Protocol. Second, China sticks to the principle of “common but differentiated responsibilities.” Developed countries should take the lead in reducing emissions substantially and provide financial support and technology transfers to developing countries. Developing countries, while developing their economies and fighting poverty, should actively adopt measures to adapt to and mitigate climate change in accordance with their actual situations. Third, China holds fast to the principle of sustainable development. A win-win situation in both socio-economic development and response to climate change should be strived for. Fourth, China adheres to coordinating the issues of mitigation, adaptation, capital and technology. Fifth, China upholds the principle that the United Nations should lead climate change negotiations as well as the decision-making mechanism of reaching unanimity through consultation. In view of this, China also submitted its plans for 2020 to the UNFCCC, in which it declared a 40–45% target reduction in carbon intensity in 2020

(relative to 2005) and an increase in the share of non-fossil fuels in primary energy consumption to around 15% by 2020 (EE, 2012).

NOTABLE ENERGY DEVELOPMENTS

MAJOR ACTIVITY

The NEA held the National Energy Work Conference 2013 in January 2013. The conference proposed to promote an energy revolution in production and consumption, control total energy consumption, optimize energy structures and change the mode of energy development. Eight major tasks were assigned in the conference, including: (1) Enhancing domestic energy supply in ways such as developing the coal industry in a safe and highly efficient way, optimizing coal-fired power development, accelerating the construction power transmission infrastructure, accelerating the development of shale gas and coal bed methane, and ensuring a balance between energy supply and demand; (2) Vigorously developing new and renewable energy: actively developing hydropower, effectively developing wind power, constructing distributed photovoltaic power generation systems; (3) Controlling total energy consumption and establishing a "reverse coercion mechanism" to promote the strategic restructuring of the energy structure; (4) Promoting scientific and technological innovation, implementing national high-tech programs and promoting the localization of key energy equipment; (5) Intensifying institutional reform in the energy sector; (6) Strengthening international cooperation in energy; (7) Accelerating the implementation of energy livelihood projects, providing universal access to electric power; and (8) Tightening administration of the energy sector and accelerating building of a legal regime.

COAL INDUSTRY

On 21 October 2010, the State Council announced the Instructions for Accelerating Coal Mine Enterprise Mergers and Restructuring, prepared by the NDRC. Some commentators believe that mutual ties between a coal enterprise and its relevant upstream and downstream industries will be a trend and that the integration of coal production and related industries will be an important characteristic of future large coal companies (CEN, 2010).

On 7 December 2011, China announced the Twelfth Five-Year Plan for Coal Production Safety to strengthen and improve safety in coal production. It aims to reduce the number of accidents during coal production and enhance emergency rescue capabilities. The Plan also emphasizes that safety is more important than production for the long-term stable supply of coal (CEN, 2011).

In June 2011, the NDRC and the Ministry of Finance proposed to establish strategic coal reserves based in major coal production areas and at import ports. It is expected that the first round of reserves with a capacity of 5 mt will be established through cooperation between coal producers and power companies by the end of 2012. China will continue to look for new locations for the second round of strategic coal reserves with another 10 mt and expects to finish by the end of 2013 (CEN, 2011).

In 2012, driven by decreasing international coal prices, thermal coal-fired power plants in south-east coastal areas increased their purchases of overseas coal. China's net imports of coal reached 280 mt in 2012, up 34.5% from the previous year.

OIL INDUSTRY

On 1 November 2010, the first crude oil pipeline between China and Russia began its trial run. This pipeline will allow the transport of 15 mt of crude oil a year. According to the agreement, the pipeline will carry 15 mt of crude oil a year from 1 January 2011, for a period of 20 years, up to a maximum of 30 mt a year (CEN, 2010).

In 2010, the first round of economy-wide strategic petroleum reserve projects successfully completed collections. The second round of strategic petroleum reserve projects is being implemented. A number of commercial petroleum reserve bases were set up and put into

operation, with a capacity of up to 26.5 million cubic metres by the end of 2010. Three gas storage units were established with a total storage capacity of 1.39 billion cubic metres (bcm), and the construction of another 10 gas storage units has begun, with a total capacity of 24.4 bcm (NEA, 2011).

“Ocean Oil 981” is the sixth generation of China’s first independently designed 3 000 metre deep-water semi-submersible drilling platform. It represents the world’s highest level of offshore oil drilling platform technology. On 9 December 2011, it successfully completed its first navigation of more than eight days and 950 miles. For the first time, it will also be used to perform deep-water drilling for the China National Offshore Oil Company (CNOOC), which means that CNOOC will now be able to perform independent deep-sea oil and gas exploration and production work in the South China Sea, one of its major deep-sea oil and gas producing areas (CEN, 2011).

The development and expansion of the refined oil market is advancing at a stable rate in China. The refined oil electronic trading platform at the Beijing Petroleum Exchange has begun operation, and a first round of 1 000 tonnes of No. 93 gasoline was traded on this platform in May 2011. Another trading platform in Xiamen was also opened on 18 November 2011 (CEN, 2011). In March 2013, the NDRC announced a new pricing system to better reflect fluctuations in global oil prices. The new system will shorten the current 22-day adjustment period to 10 days and remove the 4-percent limit, ushering in a more market-based mechanism that could better reflect production costs and energy shortages.

NATURAL GAS INDUSTRY

On 29 March 2010, the Sichuan–East China gas production and related transmission pipeline was put into operation. This included Puguang gas field exploration and development, acidic gas processing and matching long-distance pipelines. At present, the Puguang gas field has an annual production capacity of 10.5 bcm of natural gas mixture, with plans to purify 4 bcm of natural gas. The pipeline is 2 170 kilometres long and will carry 12 bcm of natural gas to eastern China and the regions along the line (CEN, 2010).

On 1 June 2010, a Notification on the Increase of the Benchmark Price of Domestic Onshore Natural Gas issued by the NDRC went into effect. This notification aims to appropriately increase domestic natural gas prices and to publicise related policies about natural gas pricing and supporting measures (CEN, 2010).

On 19 November 2010, the Regulation on the Administration of Urban Gas was approved by the State Council and went into effect on 1 March 2011.

On 3 December 2010, four ministries jointly issued a notice announcing further expansion of international cooperation on coal bed methane (CBM) exploration. Three companies were selected for the first round of pilot units. As of the end of 2010, four domestic companies hold franchises for CBM international cooperation (CEN, 2010).

The first stage of the Shanxi Coal Bed Methane Pipeline was completed at the end of 2011 at a length of 354 km. The second and third stages will follow with an additional 1 328 km. This is the longest pipeline for a coal bed methane transportation system in China. It will be used to support the Gasification Shanxi strategy and speed up the development of coal bed methane in China. Construction of a so-called “five horizontal and three vertical” pipeline network across Shanxi Province is also planned, with a total length of 3 300 km to support 12 bcm of annual gas production by the end of 2015 (CEN, 2011).

On 30 June 2011 a commissioning ceremony for the eastern section of the PetroChina East Gas Pipeline project was held in Conghua, Guangdong. At this point, the Central Asia - East Gas Pipeline project will deliver Central Asian natural gas to the Pearl River Delta through these thousands of miles of pipeline. It is further expected that this gateway to Hong Kong, including a branch line, will be fully completed by 30 June 2012. Construction on the overall East Gas Pipeline project began in 2008 and includes one main pipeline and eight branch lines with a total

length of 8 704 km. It can transport 30 bcm per year of natural gas to the Pearl River Delta (CEN, 2011).

ELECTRICITY

On 21 July 2011, China's first fast neutron reactor—China's experimental fast reactor (CEFR)—had its first critical success operation, a significant breakthrough for the nation's fourth advanced nuclear energy power generation system technology. China has become one of the few economies with fast reactor technology (CEN, 2011).

On 31 August 2011, the Shanghai Donghai Bridge offshore wind power plants passed their 240 hours' inspection. This is China's first offshore wind turbine project and has a total capacity of 100 MW (CEN, 2011).

By the end of 2010, China's total installed power generation capacity reached 966 million kW, a 10.56% increase from the previous year, giving it the second largest capacity in the world. China has the largest grid network in the world. Transmission lines for 220 kilovolt (kV) and above extended to 445 600 km, and 220 kV and higher substation equipment capacity was 1.99 billion kilovolt-ampere (kVA) as of the end of 2010. This is an increase of 10.87% and 16.37% from the previous year, respectively (CEC, 2011).

The power grid network connecting Qinghai and Tibet—the Qinghai-Tibet power grid project—was completed and put into operation on 9 December 2011 with a total length of 1 038 km. The network includes DC transmission lines and two ± 400 kV converter stations; it also supports the construction of the Xining-Mountain-Hercynian-Golmud 750 kV power transmission project and a 220 kV power grid project in Tibet. This will end the long-term isolated operation of the Tibet Power Grid and marks the completion of a comprehensive grid network system in China (CEN, 2011).

Asia's first flexible DC power transmission demonstration project—the Shanghai Nanhui Wind Farm Flexible DC Transmission Project—was put into operation on 25 July 2011. The project links the Shanghai Nanhui wind farm and the Sulo converter station, with a DC transport capacity of 20 MW at the ± 30 kV level and a transport distance of 8.6 km. It is a completely independent intellectual property of China (CEN, 2011).

The 4 GW of clean energy generated in eastern Ningxia is transmitted to the Shandong power grid through the over 1 300 km-long Ningdong DC transmission line. This marks the completion and successful operation of an important trans-regional DC power transmission project: the Ningdong-Shandong ± 660 kV DC transmission line. The Ningdong DC transmission project is the world's first DC transmission project at the ± 660 kV voltage level and a key project in the construction of China's west-to-east power grid. The creation of a power grid to connect the Northwest Power Grid to the North China Power Grid was also an important achievement (CEN, 2011).

In February 2011, China released its "Thermal Power Plant Air Pollutant Emission Standards (second draft)," which state that carbon oxide emissions for all new thermal power plants in 2012 should be less than 100 mg/cubic metre and that all thermal power plants in key regions should emit less than 100 mg/cubic metre beginning in January 2012. Carbon dioxide emissions for those thermal power plants constructed by 2003 in non-key regions should be less than 200 mg/cubic metre, also from January 2012 (CEN, 2011).

The first privately owned million-kilowatt hydropower station, the Jin'anqiao Hydropower Station with a 2.4 GW capacity, began operations and connected to the grid on 27 March 2111 (CEN, 2011).

The No. 2 Unit in the second phase of the Daya Bay Nuclear Power Base Ling Ao Nuclear Power Station was put into commercial operation in August 2011, a million-kilowatt nuclear power plant that is the first put into operation during the Twelfth Five-Year Period. At this point, there are a total of six units in the Daya Bay Nuclear Power Base, making it the largest nuclear power base in China. More than 64% of this unit's equipment was manufactured locally, including parts of key components such as pressure vessels, steam generators and main pumps. It

has proven that China already possesses the capability to construct a million-kilowatt nuclear power plant on its own (CEN, 2011).

In March 2013, the State Electricity Regulatory Commission (SERC) was merged into the NEA. The NEA now consists of 12 departments, with an authorized staff size of 240 civil servants.

ENERGY CONSERVATION AND ENVIRONMENTAL PROTECTION

China has accomplished the energy conservation goals listed in its Eleventh Five-Year Plan. China's energy consumption per unit of GDP dropped 19.1% from that of 2005, a reduction of 1.46 billion tons of carbon dioxide emissions. During the same period, China's economy expanded at an average annual growth rate of 11.2%, while its energy consumption grew only 6.6% annually on average. The energy consumption elasticity coefficient dropped from 1.04 in the Tenth Five-Year Plan period (2001-05) to 0.59 in the Eleventh Five-Year Plan (2006-2010), which eased the contradiction between energy supply and demand (IOSC, 2011).

In 2010, China launched an economy-wide "low-carbon province and low-carbon city" experimental project. The first round of selected localities included five provinces, namely, Guangdong, Hubei, Liaoning, Shaanxi and Yunnan, and eight cities, namely, Tianjin, Chongqing, Hangzhou, Xiamen, Shenzhen, Guiyang, Nanchang and Baoding.

In 2010, China took an active part in negotiations and consultations at the Cancún Conference. It adhered to the principles of maintaining openness and transparency, extensive participation and consensus through consultations; proposed constructive plans on various issues; and made important contributions to help the conference achieve practical results and put the talks back on track. In particular, during negotiations on issues with greater disparity, such as the long-term global goal, the second commitment period of the Kyoto Protocol, the system of international consultation and analysis to reduce the burden on developing countries and reach the emission-reduction goals of developed countries, China actively communicated and coordinated with the engaged parties, candidly exchanged in-depth opinions with all parties at all levels, enhanced mutual understanding and acted as a unifying and motivating force. Before the Cancún Conference was called, China enhanced exchanges and coordination with developing countries through the G77 and China' and the BASIC (Brazil, South Africa, India and China) mechanisms and strengthened dialogue with developed countries through various channels in preparation for the conference. China also maintained close communication and exchanges with the host nation of Mexico and provided beneficial suggestions and full support. In October 2010, before the opening of the Cancún Conference, China hosted a United Nations climate change meeting in Tianjin, which laid the basis for the Cancún Conference to achieve positive results.

In 2011, the Chinese Government released the Comprehensive Work Plan for Energy Conservation and Emission Reduction during the Twelfth Five-Year Plan period (2011–15) and established overall arrangements for energy conservation, emissions reduction and greenhouse gas emissions control during that period.

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USEFUL LINKS

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www.eri.org.cn
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- Ministry of Housing and Urban–Rural Development—www.mohurd.gov.cn
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- National Bureau of Statistics (NBS)—www.stats.gov.cn
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- National Energy Administration (NEA)—www.nea.gov.cn
- Standardization Administration—www.sac.gov.cn

HONG KONG, CHINA

INTRODUCTION

Hong Kong, China—a special administrative region of the People’s Republic of China—is a world-class financial, trading and business centre of some 7.1 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 2011, the per capita GDP of Hong Kong, China was 39 589(USD 2000 at PPP), among the highest of the Asia–Pacific Economic Cooperation (APEC) economies. GDP increased 4.9% in real terms in 2011 to 279.96 billion (USD 2000 at PPP). The services sector remained the dominant driving force of overall economic growth, accounting for 93.0% of GDP in 2011 (EDMC 2013).

The economy of Hong Kong, China is driven by its financial services, as well as its higher value-added and knowledge-based services. To stay competitive and attain sustainable growth, Hong Kong, China not only needs to restructure and reposition itself in the 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 originating in Hong Kong, China enjoy tariff-free access to mainland China by local manufacturers.

With the support of mainland China under CEPA and the Framework Agreement on Hong Kong/Guangdong Co-operation, 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. Mainland China’s Twelfth Five-Year Plan for National Economic and Social Development also supports the opening up of service industries to the economy’s service providers, starting with pilot programs in Guangdong. Hong Kong, China will enhance government-to-government co-operation and economic partnership with provinces and municipalities in the Mainland on all fronts, and maintain ties with its trading partners and related international organisations around the world to expand its markets (Policy Address 2013).

Table 7 Key data and economic profile, 2010

| Key data | | Energy reserves | |
|------------------------------------|--------|----------------------------|---|
| Area (sq. km) | 1 104 | Oil (million barrels) | – |
| Population (million) | 7.1 | Gas (billion cubic metres) | – |
| GDP (USD (2000) billion at PPP) | 279.96 | Coal (million tonnes) | – |
| GDP (USD (2000) per capita at PPP) | 39 589 | | |

Source: EDMC (2013).

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 13.9 million tonnes of oil equivalent (Mtoe) in 2011, about the same amount as in 2010. Coal maintained the highest share of the total primary energy supply (53.1%), followed by oil (22.9%), gas (18.3%) and other sources (5.6%) (EDMC, 2013).

In 2013, the total installed electricity generating capacity in Hong Kong, China was 12 624 megawatts (MW) (EDMC, 2013). All locally-generated power is thermal fired. Electricity is supplied by CLP Power Hong Kong Limited (CLP Power) and Power Assets Holdings Ltd (PAH). 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. To secure its supply of natural gas, CLP Power has preliminary arrangements with the China National Offshore Oil Corporation and the PetroChina International Company for long-term gas supplies that started early in this decade. PAH's electricity is supplied by the Lamma Power Station, which has a total installed capacity of 3,736 MW. Natural gas used at PAH's power station is mainly imported through a submarine pipeline from the Dapeng liquefied natural gas (LNG) terminal in Guangdong, mainland China. PAH has also operated wind turbines (800 kW) since 2006, and a photovoltaic (PV) system (1MW) since 2010 (PAH, 2013a, 2013b).

Table 8 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|-------|----------------------------|--------|
| Indigenous production | 53 | Industry sector | 352 | Total ^a (gross) | 39,071 |
| Net imports and other | 29,673 | Transport sector | 2,159 | Thermal | 39,025 |
| Total PES | 13,889 | Other sectors | 4,247 | Hydro | – |
| Coal | 7 403 | Total FEC | 6,758 | Nuclear | – |
| Oil | 3,137 | Coal | – | Other | 46 |
| Gas | 2,547 | Oil | 2,408 | | |
| Other | 802 | Gas | 672– | | |
| | | Electricity and other | 3,678 | | |

a. Total does not include electricity generated by hydro and nuclear energy facilities located in mainland China. (This "China" needs to be moved flush left to the margin.)

Sources: EDMC (2013)

While natural gas and liquefied petroleum gas (LPG) are the main types of gaseous fuels used in Hong Kong, China, there is another product available. 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, 2012).

FINAL ENERGY CONSUMPTION

In 2011, the total final energy consumption in Hong Kong, China was 6731 ktoe, an increase of 0.6% from the previous year. The other sectors (residential and commercial) accounted for the largest share of energy used at 62.7%, followed by the transport sector (32.07%) and the industry sector (5.23%). By energy source, electricity and others made up 54.633% of end-use consumption, followed by petroleum products (35.38%) (EDMC, 2013).

Natural gas and LPG were used in the domestic, commercial and industrial sectors. While LPG is used as fuel for taxis and light buses, natural gas is used for electricity generation and town gas manufacturing.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Government of Hong Kong, China has pursued two key energy policy objectives. The first is to ensure the energy needs of the community are met safely, efficiently and at reasonable prices. The second is to minimise the environmental effects of energy production and consumption, and to promote the efficient use and conservation of energy. In combating climate change, reducing greenhouse gas emissions and developing a low-carbon economy, Hong Kong, China's emissions reduction strategy emphasizes 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 power, oil and gas companies to maintain strategic reserves of coal, diesel, gas and naphtha. It monitors the performances of the power companies and other energy providers through the Scheme of Control Agreements, most recently revised in 2008, to encourage energy efficiency, quality services and renewable energy use.

Specifically, Hong Kong, China proposes to optimise the fuel mix for power generation. This will mean significantly reducing its reliance on fossil fuels, gradually phasing out existing coal-fired power generation units, and increasing the use of non-fossil, cleaner and low-carbon fuels, including renewable energy and imported nuclear energy. Its plan is that, by 2020, natural gas will account for about 40% of its fuel mix for power generation, coal no more than 10%, renewable energy about 3%–4%, and imported nuclear energy the balance of about 50%. Hong Kong, China will also endeavour to enhance energy efficiency, promote green buildings, advocate electricity savings, facilitate low-carbon transport and develop facilities to turn waste into energy. By implementing this strategy, the economy expects to reduce its carbon intensity by 50%–60% by 2020, compared with the 2005 level; decrease its greenhouse gas emissions by 19%–33% compared with 2005; and lower its greenhouse gas emissions per capita from 6.2 tonnes at 2005 to 3.6–4.5 tonnes (Policy Address by Chief Executive, 2010–11, 2011–12). The Government will also launch a public consultation on the future fuel mix for electricity generation in Hong Kong.

A major target for the economy's energy policy is to reduce its energy intensity by 25% by 2030, based on the 2005 level. The key measures are:

- Reduce carbon emissions through the use of clean fuel and improved energy efficiency
- Promote the energy efficiency of buildings and products
- Promote renewable energy

- Seek input from the community to improve energy efficiency
- Enhance the management of electricity demand.

ENERGY MARKETS

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

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

The MOU also contemplates the ongoing supply of nuclear-generated electricity to Hong Kong, China. An extension of the Guangdong Daya Bay Nuclear Power Station joint venture and supply contracts was approved by the Hong Kong, China Government in September 2009. These contracts will enable the continued supply of non-carbon-emitting electricity to Hong Kong, China for a further term of 20 years from 2014 (CLP 2012a, 2012b).

ENERGY EFFICIENCY

Buildings consume about 90% of the electricity used in Hong Kong, China. The economy is putting its efforts into conserving building energy as its first priority. Following that, efforts will go into improving the energy efficiency and air quality of the transport sector.

Energy Data

To help monitor the energy situation, Hong Kong, China has developed an energy end-use database. The database provides useful insight into the energy demand situation, including the energy consumption patterns, trends, and usage characteristics of each sector and segment. A basic data set is publicly available on the internet. The Government is able to analyse the current system based on the data and develop policy and strategy revisions for future implementation, while the private sector can use the data to benchmark their own energy efficiency, as they seek improvements in their energy consumption systems (EMSD, 2012d).

Buildings

To strengthen its efforts to improve the effects of 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).
- Responsible persons of prescribed buildings (i.e. owners, tenants or occupants, etc.) should ensure that the four key types of building services installations comply with the design standards of the BEC when carrying out "major retrofitting works".

- The owners of commercial buildings, including the commercial portions of composite buildings, should carry out an energy audit for the four key types of central building services installations in accordance with the Energy Audit Code (EAC) every 10 years.

It is estimated that implementation of the Ordinance will result in a savings of approximately 2.8 billion kWh of electricity and 1.96 million tonnes of carbon dioxide emissions in its first decade. These figures only take into account the savings achieved from new buildings. It is expected that more savings can be achieved from existing buildings when carrying out “major retrofitting works” and energy audits (EMSD 2012b).

The Government continues to demonstrate in government buildings state-of-the-art energy efficient designs and building energy conservation technologies. These are based on an environmental performance framework that covers energy efficiency, greenhouse gas reduction, renewable energy application, waste reduction, water management and indoor air quality. In its effort, all newly built government buildings over 10 000 square metres will be assessed against the environmental performance assessment standards to not lower than the second highest grade.

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 aims to achieve 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.

Also in April 2009, the Government introduced the Buildings Energy Efficiency Funding Schemes, with a total of HKD 450 million to subsidise environmental performance reviews and upgrades for communal areas of residential, commercial and industrial buildings. The Schemes also cover energy/carbon audits and works to upgrade the energy efficiency performance of building services installations. The subsidy can cover up to 50% of the expenditure. These funding schemes were ended in April 2012 (EMSD 2012a).

Water Cooled air conditioning systems

Water-cooled air-conditioning systems using fresh water cooling towers are generally more energy efficient than air-cooled systems. A voluntary Fresh Water Cooling Towers Scheme was launched in 2000 to promote a wider use of fresh water in evaporative cooling towers for air conditioning systems in non-domestic buildings for energy efficiency. At the end of December 2013, 499 installations were completed under the Scheme. It is estimated that these installations could save up to about 314 million kWh of electricity and 219,000 tonnes of carbon dioxide emissions per annum (EMSD, 2012h).

The Government implements a District Cooling System (DCS) at the Kai Tak Development to supply chilled water to buildings in the new development for centralised air conditioning. The DCS is the first project of its kind implemented by the Government. Initial phases of the project have been completed and the Kai Tak Cruise Terminal Building was provided with chilled water in February 2013 (EMSD, 2012i).

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 serve to allow the energy-consuming groups to understand their energy consumption levels and performance with respect to corresponding peers. They help foster the concept of efficient energy consumption and promote general awareness (EMSD, 2012c).

Energy efficiency labelling

Hong Kong, China has a voluntary Energy Efficiency Labelling Scheme that covers 21 types of household and office appliances, among which there are 12 types of electrical appliances (refrigerators, washing machines, non-integrated type compact fluorescent lamps, dehumidifiers, electric clothes dryers, room coolers, electric storage water heaters, television sets, electric rice-

cookers, electronic ballasts, LED lamps and induction cookers), seven types of office equipment (photocopiers, fax machines, multifunction devices, laser printers, LCD monitors, computers and hot/cold bottled water dispensers) and two types of gas appliances including domestic instantaneous gas water heaters and gas cookers. The Scheme has further been extended to cover petrol passenger cars (EMSD, 2012g).

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, compact fluorescent lamps, washing machines and dehumidifiers. Under the MEELS, energy labels are required to be shown on the products for supply in Hong Kong, China to inform consumers of their energy efficiency performance (EMSD, 2012f).

Transport

Land transport accounts for 17% of the total greenhouse gas emissions in the economy, and is the second most significant contributor. In order to reduce carbon emissions from the transportation system, Hong Kong, China, is conducting the following efforts:

- **Extend the Public Transport System**

An extensive and energy-efficient public transport system in Hong Kong, China has been instrumental in helping to maintain its low level of greenhouse gas 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 emphasis on railways.

- **Promote Cleaner Vehicles**

To encourage the use of cleaner vehicles, the Government launched tax incentive schemes for environmentally-friendly petrol private cars and commercial from April 2007. Vehicles meeting the energy efficiency and exhaust emissions criteria can have the First Registration Tax (FRT) reduced. The latest revision of the FRT reduction rate has been raised from 30% to 45%, subject to a cap which has been increased from HK\$50,000 to HK\$75,000 per car. Also, the Government actively promotes wider use of electric vehicles.

- **Promote the Use of Biodiesel as Motor Vehicle Fuel**

In order to promote the use of biodiesel in motor vehicles, a duty-free arrangement for using biodiesel as motor vehicle fuel has become a standing policy since 2007. Specifications on the use of biodiesel in motor vehicles were drawn up to promote the development of the biodiesel market. The Air Pollution Control (Motor Vehicle Fuel) Regulation was amended in 2010 to introduce regulatory control over motor vehicles using biodiesel.

- **LPG Vehicle Scheme**

In order to reduce emissions from vehicles, the Government announced the introduction of an LPG Vehicle Scheme in the 1999 Policy Address, which includes:

- Provision of an incentive scheme in 2000 for the replacement of diesel taxis with liquefied petroleum gas (LPG) taxis. The scheme was completed at the end of 2003. Nearly all taxis (about 99.9%) had switched to LPG by that time.
- Provision of an incentive scheme in 2002 for replacing diesel light buses with LPG or electric light buses. The scheme has been making good progress, and there were already over 3 400 LPG light buses in operation by the end of 2012.

In Hong Kong, China, franchised bus operations are the major cause of roadside air pollution in busy corridors. The government's ultimate policy objective is to have zero-emission buses running across the territory. When the current bus franchises expire in the coming few years, Hong Kong, China will impose additional requirements on the franchisees. The bus companies will be required to switch to zero-emission buses or the most environmentally-

friendly alternatives when replacing existing buses, taking into account feasibility and affordability for both bus operators and passengers.

In terms of fuel consumption and environmental performances, hybrid buses are superior to ordinary diesel buses. The Government proposes to fund the full cost of procuring six hybrid buses for use by the franchised bus companies along busy corridors to test the operational efficiency and performance of these buses under the economy's conditions and to collect operational data. The Government will provide the same financial support to bus companies that wish to test other 'green' buses, such as electric buses.

At present, over 60% of franchised buses are Euro II and Euro III vehicles, and there are too many to phase them all out in the coming few years. In view of this, the Government and franchised bus companies are conducting a trial to retrofit Euro II and Euro III buses with catalytic-reduction devices to meet Euro IV nitrogen-oxide emission standards. Subject to satisfactory trial results, the Government will fully fund retrofitting of the devices on all Euro II and Euro III buses. Bus companies will bear the subsequent operational and maintenance costs.

The Government also plans to designate pilot low-emission zones in busy districts such as Causeway Bay, Central and Mong Kok. It will increase, to the extent possible, the ratio of low-emission franchised buses running in these zones from 2011, with the target of having only low-emission buses in these zones by 2015.

Following the building sector, land and sea transport is the second largest source of air pollution and greenhouse gas emissions in Hong Kong, China. To encourage the transport sector to test green and low-carbon transport means and technology, in 2011 the Government set up a HKD 300 million Pilot Green Transport Fund for which the transport sector can apply.

RENEWABLE ENERGY

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

CLP Power is continuing the feasibility study for an offshore wind farm. An offshore meteorological wind mast was installed to collect site environmental data. CLP Power completed Phase 2 of the 192kW renewable energy power system on Town Island in late 2012. The system now consists of 672 solar panels and two wind turbines supplying renewable energy to the Island (CLP 2012b).

Power Assets Holdings Ltd.'s (PAH's) renewable energy assets also performed well, with Lamma Winds generating more than 7000 MWh of electricity since being commissioned in 2006, offsetting more than 6000 tonnes of carbon dioxide emissions. Another 1 MW thin-film photovoltaic (TFPV) solar power system was installed on building roofs at Lamma Power Station, generating more than 3000 MWh of electricity since commissioning in 2010, offsetting more than 2500 tonnes of carbon dioxide emissions (PAH 2013c, 2013d).

To increase its renewable energy portfolio, PAH has expanded the solar power system to 1 MW since 2013. PAH plans to install about 35 offshore wind turbines at a capital cost of about HKD 3 billion with a total generation capacity of around 100 MW, producing 175 GWh of electricity and offsetting 150 000 tonnes of carbon dioxide emissions annually after completion by 2015. In 2012, PAH commenced a wind monitoring station at its offshore wind farm site to collect meteorological and oceanographic data for detailed design purposes. (PAH 2012)

The Government has taken the lead in using renewable energy by installing a 350 kW PV system on the roof of the Electrical and Mechanical Services Department headquarters. The Government also installed large-scale solar water heating devices on government buildings, including swimming pools, to save power in water heating.

In its effort to convert waste to energy and to reduce greenhouse gas 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 2% of the total electricity demand by 2020.

NUCLEAR

Hong Kong, China has set a target for nuclear energy to be 50% of the economy's fuel mix by 2020. In view of this vision, CLP Power has 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 (CLP, 2012a). This meets almost 25% 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 from 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 greenhouse gas emissions locally (CLP, 2012b).

Following the Fukushima accident in 2011, a comprehensive safety review was conducted by the National Nuclear Safety Administration (NNSA) at all nuclear power stations in China, including Guangdong Daya Bay Nuclear Power Station. Preliminary results confirmed that the design and operation of Guangdong Daya Bay Nuclear Power Station are in full compliance with existing national regulations and standards. Prior to the NNSA's review, the Station had also conducted its own internal review and had been formulating improvement initiatives to deal with natural disasters of extreme severity in order to further enhance its safe operation.

To increase the public's confidence in nuclear safety, in January 2011 CLP Power announced an enhanced notification mechanism for 'non-emergency licensing operational events'. These include those Below Scale (Level 0) and Level 1 events under the International Nuclear Event Scale (INES) and Level 2 or above events that do not require an emergency response. These events carry no nuclear safety consequences and have no impact on the external environment or public safety. The enhanced mechanism for reporting such non-emergency licensing operational events within two working days was generally well received by the public. CLP Power will also contribute to an enhanced program of public education and awareness about nuclear energy through initiatives such as plant visits, roving exhibitions and an online education platform. The program aims to better inform judgments by the media, politicians and the public on nuclear-related matters, and to bring a higher degree of confidence in the future role of nuclear energy in powering Hong Kong, China.

CLIMATE CHANGE

Hong Kong, China is committed to working closely with the international community to combat climate change. In the past decade, a string of measures have been implemented to reduce the economy's greenhouse gas emissions.

The major contributors of greenhouse gases in Hong Kong, China are power generation and the transport sector. Therefore, the most direct and effective method of reducing carbon emissions would be to enhance the overall energy efficiency of the society.

In 2010, the Government devised Hong Kong, China's Climate Change Strategy and Action Agenda and proposed setting a target to reduce the carbon intensity level by 50%–60% by 2020, compared with 2005. The Government also suggested a number of emissions reduction measures and has been seeking input from the community to improve energy efficiency and to enhance the management of electricity demand (EPD 2012b).

The proposed greenhouse gas emissions reduction measures can be classified as follows:

1. *Maximising energy efficiency.* In particular, measures to improve energy efficiency in buildings, including 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.
 - Expanding the scope and tightening the energy efficiency of electrical appliance standards for domestic use, so that by 2020 all appliances sold in the market will be 25% more energy efficient compared with those sold in 2005.
2. *Greening road transport.* Includes 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.
 - Making wider use of motor vehicles running on alternative fuels, so that 30% of private cars, and 15% of buses and commercial vehicles are hybrid and electric vehicles (EVs) or other vehicles with similar performance by 2020.
 - Implementing importers' average fleet-efficiency standards, so that new vehicles will be 20% more energy efficient than the 2005 market average.
 3. *Promoting the use of clean fuels for motor vehicles.* Measures to promote clean fuels such as biofuels.
 4. *Turning waste into energy.* Measures to explore the potential of renewable energy. Specific measures include:
 - Developing and fully operating one integrated waste management facility, two organic waste treatment facilities, and one sludge treatment facility by 2020.
 - Fully utilising recovered landfill gas and gas generated from wastewater treatment.

Revamping the fuel mix for electricity generation. Implement measures to increase the use of non-fossil, clean and low-carbon fuels for electricity generation, having balanced the various objectives of Hong Kong, China's energy policy. It is proposed that, by 2020, coal will account for no more than 10% of the fuel mix, natural gas around 40%, renewable energy about 3%–4% and imported nuclear-generated power will meet the balance of about 50%.

NOTABLE ENERGY DEVELOPMENTS

In order to create a more ecologically-friendly environment, the Government has initiated a number of major actions to save energy, reduce carbon emissions and improve waste recovery. Some major actions and achievements are summarized as follows (EPD, 2012a):

- The CLP Power and its Mainland counterparts have completed construction of the Second West-East Natural Gas Pipeline (Hong Kong Branch Line) to supply cleaner energy to Hong Kong.
- A mandatory energy efficiency labelling scheme for certain products and building energy efficiency codes for both new and existing buildings were introduced.

- An Environmental Impact Assessment report on the development of a 100MW offshore wind farm in Hong Kong, China was approved in May 2010.
- The Buildings Energy Efficiency Ordinance was enacted in November 2010, mandating compliance with codes of practice promulgated by the Electrical and Mechanical Services Department concerning the energy efficiency of four types of buildings services.
- High-efficiency equipment (air-conditioning, electrical systems, lifts and escalators, and lighting installations) has been newly installed and energy audits are being conducted.
- The number of electric vehicles in Hong Kong has started to expand with the Government's active promotion. As at December 2013, the total number of electric vehicles is over 590.

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USEFUL LINKS

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- Electrical and Mechanical Services Department—www.emsd.gov.hk
- Environment Bureau—www.enb.gov.hk
- Environmental Protection Department—www.epd.gov.hk
- Transport Department—www.td.gov.hk

INDONESIA

INTRODUCTION

Indonesia is a large archipelago located south-east of mainland South-East Asia, between the Pacific Ocean and the Indian Ocean. Indonesia's territory encompasses 17 508 large and small islands and large bodies of water at the equator over an area of 7.9 million square kilometres, which includes Indonesia's exclusive economic zone. Indonesia's total land area (24.5% of its territory) is about 1.91 million square kilometres. The population was 243.8 million in 2011.

Indonesia had a gross domestic product (GDP) of around USD 881 billion and a per capita GDP of USD 3 612 in 2011 (USD 2000 at PPP). Excluding the oil and gas sector, manufacturing accounted for the largest component of GDP in 2011 (25.7%), followed by retail, hotels and restaurants (17.7%); agriculture, livestock, forestry and fisheries (12.7%); transport and communications (9.8%); finance, leasing and corporate services (9.6%); other services (9.4%); mining and quarrying (7.7%); construction (6.6%); and electricity, gas and water supply (0.8%). In 2011, Indonesia attained economic growth of 6.5%, an increase of 0.3% from 2010 (BPS, 2012).

Domestic oil, gas and coal reserves have played an important role in Indonesia's economy as a source of energy, industrial raw material and foreign exchange. In 2011, oil and gas exports contributed 20.4% and coal exports contributed 13.4% of Indonesia's total exports of about USD 203.5 billion (BPS, 2012). Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 29.4% of the Indonesian Government's budget in 2011 (ESDM, 2011).

Indonesia's proven fossil energy reserves at the end of 2011 consisted of 3.7 billion barrels of oil; 3 trillion cubic metres of natural gas and 5.5 billion tonnes (Bt) of coal.

Table 9 Key data and economic profile, 2011

| Key data ^a | | Energy reserves ^b | |
|------------------------------------|-------|------------------------------|-----|
| Area (million sq. km) | 7.9 | Oil (billion barrels) | 3.7 |
| Population (million) | 243.8 | Gas (trillion cubic metres) | 3.0 |
| GDP (USD (2000) billion at PPP) | 880.6 | Coal (billion tonnes) | 5.5 |
| GDP (USD (2000) per capita at PPP) | 3612 | | |

Source:

a. EDMC (2013).

b. Proven reserves at the end of 2011 (BP, 2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011, Indonesia's total primary energy supply (TPES) was 174 724 kilotonnes of oil equivalent (ktoe) of commercial energy, made up of oil (46.8%), coal (26.8%), natural gas (21.2%) and other energy (mainly hydropower and geothermal) (5.3%), and 37 861ktoe of biomass. Indonesia is a net exporter of energy, and overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal totalled 217 441 ktoe in 2011. Total energy exports in 2011 increased by 20.8% from 2010 (179 938 ktoe), an increase driven primarily by coal exports.

Oil

In 2011, Indonesia produced 51 322 ktoe of crude oil and condensates; of this, 20 726 ktoe (40%) was exported, representing an increase of 0.8% from 2010. Since oil production has declined significantly over the past decade (in 1997 Indonesia produced 72 474 ktoe of crude oil and condensates), the economy imported 14 808 ktoe of crude oil and 26 315 ktoe of petroleum products in 2011 in order to meet its domestic oil requirements, up 5% from total of 39 157 ktoe in 2010 (EDMC 2013).

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. As 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 72 796 ktoe of natural gas in 2011, a decrease of 5% from the 76 638 ktoe produced in 2010 (EDMC, 2013). Of the total natural gas production, 32.8% was converted to LNG for export shipping. The economy produced 32 283 ktoe of LNG in 2011, a decrease of 9.4% from 35 647 ktoe in 2010. In 2011, Indonesia also exported 8 375 ktoe of natural gas (11.5% of its total natural gas production) through pipelines to Singapore and Malaysia (ESDM, 2012). Overall, 49.1% of Indonesia's natural gas production is exported. The balance is made available for domestic requirements.

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

Coal

In 2011, Indonesia produced 207 723 ktoe of coal, an increase of 28.4% from 161 797 ktoe in 2010. Most of Indonesia's coal production in 2011 (160 331 ktoe, or 77.2%) was exported with domestic demand (46 780 ktoe in 2011) being allocated for power generation (56.7%), and industry (43.3%) uses (EDMC, 2013).

About 57% of Indonesia's total recoverable coal reserve is lignite, 27% is sub-bituminous coal, 14% is bituminous coal, and less than 0.5% is anthracite. Most of Indonesia's coal reserves are in South Sumatra and East Kalimantan. Relatively small deposits of coal are in West Java and in Sulawesi. As a result, while Indonesian coal's heating value can range from 5000 to 7000 kilocalories per kilogram, it is generally distinguished by its low ash and sulphur content (typically less than 1%).

Electricity

Indonesia had 39 899 MW of electricity generation capacity in 2011, which was owned by the state-owned electricity company (PLN) and independent power producers (IPPs). In 2011, 183 418 GWh of electricity were generated, of which 22.2% was supplied by IPPs. In 2011, electricity was produced by several types of power plants, namely coal-powered thermal plants (44%), steam-powered thermal plants (25%), renewable energy power plants (geothermal, hydro, biomass, solar, and wind) (12%), diesel power plants (9%), gas power plants (6%), oil powered thermal plants (3%), and gas-powered thermal plants (1%) (ESDM, 2012).

FINAL ENERGY CONSUMPTION

The total final energy consumption was 115 504 ktoe in 2011, an increase of 3.4% from 111 705 ktoe in 2010. The share of final energy consumption by sector in 2011 was 44.8% for industry, 34.8% for transport and 20.5% for other sectors. Indonesia's economy is highly dependent on oil; final energy consumption of oil in 2011 was 64 519 ktoe (55.9% of the total final energy consumption) (EDMC, 2013).

Table 10 Key data and economic profile, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------------|----------|---------------------------------|---------|------------------------|---------|
| Indigenous production ^a | 341,034 | Industrial sector | 51,691 | Total | 183,418 |
| Net imports & other | -176,293 | Transport sector | 40,167 | Thermal | 161,425 |
| Total PES | 174,724 | Other sectors | 23,646 | Hydro | 12,419 |
| Coal | 46,780 | Total FEC | 115,504 | Nuclear | - |
| Oil | 81,733 | Coal | 20,239 | Others | 9,574 |
| Gas | 37,018 | Oil | 64,519 | | |
| Others | 9,192 | Gas | 16,996 | | |
| | | Electricity & Others | 13,749 | | |

a. Excludes biomass.

Source: EDMC (2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Energy Law

On 10 August 2007, Indonesia enacted Law No. 30/2007 regarding energy issues. This Energy Law contains principles regarding the utilisation of energy resources and final energy use, security of supply, energy conservation, protection of the environment with regard to energy use, pricing of energy, and international cooperation. The Energy Law 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 will address the sufficiency of energy to meet the economy's needs, energy development priorities, utilisation of indigenous energy resources and energy reserves. The Energy Law mandates the creation of a National Energy Council (Dewan Energi Nasional, DEN). Its tasks 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
- Provide oversight on the implementation of energy policies that are cross-sectoral.
- The National Energy Master Plan (RUEN) implements the KEN. By law, RUEN is drafted by the government, namely the Ministry of Energy and Mineral Resources, in a process that involves the related ministries and other government institutions, state-owned companies in the energy sector, and regional governments, as well as academia and other energy stakeholders, with due regard to input from the public.

The President chairs the assembly of DEN members. As an institution, DEN is headed by the minister responsible for energy affairs, and it 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 DEN was finalised in late 2008.

DEN finalised the draft of the National Energy Policy in March 2011, a document that would need to be discussed with the parliament (the DPR) before being enacted by the

government. Thus, this new energy policy would replace the existing National Energy Policy that was established by Presidential Regulation No. 5/2006.

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), the Mineral and Coal Mining Law (Law No. 4/2009), and the Electricity Law (Law No. 30/2009).

These laws were established to promote an increased role for business in the energy supply chain, in terms of 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.

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).

The Oil and Gas Law

Indonesia's oil and gas industry is currently undergoing regulatory changes. The industry was reformed in 2001 under the Oil and Gas Law (Law No. 21/2001). The regulatory bodies known as BP MIGAS and BPH MIGAS were created to address oil upstream and downstream activities, respectively. Exploration and production activities were conducted based on a fiscal contractual system that relies mainly on production sharing contracts (PSCs) between government and private investors, which may 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 was in conflict with the Constitution of 1945 and ordered its dissolution. At the time of this writing, the government is drafting a new Oil and Gas Law that will determine a new industry structure and 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 take over all BP Migas roles and responsibilities. Furthermore, on 14 January 2013, the government issued Presidential Regulation Number 9 Year 2013 as the umbrella for the establishment of the working Unit for Upstream Oil and Gas Business Activities (SKKMIGAS) with its tasks in managing the upstream oil and gas business in Indonesia.

BPH MIGAS has supervisory and regulatory functions in the downstream oil and gas sector with the aim of ensuring 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, relinquish its governmental roles to the new regulatory bodies BP MIGAS (now handed over 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 new law was enacted by the government on 12 January 2009 as Law No. 4/2009 regarding Mineral and Coal Mining.

The new Mining Law basically 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 from the central 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 to by both the government

and the investor. By instituting permits, the government expects to be better positioned to promote investments and to regulate mining.

The law creates greater opportunity for smaller investments in mining and gives regional governments a greater role in regulating the industry, along with revenue from mining. The Mining Law called for regulations on:

- Concession areas and concession periods (for exploration permits) and production limits (for production permits) in 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, fees and allocation of profits
- Reclamation and post-mining costs.

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

Electricity Law

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

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

Under the new Electricity Law, the electricity industry will be made up of electricity business entities that are title holders of electricity supply business licences, or Izin Usaha Penyediaan Tenaga Listrik (IUPTL). The IUPTL may be in integrated electricity supply, power generation, transmission, distribution or retailing of electricity. Indonesia's electricity systems will retain vertically integrated configurations. However, these will consist of several licensed 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, as licence holders in power generation for the supply of electricity to the public) will participate in the vertically integrated systems.

By law, the government and regional governments regulate the electricity industry within their respective jurisdictions and through electricity regulatory authorities. The Electricity Law allows electricity tariffs to be differentiated by region to allow for different costs of supply. Under the previous Electricity Law, Indonesia had a uniform electricity tariff regime and applied cross-subsidies between 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, MEMR has issued three government regulations (GR), namely GR No. 14/2012 on electricity supply businesses activity, GR No. 42/2012 on the buying and selling of electricity across Indonesia's borders, and GR No. 62/2012 on electricity support businesses.

Geothermal Law

Law No. 27/2003 Regarding Geothermal states that geothermal resource development is granted by authority of the state and executed by the government and provincial governments. MEMR, on behalf of the government, holds exclusive rights to establish policies, regulations, and licensing for geothermal exploration and exploitation.

Geothermal exploration and exploitation are based on the award of licences. The process involves the government offering geothermal work areas for competitive bidding to prospective business investors, and public, private or cooperative entities may submit bids on work areas for offer.

Successful bidders are awarded a maximum work area of 200 000 hectares and have the right to conduct exploration for three years with a possible extension of two more years. Upon completion of exploration, the awarded entity is required to complete a feasibility study within two years. During the exploitation stage, the awarded entity may be granted 30-year exploitation rights, which are extendable. Working areas are subject to tax, land rent, and royalties determined by the government (see following section). 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 improved 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 previous maximum progressive rate of 30%. Tax rates are to be further reduced to a flat rate of 25% in 2010 (ASEAN Affairs, 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 the governments whose economies produce hydrocarbons now use PSCs (Johnston et al., 2008). Several types of PSC have since emerged internationally.

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

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

Since 2008, fifth generation PSCs have been introduced. The key differences between the later generation PSCs and earlier generations are as follows: a) Rather than a fixed production historical after-tax share, there has been some flexibility in the production sharing percentage offered; b) PSCs now provide for a domestic market obligation for natural gas; c) BP MIGAS is entitled to FTP of 10% of the petroleum production that is not shared with the contractor; d) The profit sharing percentages appearing in the contract have been determined on the

assumption that the contractor is subject to dividend tax on after-tax profits under Article 26(4) of the Indonesian Income Tax Law, which is not reduced by any tax treaty; e) Certain pre-signing costs (e.g. for seismic purchases) may be cost recoverable; f) BP MIGAS must approve any changes to the direct or indirect control of the entity; and g) 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.

Table 11 Main features of Indonesia's production sharing contracts (PSC)

| Element | 1 st Generation PSC (1965-1975) | 2 nd Generation PSC (1976-1988) | 3 rd Generation PSC (1988-recent) | 4 th Generation - 1995 East Indonesia* | 5 th Generation Post Law No. 22/2001 | New Contracts (2008 – present) |
|---|---|---|--|---|---|---|
| FTP | None | None | 15-20% | 15% | 10% to BP MIGAS and not to be shared with contractor | 20% to BP MIGAS and not to be shared with contractor |
| Cost Recovery Limit | 40% | 100% | 80-85% | 85% | 90% | 90% and limited to costs from producing field or POD approved fields. Exploration cost limited to cost incurred prior to the approval of POD |
| Income Tax: Effective on net income • On distributable income after tax (with holding) • Total | | <ul style="list-style-type: none"> • 45% to 35% • 20% or 11% to 13% • 56%, 48% (depend on the tax regime) | <ul style="list-style-type: none"> • 35% to 30% • 20% or 13% to 14% • 48%, 44% (depend on the tax regime) | <ul style="list-style-type: none"> • 30% • 14% • 44% | <ul style="list-style-type: none"> • 30% • 14% • 44% | <ul style="list-style-type: none"> • 30% • 14% • 44% |
| Equity split Government/ Contractor • Oil • Gas • Oil • Gas • Oil | Determined on after tax basis: • 65/35% • n/a | Determined on after tax basis: • 85/15% split • 70/30% or 65/35% split Before tax at 56% • 65.909/34.09 1% • 31.818/68.18 2% (for 70/30% split) • 20.455/79.54 5% (for 65/35% split) Before tax at | Determined on after tax basis: • 85/15% split • 70/30% split Before tax at 48% • 71.154/28.84 6% • 42.308/57.59 2% Before tax at 44% | Determined on after tax basis: • 85/15% split • 60/40% split Before tax at 44% • 73.215/26.78 5% • 28.571/71.42 9% | Determined on after tax basis (based on negotiation), example: • 75/25% split • 60/40% split Before tax at 44% • 55.357/44.6 43% • 28.571/71.4 29% | Determined on after tax basis (based on negotiation), example: • 80/20% split • 70/30% split Before tax at 44% • 64.286/35.71 4% • 46.429/53.57 1% |

| | | | | | | |
|---|---|---|--|--|---|---|
| • Gas | | 48% • 71.154/28.84 6% • 42.308/57.59 2% (for 70/30% split) • 32.693/67.30 7% (for 65/35% split) | • 73.215/26.78 5% • 46.429/53.57 1% | | | |
| Investment Credit | 0% | 20% | 17% to 20% | 0% | 17% (oil), 55% (gas) | Not available |
| DMO - Oil | DMO was defined as 25% of contractor share of total oil production at .20 cents/bbl | 25% of contractor share of total oil production, full price for first years and .20 cents/bbl thereafter | 25% of contractor share of total oil production, full price for first five years and 10% of export price thereafter | 25% of contractor share of total oil production, full price for first five years and 25% of export price thereafter | A floor percentage of contractor share of total oil production, full price for first five years and 25% of export price thereafter | 25% of contractor share of total oil production, full price for first five years and 25% of export price thereafter |
| DMO-Gas | N/A | N/A | N/A | N/A | A floor percentage of contractor share of total gas production, weighted average contract price | 25% of contractor share of the quantity of Natural Gas proven reserves in the newly discovered reservoir, price depends on negotiations with potential domestic gas buyer |
| Depreciation: • Oil | No distinction between oil and gas. DDB or SLD as follows: • 14 years for production facilities • 3-18 years for moveable equipment • 14-20 years for others | •Seven years for capital cost (DDB) and 10 years amortization of non- capital costs (switching to SLD). Post 1985 7 years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | •Seven years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | •Seven years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | • Seven years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | •Five and ten years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) |
| • Gas | | •Fourteen years (switching to SLD). Post 1985 7 years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life;), except for certain contract still use 14 years | • Fourteen years (switching to SLD). Post 1985 7 years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life;), except for certain contract still use 14 years | •Seven years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | • Seven years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) | •Five and ten years DB (Balance of unrecovered capital costs is eligible for full depreciation at the end of the individual assets' useful life.) |
| Interest recovery | None | Available | Available | Available | Available | None |
| Abandonment liability to PSC contractor | None | Non | Non. Post 1995 PSCs require the contractor | Non. Post 1995 PSCs require the contractor to | PSCs require the Contractor to provide for | PSCs require the Contractor to provide for |

| | | | | | | |
|--|--|--|----------------------------|-------------------------|-------------|-------------|
| | | | to provide for abandonment | provide for abandonment | abandonment | abandonment |
|--|--|--|----------------------------|-------------------------|-------------|-------------|

DDB = double declining balance; DB = declining balance; SLD = straight line decline

DMO = domestic market obligation; POD = plan of development

Source: PwC, 2012.

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

Coalbed Methane

Business in coalbed methane gas is regulated by the laws and regulations that govern business activities in the oil and gas sector. The Directorate General of Oil and Gas has oversight of business activities in coalbed methane gas development. MEMR issues regulations and establishes and offers coal methane gas work areas. The Directorate General of Oil and Gas technically establishes and offers coalbed methane work areas, with due consideration to the opinion of BP MIGAS (since handed over to SKKMIGAS).

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

Minerals and Coal Mining

Indonesia's new Minerals and Coal Mining Law (Law No. 4/2009) replaced the systems of contract of work (COW) and work agreements for coal mining businesses (PKP2B) with two forms of permits: specifically, mining business permits (Izin Usaha Pertambangan, IUPs) and citizens mining permit (Izin Pertambangan Rakyat, IPRs), and 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, with the government represented by an implementing body 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 for 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 on transition states that existing contracts will be upheld, but the specific scheme for the transition of existing concessions is yet to be formulated.

Geothermal

Under the previous taxation law, geothermal companies are subject to corporate income tax at a flat rate of 34%. The government expects to revise this level of corporate tax to promote the greater development of geothermal resources.

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:

- Formulation of a National Energy Conservation Master Plan (Rencana Induk Konservasi Energi Nasional, RIKEN) that is to be updated once every five years or annually, as required
- Appointment of an energy manager, energy audits and an energy conservation programme for final energy users of 6000 toe or greater
- Implementation of energy efficiency standards and energy labelling
- Government incentives in the form of tax exemptions, fiscal incentives on the import of energy-saving equipment, and low-interest lending rates to encourage investments in energy conservation
- 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 stated:

- Energy source users and energy users who use energy sources and/or energy of 6000 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 6000 toe per year shall carry out energy management and/or implement energy savings
- Energy conservation programmes consist of short term programmes (improvements in operating procedures, maintenance, and installation of simple device controls), medium-to long-term programmes (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, at least on main energy-consuming appliances and equipment at least once every three years
- An annual report on energy management implementation shall be provided by energy source users and energy users to ministers, governors and regents or mayors within their respective jurisdictions
- Incentives shall be given to energy source users and energy users who have succeeded in reducing their specific energy consumption by at least 2% per year during a three-year period. These incentives include eligibility for energy audit partnerships funded by the government and/or recommendation for priority access to energy supplies by ministers, governors and regents or mayors within their respective jurisdictions. Disincentives shall imposed upon energy source users and energy users who have not implemented energy conservation through energy management. These disincentives include written notices to comply, public announcements of non-compliance, monetary fines (calculated at 5% of the cost of energy used during the one year reporting period), and/or reduced energy supply for non-compliance (maximum 5% of contract capacity for a period of one month, with an extension possible).

Barrier removal

Indonesia is participating in a UNDP–GEF project that involves six developing Asian economies. This project, Barrier Removal to the Cost Effective Development and Implementation of Energy Efficiency Standards and Labelling Project (BRESL), has five major programmes promoting energy standards and labelling: policy making, capacity building, manufacture support, regional cooperation, and pilot projects.

RENEWABLE ENERGY

Until the time the National Energy Council (DEN) establishes a new National Energy Policy (KEN), the National Energy Policy of 2006 is in force. The aim of this policy is to:

- Achieve energy elasticity to GDP of less than one by year 2025
- Realise an optimum primary energy consumption mix in 2025, with shares as follows:
 - Oil—to be less than 20%
 - Natural gas—to be greater than 30%
 - Coal—to be greater than 33%
 - Biofuels—to be greater than 5%
 - Renewable energy and other energy including nuclear—to be greater than 10%
 - Liquefied coal—to be greater than 2%.

The details of the energy programs and targets of the National Energy Policy are elaborated in the *Blue Print – National Energy Management 2005 to 2025* (ESDM, 2006).

Indonesia's 2006 energy policy expects the combined share of renewable energy and nuclear in the overall energy mix in 2025 to exceed 17%. The policy places special emphasis on enhancing the share of biofuels. Renewable energy and other energy including nuclear, as in the list above, are expected to be made up of at least a 5% share from geothermal and a combined share of biomass, hydropower, solar, wind and nuclear power to comprise the remainder of the 10% by 2025.

BIOFUELS

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

The matters regulated are the utilisation priority of biofuels; categories of biofuels; standards and specifications of quality; setting of price; commerce involving biofuels as other fuel; directives and oversight; and sanctions. In order to reduce fuel imports by accelerating the improvement and expansion of the use of biofuels, the Government revised Ministerial Regulation No. 32/2008 on 28 August 2013. This regulation sets mandatory targets in terms of the percentage share that biofuel has in the fossil fuels share of the total fuel consumption (biofuel blend), as shown in the following table.

Table 4 Minimum obligations for biofuel use (% blend)

| Sector | Sep 2013 | Jan 2014 | Jan 2015 | Jan 2016 | Jan 2020 | Jan 2025 |
|---------------------------|----------|----------|----------|----------|----------|----------|
| Biodiesel | | | | | | |
| PSO transport | 10 | 10 | 10 | 20 | 20 | 25 |
| Non-PSO transport | 3 | 10 | 10 | 20 | 20 | 25 |
| Industrial and commercial | 5 | 10 | 10 | 20 | 20 | 25 |
| Electricity generation | 7.5 | 20 | 25 | 30 | 30 | 30 |
| Ethanol | | | | | | |
| PSO transport | - | 0.5 | 1 | 2 | 5 | 20 |
| Non-PSO transport | 1 | 1 | 2 | 5 | 10 | 20 |

| | | | | | | |
|------------------------------------|---|---|----|----|----|----|
| Industrial and commercial | - | 1 | 2 | 5 | 10 | 20 |
| Straight vegetable oil fuel | | | | | | |
| Industry | 1 | 5 | 10 | 20 | 20 | 20 |
| Marine | - | 5 | 10 | 20 | 20 | 20 |
| Aviation | - | - | - | 2 | 3 | 5 |
| Electricity generation | 1 | 6 | 15 | 20 | 20 | 20 |

PSO = public service obligation fuel means subsidized fuel.

Source: ESDM (2013).

Until the end of year 2012, the realization of biodiesel (biofuel and bioethanol) utilization was 544 963 kL or 38.93% from 1 400 000 kL of the mandatory regulation target under Ministerial Regulation No. 32/2008.

Geothermal

The 2006 energy policy implicitly calls for Indonesia to increase total geothermal capacity to 9 500 MW by 2025. In 2011, Indonesia's total geothermal capacity was 1 189 MW, which is 4.1% of the total geothermal potential of 29 215 MW. Indonesia has identified 4 925 MW of geothermal power potential, to come from existing geothermal plants, capacity expansion of productive geothermal resources, and from new geothermal projects at 51 sites, specifically 2 670 MW in Sumatra at 18 sites, 2 010 MW in Java at 20 sites, 145 MW in Sulawesi at five sites, 65 MW in the Nusa Tenggara at five sites, and 35 MW in the Maluku Islands at three sites.

This geothermal power potential will be developed under the 10 000 MW Accelerated Development of Electricity Generation—Phase II programme, and it is expected that these projects could commence operation between 2011 and 2019. Of this total capacity, 4 585 MW will be developed by IPPs and 340 MW by PLN. Under PLN's Electricity Power Supply Business Plan 2012–2021 (*Rencana Usaha Penyediaan Tenaga Listrik, or RUPTL*), a further increase in geothermal capacity by 1 423 MW is expected between 2012 and 2021 (PLN, 2012).

Hydropower

In 2011, Indonesia's total hydropower capacity was 3 944 MW (including 64 MW of micro and mini hydro), which was 5.3% of the total hydropower potential of 75 GW (ESDM, 2012). Under the 10 000 MW Accelerated Development of Electricity Generation—Phase II programme over 2011–19, Indonesia is committed to developing additional hydropower with a total capacity of about 1 753 MW; of this total capacity, 484 MW will be developed by IPPs and 1 269 MW by PLN.

PLN's Electricity Power Supply Business Plan (RUPTL) also expects the addition of 4 557 MW to Indonesia's hydropower capacity during 2012–21 (including mini hydro and pump-storage plants); of this capacity, 3037 MW would be developed by PLN and 2 004 MW by IPPs. The hydropower capacity addition 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 10 254 MW, or 13.7% 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.

NUCLEAR

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, but to date the team has not conducted any significant

activities or performed relevant tasks. The legal basis of Indonesia's nuclear power development includes Law 17/2007 on Long Term Development, Years 2005–2015, and Government Regulation 43/2006 on Licensing of Nuclear Reactors.

Indonesia has developed an indigenous nuclear fuel cycle, although certain stages are still at the laboratory scale. 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 kW Triga Mark-II reactor in Yogyakarta; and the Bandung 1000 kW Triga Mark-II reactor in Bandung. A fourth 10 MW pool-type research reactor is planned.

Indonesia currently has two prospective uranium mines: 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 of a grade ranging between 0.10–0.30; and the Riang Tanah Merah Ore Body, a uranium vein that may contain fewer than 5 000 tonnes of uranium of a grade ranging between 0.30–1.00. The uranium mines are located in West Kalimantan.

Despite the above developments, however, the Fukushima nuclear accident in 2011 generated negative perceptions that have discouraged prospects for building nuclear power plants in Indonesia. At the same time, resistance from the people of the candidate sites also makes planning uncertain. Hence, the government has stated that nuclear power will be the last option to fulfil energy demand in Indonesia, after maximizing the use of renewable energy sources.

CLIMATE CHANGE

Indonesia strongly supports the objective of the United Nations Framework Convention on Climate Change (UNFCCC) to prevent atmospheric concentrations of anthropogenic gases exceeding a level that would endanger the existence of life on Earth. To indicate its firm decision and serious concerns 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 it stipulates.

As a non-Annex 1 party in the Kyoto Protocol, Indonesia has no obligation to reduce 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 G 20 Finance Ministers and Central Bank Governors Summit held in September 2009 in Pittsburgh, the United States. In addition, the government of Indonesia has pledged to reduce GHG emissions from forestry and the energy sector by 26% through domestic efforts, and by up to 41% through cooperation with other economies.

In response to this commitment and the challenges of climate change, the Indonesian government has set out a roadmap to integrate climate change issues into development planning. The climate change roadmap will integrate mitigation and adaptation into policy instruments, regulations, programmes, projects, funding schemes and capacity building in all development sectors. Two initial phases of the roadmap are the integration of climate change into the Mid-Term Development Plan 2010–2014 (Rencana Pembangunan Jangka Menengah 2010–2014, 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 reducing 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 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 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 programmes, projects and initiatives by private parties. The Transformation Fund is not a grants fund but a revolving fund, so projects are expected to generate returns on the fund's investments.

NOTABLE ENERGY DEVELOPMENTS

OIL AND GAS

Upstream

The upstream oil and gas implementing agency—BP MIGAS (before being changed to SKKMIGAS)—approved 41 oil and gas plans of development (POD) and accelerated production (put on production – POP) in 2011, which is expected to increase oil reserves by 301.72 million barrels and gas reserves by 4 Tcf. The number of POD and POP approvals in 2011 was exceptionally high compared to 2003-2010. With these reserve increases, Indonesia's proven oil reserve is 3.9 billion barrels, and its natural gas reserve is 104 Tcf as of 1 January 2012.

In 2011, BP MIGAS, on behalf of the Government, signed 31 work area cooperation contracts in oil and gas exploration and exploitation, and 27 work area cooperation contracts in coal methane gas exploration and exploitation.

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 5.21 billion litres of heavily subsidised kerosene for use in households in those provinces.

In an extension of the program, 4.7 million three-kilogram LPG canisters were distributed in 2010. As of May 2011, some 2.4 million three-kilogram LPG cylinders had been distributed. In 2012, the program expects to distribute 800 000 cylinders with the same characteristics.

ELECTRICITY

Public Private Partnership

With the signing of project documents in late 2011, the Central Java ultra-supercritical coal power plant 2 x 1000 MW will 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, since it is considered more transparent and accountable. The PPP scheme for the Central Java power plant project is Build-Own-Operate-Transfer (BOOT) for a concession period of 25 years. Commercial operation is expected to commence at the end of 2016.

ACCELERATED ELECTRICITY GENERATION PHASE I AND PHASE II

The accelerated power development program 10 000 MW Phase I had completed 4 520 MW of new generation capacity as of the end of November 2012. With regard to project constraints, the Ministry of Energy and Mineral Resources has set a new final completion date for the 10 GW Phase I of 2014.

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 generation capacity mix for Phase II of the 10 GW Accelerated Power Program is required to be updated to accommodate the current situation condition. In 2013, MEMR established a new final energy mix for the 10 GW Phase II, with a total capacity of 16 878 MW, 64% of which will be developed from coal, 29% from geothermal, 5% from hydropower, and 2% from gas. The scheduled completion date for the 10 GW Phase II is 2014 and it can be extended to 2019.

Hydroelectric Power

The Upper Cisokan pumped storage hydroelectric power plant 4 x 260 MW project in West Java received government loans from the World Bank/IBRD in late 2011. Completion of the project is expected in 2017. The Upper Cisokan pumped storage hydropower plant will be the first of its kind in Indonesia.

PLN has also secured financing for construction of the Jati Gede hydroelectric power plant 2 x 55 MW in West Java, Baliem hydroelectric power plant 50 MW in the province of Papua, Asahan III hydroelectric power plant 174 MW in the province of North Sumatra, Sumatra, and the Merangin hydroelectric power plant 2 x 175 MW in the province of Jambi, Sumatra.

REGULATIONS

Presidential Instruction No.13 of the Year 2011: 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 to save energy and water within their institutional domains and/or in the domains of State Owned Business and Regional Government Owned Business within their jurisdiction.

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

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

Ministerial Regulation NO.22 of the Year 2012: Assignment to PLN to make power purchases from Geothermal power plants AND ceiling price

Ministerial Regulation No 22 of the year 2012 was issued to revise Ministerial Regulation No. 02 of the Year 2011 Regarding Assignment to PLN to Make Power Purchases from Geothermal Power Plants, also known as the regulation for the implementation of feed in tariff (FIT) in the geothermal business in Indonesia. This regulation is a mandate for PLN to purchase geothermal power at a price that is set to different maximum levels depending on the location of the projects within Indonesia and the voltage connection point, ranging from approximately USD 10 cent/kWh in Sumatera to USD 18.5 cent/kWh in Maluku and Papua.

Based on that regulation, ceiling prices are in force for purchasing geothermal power in geothermal mining work areas, derived from holders of valid geothermal mining work areas following the enactment of this Ministerial Regulation; for holders of existing geothermal business authority, license or contract geothermal business prior to Law No. 27 of the year 2003 regarding geothermal, who intend to expand their power generation capacity based on power purchase agreements; those whose power purchase agreements have ended and will be extended; or those possessing power purchase agreements, and who have either produced or not yet produced electricity or steam, as long as both parties have agreed to change the selling price of electricity or steam on agreement; or license holders of geothermal businesses who want to sign power purchase agreements, as long as both parties have reached an agreement which includes an option to review prices.

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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

JAPAN

INTRODUCTION

Located in East Asia, Japan consists of several thousand islands, the largest of which are Honshu, Hokkaido, Kyushu and Shikoku. Most of its land area of approximately 377 800 square kilometres is mountainous and thickly forested.

Japan is the world's third largest economy after the United States and China. Its real GDP in 2011 was approximately USD 3 526.51 billion (USD 2000 at PPP). Japan's population of 127.8 million people in 2011 had a per capita income of USD 27 590. Japan's GDP decreased by 0.6 % in 2011 compared to 2010.

Since indigenous energy resources are modest, Japan imports nearly all of its fossil fuels to sustain economic activity. In 2011, proven energy reserves included approximately 44 million barrels of oil, 21 billion cubic metres of natural gas and 350 million tonnes of coal.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves(a) | |
|------------------------------------|---------|------------------------------|------|
| Area (thousand sq. km) | 377.8 | Oil (million barrels)—proven | 44 |
| Population (million) | 127.8 | Gas (billion cubic metres) | 20.9 |
| GDP (USD (2000) billion at PPP) | 3 526.5 | Coal (million tonnes)—proven | 350 |
| GDP (USD (2000) per capita at PPP) | 27 590 | | |

(a) Proven Reserves at the end of 2011 (BP, 2012).

Sources: EDMC (2013a), Oil & Gas Journal (2012).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011, Japan's total primary energy supply was about 491.4 million tonnes of oil equivalent (Mtoe), 1.3% less than in 2010. By fuel types, oil contributed the largest share (46%), followed by coal (22%) and natural gas (19%). In 2011, net imports of energy sources accounted for 87% of the total primary energy supply. With limited indigenous energy sources, Japan imported almost 99% of its oil, 99% of its coal and 96% of its gas.

In 2011, Japan was the world's third largest oil consumer after the United States and China (BP, 2012) and almost all of the oil was imported. The bulk of the imports (78.9% in 2011) came from economies in the Middle East such as the United Arab Emirates, Saudi Arabia, Iran, Qatar and Kuwait (BP, 2012). In 2011, the primary oil supply was 227.5 Mtoe, an increase of 12.8% from the previous year.

Japan is endowed with only limited coal reserves (350 million tonnes). Japan is the world's largest importer of coking coal for steel production and of steam coal for power generation, and pulp, paper and cement production. Japan's main steam coal suppliers are Australia, Indonesia, Russia, China, Canada, the United States, and South Africa, while for coking coal the main sources are Australia, Indonesia, Canada, the United States, Russia and China.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 20.9 billion cubic metres and are located in the prefectures of Niigata, Chiba and Fukushima. Domestic demand is met almost entirely by imports in the form of liquefied natural gas (LNG) (BP, 2012), which come from Malaysia (19.0% of imports in 2011), Australia (17.8%), Qatar (14.8%), Indonesia (11.8%), Russia (9.2%), Brunei Darussalam (7.9%), the United Arab Emirates (7.2%), Oman (5.0%) and other economies. In 2011, LNG imports to Japan comprised 32.3% of the total world LNG trade. Natural gas is mainly used for electricity generation, followed by reticulation as city gas and use as an industrial fuel. In 2011, the primary natural gas supply was 95.3 Mtoe, an increase of 11.7% from the previous year.

Japan has 282.284 GW of installed generating capacity and generated 1 107 149 GWh of electricity in 2011. Electricity is generated from thermal fuels (coal, natural gas and oil—73.6%), nuclear (14.7%) and hydro (8.1%); geothermal, solar and wind technologies produce the remainder (3.7%).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|---------|------------------------|-----------|
| Indigenous production | 65 963 | Industry sector | 142 518 | Total | 1 107 149 |
| Net imports and other | 425 458 | Transport sector | 77 841 | Thermal | 814 407 |
| Total PES | 491 421 | Other sectors | 94 630 | Hydro | 89 307 |
| Coal | 107 074 | Total FEC | 318 976 | Nuclear | 162 927 |
| Oil | 227 528 | Coal | 0 | Other | 40 508 |
| Gas | 95 301 | Oil | 36 060 | | |
| Other | 95 125 | Oil | 164 036 | | |
| | | Gas | 30 833 | | |
| | | Electricity and others | 84 615 | | |

Source: EDMC (2013b).

FINAL ENERGY CONSUMPTION

In 2011, Japan's total final energy consumption was 318.9 Mtoe, or 2.9% less than in the previous year. The industrial sector consumed 45% of the total, followed by the transportation sector at 25%. By energy source, petroleum products accounted for 51% of the total final energy consumption, followed by electricity and other (27%), coal (11%) and gas (10%).

In 2011, energy consumption in the industrial sector decreased by almost 1.6%. The residential/commercial sector's energy consumption also decreased by 3.9% and the transport sector's consumption decreased by 3.9%.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Economy, Trade and Industry (METI) is responsible for designing Japan's energy policy. 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. The Nuclear and Industrial Safety Agency, which was responsible for the safety of energy facilities and industrial activities, was abolished in September 2012. Its functions in relation to nuclear energy were transferred to the newly-established Nuclear Regulation Authority with the aim of achieving "the separation of nuclear regulation and promotion." The Ministry of Foreign Affairs formulates international

policies, while the Ministry of Environment is responsible for environmental and global warming-related matters.

The aim of Japan's energy policy is to achieve the '3E' goals—energy security, economic growth and environmental protection (for example, against global warming)—in an integrated manner. 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 based on this law was revised in 2007 (METI, 2008). It focuses on achieving the construction of an international framework for energy conservation and countermeasures to global warming; the establishment of a nuclear fuel cycle at an early stage; the promotion of new energy sources for electric power suppliers; assurance of a stable supply of oil and other fuels; the promotion of international cooperation in the energy and environmental fields; and the development of an energy technology strategy.

In 2006, Japan launched the New National Energy Strategy in response to the global energy situation (METI, 2008). The strategy contains a programme of action that extends to 2030 and it places considerable emphasis on achieving energy security. Its five targets are further energy efficiency improvements of at least 30%; increasing the share of electric power derived from nuclear energy to more than 30%–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 below 40%.

The Strategic Energy Plan was revised again in 2010. It is required to be reviewed at least every three years and to be revised, if needed. In this revision, two new principles—energy-based economic growth and reform of the energy industrial structure—were added to the three existing principles of energy security, environmental suitability and economic efficiency (METI, 2010).

The Strategic Energy Plan aims to fundamentally change the energy supply and demand system by 2030 and has set ambitious targets for 2030:

- Doubling the energy self-sufficiency ratio (18% at present) and the self-developed fossil fuel supply ratio (26% at present) and as a result, raising Japan's energy independence ratio to about 70% (38% at present)
- Raising the ratio of zero-emission power sources to about 70% (34% at present)
- Halving CO₂ emissions from the residential sector
- Maintaining and enhancing energy efficiency in the industrial sector at the highest level in the world
- Maintaining or obtaining top-class shares of global markets for energy-related products and systems.

If the policies in the Strategic Energy Plan are implemented in a strong and sufficient manner, the economy's total energy-related CO₂ emissions are expected to be reduced by 30% or more in 2030 compared to the 1990 level. A 30% emissions reduction means that about a half of the reduction that has to be achieved from the current level to 2050 (80% reduction compared to 1990) will have been realized in 2030.

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

However, Prime Minister Shinzou Abe, who was inaugurated on 26 December 2012, has stated that the coalition of the Liberal Democratic Party and Clean Government Party would reconsider the Democratic Party's nuclear energy policy.

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 accounts for around 40% of Japan's total primary energy supply and is expected to continue to dominate Japan's future energy supply. Securing a stable supply of oil will remain one of Japan's major energy policy issues.

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

The Japan Oil, Gas and Metals National Corporation (JOGMEC) is responsible for the economy's stockpile business and also provides financial and technical assistance to Japanese oil industries for oil and natural gas exploration and development, both domestically and abroad. Japan's oil stocks are well in excess of the International Energy Agency's 90-day net import requirements. As of July 2013 Japan held the equivalent of 188 days of net imports, including state-owned and private sector stocks (PAJ, 2013a).

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

The number of service stations in the economy decreased from 59 615 in 1996 to 36 349 in 2012 as a result of market liberalization (Sekiyu Tsushinsha 2013). The Provisional Measures Law on Importation of Specific Kinds of Refined Petroleum Products was abolished in March 2012. In this context, the Japanese Government aims to establish a fair and transparent market in terms of quality and prices, where oil product retailers are able to play an important role as the point of interaction with final consumers.

The number of oil refineries in Japan decreased from 40 in 1996 to 25 in 2013. Refining capacity decreased from 5.27 million barrels/day (mbd) in 1996 to 4.33 mbd in 2013 (Sekiyu Tsushinsha 1996; PAJ, 2013b).

Natural gas

Demand for natural gas has been increasing rapidly over the past two decades. Between 1990 and 2011, natural gas demand grew at an annual rate of 3.9% (EDMC, 2013b). This robust growth is expected to continue, partly for environmental reasons and partly due to its ease of use. Since 1995, Japan has undertaken natural gas market reform in an attempt to lower the cost of gas supply and increase the economy's industrial competitiveness in the global market.

Natural gas is supplied almost entirely by imports in the form of LNG. Since Japan has placed priority on a stable and secure supply of LNG, Japanese LNG buyers have generally been paying a higher price than buyers in Europe or the United States under long-term 'take or pay' contracts with rigid terms on volume and price.

However, Japanese gas and electric utilities are faced with mounting pressure to reduce costs because of the deregulation of the gas and electricity markets. The utilities have been making efforts to secure LNG supply on flexible terms that enable them to quickly respond to changes in the market situation and to supply gas at lower prices.

In addition, Japan has promoted technological developments in the production and processing of methane hydrate, which is abundant in the ocean areas surrounding Japan and is viewed as a future energy resource.

Coal

In 2011, coal accounted for 22% of the total primary energy supply. Coal will continue to play an important role in Japan's energy sector, mainly for power generation and for iron, steel, cement, papers and pulp production. Japan is the biggest coal importer in the world, accounting for about 18% of total global coal imports in 2011 (IEA, 2012)

Electricity market

Electricity was the second largest contributor, after the petroleum industry, to the total final energy consumption in 2011. Increased use of electrical appliances in the home, the widespread use of personal computers and related information technology in offices, and a shift in industry structure to more services-based sectors has driven the steady increase in electricity consumption in recent years.

Japan's electricity prices have been among the highest of the developed economies. To lower electricity prices and increase industrial competitiveness, Japan has undergone a programme to reform the electricity sector, through amendments to the Electricity Utilities Industry Law in 1995, 1999, 2004, 2008 and 2013, respectively

The main points of the amendments to the Electricity Utilities Industry Laws in 2013 are as follows (METI, 2013a):

- Enlargement of the power system operation over a wide area
- Overall liberalization of power generation and the retail sector
- Securing greater neutrality of the transmission and distribution sector based on legal separation.

FISCAL REGIME AND INVESTMENT

The Japanese government recognizes 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 offer financial support to companies.

In the short term, the government will 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 is the basis of all energy conservation policies in Japan. It was established in 1979, triggered by the Oil Crisis of 1979. It requires improving the energy efficiency of the industrial, consumer (commercial and household) and transport sectors.

In 2010, the revised Strategic Energy Plan set these initiatives (METI, 2010):

- Enhancing Japan's energy efficiency (already at the highest level in the world) through introduction of the most advanced technologies for replacing equipment in the industrial sector.
- Making net-zero-energy housing available by 2020 and achieving net-zero-energy housing as the average across the economy by 2030.
- Setting compulsory energy-saving standards for houses and compiling compulsory standardization targets.
- Replacing 100% of lighting with high-efficiency lamps (including LED and organic EL lighting) on a flow basis by 2020 and on a stock basis by 2030.

- Introducing new integrated standards for energy consumption in all buildings for implementation within two years.
- Enhancing support and regulatory measures (including top-runner standards) to increase the adoption of energy-saving consumer electronics, energy-saving information technology equipment, heat pump water heaters, fuel cells, hybrid construction machines and other highly efficient equipment.
- Raising next-generation vehicles' share of new vehicle sales to up to 50% by 2020 and up to 70% by 2030 by mobilizing all possible policy measures.

However, in 2011, following the temporary shutdown of nuclear power plants due to periodic inspection, the Japanese government began a significant review of its Strategic Energy Plan.

RENEWABLE ENERGY

Japan has a system of feed-in tariffs, where electric power companies are obliged to buy electricity generated from renewable sources at a certain price. Utilities are required to pay attention to the burden on consumers and implement measures for stabilising the power grid.

In August 2011, the Act on Purchase of Renewable Energy-Sourced Electricity by Electric Utilities was passed by the Diet (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 hydro power, geothermal and biomass) based on fixed-period contracts with fixed prices. Table 3 shows prices for the Feed-In Tariff in FY 2013. Solar power prices for the Feed-In Tariff were reduced from the FY 2012 levels (METI, 2013b).

Table 3 Prices for Feed-In Tariff in FY 2013

| Renewable Energy | | Prices (JPY per kW) | Periods (Years) |
|------------------|--|---------------------|-----------------|
| Solar | Over 10 kW | 37.8 | 20 |
| | Less than 10 kW | 38.0 | 10 |
| | Less than 10 kW (Double generation) | 31.0 | 10 |
| Wind | Over 20 kW | 23.1 | 20 |
| | Less than 23 kW | 57.75 | 20 |
| Hydro | From 1,000 kW to 30,000 kW | 25.2 | 20 |
| | From 200 kW to 1,000 kW | 30.45 | 20 |
| | Less than 200 kW | 35.7 | 20 |
| Geothermal | Over 15,000 kW | 27.3 | 15 |
| | Less than 15,000 kW | 42.0 | 15 |
| Biomass | Methane fermentation gasification | 40.95 | 20 |
| | Unused woods | 33.6 | 20 |
| | General woods | 25.2 | 20 |
| | Waste (excluding woods) | 17.85 | 20 |
| | Recycled woods | 13.65 | 20 |

Source: METI (2013b).

Note: 5% of tax is included.

Costs incurred by the utilities in purchasing renewable energy-sourced electricity shall be transferred to all electricity customers, who will pay a surcharge for renewable energy at a rate proportional to their electricity usage. Surcharge for renewable energy is calculated as follows (METI, 2013c):

Surcharge for renewable energy

= Monthly electricity consumption (kWh) \times (0.35 JPY/kWh + Solar added unit price JPY/kWh)

Each 10 Electric Utility Company has a different level for its solar-added price: from 0.01 JPY/kWh to 0.09 JPY/kWh.

Electric utilities are obliged to allow grid connections and execute contracts as required for that purpose. Feed-in tariff (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 set by the Minister of Economy, Trade and Industry and will be based on the recommendations of a newly-established independent committee every year. To promote the generation of renewable energy-sourced electricity, special consideration shall be given to the profits of renewable energy-sourced electricity suppliers when decisions are made about the FIT rate for the three years from the enforcement of the Act (METI, 2011).

Table 4 shows the installed generation capacity for each renewable source of energy after the introduction of FIT (METI, 2013d). One year after the introduction of FIT, in total 22,915 MW of generation capacity based on renewable energy has been authorized under the FIT scheme, while accumulated generation capacity based on renewable energy by the end of June 2012, that is to say, before the introduction of FIT, was 20,600 MW. This indicates that the generation capacity based on renewable energy has doubled since the introduction of FIT. Start-up generation capacity based on renewable energy is 3,541 MW, only 15.5% of the authorized capacity.

Table 4 Installed Generation Capacity by Renewable Energy after Introduction of FIT
(Unit: MW)

| | Introduced & Started-up Capacity | | | Authorized Capacity |
|-----------------------------------|--|-----------------------|----------------------|-----------------------|
| | Before FIT | After FIT | | After FIT |
| | Accumulated capacity by the end of June 2012 | July 2012 – Mar. 2013 | Apr 2013 – June 2013 | July 2012 – June 2013 |
| Solar (Residence) | 4,700 | 969 | 410 | 1,633 |
| Solar (Non-Residence) | 900 | 704 | 1,292 | 19,755 |
| Wind | 2,600 | 63 | 3 | 805 |
| Medium Hydro (Over 1,000 kW) | 9,400 | 0 | 0 | 65 |
| Medium Hydro (Less than 1,000 kW) | 200 | 2 | 0 | 14 |
| Biomass | 2,300 | 30 | 67 | 639 |
| Geothermal | 500 | 1 | 0 | 4 |
| * Total | 20,600 | 1,769 | 1,772 | 22,915 |

Source: METI (2013d).

NUCLEAR ENERGY

Japan's Nuclear Energy Policy is under review following the Fukushima Daiichi Nuclear Power Plant Accident. Nuclear power plants in Japan have historically stopped operation for periodic inspections, once in every 13 months in succession, regardless of the Fukushima Daiichi Nuclear Power Plant Accident. However, in April 2012, the four units of the Fukushima Daiichi Nuclear Power Plant were decommissioned and by May 2012 Japan had no operating nuclear power plants.

In July 2012, two nuclear power plants (Ohi units 3 and 4) restarted operations, but stopped operations again for periodic inspections in September 2013. Since then, Japan has again had no operating nuclear power plants.

New regulations for nuclear power plants came into force in June 2013. Five Electric Utilities Companies have submitted application for the re-start of their nuclear power plants to Nuclear Regulation Authority.

CLIMATE CHANGE

In 2007, the Japanese government announced Cool Earth 50, a cooperative initiative with major greenhouse gas (GHG) emitters to reduce worldwide emissions by 50% from the current levels by 2050. The actions required to achieve these goals are set out in the Cool Earth Innovative Energy Technology Programme, which includes the Innovative Energy Technology Roadmap (METI, 2008b) and the Technology Development Roadmap (METI, 2008c).

At the United Nations Summit on Climate Change in September 2009, then-Prime Minister Yukio Hatoyama pledged that Japan would cut its GHG emissions by 25% from its 1990 levels by 2020. The target is premised on the establishment of a fair and effective international framework in which all major economies participate, and on those economies agreeing on ambitious targets. Japan's GHG emissions stood at 1 341.00 million tonnes of CO₂ equivalent in 2012 (preliminary figures, an increase of 2.5% compared to the previous year and an increase of 6.3% compared to the base year 1990) (ME, 2013a).

Japan's GHG emissions in the first UNFCCC's commitment period between 2008 and 2012 stood at 1 279.00 million tonnes of CO₂ equivalent. Therefore, Japan exceeded its emission target of reducing GHGs by 1.4%. The carbon sink by forest ecosystems is equivalent to a 3.8% reduction of GHG, while Kyoto Mechanism Credit is equivalent to a 5.9% reduction of GHG. If these were taken into account, Japan would be able to achieve an 8.2% GHG emission reduction compared to the levels for 1990 (ME, 2013a).

The Tax for Promotion of Global Warming Countermeasures took effect in 1 October 2012 (ME, 2012b). This tax is levied on crude oil/oil products, gas and coal (ME, 2012). The tax value is JPY 289/tonne-CO₂ for each kind of product. Revenue from this tax is used for implementing various measures to promote energy efficiency and renewable energy, as well as the use of clean fossil fuels.

The tax values for crude oil/oil products, gas and coal were raised in phases as follows.

Table 5 Tax for Promotion of Global Warming Countermeasures

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

(Source) ME, 2012.

At the COP 19 Meeting in November 2013, the Japanese Government through the Ministry of the Environment announced that Japan would cut its GHG emissions by 3.8% in 2020 compared to 2005 (ME, 2013b). This is an aspirational goal of improving energy efficiency, which already stands at the highest level in the world, by 20%. Moreover, Japan does not take into account the effect of nuclear power plants for reducing GHG emissions

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY

In 2013, the Japanese government anticipated the possibility of a shortage of electricity supplies due to the stoppage of almost all of the economy's nuclear power plants. As a result, it asked the people of Japan to save electricity during specified periods during both the summer and the winter. In the summer, citizens were asked to conserve electricity from 9:00 to 20:00 on weekdays from 1 July to 30 September 2013, excluding the period between 13 and 15 August 2013; no numerical targets were set (PMJHC, 2013a). During the winter, they were asked to

conserve from 9:00 to 21:00 (from 8:00 to 21:00 in Hokkaido and Kyushu District) on weekdays from 2 December 2013 to 31 March 2014, excluding 30-31 December 2013 and 2-3 January 2014. Once again no numerical targets were set. In Hokkaido, however, there is a numerical target designed to save electricity by more than 6% compared to what was used in FY 2010 (PMJHC, 2013b).

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KOREA

INTRODUCTION

The Republic of Korea is located in Northeast Asia between China and Japan. It has an area of 99 538 square kilometres and a population of around 49.78 million people as of 2011. Korea's population density is very high, with an average of more than 490 people per square kilometre. Around 20% of the population lives in Seoul, Korea's capital and its largest city. The economy's geography is largely made up of hills and mountains, with wide coastal plains in the west and the south. The climate is relatively moderate with four distinct seasons. Air conditioning is commonly necessary during the tropical hot summers and buildings need to be heated during the bitterly cold winters.

During the last few decades, Korea has been one of Asia's fastest-growing and most dynamic economies. Gross domestic product (GDP) increased at a rate of 6.22% per year from 1980 to 2011, reaching USD 1 259 billion (USD (2000) at PPP) in 2011. Per capita income in 2011 was USD 25 299, more than four times higher than in 1980. Korea's major industries include the semiconductor, shipbuilding, automobile, petrochemicals, digital electronics, steel, machinery, parts and materials industries.

Korea has few indigenous energy resources. It has no oil resources, only 326 million tonnes of recoverable coal reserves and 3 billion cubic metres of natural gas. To sustain its high level of economic growth, Korea imports large quantities of energy products. Korea imported about 90% of its primary energy supply in 2011. It was the world's fifth-largest importer of oil and the world's second-largest importer of both coal and liquefied natural gas (LNG).

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|------------------------------------|----------|--|-----|
| Area (sq. km) | 99 538 | Oil (barrels) | — |
| Population (million) | 49.78 | Gas (billion cubic metres)— recoverable | 3 |
| GDP (USD (2000) billion at PPP) | 1 259.34 | Coal (million tonnes)— recoverable | 326 |
| GDP (USD (2000) per capita at PPP) | 25 299 | | |

Sources: EDMC (2013); EIA (2009); MKE and KEEI (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased more than six fold between 1980 and 2011, from 38.32 million tonnes of oil equivalent (Mtoe) in 1980 to 255.7 Mtoe in 2011. In particular, from 1990 to 2000, the energy supply increased at an annual average rate of 7.3%, far exceeding the economic growth rate of 6.1% for the same period. Likewise, the per capita primary energy supply grew from 1.0 tonne of oil equivalent in 1980 to 5.1 tonnes of oil equivalent in 2011. The increase was similar to that of Japan and most European economies.

In 2011, Korea's total primary energy supply was 255.7 Mtoe, a 1.1% increase from the previous year. By energy source, oil represented the largest share (38%), followed by coal (31%), and gas (16%). The remaining 15% of the primary energy supply came from nuclear and hydro energy sources. Korea imported around 88% of its total energy needs in 2011, including all of its oil, 99% of gas requirements and 98% of its coal supply. Energy imports accounted for almost one third of Korea's total import value in 2011.

The oil supply in 2011 was 96.9 Mtoe, a 9.54% increase from the previous year. In 2011, the economy imported about 81.8% of its crude oil from the Middle East. In the case of coal, its supply in 2011 totalled 79.9 Mtoe, a 9.5% increase from the previous year. This substantial increase was the result of a strong demand from the power sector for coal, due to its cost competitiveness compared to other fuels. Korea has modest reserves of low-quality, high-ash anthracite coal that are insufficient to meet its domestic demand. Almost all of Korea's coal demand is therefore met by imports. Korea is the world's second-largest importer of both steam and coking coal after Japan. Main coal imports come from China, Australia, Indonesia, Canada, Russia and the United States.

Since the introduction of LNG in 1986, natural gas use in Korea has grown rapidly. Gas supply reached 41.5 Mtoe in 2011; its share of the primary energy supply was 16% in that year. Most of Korea's LNG imports come from Qatar, Indonesia, Oman, Malaysia, Brunei Darussalam and Russia's Sakhalin-2 LNG plant. 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 of the economy.

Korea's electricity generation in 2011 was 525 Terawatt-hours, a 5.16% increase from 2010. Generation by thermal sources, including coal, oil and natural gas, accounted for 68% of the total electricity generated, followed by nuclear at 29% and hydro at 1.3%.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|---------|------------------------|---------|
| Indigenous production | 50 293 | Industry sector | 48 525 | Total | 525 297 |
| Net imports and other | 227 383 | Transport sector | 29 131 | Thermal | 356 866 |
| Total PES | 255 760 | Other sectors | 82 801 | Hydro | 7 831 |
| Coal | 79 995 | Total FEC | 160 457 | Nuclear | 154 723 |
| Oil | 96 936 | Coal | 9 435 | Other | 5 877 |
| Gas | 41 594 | Oil | 81 972 | | |
| Other | 37 235 | Gas | 21 577 | | |
| | | Electricity and other | 47 473 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2011 was 160.5 Mtoe, a 1.9% increase from the previous year. The industry sector accounted for the largest share at 30.2%, while the transport sector accounted for 18.1%. The remainder (51.7%) 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 industry sector has weakened since the late 1990s, and demand in the transport and commercial sectors has increased.

By energy source, petroleum products accounted for 51.1% of total energy consumption, followed by electricity and other (29.6%), natural gas (13.4%), and coal (5.9%). Natural gas consumption has increased significantly due to the economy's policy measures.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In the past, Korea's energy policy 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 between a number of government institutions. The Ministry of Knowledge Energy (MKE) 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 government and non-governmental experts. The committee's role is to deliberate and mediate 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 and physical distribution plan for energy, the effective execution of the energy budget, and energy issues within the United Nations Framework Convention on Climate Change.

As part of its liberalisation efforts in the energy sector, in 2001 the government established the Korea Electricity Commission (KOREC) 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, which 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, as well as 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 Research (KIER), funded by the government, is Korea's major energy technology research institute. KIER's mission is to contribute to an economy-wide economic growth by developing industrial core energy technologies and deploying outcomes.

The Korea Energy Management Corporation 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 manages R&D planning and financial support and management.

In August 2008, faced with high energy prices and rising concerns over climate change, Korea announced a long-term strategy that will determine the direction of its energy policy until 2030. The strategy's long-term energy goals are to:

- *Improve energy efficiency and reduce energy consumption.* By 2030, Korea will reduce its energy intensity by 46%, from 341 toe/USD million to 185 toe/USD million. This is expected to result in an energy savings of 42 Mtoe (KEEI, 2010a).
- *Increase the supply of clean energy and reduce the use of fossil fuels.* By 2030, the share of renewable energy in total primary energy supply will reach 11%, up from 2.4% in 2007.
- *Boost the green energy industry.* By 2030, Korea's green energy technologies will be comparable to those of most advanced economies.
- *Ensure Korean citizens have access to affordable energy.* The government will ensure energy sources are accessible and affordable to low-income households.

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 there may be stages of restructuring and liberalisation during the outlook period, allowing more private participation in the oil, gas and electricity industries.

ENERGY MARKETS

Market reform

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

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 privatized in stages. However, in July 2008, the government announced there would be no further privatization of KEPCO and its five subsidiaries. At the end of 2009, 51% of KEPCO, as a holding company, was owned by the Korean Government. KEPCO is still a dominant player in the electricity sector, controlling 94% of total power generation and 100% of transmission and distribution in Korea (KEPCO, 2009).

The Korean Government has also made moves to restructure the gas industry. In November 1999, the government sold 43% of its equity in the KOGAS and developed the Basic Plan for Restructuring the Gas Industry to further promote 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 how to achieve the smooth succession of the existing import and transportation contracts, the privatisation of import and wholesale businesses, stabilize prices and balance supply and demand, and the revision of related legislation and enforcement (KEEI 2002).

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

OIL, GAS AND ELECTRICITY MARKETS

Oil

Due to 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 August 2011, Korea held 117 million barrels in strategic reserves and had already purchased 2.3 million barrels, or 94% of that year's purchase target. Korea aims to build its strategic reserves to 141 million barrels, stockpiled at nine locations across the economy, by 2013. The economy-wide stockpile capacity substantially exceeds the IEA's 90-day requirement.

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

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

Korea has also been trying to diversify its crude oil supply sources. The number of source countries increased from nine in 1980 to 29 in 2004, but the economy's dependency on oil imports from the Middle East remains high (84.5% in 2009). Korea is also actively strengthening its bilateral relations with oil-producing economies as well as its multilateral cooperation through the IEA, APEC, the Association of Southeast Asian Nations (ASEAN)+3, the International Energy Forum and the Energy Charter, 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

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

The Ninth Plan for Long-Term Natural Gas Demand and Supply, finalized by MKE in December 2008, projected natural gas demand would grow by 0.2% per year from 2007 to 2030. By sector, the city gas sector's demand for natural gas is projected to increase by 2% per year, while the demand for gas for power generation is projected to decrease by 3.8% per year.

The Korean Government is considering new reforms for the gas industry, with the introduction of gas-to-gas competition by unbundling imports and sales activities from the operation of terminals and transmission facilities, and by instituting an open access regime for receiving terminals and the transmission network.

Electricity

Due to 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 2009, installed capacity increased by more than threefold from 21 GW in 1990 to 78 GW in 2009.

The Fourth Basic Plan of Electricity Demand and Supply (2008–22), finalized by MKE in December 2008, projects that electricity demand will grow by 2.1% per year from 2008 to 2022 and an additional capacity of 33.6 GW will be required by 2022. When decommissioning is taken into account, this translates to about 101 GW of total generation capacity for that 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.

To rectify an energy supply and demand structure that is overly dependent on oil, the construction of oil-fired power plants was strictly controlled and the development of nuclear, coal and natural gas electricity generation units was promoted. Gas-fired power plants were first introduced in 1986. During the period of the Fourth Basic Plan, 12 nuclear-energy power plants, seven coal-fired power plants, and 11 gas-fired power plants are planned for construction. Korea has been building nuclear-energy power plants since the 1970s as nuclear energy is a strategic priority for the government. Its share of total electricity production capacity is projected to increase to 32.6% in 2022.

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 include a reduction in corporate tax rates and an increase in tax benefits for research and development (R&D).

In 2007, the corporate tax rate was 25% 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 lowered further from 22% in 2009 to 20% in 2010, and from 11% to 10% for the same period, respectively. However, implementation of the tax rate reduction was postponed until the end of 2011.

To promote investment in R&D that will boost economic growth, the government has increased its tax assistance for R&D. The new measures include an R&D reserve fund, which will be deductible up to 3% of sales revenue, an increase in investment tax credits for R&D facilities from 7% to 10% 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 allocated around USD 14.2 billion for an energy efficiency initiative that is effective until 2012. This initiative aims to improve energy efficiency by 11.3% by 2012 compared with 2007 and to save 34.2 Mtoe. Announced in August 2008, it is part of Korea's long-term energy plan, which aims to achieve a 4.6% annual energy efficiency improvement compared to the previous year by 2030.

To meet the target, the government will provide incentives for companies to invest in energy efficiency, to phase out incandescent lamps by 2013 and to implement a programme modelled on Japan's Top Runner Program that will complement the current Energy Efficiency Label and Standard Programme.

RENEWABLE ENERGY

In January 2009, the Korean Government announced a renewable energy plan, under which renewable energy sources will account for a steadily increasing share of the energy mix to 2030 (MKE 2009a). The plan covers areas such as investment, infrastructure, technology development and programmes to promote renewable energy.

New and renewable energy resources are seen as significant not only because they are sustainable, but because they will lead green growth in response to climate change while securing

energy security for Korea. In line with this, the new and renewable energy industry is to be fostered as a new growth area through the government's continuous support for R&D in sectors with market potential, such as photovoltaic systems, wind power and hydrogen fuel cells.

Under the new plan, renewable energy sources will account for 4.3%, 6.1% and 11% of the energy mix in 2015, 2020 and 2030, respectively—a significant increase from the 2007 share of just 2.4%. According to this initiative, the government will:

- *Allocate funds and attract investment to increase the use of renewable energy sources.* The initiative will cost KRW 111.5 trillion (about USD 85.8 billion) between 2009 and 2030, of which nearly one-third will come from the government. Of that amount, KRW 100 trillion (about USD 76.9 billion) has been allocated to promote renewable energy and KRW 11.5 trillion (about USD 8.8 billion) to develop green technologies. After 2020, when renewable energy sources are expected to become more economically viable, the proportion of private investment is expected to increase steadily. In 2009, private investment was expected to surge to KRW 3.1 trillion (about USD 2.4 billion, a 103% increase from 2008) and the renewable energy industry was expected to create nearly 2 050 jobs to augment its existing workforce of about 2 900 people.
- *Support the development of green technologies to make renewable energy more cost effective.* The government introduced a renewable portfolio standard in 2012 that supported the construction of 1 million 'green homes' between 2009 and 2020 and provided incentives for the wider use of renewable energy sources in new and newly-renovated buildings. It also strengthened the role of local governments in encouraging the wider use of renewable energy.
- *Improve the infrastructure for renewable energy.* These measures will include: a renewable energy investment fund; the amendment of any regulations that hinder the transition to renewable energy; promotional efforts to raise public awareness of the benefits of renewable energy; a more detailed classification system that conforms to the system used by the IEA, which will facilitate a more effective analysis of statistics; and human resources programmes to foster technical professionals with the necessary expertise.

CLIMATE CHANGE

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

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 the vision of green growth more effectively, the National Strategy for Green Growth was adopted along with the Five-year Plan for Green Growth in June 2009.

The National Strategy for Green Growth calls for building 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 10 policy directions:

- Mitigation of climate change and achievement of energy independence
 - Effective reduction of greenhouse gas emissions (MKE, 2009b)
 - 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, 2010b)
 - Greening of existing industries and the promotion of green industries
 - Advancement of industrial structure
 - Engineering a structural basis for the green economy (KEEI, 2010c).

- 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.

To fulfil the policy goals set out in the strategy, the Korean Government is adopting the practice of five-year planning. Five-year plans are mid-term programmes designed to implement the long-term strategy for green growth. Table 3 outlines the policy indicators for the first plan for 2009–13 and shows the years beyond as a reference.

The Five-Year Plan for Green Growth envisages fiscal spending of KRW 107 trillion (USD 86 billion) for 2009–13. Under the plan, three objectives and 10 policy directions will be implemented in an efficient and predictable manner. The fiscal budget will be mainly spent on R&D in green technology, such as solar energy and fuel cells, the restoration of the four major rivers and green transportation.

Table 3 Policy indicators, five-year plan, 2009–2013

| Policy indicator | 2009 | 2013 | 2020 | 2030 |
|---------------------------------|-------|-------|-------|-------|
| Energy intensity (toe/USD '000) | 0.317 | 0.290 | 0.233 | 0.101 |
| Energy independence (%) | 27 | 42 | 54 | 70 |

Source: MKE (2009a).

Roughly 2% of the economy's annual GDP is being allocated to green investment, which is twice the amount recommended in the Green Economy Initiative advocated by the United Nations Environment Programme (1% of GDP). Table 4 shows the rates of green investment in Korea up to 2013.

In its response to climate change, the Korean Government a) has set an economy-wide greenhouse gas (GHG) reduction goal; b) supports voluntary reduction efforts by industry; c) has activated the carbon market by expanding market mechanisms such as the carbon neutral programme and the carbon fund, and fosters companies that specialize in emissions trading schemes; and d) is considering introducing a system for the mandatory supply of new and renewable energy focusing on the electricity generation sector. It will also introduce legal controls in part, such as obligating Renewable Portfolio Agreements based on existing voluntary agreements.

Table 4 Rates of green investment, 2009–13 (KRW trillion)

| Category | Total | 2009 | 2010–20 | 2012–13 | Rate of increase (%) |
|--|-------|------|---------|---------|----------------------|
| Total | 107.4 | 17.5 | 48.3 | 41.6 | 10.2 |
| Mitigating climate change and achieving energy independence | 56.9 | 8.6 | 29.2 | 19.2 | 14.0 |
| Creating new engines for economic growth | 28.6 | 4.8 | 10.7 | 13.1 | 9.4 |
| Improving quality of life and enhancing international standing | 27.9 | 5.2 | 10.5 | 12.2 | 3.6 |

Source: MKE (2009a).

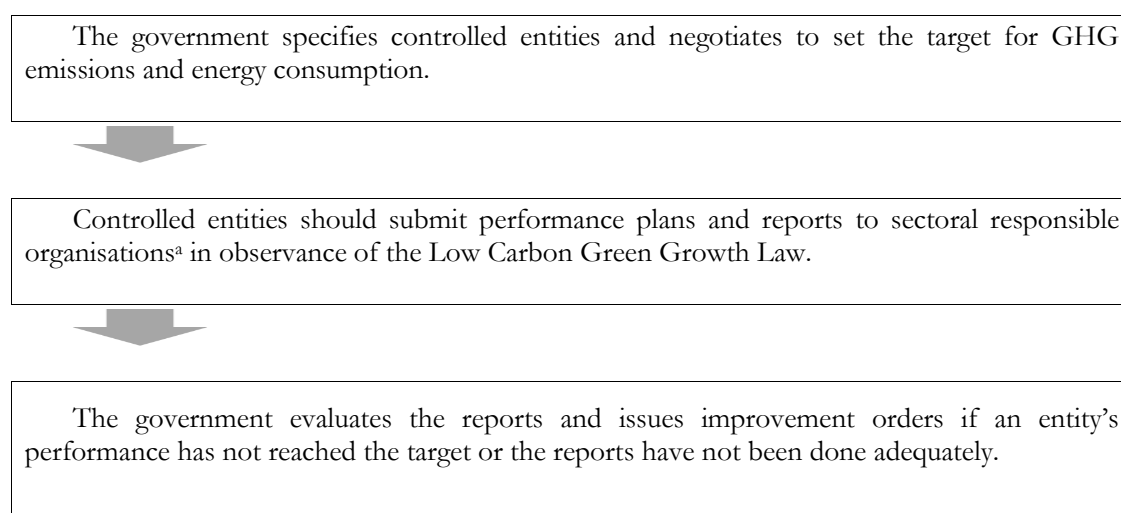
NOTABLE ENERGY DEVELOPMENTS

CLEAN ENERGY/ENERGY EFFICIENCY
R&D Plan to Nurture the Green Industry

As part of its efforts to become one of the world's top-five green energy powerhouses by 2020, Korea intends to double its budget for energy R&D between now and then. Under a plan announced in November 2011, Korea will strengthen its core technology in the area of green energy and secure 10% of the global market. Technology development and R&D carried out under the plan will effect a 12% increase in energy efficiency and account for half the reduction in emissions needed for Korea to meet its 2020 target of 30% below the business-as-usual level (MKE 2011).

Greenhouse gas emissions and energy target management

The GHG Emissions and Energy Target Management scheme aims to set and implement a target for GHG emissions reductions that will apply to public/private large emitters.

Figure 1 Operational process and roles in GHG emissions and energy target management


a. Sectoral responsible organisations:

- Industry and electricity generation: Ministry of Knowledge Economy;
- Building and transport: Ministry of Land, Transport, and Maritime Affairs;
- Agriculture and livestock: Ministry for Food, Agriculture, Forestry, and Fisheries;
- Waste: Ministry of Environment (main authority).

Controlled entities are selected by their average GHG emission and energy consumption performances over the last 3 years. Table 5 shows the suggested GHG emissions and energy standards of specified controlled entities; the standards will be valid from 2011–14 during the first phase.

Table 5 GHG emissions and energy standards in Korea of specified controlled entities, valid from 2011–14

| Concept | Until 12 December 2011 | | From 1 January 2012 | | From 1 January 2014 | |
|---------|------------------------|------------------------------|---------------------|------------------------------|---------------------|------------------------------|
| | Company | Business unit within company | Company | Business unit within company | Company | Business unit within company |
| | | | | | | |

| | | | | | | |
|----------------------------------|---------|--------|--------|--------|--------|--------|
| GHG emission (tCO ₂) | 125 000 | 25 000 | 87 500 | 20 000 | 50 000 | 15 000 |
| Energy consumption (TJ) | 500 | 100 | 350 | 90 | 200 | 80 |

Note: 1 TJ = 23.8846 toe; 1 toe = 3.2 tCO₂

Source: Republic of Korea (2011).

To increase the awareness of business and to enhance the acceptability of the system, the government launched pilot projects for the industry sector from December 2009 to June 2010. Forty-seven companies, including the top 10 energy consumers in 15 areas, participated in pilot projects. Total energy consumption for all participating companies accounts for 41% of the total energy use in the industry sector.

After the pilot projects, the government selected 471 controlled entities in 2010. GHG emissions from those entities account for approximately 60% of the total emissions in Korea. These entities also account for 40% of the economy's total energy consumption. The industry and power generation sectors are the biggest consumers, accounting for 80%. The number of entities will be increased until 2014.

Table 6 Specified controlled entities in Korea for GHG emissions and energy consumption performances

| Sector | No. of entities | % |
|----------------------------|-----------------|-------|
| Industry, power generation | 375 | 79.6 |
| Building, transportation | 46 | 9.8 |
| Agriculture, livestock | 27 | 5.7 |
| Waste | 23 | 4.9 |
| Total | 471 | 100.0 |

Note: Sector estimated and target GHG emission in 2012 (unit: thousand tonnes of CO₂).

Source: Republic of Korea (2011).

The sectoral responsible organisations evaluate the performance of the controlled entities in terms of GHG emissions and energy consumption, and take any necessary measures, including enforcement notices. Entities with improvement orders are expected to incorporate the improvements into their new implementation plans. The government has the right to impose penalties if companies fail to follow the scheme.

The government is focusing on building infrastructure, supporting finance, and supporting small and medium-sized enterprises to stimulate the early stage of implementing the GHG Emissions and Energy Target Management scheme.

President Park Geun-hye in October 2013 proposed the "Eurasia Initiative" that calls for linking the energy and logistics infrastructure across the continent. It would expand ties among Eurasian countries through connections of energy infrastructure, roads and railways to build the new "Silk Road Express," which would run from South Korea to Europe via North Korea, Russia and China.

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 Ministry of Strategy and Finance—www.mosf.go.kr
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MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia. Its territory covers 330 803 square kilometres, spread across the southern part of the Malay Peninsula and the Sabah and Sarawak states on the island of Borneo. In 2011, Malaysia's population was around 29 million.

In 2011, Malaysia's GDP was USD 362.89 billion (USD (2000) at PPP). GDP per capita was USD 12 618 (USD (2000) at PPP), an increase of 3.32% from 2010 (EDMC, 2013). Malaysia's economy is strongly driven by the services and manufacturing sectors, contributing 54.1% and 25.0% of GDP respectively in 2011 (MOF, 2013, Table 3.1). The economy's main exports are electrical and electronic products, petroleum products, chemical products, palm oil products, liquefied natural gas (LNG) and crude petroleum (MOF, 2013). Its top three export destinations are Singapore, China and Japan (MOF, 2013, Table 3.21).

Malaysia is well endowed with conventional energy resources such as oil, gas and coal, as well as renewable energy sources such as hydro, biomass and solar energy. Malaysia's domestic oil production occurs offshore, primarily near Peninsular Malaysia. As of 1 January 2011, Malaysia's crude oil reserve, including condensate, was 5.858 billion barrels (EC, 2013, p. 32). Malaysia also has an abundant natural gas reserve, estimated to be 2.55 trillion cubic metres (89.988 trillion standard cubic feet) (EC, 2013, p. 40). Malaysia's hydropower potential is assessed at 29 000 megawatts (MW), and 85% of the potential sites are located in East Malaysia. Biomass sources are mainly palm oil, wood and agro-industry (APEREC, 2011).

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|---|---------|---|-------|
| Area (sq. km) ^a | 330 803 | Oil (billion barrels)—proven ^c | 5.858 |
| Population (million) ^b | 28.76 | Gas (trillion cubic metres)—proven ^c | 2.55 |
| GDP (USD (2000) billion at PPP) ^b | 362.89 | Coal (million tonnes) ^c | 1938 |
| GDP (USD (2000) per capita at PPP) ^b | 12 618 | Uranium (million tonnes) | N/A |

Sources: a. EPU (2010a), b. EDMC (2013), c. EC (2013, pp. 12, 32, 40 & 46).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 71 962 kilotonnes of oil equivalent (ktoe) in 2011. Of this, oil and natural gas accounted for the largest shares with about 40% each of the total primary energy supply, at 29 127 ktoe and 28 819 ktoe respectively. This is followed by coal with 13 314 ktoe (18.5%), and other sources with 702 ktoe (less than 1%) (EDMC, 2013).

Malaysia is also a net energy exporter. Its total energy exports in 2011 were 49 142 ktoe, while the total energy imports in the same year were 41 244 ktoe (EC, 2013, p.73).

Oil

Malaysia's oil production averaged 569.8 thousand barrels per day (Mbbbl/d) in 2011, of which 81% was crude oil. The majority of the production comes from the offshore fields in the Malay basin in the west (43%) as well as the Sabah (23%) and Sarawak (34%) basins in the east. The economy has five oil refineries with a combined capacity of 566.3 (including condensates splitter) Mbbbl/d. Domestic consumption of petroleum products was 205 824 thousand barrels in 2011,

mostly in the form of motor petrol and diesel. In 2011, net export of crude oil amounted to 2300 ktoe, while exports of petroleum products totalled 9421 ktoe. To meet domestic requirements, Malaysia imported 11 580 ktoe of petroleum products the same year (EC, 2013, pp. 32-35).

Natural Gas

Like its oil reserves, Malaysia's natural gas reserves lie offshore of Peninsular Malaysia's east coast, Sabah and Sarawak. In 2011, Malaysia's average daily natural gas production stood at 206.7 million cubic metres per day (mcmd). Most of the production came from Sarawak (126.8 mcmd or 61%), followed by Peninsular Malaysia (67.6 mcmd or 33%) and Sarawak (12.3 mcmd or 6%) (EC, 2012, p. 40).

Malaysia has two gas pipeline networks. The Peninsular Gas Utilisation (PGU) network now includes over 2500 km of pipelines linking most cities in Peninsular Malaysia, and it has cross-border interconnections to Singapore and Songkhla, Thailand. The PGU pipeline system incorporates six gas-processing plants with a combined capacity of 56.6 million cubic metres (2000 million standard cubic feet) per day, producing methane, ethane, butane and condensate (Gas Malaysia, 2012). The system receives gas from offshore Peninsular Malaysia fields as well as imported gas from the JDA, West Natuna and PM3 CAA fields. About half of the PGU system gas is consumed by the power sector, while the rest goes to non-power industries and is exported to Singapore (Maybank, 2012).

The second gas pipeline linking the states of Sabah and Sarawak is almost completed and expected to begin operations in early 2014 (Borneo Post, 2013). The Sabah–Sarawak Gas Pipeline (SSGP) will be approximately 521 km in length, and will deliver natural gas from Kimanis in Sabah to an LNG facility in Bintulu, Sarawak (OBG, 2012).

The economy operates extensive LNG export facilities and produces about 10% of world LNG exports (BP, 2013, p. 28). As of 2011, Japan remained the largest importer of liquefied natural gas (LNG), followed by Chinese Taipei and Korea (DOS, 2013, p. 18)

Coal

Bituminous and sub-bituminous coals make up the bulk of coal reserves in Malaysia. Although coal resources in Malaysia are substantial (estimated coal reserves as of 31 December 2011 was 1938 million tonnes), domestic coal production has not been aggressively pursued, because most of these coal deposits are far inland, where infrastructure is lacking, and the extraction cost is high. Some locations, like the Maliau Basin in Sabah, have been designated as protected areas. Currently, coal mining is conducted only in Sarawak. In 2011 production came from the areas of Sri Aman (183 556 metric tonnes) Kapit (405 658 metric tonnes) and Mukah-Balingan (2 326 575 metric tonnes) (EC, 2013, p. 46).

Malaysia's domestic coal consumption in 2011 was 23 million tonnes, of which 88% was consumed by the power generation sector. The remainder was consumed by the iron and steel industry and by cement manufacturers (EC, 2013, p. 46). To meet this demand, coal is imported from Australia, Indonesia, South Africa and Viet Nam (Tse, 2011).

Electricity

Malaysia's total installed electric power generation capacity as of 31 December 2011 was 28 749 MW, of which 30% was owned by government-linked utilities, while the rest are independent power producers (IPPs), co-generation and self-generation facilities (EC, 2012, p. 50). Total power generation in the same year was 128 741 gigawatt-hours (GWh), an increase of 14% from the previous year (EDMC, 2012). Thermal generation, mostly from natural gas and coal, accounted for 94% of total power generation; hydropower accounted for the remainder.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|--------|------------------------|---------|
| Indigenous production | 81 723 | Industrial sector | 11 181 | Total | 128 741 |
| Net imports and other | - 8 023 | Transport sector | 15 253 | Thermal | 121 118 |
| Total PES | 71 962 | Other sectors | 15 570 | Hydro | 7 623 |
| Coal | 13 314 | Total FEC | 42 003 | Nuclear | – |
| Oil | 29 127 | Coal | 1 503 | Geothermal | – |
| Gas | 28 819 | Oil | 23 903 | Other | – |
| Other | 702 | Gas | 7 347 | | |
| | | Electricity and other | 9 251 | | |

Source: EDMC (2013).

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

FINAL ENERGY CONSUMPTION

In 2011, total final energy consumption in Malaysia was 42 003 ktoe, an increase of 4.3% from 40 290 in 2010. The other sectors, including the agriculture, residential/commercial and non-energy sectors, was the biggest final energy user at 15 570 ktoe, or 37.1% of total final energy consumption, followed by the transport sector at 15 253 ktoe, or 36.3%, and industrial sector at 26.6%. By energy type, oil contributed the largest share, with 56.9% of consumption, followed by electricity (22%), gas (17.5%) and coal (3.6%).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Malaysia's National Energy Policy was first formulated in 1979 by the Economic Planning Unit under the Prime Minister's Department. The policy consists of three principal energy objectives:

1. The Supply Objective: To ensure the provision of an adequate, secure and cost-effective supply of energy.
2. The Utilisation Objective: To promote efficient utilisation of energy and to discourage wasteful and non-productive patterns of energy consumption.
3. The Environmental Objective: To minimise the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

These three principal objectives are instrumental in the development of Malaysia's energy sector. Subsequent policies are designed to support these objectives and their implementation.

The National Depletion Policy was formulated in 1980 to extend and preserve the economy's energy resources, particularly its oil and gas resources. Under this policy, the total annual production of hydrocarbons should not exceed 3% of "oil initially in place." This effectively limits the production of crude oil to 650 000 barrels per day and natural gas in Peninsular Malaysia to 2000 million standard cubic feet (56.6 million cubic metres) per day (KeTTHa, 2009).

A year later, the economy introduced the Four-Fuel Diversification Policy to diversify the fuel mix used in electricity generation. The initial focus of this policy was to reduce the economy's dependence on oil as the principal energy source, and it aimed for the optimization of the energy mix of oil, gas, hydro and coal used in generation of electricity.

As a result, oil's domination of the electric power generation energy mix has been significantly reduced and replaced with gas and coal. In 2001, the Five-Fuel Diversification Policy was introduced to incorporate renewable energy as the fifth fuel after oil, gas, coal and hydro. Currently, nuclear energy has no share in Malaysia's energy mix.

To diversify fuel use in non-power sectors, particularly the transportation sector, the National Biofuel Policy was introduced in 2006. The policy promotes the production of biofuel by the blending of processed palm oil (5%) with petroleum diesel (95%) and promotes biofuel consumption by establishing biodiesel pumps at selected stations. It ensures biodiesel quality by establishing an industry standard, and it stimulates biodiesel production by encouraging the establishment of biodiesel plants.

The National Renewable Energy Policy and Action Plan came into being in 2010. Its aim is to spur utilization of indigenous renewable energy resources to contribute towards Malaysia's electricity supply security and sustainable socio-economic development. Under this policy, two crucial acts were passed: the Renewable Energy Act 2011 and the Sustainable Energy Development Authority Act 2011, which together set up the framework for the new feed-in tariff mechanism.

Malaysia's short-term and medium-term energy strategies are largely outlined in the Malaysian Government's five-year plan. The latest, the Tenth Malaysia Plan (2011–15), was published on 10 June 2010. Under the plan, Malaysia emphasises energy supply security and economic efficiency as well as environmental and social considerations by focusing on five strategic pillars: initiatives to secure and manage reliable energy supplies; measures to encourage energy efficiency; the adoption of market-based energy pricing; stronger governance; and managing change. The plan also lays out actions that need to be taken in developing a sustainable energy sector, with a focus on renewable energy and energy efficiency (EPU, 2010b).

Energy Sector Structure

In Malaysia, the government-owned company Petronas holds exclusive ownership rights to all oil and gas exploration and production projects, and all foreign and private companies must operate through production sharing contracts (PSC). The electrical power industry is dominated by three integrated utilities: Tenaga Nasional Berhad (TNB) serving Peninsular Malaysia, Sabah Electricity Berhad (SESB) in Sabah state and Sarawak Energy Berhad (SEB) in Sarawak state. TNB is publicly listed, while SESB and SEB are privately owned, with the government owning some shares in each utility. The three utilities are complemented by various independent power producers (IPPs), dedicated power producers, and co-generators.

The key ministries and agencies for Malaysia's energy sector are the Energy Unit of the Economic Planning Unit (EPU) of the Prime Minister's Department; the Ministry of Energy, Green Technology and Water (KeTTHA); and the Energy Commission (ST). The Economic Planning Unit provides the general direction of and strategies for energy policy and determines the level of their implementation. The role of the Ministry of Energy, Green Technology and Water is to formulate energy policies, in coordination with the Economic Planning Unit, and to establish the legal framework for effective energy regulation; to set the direction for the energy industry, green technologies and water industry in line with national development goals; and to develop an efficient energy management and energy monitoring system. The Energy Commission is a statutory body responsible for regulating the energy sector, particularly the power supply and piped gas industries in Peninsular Malaysia and Sabah. The commission's main tasks are to provide technical and performance regulations for the electricity and piped gas supply industries, to act as the safety regulator for electricity and piped gas and to advise the Minister on all matters relating to the electricity and piped gas supplies, including energy efficiency and renewable energy issues.

ENERGY SECURITY

The Tenth Malaysia Plan outlines measures the government will take to improve energy supply security. The government's main strategy to enhance energy security is the diversification of its energy resources. It will use economic and regulatory measures to encourage the development of alternative resources, with emphasis on renewable and clean carbon technology for the power generation sector, and biofuels for the transportation sector.

The importation of liquefied natural gas (LNG) has also been identified as a way to improve energy security. Malaysia's first LNG Regasification Terminal (RGT) in Malacca commenced

operations on 23 May 2013 with a capacity of 2 x 130 000 cubic meters and storage volume up to 3.8 million tonnes per annum of LNG. A second RGT is being planned for the Pengerang Integrated Petroleum Complex (PIPC) in Johor and a third RGT in Lahad Datu, Sabah.

Malaysia also addresses energy security by cooperating closely with its neighbours under the Association of South-East Asian Nations (ASEAN) framework. Malaysia and other ASEAN members have agreed to strengthen the region's energy security by signing the ASEAN Petroleum Security Agreement. Malaysia is also working with ASEAN members through the Trans-ASEAN Gas Pipeline Project, which is expected to provide the region with a secure supply of energy by means of an interconnected gas infrastructure. The ASEAN Power Grid Project aims to strengthen energy security by integrating the power grids of ASEAN members. Development of the grid will provide the necessary interconnectivity for the regional mobilisation of electricity sales and will optimise the development of energy resources in the ASEAN region.

GREEN TECHNOLOGY POLICY

In August 2009, the Malaysian Government launched its National Green Technology Policy. The policy is built on four pillars:

1. Energy: To attain energy independence and promote efficient utilization;
2. Environment: To conserve and minimize environmental impacts;
3. Economy: To enhance economic development through the use of green technology;
4. Society: To improve quality of life for all.

Four focus sectors were chosen:

- Energy: Application of green technology in power generation and in energy supply-side management, including cogeneration by the industrial and commercial sectors, in all energy-use sectors, and in demand-side management;
- Buildings: Adoption of green technology in the construction, management, maintenance and demolition of buildings;
- Water and waste management: Use of green technology in the management and use of water resources, wastewater treatment, solid waste and sanitary landfill;
- Transport: Incorporation of green technology into transportation infrastructure and vehicles, in particular biofuels and public road transport.

Malaysian government initiatives include the restructuring of the Malaysian Green Technology Corporation, the organisation of the annual International Greentech and Eco Products Exhibition and Conference Malaysia (IGEM), and the development of Putrajaya and Cyberjaya as pioneer townships in Green Technology.

In January 2010, the Green Technology Financing Scheme (GTFS) amounting to MYR 1.5 billion (USD 490 million) was officially launched. This scheme provides soft loans to companies that supply and utilize green technology. By the end of December 2010, 68 projects have been certified for the GTFS fund (GreenTech, 2010).

The Malaysia Green Labelling Program (MGLP) has also been introduced. This includes the National Eco Labelling Program to certify eco-friendly domestically manufactured products, and the Energy Star Rating certification for energy-efficient home appliances.

To promote green technology in the building sector, the Green Building Index (GBI) has been developed. To obtain a GBI certificate, the developer must ensure that the building meets criteria in six areas: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation. Building owners obtaining GBI certificates from 24 October 2009 to 31 December 2014 are given income tax exemptions equivalent to the additional capital expended in obtaining such certificates. Buyers purchasing buildings with GBI certificates from developers are given stamp duty exemptions on instruments of transfer of ownership. The exemption amount is equivalent to the additional cost

incurred in obtaining the GBI certificates. This exemption is given to buyers who execute sales and purchase agreements from 24 October 2009 to 31 December 2014.

ENERGY MARKETS

MARKET REFORM

The Malaysian energy market is regulated, and subsidies are provided to energy users. However, the economy is implementing energy market reforms through a gradual withdrawal of energy subsidies. Under the Tenth Malaysia Plan, the government plans to achieve market pricing by 2015. The plan states that gas prices for the power and non-power sectors will be revised every six months to gradually reflect market prices. The first round of subsidy cuts for the power sector's natural gas prices has been in place since 1 June 2011. A decoupling approach for energy pricing will be used to explicitly itemise subsidy value in consumer energy bills and eventually delink subsidies from energy use. Assistance for low-income households and other groups for which the social safety net is required will be provided in different forms (EPU, 2010b).

UPSTREAM ENERGY DEVELOPMENT

Petronas is intensifying its exploration of deepwater and extra-deep water areas. In 2012, eight new fields came on stream, increasing the total number of producing fields in Malaysia to 132, of which 77 are oil fields and 55 are gas fields. Nine new production-sharing contracts (PSC) and two new risk-service contracts (RSC) were awarded during 2012, bringing the total number of PSCs in operation to 95 and RSCs to four.

Malaysia's total reserves increased in 2012 by 4.4% to 22.24 billion barrels of oil equivalent (boe). This was accomplished through enhanced oil recovery (EOR), improved oil recovery (IOR) and improved gas recovery (IGR) projects, as well as additions from new discoveries at the Kasawari gas field and Kuang North. Petronas continues to build technologies to develop oil and gas reserves that are located in geologically more complex, riskier and higher-cost frontier acreages (Petronas, 2013).

ELECTRICITY AND GAS MARKETS

Malaysia has a reliable and stable electricity supply system, which is regulated by the government. In light of volatile global energy prices and declining gas production, particularly in Peninsular Malaysia, under the Tenth Malaysia Plan the government is focusing on ensuring the continued security of electrical power supply as well as creating a sustainable power supply industry. In addition, it will work to enhance the productivity and efficiency of utility providers. During the plan period, the government intends to increase and diversify generation capacity; strengthen transmission and distribution networks; restructure the electricity supply industry; and improve customer service delivery.

The main means of increasing and diversifying generation capacity will be the development of alternative sources of energy, particularly hydro, and increasing the importation of coal and LNG by 2015. To improve the efficiency of coal use and to reduce carbon dioxide emissions, the government will explore new investments in super-critical coal technology.

In addition, transmission and distribution systems will be strengthened and expanded to reduce losses. By 2015, the System Average Interruption Duration Index (SAIDI), a measure of supply reliability, is expected to improve from 68 to 50 minutes per customer per year in Peninsular Malaysia. The potential of implementing a Smart Grid system to minimise losses, reduce costs and increase reliability will also be considered.

The gradual adoption of market pricing for gas (see Market Reform, above) is expected to have a significant effect on the electricity supply industry. Currently, gas for power generation supplied by the Peninsular Gas Utilisation system is heavily subsidised. The government is also planning to instil greater market discipline through measures such as creating separate accounting for generation, transmission and distribution activities, introducing performance-based

regulations and renegotiating power purchase agreements. The delivery of services by utilities to new and existing customers will be accelerated through the use of new technologies and performance-based regulations. It will include faster response times for providing new electrical connections and for restoring supply interruptions.

ENERGY EFFICIENCY

Improving energy efficiency is an important element in Malaysia's energy policy. In the Tenth Malaysia Plan, the economy plans to intensify energy efficiency measures to harness its energy savings potential and to reduce Malaysia's carbon emissions and dependence on fossil fuels. Initiatives to drive energy efficiency efforts are categorized under different demand sectors:

- Residential
 - Phasing out of incandescent light bulbs by 2014 to reduce energy usage and carbon dioxide emissions;
 - Increasing energy performance labelling from four (air conditioner, refrigerator, television and fan) to ten electrical appliances (six additional appliances - rice cooker, electric kettle, washing machine, microwave, clothes dryer and dishwasher) to enable consumers to make informed decisions as they purchase energy efficient products;
- Township
 - Introduction of guidelines for green townships and rating scales based on carbon footprint baseline and promoting such townships, starting with Putrajaya and Cyberjaya;
- Industrial
 - Increasing the use of energy efficient machineries and equipment such as high efficiency motors, pumps and variable speed drive controls;
 - Introduction of minimum energy performance standards for selected appliances to restrict the manufacture, import and sale of inefficient appliances to consumers;
- Building
 - Revision of the Uniform Building By-Laws to incorporate the Malaysian Standard: Code of Practice on Energy Efficiency and Renewable Energy for Non-Residential Buildings (MS1525). This allows for integration of renewable energy systems and energy saving features in buildings;
 - Wider adoption of the Green Building Index (GBI) to benchmark energy consumption in new and existing buildings;
 - Increasing the use of thermal insulation for roofs in air conditioned buildings to save energy.

Malaysia's Economic Transformation Programme (ETP), launched in 2010, also highlights energy efficiency as one of the Entry Point Project (EPPs). This means that energy efficiency projects will be prioritized in government planning and fund allocation (PEMANDU, 2012). The five key initiatives under ETP are:

1. Government leading by example through the promotion and implementation of an efficient energy management system and practices in government buildings. Additionally, the government will launch large-scale education campaigns to help industries and consumers identify and apply energy-efficient practices;
2. Stimulate sales of energy efficient appliances through the SAVE Rebate Programme, in which rebates are given for the purchase of efficient Five Star-rated appliances (refrigerators, air-conditioners and chillers);
3. Regulate better insulation for new buildings and renovated buildings;
4. Promotion of more economically viable cogeneration for industries;
5. Stimulate the sales of energy-efficient vehicles by offering rebates to encourage the adoption of hybrid or electric vehicles.

Malaysia is involved in regional and multi-lateral schemes for energy efficiency improvements. Malaysia and other South East Asia economies under ASEAN have agreed to improve energy efficiency through the ASEAN Plan of Action for Energy Cooperation (APAEC). As a member of United Nations, Malaysia hosted the Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) with assistance and co-funding from the United Nations Development Program (UNDP) and Global Environment Facility (GEF). The MIEEIP was aimed at addressing barriers to energy efficiency and energy conservation in the Malaysian industrial sector.

RENEWABLE ENERGY

Malaysia encourages the development of renewable energy in the economy through various policies and strategies. The Five-Fuel Policy has made renewable energy one of the components in the fuel mix for power generation after oil, coal, gas and hydro. The Tenth Malaysia Plan specified a target of 985 MW by 2015 for grid-connected generation from renewable sources, which would contribute 5.5% to Malaysia's total electricity generation mix. This is to come from biomass (330 MW), biogas (100 MW), mini hydro (290 MW), solar photovoltaic (65 MW) and solid waste (200 MW) sources.

Malaysia's comprehensive Feed-in Tariff (FiT) mechanism framework was mandated under the Renewable Energy Act 2011 and the implementation is administered and managed by the Sustainable Energy Development Authority (SEDA), under KeTTHA. The FiT is funded through a levy imposed on heavy users of electricity. By 2020, Malaysia expects to have an installed capacity of more than 3 GW of new renewable energy, of which one-third will be from solar photovoltaic and another one-third from biomass sources.

Malaysia also provides tax incentives for clean/green projects through the Malaysia Investment Development Authority (MIDA). This has encouraged the development of manufacturing facilities for renewable energy products like solar cells and modules, inverters, polycrystalline silicone, and lithium ion batteries in the economy (MIDA, 2013).

CLIMATE CHANGE

Malaysia signed the United Nations Framework Convention on Climate Change (UNFCCC) on 9 June 1993 and ratified it on 17 July 1994. At the 2009 Climate Change Summit in Copenhagen, Malaysia's Prime Minister pledged to "voluntarily reduce CO₂ emission intensity of GDP up to 40% by 2020 as compared to 2005 levels, conditional on financial and technological assistance from developed countries." To achieve this goal, the Malaysian cabinet approved two progressive policies in 2009 to set the national agenda on environmental protection and conservation: the National Green Technology policy (see Green Technology Policy, above) and the National Climate Change Policy.

The National Climate Change Policy has three main objectives: to streamline and coordinate government action across existing legislation and policies, to establish an inter-ministerial and cross-sectorial committee to drive and facilitate the implementation of adaptation and mitigation measures, and to identify options and strategies for achieving a low-carbon economy (NRE, 2009). Ten strategic thrusts and 43 key actions were outlined in this policy, which are underpinned by five principles:

1. Development on a Sustainable Path: Integrate climate change responses into national development plans to fulfil the aspiration for sustainable development;
2. Conservation of Environmental and Natural Resources: Strengthen implementation of climate change actions that contribute to environmental conservation and sustainable use of natural resources;
3. Coordinated Implementation: Incorporate climate change considerations into implementation of development programmes at all levels;
4. Effective Participation: Improve participation of stakeholders and major groups for effective implementation of climate change responses;

5. Common but Differentiated Responsibilities and Respective Capabilities: International involvement in climate change issues will be based on the principle of common but differentiated responsibilities and respective capabilities.

The Tenth Malaysia Plan continues these efforts to address the impacts of climate change by focusing on two main areas: developing a roadmap for climate resilient growth and enhancing conservation of the economy's ecological assets.

NOTABLE ENERGY DEVELOPMENTS

NATIONAL ENERGY EFFICIENCY MASTER PLAN

To better coordinate and implement energy efficiency and conservation targets and programmes, KeTTHA is preparing the National Energy Efficiency Master Plan (NEEMP). The proposed master plan has an implementation horizon of ten years to achieve savings from three main sectors: industrial, commercial and buildings. KeTTHA has also drawn up a law to mandate energy efficiency in the economy. The law will likely include provisions for banning incandescent light bulbs and the mandatory import of energy-efficient refrigerators (OBG, 2012).

PENGERANG INTEGRATED PETROLEUM COMPLEX (PIPC)

The PIPC project is being developed as part of the Malaysia Economic Transformation Programme to enhance downstream oil and gas growth. The project is located on a single plot of land in Pengerang, Johor measuring about 8 100 hectares and is expected to house oil refineries, naphtha crackers, petrochemical plants as well as a LNG import terminal and a regassification plant.

As of January 2013, two major projects have already been committed within the PIPC area. The first is the Pengerang Independent Deepwater Petroleum Terminal (PIDPT), a deepwater oil terminal with an expected completion date of 2020 (MPRC, 2013). The second is Petronas's Refinery and Petrochemical Integrated Development (RAPID) project, which will include a 300 Mbbbl/d crude oil refinery that will supply feedstock for RAPID's petrochemical complex as well as produce gasoline and diesel that meet European specifications (Petronas, 2012).

NEW ENERGY POLICY STUDY (2013-2050)

The Economic Planning Unit (EPU) has undertaken a study to formulate an energy policy for Malaysia (2013-2050). Seven working groups have been formed that cover a range of energy issues, namely, gas and LNG, power, energy efficiency, transport, refining and petrochemicals, energy security, and emergency and governance. The initial findings suggest several opportunities for improvement that will be addressed in the proposed policy. The final report for this study is expected to include an implementation plan, policy recommendations and an energy balance model (EPU, 2013).

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USEFUL LINKS

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

The United Mexican States (in Spanish, *Estados Unidos Mexicanos*), commonly known as Mexico, is a federal constitutional republic located in North America, divided into 31 states and one federal district, with the Mexican Peso (MXN) as its currency. Bordered by the United States to the north, Belize and Guatemala to the south and with access to both the Atlantic and Pacific Oceans, Mexico has an approximate land area of 1.96 million square kilometres that is rich in biodiversity, natural resources and climatic conditions, ranging from very dry with high temperatures in the north, to very humid with high temperatures in the south, mild temperatures in the centre and warm on the coasts. Mexico's economy, the second largest in Latin America, is dominated by crude oil exports, remittances (mostly from the US), manufacturing and tourism. Along with Chile and Peru, Mexico is one of APEC's three Latin American members.

According to the most recent census (INEGI, 2013), Mexico's total population amounted to 112.3 million in 2010, with official projections (Conapo, 2012) expecting a growth by 2050 to nearly 150.8 million. Governmental statistics (Coneval, 2012), reveal that in 2012 approximately 45% of the Mexican population was deemed poor, and 10% was still living under extreme poverty conditions. Located in the centre of Mexico with approximately 20 million inhabitants, Mexico City not only is the capital city but represents one of the largest urban centres in the world as its Federal District (Distrito Federal) overlaps with the surrounding metropolitan area known as Zona Metropolitana del Valle de México (ZMVM). After Mexico City, the most important cities are Guadalajara and Monterrey, which are respectively located in the west-central and northeastern side of the territory.

In spite of some significant political changes and reforms, the economy's growth between 2000-2011 has been meager, rising at an annual average rate close to 2%, with Mexico's real gross domestic product in 2011 amounting to USD 1 116 billion—in USD 2000 at PPP—(EDMC, 2013). Nonetheless, Mexico's economy has been growing in comparison to previous years due to the expansion of domestic demand and exports, at respective annual rates of 4% and 4.6%, with official projections expecting the economy to grow by 5% in 2014 (SHCP, 2013).

The energy sector is highly relevant to the Mexican economy. The oil sector in particular is a central component of the Mexican economy with oil exports in 2011 having represented 16% of the economy's total exports but providing more than one-third of government's total revenue, which is a main source of the economy's social development expenditure (SHCP, 2013).

In the last decade, Mexico has made important changes to its energy policy to enhance competitiveness and ensure a steady energy supply. Following the energy reform of 2008, the state-owned company *Petróleos Mexicanos* (PEMEX) was given greater flexibility through the ratification of the new PEMEX Law (in Spanish, *Ley de Petróleos Mexicanos*). Another important achievement was the liquidation of the utility *Luz y Fuerza del Centro* in 2009. This task was undertaken in order to improve Mexico's financial and operational electricity supply in Mexico's central area, which encompasses Mexico City. Nonetheless, these measures alone could not provide solid investments for the energy sector to develop its full potential to become an effective lever of economic transformation.

In this context, on December 20, 2013, President Peña Nieto promulgated an ambitious constitutional energy reform, to strengthen the capacities of Mexico's National Oil Company and allow the participation of private investment across the entire value chain of the oil and gas industry. In this way, private investment will be able to complement the public efforts to increase the competitiveness of the energy sector for the benefit of the Mexican economy and population. In 2011, Mexico's proven primary energy reserves were 10.2 million barrels of crude oil (11.4, if gas liquids are included), 0.35 trillion cubic metres of natural gas, 1.21 billion tonnes of coal, and 2.8 thousand tonnes of uranium.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|------------------------------------|-------|---|------|
| Area (million sq. km) | 1.96 | Oil (billion barrels) – proven ^a | 10.2 |
| Population (millions) | 112.3 | Gas (trillion cubic metres) – proven ^a | 0.35 |
| GDP (USD (2000) billion at PPP) | 1 074 | Coal (billion tonnes) – proven ^b | 1.21 |
| GDP (USD (2000) per capita at PPP) | 9 465 | Uranium (thousand tonnes of uranium metal) ^c | 2.8 |

a. As of 1 January 2012. Oil reserves do not include condensates and natural gas liquids. “Gas reserves” refers to dry gas. PEMEX (2013).

b. At the end of 2012. BP (2013)

c. As of 1 January 2012. “Reserves” refers to reasonably assured resources. NEA (2012)

Source: EDMC (2013).

KEY ELEMENTS OF THE 2013 ENERGY REFORM

- a) The reform to articles 25, 27 and 28 of the Mexican Constitution reaffirms the Nation’s ownership of hydrocarbons in the subsoil. Exploration and extraction, radioactive minerals, nuclear energy generation, planning and control of the national power system, and the public service of electric power transmission and distribution are established as exclusive and strategic State activities.
- b) The State may perform oil and other hydrocarbon exploration and extraction activities through assignments granted to PEMEX, contracts with PEMEX, with private parties, and with PEMEX associated with private parties. There will be four types of combinable contracts for hydrocarbons: services, profit sharing, production sharing, and licenses. The last three will allow the transfer of geological and financial risks associated with exploration and extraction to contractors.
- c) Private investment will be allowed in the treatment and refining of oil, as well as transport, storage and distribution of oil, natural gas, gasoline, diesel and other oil products. Private parties will also be able to participate in the entire petrochemical value chain.
- d) A National Center for Natural Gas Control will be created to administer, coordinate and manage efficiently the pipeline grid and the storage of natural gas.
- e) PEMEX and the Federal Electricity Commission (CFE) are strengthened and transformed into State Productive Enterprises with technical, management and budgetary autonomy. Their purpose will be to create economic value and increase Mexico’s income, with social and environmental equality and accountability. A round zero, a new tax regime, and best practices for its corporate governance will safeguard PEMEX.
- f) The Mexican Fund of Petroleum for Stabilization and Development is created, which will be in charge of receiving, administrating and distributing income derived from assignments and contracts, with the exception of taxes. It will be a Trust within Mexico’s Central Bank, with a Technical Committee that will have 4 independent board members and 3 from the State.
- g) The National Hydrocarbons Commission is strengthened, by granting it legal personality, technical and management autonomy, as well as budgetary self-sufficiency. It will perform public biddings on hydrocarbons, to determine winners and administer contracts.
- h) The Regulatory Energy Commission is strengthened by granting it legal personality, technical and management autonomy, as well as budgetary self-sufficiency. It will regulate the activities of the power industry, as well as the storage, transport and distribution of oil products through the pipeline.

- i) The Ministry of Energy (SENER) is strengthened as the head of the energy sector since it will define energy policy, adjudicate assignments to PEMEX, and select the areas that can be subjected to contracts for oil gas exploration and production. It will also design the contracts and the technical guidelines for their public bidding, as well as grant permits for activities of oil treatment and refining, and for processing natural gas.
- j) The State will promote the protection and care of the environment through sustainability principles, the use of renewables and cleaner fuels, as well as measures to reduce polluting emissions from the electric power industry. The use of renewables will be promoted by eliminating legal barriers for new projects and constructing more transmission lines. Access will also be given to green preferential credits in the financial system. A self-determining entity will be created to regulate and supervise activities in the hydrocarbon sector concerning industrial safety and environmental protection.
- k) Mechanisms will be created to assure transparency and punish corruption. Citizens will be able to verify payments to companies and there will be external audits.
- l) Private parties are permitted to participate in power generation and marketing under State regulation. Concerning transmission and distribution, private parties may participate under contract with the CFE, which will be restructured with clear and transparent rules.
- m) The National Center of Energy Control (CENACE) will be withdrawn from the CFE to become a public decentralized entity that will be in charge of operating the national power system, the wholesale power market, and will guarantee open and non-discriminatory access to the national transmission grid and distribution grids.
- n) Legislation will be required to establish percentages of national content in procurement, so that assignments and contracts granted to public and private enterprises will enhance national industry. Private investment must promote the inclusion and development of national and local suppliers in the value chain of the entire industry.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Mexico's total primary net energy supply in 2011 was 186 010 kilotonnes of oil equivalent (ktoe), a 3.8% increase from the 179 222 ktoe in 2010, mainly as a result of a higher production of fossil fuels, which remained dominant with nearly 90% of Mexico's primary energy supply, and only the remainder being made up of non-fossil sources such as nuclear power and renewable energy (EDMC, 2013). By the end of 2011, Mexico's proven oil reserves reached 10.2 billion barrels (PEMEX, 2013). According to official estimates, Mexico was ranked 18th in the world for its oil reserves and 30th for its gas reserves (Pemex, 2013).

In 2012, Mexico produced 2.55 million barrels per day (Mbd) of crude oil; mostly heavy oil. In recent years, Pemex has focused its efforts on discovering and exploiting new fields to offset the natural decline of its once largest oil asset, Cantarell, which peaked in 2004 with 2.14 million barrels per day of oil and has dropped ever since at an annual average rate of 17.6% up to 2012. Mexico is a net crude oil exporter with around half of its total indigenous crude oil production, equivalent to 1.26 million barrels per day, sent to overseas markets during 2012 (Pemex, 2013), mainly to the US, making Mexico the second largest oil supplier to that economy (EIA, 2012). Mexico has six oil refineries located across its territories (Cadereyta, Madero, Minatitlán, Salamanca, Salina Cruz and Tula), with a total distillation capacity of 1.69 Mbd of crude oil. These six refineries form the National Refining System (Sistema Nacional de Refinación, or SNR), which is managed by PEMEX. However, the lack of sufficient domestic refining capacity forces the economy to be an oil product importer, especially of gasoline. In 2012, half of the total gasoline demand was supplied by imported stock (Pemex, 2013).

Mexico's proven natural gas reserves at the end of 2012 totalled 0.35 trillion cubic metres, with production in the same year reaching 0.18 billion cubic metres per day, of which roughly 70% was associated with crude oil production. As a net natural gas importer, Mexico looks

forward to boosting its domestic gas resources, including shale gas, although these efforts have yielded few results so far. Gas imports have grown considerably, to about 9% from 2012 to 2013, reaching nearly 66 million cubic metres per day as a result of sustained domestic demand in the industrial and electricity generation sectors, due to the lower levels in the Henry Hub market, which is used as a reference to set gas prices in Mexico. Around 70% of these imports came by pipeline from the US, while the rest were received as liquefied natural gas (LNG) from shipping tankers from Qatar, Nigeria and Peru, among other economies (SENER, 2012d).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|---------|------------------------|---------|
| Indigenous production | 228,543 | Industry sector | 29,203 | Total | 297,848 |
| Net imports and other | -36,156 | Transport sector | 52,055 | Thermal | 238,784 |
| Total PES | 186,010 | Other sectors | 34,816 | Hydro | 36,266 |
| Coal | 9,771 | Total FEC | 116,073 | Nuclear | 10,089 |
| Oil | 99,911 | Coal | 1,721 | Others | 12,709 |
| Gas | 56,237 | Oil | 73,944 | | |
| Others | 20,091 | Gas | 13,651 | | |
| | | Electricity and others | 26,758 | | |

Source: EDMC (2013).

Coal

In Mexico, coal represents only a small proportion of the total primary energy supply, equivalent to roughly 5.3% in 2011 or 9 771 ktoe (EDMC, 2013). Most of Mexico's recoverable coal reserves of 1.21 billion tonnes are located in the state of Coahuila in the northeastern part of its territory, while some significant additional resources are found in Sonora in the northwest and Oaxaca in the south. Around 71% of the recoverable reserves are of anthracite and bituminous types, while 29% are sub-bituminous and lignite (BP, 2013).

During 2011, coal production reached 14.5 million tonnes, representing an increase of 21% from the previous year. Coal production in 2011 consisted of 94% thermal coal and 6% coking coal. Thermal coal is used as a fuel for thermal power plants, while coking coal's main use is feeding the iron and steel industry's furnaces. Total coal imports in 2011 represented a little more than one-third of the total supply, coming principally from Australia, the US, South Africa, Canada and Colombia (SENER, 2012a).

Electricity

Electricity generation in Mexico was nearly 300 terawatt hours (TWh) in 2011, with the majority coming from thermal power plants (EDMC, 2012). In 2012, the total installed power capacity for public service was approximately 53 930 megawatts (MW), an increase of 1 418 MW from 2011, mainly as a result of new electrical power plants but also due to upgrades, including to Mexico's only nuclear power plant. Around 77% of this installed capacity was run by the Federal Electricity Commission (Comisión Federal de Electricidad, or CFE), with the remaining coming from independent power producers (IPPs) that sell their energy to CFE, since by law it is the only power utility in Mexico. Thermal power plants (including combined cycle technologies from IPP generators) accounted for 67.1%; hydropower, 22.8%; coal-fired thermal plants, 4.8%; nuclear 3%; geothermal, 1.5%; and wind farms, 0.7% (SENER, 2012e).

FINAL ENERGY CONSUMPTION

In 2011, Mexico's total final energy consumption was 116 073 ktoe, an increase of 2.1% from the previous year. By energy source, oil-based products accounted for nearly 64%; electricity and others, 23.1%; natural gas, 11.8% and coal barely 1.5% (EDMC, 2013).

Energy consumption in 2011 was concentrated in the transport sector (48%), followed by the industrial (29%), residential commercial and public (20%) and agricultural (3%) sectors. The fuels most in demand in Mexico in 2010 in each sector were: natural gas, with 37% of industrial sector demand; gasoline, with 66% of transport sector demand; liquefied petroleum gas, with 37% of residential, commercial and public sector demand; and diesel, with 74% of agricultural sector demand (SENER, 2012a).

ENERGY POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Mexico's energy policy is outlined in its National Energy Strategy, which was formalised in 2008 and updated ever since in an annual planning effort that contains long-term policies for a 15-year period and serves as the guide from which all other energy policies at a general and state level must be derived. The Strategy 2013-2027 looks forward to the mission of supporting Mexico's economic growth through the energy sector, expanding the access of quality energy services to the population. To that end, the Strategy leverages across the different stages in the value chain of the oil and electricity sectors but also on an energy transition supported on the use of natural gas and non-fossil fuels.

The economy's energy policy within the legal framework is executed by its Ministry of Energy (Secretaría de Energía, or SENER), which is required by law to develop an Energy Sector Program outlining the main objectives and strategies of the energy policy at the beginning of every six-year Presidential term. The purpose of the Sectorial Energy Program (PROSENER) for the current 2013-2018 period is to steer actions toward the removal of hurdles that constrain energy supply, to promote the construction and modernization of the energy infrastructure and to foster the organizational and regulatory modernization of energy activities, including institutions and state-owned companies.

Faced with the challenge of exploiting the potential of domestic energy resources while improving economic growth, the administration of President Peña Nieto, which took office in December 2012, presented a landmark energy reform proposal on August 2013 which considers the possibility of strengthening the operational capacity in the oil and gas sector, to allow the operations of private participants both under profit sharing agreements with PEMEX or by themselves, breaking thereby the legal prohibition set by the Mexican Constitution since the economy's nationalisation of the petroleum industry in 1938.

In order to provide a better background of Mexico's peculiar energy sector, it is worth noting that before the Energy Reform, the Political Constitution granted the State absolute ownership of oil and gas resources as well as the duty to exploit them across the value chain through its exclusive operator PEMEX, which restricted upstream oil and gas activities to private participants for decades. Under the Mexican Constitution, areas such as ownership and production of radioactive minerals, oil and all other hydrocarbons, basic petrochemical feedstock, electricity and nuclear electricity generation were exclusively reserved to the government, although in recent years efforts were promoted to increase the inflow of private investments, especially towards infrastructure development. Therefore, the aim of the constitutional energy reform is to capitalise on Mexico's resources and strengthen PEMEX's mission with the participation of private operators, especially in the riskiest and most capital-intensive development projects like deep-water oil and shale gas.

In addition to hydrocarbons, the Energy Reform allows private individuals to participate in power generation and marketing activities under State regulation. Transmission and distribution of electricity will remain as exclusive State activities, although private parties may participate under contract with the CFE.

OIL SECTOR

As one of the largest oil companies in the world and Mexico's largest taxpayer, PEMEX, under the previous legal framework, was the only operator across the oil and gas value chain and responsible for the final distribution of most oil products in the economy through four subsidiaries: Pemex Exploration and Production, Pemex Refining, Pemex Gas and Basic Petrochemicals, and Pemex Petrochemicals. In spite of PEMEX being responsible for Mexico's production and transformation of hydrocarbons since 1938, several contract schemes for upstream have been fostered in the last decade to promote private investments in areas such as dry gas and mature oil basins.

In 2008, PEMEX was strengthened so that it could tackle its challenges more effectively on the basis of greater flexibility for the allocation of resources to attain economic efficiency and comply with its legal responsibilities. Along with these reforms, the autonomous technical authority known as the National Hydrocarbon Commission (in Spanish, Comisión Nacional de Hidrocarburos, or CNH) started operations in May 2009 with the objective of improving efficiency and decision-making in oil sector projects through the regulation and evaluation of PEMEX's exploration and production activities. In addition, the Mexican Government, through SENER and the Science and Technology National Council (CONACYT), signed the SENER–CONACYT agreement for the establishment of the Trust Fund for the Hydrocarbons Sector. This Trust Fund, financed by PEMEX fee payments stipulated in Mexico's Income Law, aims to support scientific and applied research in the oil sector's upstream and downstream areas. The reform introduced different types of contractual arrangements for the exploration and extraction of oil and natural gas; private industry participation in the supply chain of petroleum products (refining, petrochemical, transportation and storage); and finally the strengthening of PEMEX and the State rectory.

The Constitutional Reform enacted in 2013 allow holding contracts for exploration and extraction of hydrocarbons between the state and private companies, private participation in refining, petrochemical, transportation and storage of petroleum products, as well as the strengthening of PEMEX and guidance of the State. New possibilities are being defined through the development of secondary legislation. Prior to the opening to private investment, a zero round will be opened to allow PEMEX to choose its preferred blocks.

POWER SECTOR

Electricity transmission, transformation, distribution and sales in Mexico are mostly carried out by the state-owned utility CFE, with access to private generators that can sell their power to CFE. Mexico's electricity infrastructure is well developed, especially its grid, which is interconnected through the Interconnected Electricity System (in Spanish, Sistema Interconectado Nacional, or SIN), with the electricity being dispatched and controlled by the CFE through its National Centre of Energy Control (in Spanish, Centro Nacional de Control de Energía, or CENACE). While most of the economy's territory is covered by the SIN, two systems in the Baja California peninsula are still isolated; altogether, these systems form the National Electricity System (in Spanish, Sistema Eléctrico Nacional, or SEN). The CFE also manages all the electricity produced by private IPPs in the modalities in which their participation is allowed. Electricity is then dispatched and controlled throughout the economy by the CFE through the CENACE.

Since 1992, Mexico's power generation has been undertaken by the public and private sector. This is due to the industry's partial liberalisation that allowed private companies to generate electricity provided that their power is either sold to CFE or used for its own purposes (self-supply). However, the 2013 Energy Reform stresses the need to expand generation and retail segments so that CFE becomes more competitive and is able to regain major customers. Therefore, private generators will eventually compete with CFE for medium-sized customers.

As this Energy Reform retains State control over transmission and distribution activities, it is expected that CFE will be able to contract private companies to undertake the expansion and operation of Mexico's transmission and distribution lines, enhancing investments and introducing new technologies so that may reduce the system's losses and improve its reliability.

ENERGY EFFICIENCY

Mexico has had energy efficiency programmes in place since 1989. The institution in charge of promoting these programmes and providing technical advice is the National Commission for the Efficient Use of Energy (CONUEE, for its acronym in Spanish). Through CONUEE, the government has launched several programmes for the promotion and assessment of the sustainable use of energy, one of the most effective being the Official Mexican Standards (in Spanish, Normas Oficiales Mexicanas, or NOMs); these programmes establish the specific requirements, in terms of features, usage and maintenance, for electric products and appliances to be sold in Mexico. Since 1995, when Mexico first adopted energy standards, 24 mandatory energy efficiency standards for electrical appliances, energy building codes, and lighting have been established (SENER, 2012c).

In addition, the CONUEE also implements a mandatory comparative labelling program for room and central air conditioners, refrigerators and refrigerator-freezers, clothes washers, centrifugal residential pumps, gas water heaters, commercial refrigeration, and non-residential building envelopes. The Law for Renewable Energy Utilisation and Energy Transition Funding requires the creation of a National Strategy for Energy Transition and Sustainable Use, through which the Mexican government promotes policies, programs, actions and projects focused on the increased utilisation of clean technologies and renewable energy, promotion of energy sustainability and efficiency, and reduction of Mexico's dependence on hydrocarbons. The Law also created the Trust Fund for Energy Transition and Sustainable Use, which is managed by SENER and is aimed at funding scientific and applied research projects in clean technologies, diversification of energy sources, renewable energy sources and energy efficiency.

NUCLEAR

Mexico is experienced in the exploitation of nuclear energy, and in spite of having only one nuclear power plant with two nuclear reactors (Laguna Verde), which began operations in 1990, the government has opened the possibility of increasing its nuclear power capacity. Exploitation of nuclear energy, which is under constant evaluation has received the ISO certification and awarded for its quality standards.

On the basis of the Law for the Use of Renewable Energy and Finance of the Energy Transition and its amendments in 2011, electricity generation from fossil fuel-based technologies will be limited to 65% of the total in 2024, which means that external factors such as carbon emissions and clean technology innovation will have a significant impact on Mexico's power industry. So far, the Mexican government has not implemented any actions indicative of a stronger will to expand its nuclear-based electricity generation, although the capacity of its only power plant was increased, which will effectively expand its life span.

RENEWABLE ENERGY

To achieve its goal of reducing hydrocarbon fuel dependency and integrating sustainability into the energy policy framework, the 2008 Energy Reform allowed the development of new policy and regulatory instruments to promote the introduction and growth of renewable energy, including biofuels and research activities.

In addition, derived from the Law for the Use of Renewable Energy and Finance of the Energy Transition, the Special Programme for Renewable Energy Utilisation was issued in 2009 to provide the institutional framework for designing public policies in the renewable energy sector. It sets out goals and actions for promoting the use of renewable energy. The program envisions renewable energy utilisation in a sustainable way in the short and long term, with the

dual goals of contributing to the economy's development and mitigating climate change effects (SENER, 2009a).

CLIMATE CHANGE

In connection with the growing concerns about the perils of global warming, the Energy Sector Programme 2007–2012 directly addressed this issue as a central policy priority for the first time in federal government planning. As a result, Mexico introduced a National Climate Change Strategy (ENCC, its Spanish acronym) on 25 May 2007, which led to the publication of the Special Climate Change Programme 2009–2012 (PECC, its Spanish acronym) in 2009. PECC lists specific objectives and goals to reduce GHG emissions by up to 20% by 2020 and around 50% by 2050, compared to 2000 levels. It aims to achieve these targets through financing from several sources, including those of the Clean Development Mechanism.

In the short term, PECC established an emissions mitigation goal of 50.7 million tonnes of carbon dioxide equivalent by 2012. By the first half of 2012, Mexico had fulfilled its target by 95% with an amount of 48.1 million tonnes of carbon dioxide avoided in the activities of energy consumption and production, agriculture and forestry and waste management (Semarnat, 2012).

Committed to involvement in climate change issues, Mexico has actively participated in several multilateral climate change forums. Mexico is a regular participant in the Conference of Parties of the United Nations Framework Convention on Climate Change and in late 2012 Mexico hosted the 16th Conference in the city of Cancún.

RESEARCH AND DEVELOPMENT

In Mexico, the Ministry of Energy, through its Vice-Ministry for Energy Planning and Transition, is in charge of fostering research and development policies, which are predominantly carried out by three public research bodies: the Mexican Petroleum Institute, which supports the hydrocarbons sector; the Electric Research Institute for electric power and energy efficiency; and the National Nuclear Research Institute in charge of research in nuclear-based power generation and other peaceful applications.

Energy-related research and development in strategic areas has been boosted by the creation of two trust funds managed jointly by the Ministry of Energy and the National Technology Council (CONACYT), the Trust Fund for the Hydrocarbons Sector and the Trust Fund for the Energy Sustainability Sector. These trust funds are financed from fee payments collected from Pemex Exploration and Production as required by the National Income Law, and they fund scientific and applied research projects, as well as supporting adoption, innovation, assimilation, technological development and specialised human resources training. While the Trust Fund for the Hydrocarbons Sector is oriented to upstream and downstream hydrocarbon activities, including basic petrochemicals, the Trust Fund for the Energy Sustainability Sector supports clean technologies, diversification of energy sources, renewable energy sources and energy efficiency.

In addition, the Trust Fund for Energy Transition and Sustainable Use of Energy, which is financed through the Federal Budget, aims to promote the use of renewable energy and energy efficiency. It supports projects for the diversification of primary energy use and energy savings in industrial and domestic activities, as well as some research projects.

NOTABLE ENERGY DEVELOPMENTS

OIL SECTOR

Given the complexity, uncertainty and gradual erosion of the Mexican oil sector's competitiveness, the Mexican President, as stated above, presented an energy reform initiative in 2013 to increase the competitiveness of the energy sector to the benefit of the Mexican population. This initiative may be the largest reform since Mexico's nationalisation of the petroleum industry in 1938. Cognisant of the high risks embedded in untapping Mexico's

substantial deepwater oil and shale gas resources, the proposal considers the possibility of allowing private participants to complement Pemex's operations under profit sharing agreements. In this regard, PEMEX is poised to remain as Mexico's exclusive oil and gas operator, complementing its capacities and skills with private operators. The proposal is coupled to a great extent with a fiscal reform that aims to provide a better tax treatment to PEMEX, in the fashion of a normal oil and gas company. During 2014 the Mexican Congress will make the adjustments to the legal framework needed to implement the energy reform.

During 2012, after a previous bid process, the first contracts allowing private participation in mature basins were granted in an attempt to support PEMEX's effort to better exploit the oil resources in Mexico. In addition, on 20 February 2012, Mexico and the United States signed an agreement on cross-border oil reservoirs that gives more certainty to the players producing hydrocarbons in the Gulf of Mexico and indirectly pushes PEMEX to accelerate its development of deep waters to benefit from those resources (SENER, 2012e). Another relevant achievement was the allocation of MXN 3 billion (around USD 229 million at the official exchange rate of 13.1 MXN per USD) through the SENER–CONACYT Hydrocarbons Trust Fund, with the objective of studying and assessing Mexico's shale gas potential, which is believed to be very promising. This project includes the conceptual design and development of the required drilling, and anticipates minimising environmental impact while increasing production (SENER, 2012b).

PEMEX's downstream strategic projects aim to meet the economy's growing demand for refined oil products and to reduce the corresponding trade deficit, as imports, particularly of gasoline, are significant. Although the announcement in 2008 of a new refinery in Tula, Hidalgo represented a milestone, owing to Mexico's need for additional domestic refining capacity and given that its last refinery was built in 1979, work has advanced very little.

Liquefied natural gas

Improving the security of the natural gas supply to meet the economy's demand has been a top priority on the energy agenda for many years, one which has led to the installation of LNG storage and regasification facilities both on the Gulf of Mexico and on the Pacific Ocean coasts, to complement domestic production and expand supply sources at competitive prices. By the end of 2012, Mexico had three LNG regasification facilities in its territory.

In September 2006, the Altamira LNG Terminal, located in northern Mexico on the Gulf of Mexico, began operation. The plant's maximum regasification capacity is 21.5 million cubic metres per day (Mcmd), and its main activity is supplying natural gas to CFE's Altamira V, Tuxpan V and Tamazunchale I combined-cycle power plants. On the opposite side of the economy, located on the Pacific Ocean coastline of Baja California, close to the US, the Ensenada LNG Terminal (Energía Costa Azul), began operation in July 2008 and has a maximum regasification capacity of 36.8 Mcmd (SENER, 2012d).

Mexico's third LNG terminal in Manzanillo, Colima (Terminal KMS), with a maximum regasification capacity of 14.2 Mcmd, began operations in March 2012. The terminal will mainly service CFE power plants. CFE's demand will be about 2.6 Mcmd during the first year of operation, rising to 14.2 Mcmd by 2018. Once the three terminals are in operation, Mexico's LNG storage capacity will amount to 0.92 million cubic metres (SENER, 2012d).

POWER SECTOR

Several major projects were underway in the power sector in 2012. This includes eight new power plants, which will add 2 291 megawatts to the SEN and were under construction, with associated investments of USD 2 231 million. These plants are expected to help meet the economy's growing power demands and offset the capacity lost through plant retirement. Some of the new plants exploit renewable energy, including the La Yesca hydro power plant (750 MW capacity); the Los Humeros II geothermal power plant (50 MW); and the Agua Prieta II combined cycle power plant (14 MW solar generated capacity out of its total 408 MW capacity). Most of the fossil fuel-based plants employ improved combined cycle technologies to attain a more efficient generation at a lower environmental cost.

In 2011, Mexico exported more than USD 1 billion in nuclear-based goods, such as steel, nuclear quality graphite, steam generators, micro-chips, condensers, aluminium alloys, drilling equipment of advanced specifications. On November 2012, Mexico was officially admitted as the 47th member of the Nuclear Suppliers Group, a multilateral effort that is in charge of regulating the export control system for nuclear-based goods and technologies.

ENERGY EFFICIENCY

Mexico was able to save 28.5 GWh in 2011, an increase of 15% from the previous year, due to energy efficiency programmes deployed in four major areas: normalisation, facilities (industrial, residential and commercial), daylight saving and households (SENER, 2012e).

RENEWABLE ENERGY

Due to its geophysical conditions, Mexico's potential for renewable energy development is very promising. Since the 2008 Energy Reform, Mexico has developed new instruments for the promotion and introduction of renewable energies, which have had considerable success. One of these is the National Energy Strategy's goal for the diversification of energy resources, which aims for clean technology utilisation (renewable, hydro and nuclear technologies) as a key element in attaining energy security and environmental sustainability. To this end, the economy has promoted renewable technologies for power generation, profitable cogeneration potential and bio-energy markets.

Wind Energy

By the end of 2012, the wind energy capacity of CFE and IPP generation amounted to 598 MW, which represented a growth of 6.9 times from the end of 2011, as a result of the beginning of operations of the wind power plants of Oaxaca II, III and IV (SENER, 2012e). According to SENER, if load factors higher than 20% are assumed, Mexico's wind power potential could be as large as 50 gigawatts. The best areas to exploit this resource have been identified in southern coastal Oaxaca (where current projects are sited), the Baja California coast, the Tamaulipas coast, and in the states of Quintana Roo, Hidalgo and Tlaxcala (SENER 2010b).

As with wind energy, the outlook for solar power generation in Mexico is quite promising. The estimated potential is an average of 5 to 6 kWh per square metre per day (SENER, 2010b). This means that the energy generated by a solar panel of 1 square metre with 50% efficiency is equivalent to the energy contained in 1 cubic metre of natural gas or 1.3 litres of LNG. Mexico's solar potential has been exploited very little to date. In 2007, Mexico initiated a programme promoting the use of solar water heaters in the residential, agro-industry, commercial and industrial sectors (in Spanish, Programa para la Promoción de Calentadores Solares de Agua, or Procalsol), the goal of which was to install 1.8 million square metres of solar water heaters by 2012 (SENER 2007b). Through the first half of 2012, the total installed area of solar water heaters was 1.3 million square metres, about 72% of the target.

In addition, after the approval of a grant from the Global Environmental Facility for the construction of a new hybrid power plant (combined cycle plus thermo-solar) in 2006, the Agua Prieta II plant project is now at the construction stage. The plant, located in the state of Sonora, with 394 MW of thermal capacity, will have 14 MW (peak) of thermo-solar capacity, and is expected to begin operations during the first half of 2013. In addition, two permits for solar photovoltaic projects dedicated to self-supply were also granted for a joint capacity of 33.6 MW (SENER, 2012e).

Mexico was a pioneer in its utilising geothermal energy, with its first geothermal well being drilled in the 1950s. By the end of 2012, Mexico's geothermal power capacity was 811.6 MW. Four geothermal fields are under commercial exploitation: Cerro Prieto, Los Azufres, Los Humeros and Tres Vírgenes. The Cerro Prieto geothermal field, located in the northern state of Baja California, is one of the largest in the world. It has a total installed capacity of 570 MW, and produces about one-third of the electric power supplied to the Baja California state grid, which is not integrated to the SIN. In 2012, total geothermal generation was 5,817 GWh, a decrease of 11% from 2011.

In recent years, CFE has been reviewing the expansion of Mexico's geothermal power generation. In mid-2011, the Los Humeros II power plant, with an expected net capacity of 50 MW, was under construction, while the Cerro Prieto V project, which was estimated to add 107 MW of capacity, was cancelled and its commercial operation deferred (SENER, 2011a).

Biofuels

As of December 2012, the Mexican Energy Ministry had awarded 28 permits, two for production and storage, one for transportation and 25 for commercialisation of biofuels. It also had received nine permit exemption notifications for biofuel production plants, each with a capacity equal to or less than 500 litres per day and storage of up to 1000 liters (SENER, 2012e). Although Mexico's current biofuels projects are small scale and targeted to meet local consumption, there are ambitious plans for more significant projects. Two types of biofuels are currently produced in Mexico, biodiesel and bioethanol.

Furthermore, in order to increase the incorporation of bioethanol produced from sugarcane into gasoline sold across the economy, in August 2011 SENER issued bioethanol guidelines with which PEMEX must comply when purchasing this feedstock to blend with its gasoline production.

INTERNATIONAL COOPERATION

Mexico has played a significant role in international energy cooperation. In accordance with its foreign policy principles, Mexico has promoted comprehensive and sustainable development through multiple bilateral technical mechanisms, such as seminars and training internships for energy officials of Costa Rica, Peru and Guatemala. As a recipient of international cooperation in research and technological development, the Mexican energy sector has promoted cooperation with various strategic partners in energy efficiency and renewable energy, such as Germany, the United Kingdom, Denmark, Norway, France, and the United States, among others. Mexico's membership in energy-related international organisations includes APEC's Energy Working Group, the Latin American Energy Organisation (OLADE), the World Energy Council (WEC), the North American Energy Working Group (NAEWG), and the International Energy Forum.

At a multilateral level, Mexico through SENER, led the organization of regional consultations on energy with non-governmental and academic organizations in 2013, to integrate the Post-2015 Development Agenda of the United Nations, particularly in regards to the inclusion of universal and sustainable energy access, as well as the promotion of international cooperation between countries to achieve these goals.

During 2012 and 2013, Mexico fostered bilateral energy cooperation with the United States, Canada, Denmark, Norway, Germany, Poland, United Kingdom, Djibouti, Russia, Saudi Arabia, Japan, China, Korea, India, Indonesia, New Zealand, El Salvador, Guatemala, Cuba, Jamaica, Colombia, Uruguay and Bolivia. In addition, during the same period, Mexico participated in the activities of multilateral bodies such as North American Energy Working Group, the Clean Energy Ministerial, the Energy and Climate Partnership of the Americas, the International Energy Forum, the International Energy Agency, the International Renewable Energy Agency and the Organisation for Economic Cooperation and Development, among many others.

Mexico has strengthened partnerships with various economies and institutions by signing strategic agreements and memoranda of understanding, which are valuable tools for the exchange of experience, information and training on energy matters. In the oil sector in particular, PEMEX signed several cooperation and technical agreements with international oil companies and institutions in 2012 in areas encompassing technological research and human resources training to strengthen its technical capacity and expertise.

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USEFUL LINKS

Comisión Federal de Electricidad (CFE)—www.cfe.gob.mx

Comisión Nacional para el Uso Eficiente de la Energía (CONUEE)—www.conuee.gob.mx

Comisión Nacional de Hidrocarburos (CNH)—www.cnh.gob.mx/

Comisión Regulatoria de Energía (CRE)—www.cre.gob.mx

Comisión Nacional de Seguridad Nuclear y Salvaguardias—www.cnsns.gob.mx/

Instituto Mexicano del Petróleo (IMP)— www.imp.mx/

Instituto de Investigaciones Eléctricas (IIE)— www.iie.org.mx/

Instituto Nacional de Investigaciones Nucleares—www.inin.mx/

Instituto Nacional de Estadística y Geografía (INEGI)—www.inegi.org.mx

Petróleos Mexicanos (PEMEX)—www.pemex.gob.mx

Presidencia de la República—www.presidencia.gob.mx

Secretaría de Economía (SE)—www.economia.gob.mx

Secretaría de Energía (SENER)—www.energia.gob.mx

Secretaría de Hacienda y Crédito Público (SHCP)—www.shcp.gob.mx

Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT)—www.semarnat.gob.mx

NEW ZEALAND

INTRODUCTION

New Zealand is an island economy in the South Pacific, consisting of the North Island, South Island and numerous outer islands. While its land area is between that of Japan and the United Kingdom, its low population of about 4.4 million is comparable to a medium-sized Asian city. Due to its remote location, New Zealand has no electricity or pipeline connections to other economies. New Zealand is a mature economy with a per capita GDP of about USD 23 500 (USD 2000 at PPP), although this is below the average of the OECD member economies.

New Zealand is self-sufficient in all energy forms apart from oil and has modest energy resources, including reserves of 79.4 million barrels of oil, 29.2 billion cubic metres of natural gas and 571 million tonnes of coal. In 2012, hydro, geothermal, wind and bioenergy resources met around 73% of electricity demand (MBIE, 2013, BP, 2013).

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|------------------------------------|---------|---|------|
| Area (sq. km) ^a | 268 680 | Oil (million barrels) ^b | 79.1 |
| Population (million) | 4.4 | Gas (billion cubic metres) ^c | 29.2 |
| GDP (USD (2000) billion at PPP) | 103.94 | Coal (million tonnes) ^d | 571 |
| GDP (USD (2000) per capita at PPP) | 23 595 | Uranium (million tonnes of uranium metal) | – |

a. Statistics New Zealand (2012), Summary.

b. MED (2013), shown as 'Remaining Reserve P90 as at 1 January 2013' and includes LPG.

c. MED (2013), shown as 'Remaining Reserve P90 as at 1 January 2013'.

d. Proven reserves at the end of 2012 from BP (2013).

Other data: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011, New Zealand's total primary energy supply was 19 774 kilotonnes of oil equivalent (ktoe). A number of energy sources contributed to this total, including oil (30%), geothermal (28%), gas (17%), hydro (11%), and coal (8%), with wind, biomass, biogas, waste heat and solar providing the remainder (6%). Due to an assumed conversion efficiency of only 6% in geothermal electricity generation, the geothermal share of the final energy supply was only 2%, much smaller than its primary energy supply share of 28%. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2011 was 90%, down from 93% in 2010 as growth in total primary energy supply outpaced growth in indigenous production. Since 2000, growth in New Zealand's primary energy supply has been modest, increasing at an average annual rate of 1.0% (EDMC, 2013).

Coal, predominantly lignite, is New Zealand's most abundant fossil energy resource. However, almost all coal production is comprised of sub-bituminous and bituminous coals. In 2011, coal production decreased by 8% on an energy-equivalent basis compared with 2010 (EDMC, 2013).

Oil is sourced from 19 fields in the Taranaki region (MBIE, 2013, p. 31). The production of crude oil, natural gas liquids and condensate was down 13% on an energy-equivalent basis in 2011 compared with 2010, but up 120% compared to 2005 (EDMC, 2013). Oil production was

underpinned by growth in production from the newest offshore fields, Pohokura, Kupe and Maari, and from onshore fields such as Cheal and Sidewinder (MBIE 2013, p. 32). Despite this growth, domestic oil production met only 36% of demand in 2011 (MED, 2013, Figure D.7). Therefore, New Zealand imports a large volume of crude oil and petroleum products.

Natural gas is sourced from 18 fields (MBIE 2013, p. 46). In 2011, natural gas production decreased by 10% compared with 2010 (EDMC 2013). Gas is used directly by end-users in electricity generation, and in methanol and urea production. All the gas used in New Zealand is domestically produced as there are no facilities for importing liquefied natural gas (LNG). New Zealand's largest gas field discovery was the offshore Maui field in the late 1970s. However, production from the Maui field has diminished significantly in recent years and is nearing depletion. Newly commissioned gas fields have boosted reserves to meet projected gas demand in the short to medium term. However, there are concerns that New Zealand's gas supply could be inadequate unless some of the prospective fields are developed (MED, 2009a).

In 2011, New Zealand generated 46 507 GWh of electricity, about 2% more than in 2006 (EDMC 2013). New Zealand has plentiful hydro and renewable energy resources. Reflecting this, about 73% of electricity generation was from hydro and renewable sources. Hydro is the major source of electricity generation, accounting for 58% of the total generation. Hydro production fluctuates from year to year depending on rainfall; 2011 was a fairly normal hydro year. Geothermal generation accounted for another 13% of the total generation (MBIE, 2013, Table 6). More than two-thirds of New Zealand's hydro electricity is generated in the South Island, and all geothermal electricity is generated in the North Island. Most of the remaining electricity is generated in the North Island using a combination of natural gas, coal, wind and wood waste, although a small share of wind generation is located in the south island (MBIE 2013).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|--------|------------------------|--------|
| Indigenous production | 17 732 | Industry sector | 3 932 | Total | 46 507 |
| Net imports and other | 3 183 | Transport sector | 4 578 | Thermal | 10 681 |
| Total PES | 19 774 | Other sectors | 4 150 | Hydro | 25 09 |
| Coal | 1 499 | Total FEC | 12 659 | Nuclear | – |
| Oil | 5 955 | Coal | 559 | Other | 10 747 |
| Gas | 3 411 | Oil | 5 804 | | |
| Other | 8 909 | Gas | 1 704 | | |
| | | Electricity and other | 4 595 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

In 2011, New Zealand's final energy consumption was 12 659 ktoe or 1% lower than in 2010. The transport sector consumed 36% of the final energy, while the industry sector consumed 31%, and other sectors 33%. Final energy consumption was dominated by oil, accounting for 5 804 ktoe (46%), followed by electricity and other (mainly heat) at 4 595 ktoe (36%), gas at 1 704 ktoe (13%) and coal at 556 ktoe (5%) (EDMC, 2013).

Domestic passenger and freight transport in New Zealand is dominated by private road vehicles. Consequently, transport is the main consumer of petroleum products, accounting for 79% of domestic oil consumption in 2011, 1% higher than in 2010. Consumption of oil products in the other sectors was shared between residential, commercial and agricultural (9%), industry (6%) and non-energy or other (6%) (EDMC, 2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

A new Ministry of Business Innovation and Employment (MBIE) was created in July 2012 through the merger of four government ministries. These were the recently established 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. The MBIE is now responsible for developing New Zealand's energy policies and strategies with assistance from a number of other agencies, and it reports to the Minister of Energy and Resources.

New Zealand's oil and gas exploration and production activities are largely privately owned and open to competition. New Zealand generally welcomes investment in oil and gas exploration by foreign firms. Electricity generation and marketing is also largely open to competition, but three of the five major generators are state-owned firms, as is Transpower, the transmission grid operator. The New Zealand Electricity Authority oversees the conduct of the electricity market, but does not regulate electricity prices. The coal mining industry in New Zealand is dominated by Solid Energy, a state-owned firm, although there are private operators as well.

In August 2011, the government released the *New Zealand Energy Strategy 2011–21: Developing Our Energy Potential* (the Energy Strategy) (MBIE 2012a) 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 2011–2016 (NZECS), which replaces the 2007 version.

ENERGY MARKETS

New Zealand's energy sector has been subject to major reforms since the mid-1980s, coinciding with the introduction of broader economic reforms. The broader reforms aimed to improve economic growth through efficient resource use, driven by clear price signals and, where possible, competitive markets. The greatest change occurred in the electricity and gas markets—there the vertically integrated sectors were dismantled to separate the natural monopoly and competitive elements; the former government-owned and operated electricity and gas monopolies were either corporatised or privatised; and the electricity market was deregulated.

Responding to concerns about rising electricity prices, especially for residential customers, and governance arrangements in the electricity sector, the Minister of Energy and Resources initiated a Ministerial Review of Electricity Market Performance in April 2009. The review was led by the independent Electricity Technical Advisory Group (ETAG). A discussion paper was released in August 2009 (MED, 2009b). The discussion paper made a number of recommendations that were included in the Electricity Industry Act 2010.

A key governance change in the Electricity Industry Act 2010 was the replacement of the Electricity Commission with the Electricity Authority, which has more independence from the government. This change was effective from 1 November 2010 (EA 2012). Some of the responsibilities of the Electricity Commission that overlapped with those of other agencies have been transferred to those agencies, including the promotion of energy efficiency, the approval of grid upgrades and the management of supply emergencies.

The Electricity Industry Act 2010 has several provisions to promote competition. These include provisions for a swap of assets between the three state-owned generating companies to better align the generating and marketing assets of each firm, 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 electricity retailers do not profit from supply emergencies, and the requirement that a state-owned reserve

power station, criticised for distorting market incentives, be sold so that it can be operated on a commercial basis (NZG, 2010a).

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 set out 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, 2009c).

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 Ministry of Economic Development manages the New Zealand Government's oil, gas, mineral and coal resources, known as the Crown Mineral Estate. NZP&M was formed in May 2011 to maximise the gains to New Zealand from the development of its oil, gas, coal and mineral resources, in line with the government's objectives for energy and economic growth. Its role is to advise the New Zealand Government on policy and operational regulation and to promote investment in the mineral estate. It replaces the Crown Minerals Group.

Corporations earning income in New Zealand were previously taxed at a flat rate of 30% (Inland Revenue 2012). The tax rate has dropped to 28%, effective from 1 April 2011 (Inland Revenue 2012). Corporations are also required to pay other indirect taxes such as payroll tax and fringe benefits tax.

For petroleum production, companies must pay an ad valorem royalty of 5% (i.e. 5% of the net revenues obtained from the sale of petroleum) or an accounting profits royalty of 20% (i.e. 20% of the accounting profit of petroleum production), whichever is greater in any given year. For discoveries made between 30 June 2004 and 31 December 2009, an ad valorem royalty of 1% is applied to natural gas or an accounting profits royalty of 15% on the first NZD 750 million for offshore projects or 15% on the first NZD 250 million for onshore projects (NZP&M, 2011a).

For the production of Crown-owned coal, an ad valorem royalty of 1% of net sales revenue is payable on net sales revenue between NZD 100 000 and NZD 1 million. For producers with net sales revenues in excess of NZD 1 million, the royalty payable is either 1% of net sales revenue or 5% of accounting profits, whichever is higher (NZP&M, 2011b).

New Zealand has good oil and gas resources potential, but it is considered underexplored (Samuelson 2008, Section 5.3). Responding to this challenge, the government has developed an action plan for realising the potential of New Zealand's petroleum resources. The Action Plan for the Development of Petroleum Resources, released in November 2009, aims to ensure New Zealand is considered an attractive destination for investment in petroleum exploration and production. The plan is based on a number of 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 to foster more investment, particularly in frontier resources;
- developing a fit-for-purpose legislative framework for the petroleum sector (NZG 2010b; MBIE, 2012a).

In August 2011, the government announced a new approach to 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 the 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, 2011c).

New Zealand's environmental permitting process, known as 'resource consent', is governed by the Resource Management Act 1991 (RMA) and its subsequent amendments. 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, 2011a).

In December 2008, in response to concerns about the slow and costly consenting process under the RMA, the government appointed an RMA Technical Advisory Group to support the government's program of reform. A discussion paper was released in February 2009, which made a number of recommendations that were included in the Resource Management (Simplification and Streamlining) Amendment Act 2009 (MFE, 2011b).

A major criticism of the RMA had been that decision making was generally delegated to local governments, where local interests were likely to take precedence over economy-wide interests, especially for major projects. The Resource Management (Simplification and Streamlining) Amendment Act 2009 responded to this criticism by establishing a transitional Environmental Protection Authority (EPA) within the Ministry of the Environment to receive resource consent applications for proposals of significance to the economy and to support the boards of inquiry (or the Environment Court) in making decisions regarding those proposals (MFE, 2011b). Under legislation passed in May 2011, the EPA was changed to a stand-alone agency with expanded powers as of 1 July 2011 (NZG, 2011a).

The Resource Management (Simplification and Streamlining) Amendment Act 2009 also includes provisions to streamline the consenting process. These provisions make it more difficult for competitors to challenge a resource consent application, impose stricter deadlines for decisions by local governments and make procedural changes.

There are also provisions for more effective enforcement and tougher penalties for non-compliance (MFE, 2011b). An ongoing Phase 2 Review of the RMA takes on the more complex tasks of better aligning the RMA with other environmental laws and of exploring better approaches to urban planning and water management (MFE, 2011c).

In response to the Deepwater Horizon Gulf of Mexico oil spill, in June 2010 the government initiated a review of offshore petroleum health, safety and environmental (HSE) legislation. In December 2010, the Comparative Review of Health, Safety and Environmental Legislation for Offshore Petroleum Operations Report was released. The report concluded that New Zealand's HSE arrangements for offshore petroleum operations incorporate a number of key characteristics of international best practices. However, there were some areas in which New Zealand's regulatory framework could be improved (MED 2010).

Responding to a key recommendation of the review, in August 2011 the government introduced to Parliament the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill. Currently, the Resource Management Act 1991 regulates operations in New Zealand's Exclusive Economic Zone (EEZ) out to 12 miles at sea, but beyond 12 miles many activities have historically been unregulated. The new legislation will make the Environmental Protection Authority responsible for the consenting, monitoring and enforcement of activities in the EEZ that have an impact on the environment, including petroleum exploration and marine energy development (MFE, 2011d; NZG, 2011b).

ENERGY EFFICIENCY

New Zealand has a relatively long tradition of promoting energy efficiency. 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 strategy. The overall goal of the new strategy is for New Zealand to continue to improve its energy intensity (energy used per unit

of GDP) by 1.3% per year to 2016. In addition, New Zealand is part of the voluntary APEC-wide target to reduce energy intensity by 45% from its 2005 levels by 2035 (APEC, 2012).

Some of New Zealand's major policies for promoting energy efficiency include:

- for transport, fuel efficiency labelling for light vehicles and support for public transport improvements, such as the electrification of the Auckland rail system;
- for buildings, assistance for an expected 188 500 homes to install insulation and clean heating equipment by 2013, energy efficiency building codes, and energy efficiency rating tools for homes;
- for products, Minimum Energy Performance Standards (MEPS) and related labelling (coordinated with Australia) (MBIE, 2012a).

RENEWABLE ENERGY

New Zealand is well-endowed with hydro, geothermal, wind, biomass and potentially ocean energy. New Zealand's high level of renewable electricity supply has historically developed without significant explicit subsidies. Although the state-owned electricity generating companies have had a major role in the development of these resources, they are required to operate as commercial businesses and must compete with private generators (Treasury, 2011).

As part of the Energy Strategy, the New Zealand government retains the target of generating 90% of its electricity from renewable sources by 2025, provided security of supply is maintained. The major tool to achieve this goal will be the Emissions Trading Scheme, discussed in Climate Change (MBIE, 2012a).

Hydro has historically been New Zealand's major source of renewable energy. However, the best hydro sites have already been developed, so New Zealand will need to look to other forms of renewable energy to meet its 90% target. The government views the Resource Management Act 1991 (RMA), discussed above, as a major barrier to the development of renewable energy, and sees the reforms it is making to the RMA as beneficial for that development (NZG, 2011c).

On 14 April 2011, the government issued a National Policy Statement for Renewable Electricity Generation. This policy statement requires decision-makers at all levels of government, especially at the local level, to recognize the economy-wide significance of renewable electricity generation in their plans and policy statements (MFE, 2011e).

In the transport sector, a previous grant of up to 42.5 cents per litre for biodiesel producers was ended on 30 June 2012 (EECA 2012b). However, electric and plug-in electric light vehicles continue to be exempted from road user charges, which for the average user equates to a saving of around NZD 377 per year (NZG 2011d; MT, 2012).

NUCLEAR

New Zealand does not have any commercial nuclear reactors and has no plans to develop a nuclear energy industry.

CLIMATE CHANGE

The government has adopted an economy-wide target for a 50% reduction in New Zealand's carbon-equivalent net emissions, compared with the 1990 levels, by 2050. New Zealand is willing to commit to reducing greenhouse gas emissions by between 10% and 20% below 1990 levels by 2020, if there is a comprehensive global agreement and certain conditions are met (MBIE 2012a, MFE 2012).

The Climate Change Response (Emissions Trading) Amendment Act 2008 established New Zealand's emissions trading scheme. The scheme places a price on greenhouse gas emissions to provide an incentive to reduce the volume of overall emissions. Six gases covered under the

Kyoto Protocol are covered under the scheme—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (CCINZ, 2011).

In November 2009, the government approved a number of amendments to the emissions trading scheme, including amendments to the timeframe for entry into the scheme. Between 1 July 2010 and 31 December 2012, participants will be able to purchase permits from the government at a fixed price of NZD 25 per tonne of CO₂-equivalent. Over the same period, participants in the stationary energy, industrial and liquid fuel sectors (that is, all sectors in the scheme at that time except forestry) will have to surrender only one permit for every two tonnes of CO₂-equivalent emitted, effectively reducing the price of permits to NZD 12.50 per tonne (CCINZ, 2012a).

Previously all sectors of the economy were expected to be included from at the latest 2015. However, in 2012, the government revised the scheme to exclude the agriculture sector until there are economically viable and practical technologies. The revised timetable for sector entry into the emissions trading scheme is detailed in Table . Furthermore, a raft of other changes were included, which will extend the transitional period and introduce the offsetting of emissions with pre 1990s forests.

For energy, the point of obligation under the scheme generally lies with fuel or electricity suppliers, not with end-users. This means that only energy suppliers and a few large industrial facilities are directly affected by the scheme. Some free units will be available to energy-intensive trade-exposed industries (FL 2012).

New Zealand is a party to the Kyoto Protocol, and according to the latest Ministry for the Environment projections, it will exceed its 2008–12 commitment to reduce greenhouse gas emissions by 21.9 million tonnes (MFE 2011f). However, New Zealand announced it would not sign up for any continuation of the Kyoto Protocol beyond the initial commitment period beginning 2008 and ending in 2012. New Zealand intends to instead pursue domestic policies to reduce greenhouse gas emissions (CCINZ, 2012b).

Table 3 Timeframe for entry into the emissions trading scheme

| Sector | Voluntary reporting | Mandatory reporting | Full obligations |
|--|---------------------|---------------------|------------------|
| Forestry | | | 1 January 2008 |
| Liquid fuels (including transport) | | 1 January 2010 | 1 July 2010 |
| Stationary energy (including electricity, coal, gas, geothermal) | | 1 January 2010 | 1 July 2010 |
| Industrial processes | | 1 January 2010 | 1 July 2010 |
| Synthetic gases | 1 January 2011 | 1 January 2012 | 1 January 2013 |
| Waste | 1 January 2011 | 1 January 2012 | 1 January 2013 |
| Agriculture | 1 January 2011 | 1 January 2012 | No Date Set |

Source: CCINZ (2013).

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY MARKET

In 2013, the New Zealand government has completed the partial privatization of two of the three large government-owned energy utilities by selling 49% of each company. The last remaining government-owned utility is scheduled for partial privatization early in 2014. The partial privatization of government-owned utilities is expected to raise as much as NZD 6 to 7 billion, which has been set aside for reinvestment in education and infrastructure (FT, 2013).

In light of increasing electricity prices and divided public opinion over the merit of the partial privatizations, the main opposition party proposed to reform the electricity market should they win the next election. The opposition has proposed two major reforms. The first is to introduce a single buyer model (as seen in Canada) where a central government agency plans and tenders for new generation capacity from private developers. The second reform is to remove the current marginal pricing dispatch system and replace it with a fixed rate of return on investment and operating costs for each existing generation plant (Labour Party, 2013). Effectively this latter reform will lead to a significant reduction in revenue for the utility companies since many large hydro generation plants were built cheaply many decades ago and have very low operating costs. Under the proposed reform, these legacy hydro plants will likely receive a much lower return on invested capital. Thus, implementation of this reform is likely to result in a large wealth transfer from the shareholders of the utility companies to energy consumers through lower electricity prices. However, there are many drawbacks to reforming the current electricity model such as loss of market competition for new generation, reduced operation performance of existing facilities, lower potential for energy efficiency investment and higher risk premiums on invested capital among others. Even if the opposition were to take power at the next election it is highly uncertain when or if such reform could be successfully implemented. The regulatory uncertainty created by the opposition government likely reduced the price received from the recent utility partial privatizations.

The final development has been the uncertainty surrounding the profitability over the Tiwai Point Aluminium Smelter (TPAS), which accounts for about 14% of New Zealand's total electricity demand. The New Zealand government supplied a short term NZD 30 million one-off subsidy to ensure the plant continues to operate for the next few years (NZAS, 2013). It is uncertain in what capacity the TPAS will operate in the medium to long term, but a complete loss of the TPAS will result in over capacity of generation and lead to market price depression until new demand can replace what is lost.

NEW PROJECTS

In 2011, 100 MW of new wind electricity generation capacity came on line with the commissioning of the Mahinerangi (36 MW) and Te Uku (64 MW) wind farms (MED 2012 Table G3c). In addition, a new 82 MW baseload geothermal plant at Ngatamariki is undergoing the final stages of completion (MRP, 2013). There are a number of large-scale wind, geothermal and hydro projects that have regulatory and environmental consent to proceed. However all of the large utility companies have stated that they are unlikely to develop any new large-scale projects for the next several years owing to the current market's oversupply of capacity and tepid electricity demand growth. With continued improvement in energy intensity demand, growth may be much slower in the medium to long term than seen historically.

The New Zealand grid system operator Transpower has three major upgrade projects underway or in the final stages of planning. These are the NZD 417 million North Auckland and Northland Grid Upgrade Project due for completion in 2013, the NZD 100–NZD 300 million Wairakei to Whakamaru Replacement Transmission Line Project due for completion in 2013, and the NZD 672 million high voltage direct current (HVDC) Inter-island Link Project due for completion in 2014. Transpower has recently commissioned the NZD 824 million North Island Grid Upgrade project between Whakamaru and Auckland (Transpower, 2012). These projects are essential to improve the reliability and security of New Zealand's high voltage transmission network and to ensure adequate capacity for future demand growth.

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USEFUL LINKS

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Electricity Authority—www.ea.govt.nz/

Energy Efficiency and Conservation Authority (EECA)—www.eeca.govt.nz

Environmental Protection Authority—www.epa.govt.nz/Pages/default.aspx

Ministry of Business Innovation and Employment (MBIE)—www.med.govt.nz

New Zealand Government (portal for access to New Zealand government agencies and government-funded websites)—www.newzealand.govt.nz

New Zealand Government (news and speeches from government ministers)—
www.beehive.govt.nz

New Zealand Parliament—www.parliament.govt.nz

New Zealand Petroleum & Minerals (formerly Crown Minerals)—www.nzpam.govt.nz/cms

Transpower—www.transpower.co.nz

PAPUA NEW GUINEA

INTRODUCTION

Papua New Guinea (PNG) is located in the south-west of the Pacific Ocean, just south of the equator. It is made up of more than 600 islands, including the eastern half of New Guinea—the world's second largest island—as well as the Bismarck Archipelago, D'Entrecasteaux island group, and the three islands of the Louisiade Archipelago. The mainland and the larger islands are mountainous and rugged, with a string of active volcanoes dotting the north part of the mainland and continuing to the island of New Britain. PNG has a population of more than seven million, spread across a total area of 462 840 square kilometres. The resource development industry, which includes minerals, oil and gas, contributes to approximately 80% of PNG's export income (MRA 2012a).

In 2011, its real GDP was estimated at USD 14.7 billion (USD (2000) at PPP), an increase of 8.97% from 2010.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|------------------------------------|---------|------------------------------|-------|
| Area (sq. km) | 462 840 | Oil (million barrels) | 154.2 |
| Population (million) | 7.01 | Gas (billion cubic metres) | 400 |
| GDP (USD (2000) billion at PPP) | 14.7 | Coal (million tonnes) | — |
| GDP (USD (2000) per capita at PPP) | 2 097 | Uranium (million tonnes U) | — |

a. Proved reserves as of 2013 from the US Energy Information Administration and the BP Statistical Review of World Energy 1 (2013).

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011, PNG's net primary energy supply was 2257 kilotonnes of oil equivalent (ktoe). Light crude oil and petroleum products accounted for 76%, gas for 5.7%, and hydro and other fuels for the remaining 18.4% (EDMC 2013).

Production of crude oil in PNG started in 1992 and peaked at over 150 000 barrels a day the following year. However, since then production has been declining, despite exploration activities that resulted in the development of additional oilfields, and crude oil production is expected to be depleted by 2026. Oil production in 2009 was 35 050 barrels a day. 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 barrels a day.

Much of PNG's natural gas reserves are undeveloped, except for the Hides gas field, which provides 145–155 million cubic metres a year for power generation to supply the Porgera Gold Mine in the central highlands of PNG. The Hides gas field has about 113 billion cubic metres of proven gas reserves.

The PNG LNG Project is operated by the Esso Highlands Limited (Company). The project is a joint venture between Esso Highlands Limited, a subsidiary of ExxonMobil, and its partners—Oil Search Limited, Santos, AGL, JX Nippon Oil & Gas Exploration, Minerals Resources Development Company and Petromin PNG Holdings Limited, as well as local landowners. It is a 6.9 million tonne per annum integrated LNG project sourced from the Hides,

Angore and Juha fields and from associated gas in the Kutubu, Agogo, Moran and Gobe Main oil fields. The first LNG deliveries are scheduled to begin in 2014 (Esso 2010).

In 2011, PNG generated 3926 gigawatt-hours (GWh) of electricity, a 2.6% increase from 2010. Sources of generation included thermal at 65% and hydro at 25% (EDMC 2013). There is little economic potential for the expansion of large hydropower plants due to the lack of substantive demand near supply sources. However, greater potential exists for developing smaller hydro schemes. Most thermal and hydro power stations are owned and operated by PNG Power Limited, formerly the PNG Electricity Commission.

Geothermal power generation in PNG was commissioned in April 2003. In 2007 the installed capacity of the geothermal power stations was 56 MW. The Geothermal Energy Association categorises Papua New Guinea as an economy that could, in theory, meet all its electricity needs well into the future from geothermal sources alone (Geothermal Energy Association, 2010). In 2010 traditional biomass accounted for over approximately 50% of PNG's national energy consumption (IRENA 2013). However as there are no recent surveys to track its use, this is largely undocumented.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|-------|---------------------------------|-------|------------------------|-------|
| Indigenous production | 1 433 | Industry sector | 722 | Total | 3 926 |
| Net imports and other | 836 | Transport sector | 438 | Thermal | 2 539 |
| Total PES | 2 257 | Other sectors | 251 | Hydro | 987 |
| Coal | — | Total FEC | 1 411 | Nuclear | — |
| Oil | 1 714 | Coal | — | Geothermal | 400 |
| Gas | 128 | Oil | 1 099 | Other | — |
| Other | 415 | Gas | — | | |
| | | Electricity and other | 312 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

In 2011, total final energy consumption in PNG was 1431 ktoe, an increase of 23% from 2009. The industrial sector's consumption increased 2.27% from 2011, and the sector was the largest end user, accounting for 51% of the energy used, followed by transport (31%) and other sectors, including agriculture and residential/commercial (17.8%). By energy source, petroleum products accounted for 77.9% of the total consumption, while electricity and other sources accounted for 22.1%.

In PNG, around 85% of the population lives in rural areas and electrification rates remain low. Petroleum products such as diesel or petrol are used in the transport and electricity generation sectors. PNG Power Limited (PPL) and the PNG Government, with the assistance of the World Bank, is continuously extending its rural distribution network throughout the economy, especially within the outskirts of urban areas. PNG aims to increase electricity access to 41% of the population by 2020 and to 70% by 2030 (IRENA 2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Papua New Guinea, or the Independent State of Papua New Guinea, is a constitutional parliamentary democracy and a Commonwealth realm. Jurisdiction over energy matters is the

responsibility of the Papua New Guinea government's Energy Division within the Department of Petroleum and Energy (DPE). In 2011 the Energy Division authored a number of draft energy policies, however they have yet to receive formal status and are under review. The key draft policies included the National Energy Policy, the Rural Electrification Policy and Strategy, the Geothermal Policy, the Renewable Energy Policy and the Electricity Industry Policy (IRENA 2013). The exploration and development of petroleum resources have also been authorised and administered by the DPE.

The PNG Government initiated The National Strategic Plan 2010–2050, which has seven pillars. Natural resources, climate change and environmental sustainability are among the areas of focus.

In March 2010, the Papua New Guinea Government announced the Development Strategic Plan (DSP) 2010–2030, which has five pillars, one of which is 'natural resources and environment'. The DSP 2010–2030 also set this goal: All households are to have access to a reliable and affordable energy supply, and sufficient power is to be generated and distributed to meet future energy requirements and demands (12.4% of households had access to electricity in 2010).

In October 2010, the Papua New Guinea Government announced its Medium Term Development Plan (MTDP) 2011–2015. The MTDP 2011–2015 will focus on increasing access to electricity for all households in the country. New investment from the private sector in solar technology is also expected during the period of the first MTDP. A comprehensive analysis will be necessary to analyze the cost effectiveness of the various alternative sources of power.

ENERGY MARKETS

PNG's power authority, PNG Power Limited (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 PNG Power Limited. Under the Act, PNG Power Limited'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 (Privatization) Act 2002.

However, because of a lack of technical capacity to perform this regulatory role, the ICCC outsourced this role to PNG Power Limited on a contractual basis for an initial period of two years ending in 2005. The contract was extended for another three-year period ending in 2008. There is no further information on whether this role has been extended. fiscal regime and investment

In September 2003, the Papua New Guinea 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 the rate for projects established after that date (45%). The new 30% fiscal term is available for petroleum operations that have a petroleum development licence granted on or before 31 December 2017, and a petroleum prospecting licence granted within the period 1 January 2003 to 31 December 2007 (Department of Petroleum and Energy, 2003).

Papua New Guinea has arguably the most competitive terms for oil and gas investment in the region (Papua Petroleum Limited, 2008). 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 landowners' at 2%. The effective royalty rate is 2%, and the government's share of that is approximately 50%.

ENERGY EFFICIENCY

Energy efficiency policies and regulations are regulated by the Energy Efficiency Division of the Department of Petroleum and Energy. While energy efficiency is not currently a major priority for the PNG government, it might prove to be an important factor if the DSP 2010-2030 goals are to be achieved. Since there are only two separate power grids (the Port Moresby grid, which depends heavily on diesel generation, and the Ramu grid), urban areas are forced into expensive and inefficient self-generation, and large industries such as mining sites operate using off-grid self-generated power.

RENEWABLE ENERGY

Renewable energy is also regulated by the Division of Energy. PNG's renewable energy potential is very high, however the remote locations and terrain have meant that renewable energy has not been readily exploited.

In February 2007, Lihir Gold Limited, which merged with Newcrest Mining Limited in 2010, and now operates under 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. The latest plant lifted Lihir Gold's total geothermal generating capacity to 56 MW, around 75% of the economy's total electricity requirements in 2007 (Newcrest Mining, 2010).

Lihir Gold Limited was the first mining company in PNG to use geothermal energy for electricity generation and its expansion of capacity is in line with the government's goal of promoting green energy (see 'Climate Change' section) and reducing dependency on fuel oil for electricity generation. The Lihir Mine's geothermal plant generates approximately 40% of the mine's current power requirements and provides free electricity to residents who live near the Lihir mine site. It saves the plant approximately USD \$2,000,000 per year in fuel oil costs (Booth and Bixley, 2005).

The Department of Petroleum and Energy'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 1800 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 350km undersea cable (IRENA 2013).

PPL is considering constructing a wind farm near Port Moresby, but they have not commenced wind monitoring. In 2002 the Chinese Government donated 50 small combined wind/solar generators, some of which have been installed at coastal locations (IRENA 2013).

NUCLEAR

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

CLIMATE CHANGE

Climate change is one of the important pillars in the National Strategic Plan 2010-2050 (see 'Energy Policy Framework' section).

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 greenhouse gas emissions reduced by the geothermal plant is approximately 4% of PNG's total CO₂ emissions (Newcrest Mining 2012).

NOTABLE ENERGY DEVELOPMENTS

UPSTREAM DEVELOPMENT

A number of international companies have shown a renewed interest in investing in PNG's upstream oil and gas sector in recent years. At the end of 2007, the total number of petroleum prospecting licences (PPLs) was 37, compared with 17 in 2003. The surge in interest has been principally attributed to the September 2003 introduction of internationally competitive fiscal incentives designed to attract oil exploration.

In November 2011, Lihir Gold Ltd extended its drilling contract with Energy Development Corporation to 31 December 2012 (The Manila Times.net, 2011).

LNG PROJECTS

In March 2008, a joint operating agreement (JOA) for the PNG LNG Project was signed by the project's participants: 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 to be sourced from the Kutubu, Gobe and Moran oilfields as well as the Hides, Juha and Angore gas fields. In May 2008, a gas agreement was signed by the joint project's participants and the state of Papua New Guinea. PNG's Deputy Prime Minister said the first shipment of gas would be in 2014 and that it would quadruple the GDP of Papua New Guinea. The project aims to export 6.6 million tonnes of LNG from Papua New Guinea each year. ExxonMobil and its joint partners completed the front-end engineering and design phase for the project in November 2009. In November 2011, Marubeni, a highly diversified corporation, acquired a 21% share of the Merlin Petroleum Company (Marubeni, 2011). The first LNG deliveries are expected in 2014.

REVIEW OF THE MINING AND PETROLEUM TAXATION REGIME

The International Monetary Fund provided technical assistance to the PNG Department of Treasury to conduct a review of 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' (MRA 2012b).

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 given in the form of finance, expert advice and studies to help PPL and the PNG Government. The project will aim to increase electrification rates from below 10% to 70% by 2030 (World Bank 2013).

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PERU

INTRODUCTION

Peru is one of three APEC economies in Latin America located on the Pacific coast of South America. With a land area of 1.28 million square kilometres, Peru shares borders with Chile to the south, Ecuador and Colombia to the north, and Brazil and Bolivia to the east. Peru has three main geographical regions: the Costa to the west, the Sierra (Andes mountains), and the Selva, covered by the Amazon rainforest. The economy is divided into 25 political departments (administrative regions), and in 2011 had a total population of about 29.6 million people, which represents a growth of 1.2% from the previous year (EDMC, 2013). Around 34.8% of Peru's population is considered poor and 11.5% extremely poor. Its major population centre is the Lima region, which represents nine million people, nearly a third of the total population. Peru's urbanisation rate is 76% (INEI, 2011a).

Peru has a market-oriented economy, which in 2011 was composed of services (55.6%), manufacturing and construction (21.7%), agriculture and mining (13.1%) and taxes (9.7%). Economic growth has been recently supported by macroeconomic stability, which has increased exports and sustained an influx of private investment. The economy has been driven by mining, construction, exports, and domestic consumption. Mining is especially important and Peru is a major global producer, being the first in silver, second in zinc, third in copper and tin, fourth in lead, and sixth in gold. As a consequence, mineral exports have consistently accounted for a significant portion of the economy's export revenue, with as much as 61% in 2010 (INEI, 2011b).

While Peru continues to counteract the effects of the international economic crisis that broke out in 2008, its economy grew remarkably, with a 7% growth from 2010 to 2011, its GDP reaching USD 236.0 billion (USD (2000) at PPP) in 2011, and its GDP per capita growing 5% to reach USD 7 970 (EDMC, 2013). In addition, Peru's foreign reserves reached a record USD 33.1 billion, while its fiscal deficit represented 3.2% of the GDP (BCRP, 2011; MEF 2010b).

Owing to its scarce oil resources, Peru is a net importer of oil. Particularly, domestic production is not only insufficient to meet the economy's demand, but since most crude oil produced is of extra-heavy quality and several of Peru's domestic refineries are unable to process it, a substantial share of domestic production is exported. In contrast, natural gas resources are significant and the economy is a major global gas producer, representing the only source of liquefied natural gas (LNG) exports in South America.

Table 1 Key data and economic profile, 2011

| KEY DATA | | ENERGY RESERVES ^A | |
|------------------------------------|-------|------------------------------|-------|
| Area (million sq. km) | 1.3 | Oil (million barrels) | 1 206 |
| Population (million) | 29.6 | Gas (trillion cubic metres) | 0.3 |
| GDP (USD (2000) billion at PPP) | 236.0 | Coal (million tonnes) | 8.7 |
| GDP (USD (2000) per capita at PPP) | 7 970 | Uranium (tonnes) | 1 800 |

a. Proved reserves at the end of 2011 (MINEM, 2011c).
Source: EDMC (2013).

Peru's proved energy reserves by the end of 2011 were 1 206 million barrels of crude oil (including gas liquids), 0.36 trillion cubic metres of natural gas, 8.7 million tonnes of coal and 1 800 tonnes of uranium located in the Puno region (MINEM, 2011b).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2011 was 18 423 kilotonnes of oil equivalent (ktoe), which represented an increase of 8.2% from 2010, due to the growth observed in the production of natural gas and its liquids. By energy source, in 2011 almost half (8 936 ktoe) of TPES came from oil, 35% from natural gas (6 452 ktoe), and 3% from coal (637 ktoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others contributed to the remainder at 13% (2 397 ktoe) (EDMC, 2013). In 2011, Peru's energy exports represented 13% of its primary energy (1 929 ktoe) and mainly consisted of crude oil (EDMC, 2013).

Peru produced 152 716 barrels per day (B/D) of total oil liquids in 2011, with crude oil accounting for 45.5% of the total production (69 553 B/D), and natural gas liquids (NGL) making up the remainder (83 163 B/D). From 2002 to 2011, NGL production increased at an average rate of 39.8% per year and represented the bulk of the growing oil production, including a very significant increase of almost nine times between 2003 and 2005, from 4 027 B/D to 35 840 B/D. In 2011, the oil refining capacity in Peru amounted to 213.3 thousand B/D spread across six refineries (Conchán, El Milagro, Iquitos, La Pampilla, Pucallpa and Talara) (Petroperu, 2011; Repsol, 2011). From a volume of nearly 53 million barrels of crude oil that were refined in Peru during 2011, the share of indigenous feedstock processed was 35.9%, and the remaining 65.1% was imported supply coming mainly from Ecuador and Angola. The production of petroleum products decreased 3.6% over 2010 figures, to around 54 397 million barrels in 2011, with gasoline and diesel representing half of the total output (MINEM, 2011b).

Peru is a major gas producer. In 2011, the economy produced around 11.4 billion cubic metres (bcm), or 401.2 billion cubic feet –bcf, of audited natural gas, an outstanding increase of 36.3% over 2010, mainly as a result of the addition of Block 56's output, which alone represented 56% of the total production at Camisea (MINEM, 2011b)

In this regard, nearly all of the domestic supply of natural gas is non-associated to crude oil and produced in the Camisea Basin, which encompasses several natural gas fields in the Ucayali basin in south-eastern Peru, mainly in the San Martín and Cashiriari reservoirs, commonly known as 'Block 88', along the Camisea River. Discovered in the 80's, it was not until 2000 that a 30-year production contract was signed between the government and the production companies, with project development beginning in 2004. In 2011, Camisea represented one of the most important non-associated gas reserves in Latin America, with a proved potential of 0.3 trillion cubic metres (COPRI, 2000; MINEM, 2011c). Since its beginning, output capacity at Camisea has grown steadily as drilling activities have also expanded to Block 56, adjacent to Block 88. While the Camisea project was initially aimed to meet domestic demand for natural gas, production levels, which have increased at an annual average rate of 62.6% since 2004, have allowed the development of an export market in the form of liquefied natural gas (LNG), which is sent by ships primarily destined for Mexico and Europe (MINEM, 2011a; PlusPetrol, 2011).

In 2011, Peruvian LNG exports from the Melchorita liquefaction plant amounted to 5.5 billion cubic metres, which represented approximately half of Peru's total gas production (Perupetro, 2011).

Peru's proved coal reserves are around 8.7 million tonnes, of which most (95%) is anthracite and the remainder bituminous coal, with the majority of reserves being located in the La Libertad, Ancash and Lima departments. Peru is a net importer of coal, with 81% of its coal demand in 2011 met by imports and only 19% by domestic production (MINEM, 2011b).

In 2011, Peru's electricity generation totalled 39 223 gigawatt-hours (GWh), a 9% increase from the 35 907 GWh generated in 2010. Hydropower's share of this total was the largest, at 55% (21 573 GWh), with electricity generated from thermal plants accounting for 43% (16 916 GWh) and the remainder being met by other sources such as biomass and wind (EDMC, 2013).

Thermal plants are fuelled by natural gas, which represents more than two thirds of the total thermal-based power generation, followed by diesel and fuel oil. Gas share is especially high, due to the rising production from Camisea in recent years, which has favoured its demand for thermal power plants. More than 90% of the total electricity is generated by the National Interconnected Electrical System (SEIN), with the remainder being produced by isolated systems (SA) and self-use producers. By the end of 2011, access to electric power in the economy reached about 85% of the total Peruvian population (MINEM, 2011b).

Apart from hydropower, other renewable energy sources used in Peru include biomass, solar, mini-hydro and wind. In addition to mini-hydro (usually less than 30 MW of power generation capacity) and biomass (mostly through sugarcane bagasse), electricity has grown due to the expansion of wind power, which in 2011 reached 70 megawatts. While wind power barely accounts for 0.01% of the total electricity capacity in Peru, it is expected to increase in the short to medium term (MINEM, 2011b).

In the other energy sectors, other types of biomass, such as firewood, vegetable coal, dung and yaret (a moss-type plant that is dried and then burned) are used for heating and cooking. In 2011, energy supply from renewable sources was made up of firewood with 44.2%, hydropower with 44% and other biomass sources with the rest (MINEM, 2011b).

Table 2 Energy supply and consumption, 2011

| PRIMARY ENERGY SUPPLY (KTOE) | | FINAL ENERGY CONSUMPTION (KTOE) | | POWER GENERATION (GWH) | |
|---------------------------------|--------|------------------------------------|--------|---------------------------|--------|
| Indigenous production | 20 713 | Industry sector | 4 249 | Total | 39 223 |
| Net imports and other | 1 929 | Transport sector | 6 735 | Thermal | 16 916 |
| Total PES | 18 423 | Other sectors | 2 887 | Hydro | 21 573 |
| Coal | 637 | Total FEC | 13 871 | Nuclear | – |
| Oil | 8 937 | Coal | 626 | Others | 734 |
| Gas | 6 543 | Oil | 8 667 | | |
| Others | 2 397 | Gas | 1 423 | | |
| | | Electricity and others | 3 155 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

Final energy consumption in Peru grew by 10.8% in 2011, reaching 13 871 ktoe. Transportation was the most dynamic sector, with an 11.4% jump from the previous year, and representing 49% of total final energy consumption in 2011. The industrial sector's share was 31%, while the combined 'other' residential, commercial and agriculture sectors consumed 21%. Accordingly, oil products dominated the total energy consumption in 2011 with 62%, the majority of which was consumed as diesel, gasoline and liquefied petroleum gas. Electricity made up 23% of the total end-use energy demand, while gas and coal accounted for the remaining 10% and 5%, respectively (EDMC, 2013).

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 Ministry of Energy and Mines (MINEM), which is divided into two sub-ministries: the Vice-Ministry of Energy and the Vice-Ministry of Mines. MINEM 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 stretches across the major areas of influence in the sector, overseeing its activities and promoting investment to achieve sustainable national development. In addition to MINEM, the autonomous regulatory agency created in 1996, Organismo Supervisor de la Inversión en Energía y Minería (OSINERGMIN) is in charge of 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 through the design and implementation of effective regulation.

In 2002 MINEM published its Long-Term Policy Guidelines for the Energy Sector, which contains the vision, objectives, strategy guidelines, and the medium and long-term policy tools for the energy sector (MINEM, 2002). The document was intended to guide the development of an efficient energy system, covering the basic energy needs of the population while contributing to economic growth, achieving better social equity and limiting environmental impact. The guidelines set two general objectives:

- Covering the basic energy requirements of the population, both in quantity and quality, thus diminishing social and regional asymmetries, making possible the development of productive activities and improving the population's living conditions;
- Achieving a good balance between the final consumption structure, supply infrastructure characteristics and the availability of natural energy resources in the economy.

In May 2010, the Vice-Ministry of Energy issued Peru's Energy Policy Proposal 2010–2040 for public discussion. After forums were held and feedback received, the Energy Policy of Peru 2010–2040 was approved on 24 November 2010 (Supreme Decree No. 064–2010–EM – El Peruano 2010) with the goal of meeting Peru's energy demand in a safe, sustainable, reliable and efficient way, supported by planning, research and technological innovation with the following objectives (MINEM, 2010a):

- a diversified and competitive energy matrix with emphasis on renewable energy and energy efficiency;
- a competitive energy supply;
- universal access to energy supply;
- the highest efficiency levels in energy production and utilisation systems;
- self-sufficiency in energy production;
- building an energy sector with minimal environmental impact and low carbon emissions, as part of sustainable development;
- development of the natural gas industry and its use in household, transportation, commercial and industrial activities, as well as efficient electricity generation;
- strengthening of the institutions involved in the energy sector;
- join regional energy markets in order to achieve Peru's long-term vision.

Stemming from Peru's Energy Policy Proposal 2010–2040, in January 2012 MINEM published a study on a sustainable energy matrix proposal including its environmental assessment ("*Nueva Matriz Energética Sostenible y su Evaluación Ambiental Estratégica, como Instrumentos de Planificación*"), which aims to provide a reference on the Peruvian energy sector and to support energy planning purposes towards new regulations and policies (MINEM, 2012).

ENERGY MARKETS

Peru's economy has become more market-oriented following the reforms of the 1990s with the mining, electricity, hydrocarbons and telecommunications industries being partially privatised. 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. One example is the promotion of foreign investment in the natural gas industry. In 1999, Peru passed the Law for Promotion of Natural Gas Industry Development (Law No. 27133), which established specific conditions in order to promote the development of the natural gas industry, fostering competition and the diversification of energy sources to increase the reliability of the energy supply and improve the competitiveness of a productive sector of the economy (El Peruano 1999). See also the 'Fiscal regime and investment' section, that follows.

In the electricity sector, reforms began in 1992 to introduce a model closer to the one implemented in Chile a decade before. An important difference, though, lies in the limits set by the Peruvian model on vertical and horizontal integration within the sector. The Law against Oligopolies and Monopolies (*Ley Antimonopolio y Antioligopolio del Sector Eléctrico*, No. 26876), passed in 1997, limits the horizontal concentration of firms to a 15% market share in the electricity sub-sectors of generation, transmission or distribution, and to a 5% market share in the case of vertical concentration.

This reform had four main components: the vertical and horizontal de-integration of the Electroperú and Electrolima companies in power generation, transmission and distribution; the progressive and partial privatisation of those state utilities; the creation of a free market where energy providers with a capacity larger than 1 MW could freely negotiate the conditions of their supply contracts; and the establishment of a new mandate for the former Electricity Tariffs Commission (CTE), which in 2000 merged with OSINERGMIN.

Although Peru had an open electricity market, there were still barriers to the market's efficient operation. On July 2006, the government expanded the rules established in the Electricity Concessions Law to:

- ensure the supply of 'sufficient efficient generation' in order to reduce the economy's exposure to price volatility and to help ensure that consumers receive more competitive electricity tariffs;
- reduce administrative intervention in determining prices for generation by means of market solutions;
- take the necessary measures to create effective competition in the generation market;
- introduce a mechanism of compensation between the SEIN and the Isolated Systems so that prices incorporate the benefits of natural gas production, while reducing their exposure to the volatility of fuel markets.

In this context, the government has enabled the introduction of bidding and incentives for the optimal supply of electrical energy; the 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 now a private, independent operator and planner for the electricity system; and adjustments to the legal framework related to the formation of transmission prices.

FISCAL REGIME AND INVESTMENT

The Peruvian government strives to attract foreign investment to sustain economic growth and improve competitiveness. In recent years, Peru has expanded and streamlined the available investment schemes, with particular focus on areas involving exports, infrastructure, and services to the population. As such, investments in oil and gas upstream activities are conducted under licence or service contracts granted by the government.

The government guarantees that the tax law in effect on the agreement date will remain unchanged throughout the contract term. Under a licence contract, the investor pays a royalty; whereas under a service contract, the government pays remuneration to the contractor. In both cases, the distribution of the economic rent, either as royalty or remuneration, is determined through two methodologies: production scales and economic results.

The production scale methodology sets a percentage of royalty, starting at 5%, over certain scales 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. On the other hand, under the economic results methodology, the royalty percentage is set by adding a fixed royalty percentage of 5% to a variable royalty percentage, established according to certain economic results ratios (Ernst & Young 2011).

To promote domestic and international investment in the energy sector, Peru has looked forward to shifting its legal framework. In 1991 the government passed the Foreign Investment Promotion Law, Supreme Decree No. 662. A second law, concerning private investment in public services and regulatory agencies (*Ley Marco de los Organismos Reguladores de la Inversión Privada en los Servicios Públicos*, Law No. 27332), came into effect in 2000 and provided a framework for private investors in telecommunications, energy, transport and sanitary services, specifying how operations in each of these public service sectors were to be organised. Overall, Peru strives to ensure proper conditions to attract and retain investment. Foreign investors are given equal treatment to Peruvians, most activities are unrestricted and several schemes are possible.

ENERGY EFFICIENCY

The Peruvian Government has actively pursued energy efficiency since the 1980s and 1990s, when it created the Energy and Environment Centre (CENERGIA) and the Energy Conservation Project (PAE). PAE was created in 1994 after an energy shortage in Peru, and was the basis of a strong energy conservation campaign run by the government; after international awards and good results, in 2001 PAE was converted from a temporary project to a permanent programme and it continues today (MINEM, 2009).

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. In line 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 mechanisms. These included DS–No. 034–2008–EM of 19 June 2008 (Energy Saving Measures in Public Services), and RM No. 038–2009–MEM/DM of 21 January 2009 (Energy Consumption Indicators and their Monitoring Methodology). Through the Supreme Decree No. 034–2008–EM of June 2008, the Peruvian Government promoted energy-saving measures in the public sector, such as replacing less-efficient incandescent lamps with compact fluorescent lamps and acquiring equipment with energy efficiency labels.

In September 2009, the government through MINEM organised a workshop on efficient use of energy at which the Referential Plan for the Efficient Use of Energy 2009–2018 was approved. This is the main instrument to achieve the economy's energy efficiency goals through action plans proposed for each sector (MINEM, 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, identifying sector programmes 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;
- Get the commitment of the mining and energy sectors to being role models of efficiency.

On May 2010, the Peruvian Government created the General Directorate of Energy Efficiency (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 economy's energy planning and is responsible for developing the National Energy Plan, which must also incorporate electricity sector development in line with national development policies and the 2010-2040 Energy Policy Framework (El Peruano, 2010).

RENEWABLE ENERGY

Peru has established goals to increase renewable energy use and has set out a legislative and policy programme to support its development. Electricity generation from renewable resources is being expanded from an already significant reliance on hydropower generation. The Law on Promotion of Investment for Electricity Generation with Renewable Energies was enacted in May 2008 (Law No. 1002), and the Regulations for Generation of Electricity with Renewable Energies (Supreme Decree No. 050–2008–EM) were issued in October of that year. Among the incentives contained in the law are: 1) a five-year target for the share of domestic power consumption to be generated from renewable energy sources, excluding large hydropower generation (i.e. less than 20 MW of installed capacity); 2) a firm price guaranteed for bidders who are awarded energy supply contracts for up to 20 years; and 3) priority in loan dispatch and access to networks. (El Peruano, 2008a, 2008b)

To achieve these goals, MINEM established open auctions for renewable energy supplies in order to ensure competitive conditions for the electricity generators and their customers. The first auction was completed in March 2010 and added a total renewable energy capacity to the National Interconnected Electric System (SEIN) of 411 MW, awarded across 26 projects using wind, solar, biomass and mini-hydro. A second auction, open in the second half of 2011, aimed at obtaining 1981 GWh, out of which 681 GWh were restricted exclusively for hydroelectric projects (OSINERGMIN, 2011).

To promote renewable energy, in 2006, the government passed Law No. 28876, which provides in advance tax reimbursement on the electricity sales of renewable energy-based utilities. In 2008, Law No. 1058 was passed, which allows tax benefits to investment participants in electricity generation that is based on renewable energy, including hydro, by means of the accelerated depreciation of their investments by up to 20% per year in order to improve the projects' feasibility (MINEM, 2010b).

As for biofuels, government objectives were first set in 2003 and there are three regulations that provide their legal framework: Law No. 28054 (Biofuels Market Promotion); Supreme Decree No. 013–2005 EM (Regulation of the Biofuels Market Promotion); and Supreme Decree No. 021–2007 EM (Regulation of the Commercialization of Biofuels). These regulations also establish responsibilities among different government and agencies:

- Ministry of Agriculture (MINAG): Promotes the development of fields for biofuels production;
- Ministry of Energy and Mines (MINEM): Authorizes the commercialization of biofuels and their blending with gasoline and diesel;
- Ministry of Production: Authorizes the operation of biofuel production plants;
- OSINERGMIN: Supervises and controls operations during the different stages of the production chain;

- **PROINVERSION:** Promotes investment in the biofuels sector.

Under this legislation, quality standards for biofuels and procedures to register a fuel blend with MINEM were established. A schedule for blending biofuels in the conventional fuel supply was set as well. Beginning in 2010, gasoline must include 7.8% bioethanol and from 2011 diesel must contain 5% biodiesel, known as B5.

Production of ethanol for fuel in Peru began in August 2009, with operations in the northern region of Piura. In 2011, Caña Brava, the only producing company, reached an output of 0.3 million barrels of ethanol. A new ethanol project carried out by Maple Ethanol Peru, began operations in late 2011 and includes a processing capacity of 0.82 million barrels per year. Sugar cane's high yields and year-round harvest grants Peru's ethanol production a competitive advantage over other producers in the region.

As for biodiesel, its production for 2011 was estimated at 0.1 million barrels. In spite of the volume produced, imports are still necessary in order to meet Peru's biodiesel demand, especially in the light of the compulsory fuel blending standards as described above (MINEM, 2011b).

NUCLEAR

Although Peru does not use nuclear energy for electricity generation, a government-run nuclear programme has been in operation since 1975. This programme involved construction of basic infrastructure, human resources training, and the establishment of the Peruvian Institute of Nuclear Energy (IPEN) as part of MINEM. Peru has been a member of the International Atomic Energy Agency since the creation of that international body in 1957.

On 26 June 2006, the governments of Peru and the Russian Federation signed a bilateral agreement on the use of nuclear energy for peaceful purposes. A supreme decree was subsequently published on 21 August 2009 (Supreme Decree No. 057–2009–RE) to validate this ratification and disclose it in the Peruvian Parliament (El Peruano, 2009).

In late 2009, IPEN presented its Institutional Strategic Plan 2010-2016. The document comprises three main objectives, one of them regarding the promotion of electricity generation based on nuclear energy (IPEN 2009).

CLIMATE CHANGE

As one of the economies most vulnerable to climate change, Peru has looked forward to implementing an effective and sustainable strategy for adapting to and mitigating its effects. On 5 December 1993, the Peruvian Government, by Legislative Resolution No. 26185, approved the United Nations Framework Convention on Climate Change (UNFCCC), which was signed in Rio de Janeiro on 6 December 1992. Peru also ratified the Kyoto Protocol of the UNFCCC by Legislative Resolution No. 27824 on 10 September 2002.

As part of its environmental strategy policy, in October 2003 the Peruvian Government, by Supreme Decree No. 086–2003–PCM, approved the National Strategy on Climate Change (NSCC), for the mitigation of and adaptation to climate change (El Peruano 2003). The main objectives of the NSCC are to reduce climate change impacts by means of integrated studies of vulnerability and adaptation, and to control both local pollution and greenhouse gas emissions through the use of renewable energies and energy efficiency programmes in production sectors.

The NSCC was subsequently updated in 2009, and in May of that year the Climate Change Commission, which brought together regional, social, academic and private participants, was created.

In collaboration with the Swiss Agency for Development and Cooperation, Peru established a Climate Change Adaptation Programme (PACC), which is implemented by the Ministry of Environment (MINAM) and by regional governments in the Cusco and Apurimac regions. The programme, to be developed from 2009 to 2012, focuses on three main thematic lines which are

water resources, food security and natural disasters. The themes imply important cross-sector effects. The human dimension is integrated in this concept to allow for a more complete view of the vulnerabilities to climate change. The programme aims to promote the implementation of climate change adaptation strategies and measures by local populations and public and private institutions, as well as to capitalise on knowledge and allow dialogue on public policies at different levels (PACC 2011).

After the United Nations Climate Change Conference of Parties (COP16) held in Cancun, Mexico in late 2010, Peru submitted its Nationally Appropriate Mitigation Action (NAMA), in which it agrees to reduce its emissions by accomplishing the following objectives (UNFCCC, 2011):

- Reduction to zero of net deforestation of natural or primary forests;
- Modification of the current energy grid, so that renewable energy (non-conventional energy, hydropower and biofuels) represents at least 33 per cent of the total energy use by 2020;
- Design and implementation of measures which allow the reduction of emissions caused by the inappropriate management of solid waste.

Peru's international climate change commitments are the responsibility of MINAM, which is in charge of the design and execution of related policies. As of 2011, MINAM had reported progress on several of Peru's climate change projects and defined new specific priorities to be tackled. International cooperation and sufficient funding of projects were stressed as specific factors needed to carry out projects successfully (MINAM, 2011).

NOTABLE ENERGY DEVELOPMENTS

OIL AND NATURAL GAS SECTOR

During 2011, investment in oil and gas exploitation in Peru reached USD 1 046 million. About 46% of this amount was invested by Pluspetrol Peru Corporation S.A. on Block 88 at Camisea, while another considerable share of about 25% was invested by Savia Perú S.A (MINEM, 2011b).

In June 2010, Peru LNG, a consortium of four world-class energy companies—the Hung Oil Company of the United States, SK Energy of Korea, Repsol of Spain, and Marubeni Corporation of Japan—was able to start operation of the Melchorita LNG plant (the Melchorita Plant), Peru's and South America's first natural gas liquefaction plant, and sent its first shipment of LNG to Mexico. The USD 3.8 billion invested in this plant represents the largest investment ever made in a single project in Peru. The plant has a nominal capacity of 4.4 million tonnes per year and can process up to 17.5 million cubic metres per day of natural gas. (Peru LNG, 2011).

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Banco Central de Reserva del Perú—www.bcrp.gob.pe

Comité de Operación Económica del Sistema Interconectado Nacional—www.coes.org.pe

Instituto Nacional de Estadística e Informática—www.inei.gob.pe

Instituto Peruano de Energía Nuclear—www.ipen.gob.pe

Ministerio del Ambiente—www.minam.gob.pe

Ministerio de Economía y Finanzas—www.mef.gob.pe

Ministerio de Energía y Minas—www.minem.gob.pe

Organismo Supervisor de la Inversión de la Energía y Minería—www2.osinerg.gob.pe

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Programa de Adaptación de Cambio Climático—www.paccperu.org.pe

Proyecto Camisea—www.pluspetrol.net/camisea.html

THE PHILIPPINES

INTRODUCTION

The Philippines is an archipelago of 7 107 islands in the middle of South-East Asia's main water bodies: the South China Sea, the Philippine Sea, the Sulu Sea, the Celebes Sea and the Luzon Strait. It covers a total land area of 300 000 square kilometres including inland bodies of water, spread over the three main islands, Luzon, Visayas and Mindanao. Its total population in 2011 reached 95 million, a 1.9% increase from the 2010 level. Half of the economy's population is estimated to live in Luzon, the largest of the three major island groups and home of Manila, the Philippines capital, identified by the World Bank as one of the 120 largest cities in the world. The Philippine economy posted a dismal 3.9% growth in 2011, in view of the unfavorable global economic environment, in general, and the economy's lacklustre performance in public construction, in particular. In view of the modest growth of the economy, per capita GDP likewise did not increase much at USD 3 220 (USD 2000 at PPP) in 2011. The government's underspending due to delays in government projects triggered the major drag to the Philippines' economy in 2011 (Navarro & Yap, 2012).

The economy has modest proven fossil fuel reserves with more than 100 million barrels of oil including condensate, 33.3 billion cubic metres of natural gas (equivalent to 1 151 billion cubic feet) and 458 thousand tonnes of coal, mainly lignite. However, in view of the volatility of oil prices in the world market and its effort to increase its self-sufficiency level, the economy continues to harness new sources of oil, gas and coal. In addition, the economy's renewable energy (RE) sources provide a significant contribution (29%) to its power generation. Power generated from hydro source posted a remarkable increase of 14% from the previous year's electricity output of 7 803 GWh. Although there is a minimal increase in absolute terms (9 942 GWh), geothermal energy share from the total electricity generation maintains at 14% in 2011. Other renewable energy sources provide a total combined power generation of 7 894 GWh.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|------------------------------------|-------|-----------------------------------|------|
| Area (thousand sq. km) | 300 | Oil (million barrels)—proved | 111 |
| Population (million) | 95.1 | Gas (billion cubic metres)—proved | 33.3 |
| GDP (USD (2000) billion at PPP) | 306.1 | Coal (thousand tonnes)—proved | 458 |
| GDP (USD (2000) per capita at PPP) | 3 220 | Uranium | — |

Sources: a. DOE (2011), EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in 2011 reached 38 553 kilotonnes of oil equivalent (ktoe), a 2.4% decrease from the 2010 supply level of 39 494 ktoe. Of this total, 55% was contributed by indigenous sources; the remainder was imported. Geothermal and other renewable energy resources accounted for 38% of the total primary energy supply, while oil and coal, which are largely imported, contributed 33% and 20%, respectively.

Fossil energy

While the economy's total primary energy supply decreased in 2011, its net imports increased modestly by 2.1% from the 2010 level of 17 734 ktoe. This might be explained by the increase in both oil and coal imports due mainly to non-production in the Galoc oil field during the early part of the year and a need to meet the increasing demand of coal power generation as well.

Likewise, domestic coal production increased modestly by 3.5% in 2011 from its 2010 level, which remains to be attributed mainly in the improvement in production by the economy's major coal producer, the Semirara Mining Corporation.

To help meet the economy's fuel requirements, the Philippines imports 45% of its total energy supply. Of the net imported fuels, more than 70% was mainly comprised of oil and oil products, and the remaining percentage was from coal and biofuels.

Renewable energy

Renewable energy sources have a significant share of the economy's total primary energy sources, accounting for 37% of the total in 2011. Geothermal continues to be the major indigenous renewable energy source of the economy, representing 39% of its total indigenous primary energy supply in 2011 and being used solely for power generation. With a total installed capacity of 1 966 megawatts (MW), the Philippines remains the second-largest producer of geothermal energy in the world. As the economy aims to triple its capacity from the 2010 level, the government continues to encourage greater private sector involvement in the exploration and development of the economy's vast potential. Biomass and hydropower resources contributed a combined share of about 28% of the economy's total indigenous energy supply in 2011.

Electricity generation

The economy's total electricity generation in 2011 was 69 050 GWh, a meagre 2% increase from the 67 742 GWh in 2010. Its power requirements for 2011 were sourced primarily from coal-fired and natural gas-fired power plants, with shares of 37% and 29%, respectively. Electricity generated from other renewable sources, including geothermal—which ranked third in terms of the economy's power generation—and wind, solar and biomass increased by 10% during the same year. Unlike the previous year, electricity generated from hydro sources recovered with a remarkable 21% increase from the 2010 level of 7 803 GWh. Oil-based thermal plants, which provided more than 70% of the economy's total power requirements, declined by 1% in 2011.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|--------|------------------------|--------|
| Indigenous production | 21 838 | Industry sector | 5 930 | Total | 69 050 |
| Net imports and other | 18 100 | Transport sector | 7 789 | Thermal | 49 463 |
| Total PES | 38 553 | Other sectors | 9 323 | Hydro | 9 440 |
| Coal | 7 726 | Total FEC | 23 042 | Nuclear | – |
| Oil | 12 753 | Coal | 1 838 | Other | 10 147 |
| Gas | 3 473 | Oil | 11 296 | | |
| Other | 14 601 | Gas | 82 | | |
| | | Electricity and other | 9 826 | | |

Sources: (EDMC, 2013).

FINAL ENERGY CONSUMPTION

The total final energy consumption of the Philippines in 2011 reached 23 042 ktoe, a 2.2% decrease from the 2010 level of 23 559 ktoe. The ‘other’ sectors accounted for the largest energy consumption with a 40% share of the total energy demand in 2011. In terms of fuel, oil and oil products continued to be the major fuel consumed, accounting for almost half of the total energy demand. Energy demand sourced from electricity and others followed next with 43% share of the total. Meanwhile, despite the decreases in most of the fuels, natural gas use showed positive growth of 15% as compared to the previous year.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Department of Energy (DOE) launched the 2012–2030 Philippine Energy Plan (PEP 2012–2030) as the primary instrument in the realisation of the energy sector’s vision of achieving energy independence. The Plan aims to guide the country in creating a future with less carbon, in which energy efficiency is a way of life and the use of alternative fuels and renewable energy are seen as intelligent choices (DOE, 2012a). Specifically, the objectives of the Plan are as follows:

- expand energy access
- promote a low-carbon economy
- climate-proof the energy sector
- develop regional energy plans
- promote investments in the energy sector
- identify and implement energy sector reforms.

These policy objectives are supported by specific quantifiable targets to be achieved by the end of 2030, the most prominent of which include:

- triple renewable energy capacity by 2030
- achieve 90% household electrification by 2017 and 100% energisation at sitio level (an administrative-territorial category in the Philippines) by 2015
- have 30% of all public utility vehicles running on alternative fuels
- implement a higher blend of biofuels
- achieve 10% energy savings on total energy demand.

ENERGY MARKETS

Oil and Gas

The economy’s energy sector has aggressively pursued the exploration and development of indigenous oil and gas resources through the Philippine Energy Contracting Round (PECR). By the end of 2011, 27 service contracts (SCs) had been supervised and monitored by the Department of Energy, and 20 bid proposals had been received for the 12 prospective areas offered. In addition, in 2011, the government, through the DOE and its attached agencies, conducted investment road shows in Singapore, Australia, Italy and the USA. The economy has 16 sedimentary basins with a combined potential of 4 777 million barrels of oil equivalent (mmboe) and 689.8 million tonnes of oil equivalent (Mtoe) of oil and gas reserves.

In 2011, production from existing oil and gas fields yielded 2.3 million barrels of oil, 140.4 billion cubic feet (bcf) of gas and 5.1 million barrels (mmb) of condensate. The 26% decrease in oil from the 2010 level of 3.1 mmb can be attributed to the failure of the Tindalo Extended Well Test to produce oil at economic rates, resulting in the abandonment of the field at year end.

Malampaya remains the economy's primary source of gas and the largest producing gas field in the country, with an estimated daily production capacity of 10.48 ktoc (450 million cubic feet (mmcf)). Meanwhile, the Libertad gas field, with an estimated daily production capacity of 9.7 mmcf, is expected to be online by the end of the third quarter of 2011.

Coal

The economy is endowed with domestic coal resources that could be tapped for exploration, development and utilisation. There are 13 coal basins with a total resource potential of 2.4 billion metric tonnes. The largest resource potential is in Semirara, Antique with 570 million metric tonnes (mmt); the smallest is in Quezon with 2 mmt. Other coal basins are located in Cagayan Valley, Polillo-Batan-Catanduanes, Mindoro, Masbate, Samar-Leyte, Cebu, Negros, Surigao, Zamboanga, Davao, Cotabato and Sarangani. The economy's in-situ coal reserve is estimated at 438.7 mmt.

Indigenous coal production in 2011 reached 6.9 mmt at 10 000 BTU/lb., a slight increase from the 6.7 mmt produced in 2010. Domestic coal production in 2011 was the highest ever in the economy's history and represented around 47.0% of its total coal requirement.

Through the PECR, the DOE has supervised and monitored 38 prospective areas for coal as of December 2011, and has likewise awarded nine coal exploration contracts through direct negotiations.

MARKET REFORMS

Electricity

The current administration maintains its objective of providing greater access to energy as well as increasing retail competition as stipulated in the Electric Power Industry Reform Act of 2001 (EPIRA) (DOE, 2005). It strives to address power issues by spearheading continuing activities to ensure effective implementation of the Retail Competition and Open Access (RCOA), in coordination with its attached agencies, the ERC and PEMC

Meanwhile, privatisation of the remaining generating assets of the National Power Corporation continues with the ongoing bidding process for its power barges, thermal plants, hydro plants and other power plant facilities (DOE, 2012b).

Other privatisation accomplishments were:

- *Privatisation Proceeds.* As of April 2012, the total amount collected for privatisation of assets amounted to USD 5.612 billion. The total amount collected has been utilised for the prepayment of NPC loans, debt service of NPC regular loans as well as IPP obligations and payment of privatisation-related expenses.
- *Sale of Sub-Transmission Assets (STAs).* As of April 2012, the Transmission Corporation (TransCo) has signed 131 sale contracts amounting to about PHP 5.3 billion with 75 distribution utilities, electric cooperatives (ECs) and consortia. These sales cover an aggregate length of about 3 700 kct-kms of sub-transmission lines, about 33 000 sub-transmission structures and 850 MVA of substation capacity. Of the 101 sale contracts, 44 contracts with a total sale price of PhP2.22 billion have been approved by the ERC as of the April 30, 2012 posting in the ERC website. The fifty-seven (57) sale contracts are still for the ERC filing, evaluation or approval.

The economy's barangay (a village, district or ward, i.e. the basic political unit) electrification level rose from 99.89% as of end of December 2010 to 99.96% in April 2012. Among the major islands, both Luzon and Visayas have reached the 100% level of barangay electrification, while Mindanao still has less than 1% to reach 100% level.

In view of the Philippines' complex geographical system, the economy faces a continuing challenge in attempting to achieve 100% household electrification. Hence, the government, through the DOE and other energy stakeholders, spearheads the development of various innovative service delivery mechanisms designed to increase access to electricity services.

Oil

Under the Downstream Oil Industry Deregulation Act of 1998 (RA 8479), the Department of Energy was mandated to monitor the various activities of the downstream oil industry, including price levels, to ensure the continuous, adequate, and stable supply and fair price of oil products in the economy (DOE, 2010).

Demonstrating the effectiveness of the Act in the oil market, eight new oil industry companies were recorded in 2011, bringing the total to 1 200 producers with investments worth PHP 39.0 billion. To ensure product quality, the DOE conducted inspections and sampling of liquid petroleum products at 60 depots (1 200 gasoline stations and 1 400 liquefied petroleum gas (LPG) establishments) throughout the economy.

The DOE likewise implemented price mitigation measures, including regular meetings held with transport operators, drivers and consumers' groups to educate them in the market and provide them with updates on oil price movements. International prices are closely and continuously monitored to determine their estimated impact on domestic prices in order to ensure reasonable price adjustments.

ALTERNATIVE FUELS

The passage of the Biofuels Act of 2006 (RA 9367), was a major policy leap toward harnessing the economy's domestic alternative energy resources.

The introduction of alternative fuels in the Philippines provides a feasible option for minimizing the effects of continuous increases in the price of crude oil in the world market, and of worsening environmental conditions. In implementing the Act, the DOE, under its Biofuels Programme, accredited a total of 13 biofuel producers, nine for biodiesel and four for bioethanol, in 2011.

The biofuels programme of the Philippines hopes to create market awareness for alternative energy projects in collaboration with various industry stakeholders. In addition, as the transport sector accounts for the greatest share of demand in the economy's total consumption, it plans to pursue efforts to forge partnerships with academic and research institutions to conduct on-road performance and durability tests for a higher biofuels blend for vehicles.

In a related effort, the government's Natural Gas Vehicle Programme for Public Transport (NGVPPT), together with the private sector, has pushed for the use of compressed natural gas (CNG) buses. As of June 2011, there were 61 CNG buses plying routes in southern Luzon and Metro Manila. The government is currently supporting and working to facilitate the passage of the Natural Gas Bill to ensure this programme is successful.

In support of the DOE's campaign to promote the use of cleaner and alternative fuels, the Land Transportation Franchising and Regulatory Board granted incentives to operators using LPG and CNG-fed engines by giving them preference in applying for a franchise to provide public bus service, as well as an additional extension of two years to the maximum age vehicles are allowed to operate. As of 2011, there were about 19 052 taxis running on LPG and 229 LPG refilling stations spread over the three regions of the economy. The economy is pushing for wider utilisation of LPG from households to the transport sector, since LPG offers the same environmental advantages as other alternative energy sources.

ENERGY EFFICIENCY

As a way of hedging against the high cost of oil, the National Energy Efficiency and Conservation Programme (NEECP) is seen as an essential strategy in rationalizing the economy's demand for petroleum products and eventually lessening the impact of escalating prices on the economy. In 2011, the government enhanced the implementation of energy efficiency under its new campaign theme of "Bright Now! Do Right. Be Bright". The theme is designed to effectively promote and sustain the NEECP campaign programme, primarily to conserve energy and rationalize energy demand consumption (APEREC, 2011).

The NEECP contains a comprehensive set of measures that cover six sectors, namely: commercial and government buildings, industrial/manufacturing, residential, power, transport and agriculture. The NEECP consists of nine programme components across six sectors, including:

- Component 1: Social Mobilisation, Information, Education and Communication Campaign
- Component 2: Energy Efficiency Standards and Labelling Program
- Component 3: Government Energy Management Program (GEMP)
- Component 4: Energy Management Services/Energy Audits
- Component 5: Voluntary Agreement Programme
- Component 6: Recognition Award Programme
- Component 7: Fuel Economy Run Programme (currently part of the IEC programme; however, necessary to establish and generate significant data for a vehicle labelling programme in the future)
- Component 8: Locally Funded Projects that promote energy efficiency and conservation including:
 - Fuel Conservation and Efficiency in Road Transport (FCERT);
 - Power Conservation and Demand Management (Power Patrol)
- Component 9: Foreign Assisted/Technical Assistance. This component includes the following projects:
 - Philippine Industrial Energy Efficiency Project for the Philippines, a United Nations Industrial Development Organization-Global Environment Facility (UNIDO-GEF) that assisted and funded projects with the objective of introducing process system optimisation models in industrial manufacturing facilities; introducing and promoting energy efficiency projects using financing windows of local banks; and establishing a Philippine Energy Management System based on the ISO 50001 framework, through building capacity among industrial energy managers, local consultants and practitioners, and energy service providers (ADB, 2009).
 - Development Study on Energy Efficiency for the Philippines, a Japan International Cooperation Agency (JICA) technical assistance project aimed at the development of energy efficiency and a conservation policy framework for the country.
 - Philippine Energy Efficiency Project (PEEP)—a USD 31 million Asian Development Bank (ADB) loan by the Philippine Government to promote energy efficiency and conservation in households, government buildings, and public street lighting.

In addition, the DOE, in partnership with the Philippine Information Agency (PIA), spearheaded the coordination and execution of the new campaign theme's unveiling. The enhanced Information, Education and Communication Campaign (IECC), which aims to educate and empower Filipinos to be smart energy users, achieved a 4.56 mmbtoe or PHP 220 billion worth of energy savings in 2011.

As for the government energy management program, as of 2011 there were 590 government offices that had submitted fuel and electricity reports. Based on the consolidated reports, a total of PHP 1.8 billion in savings were achieved from September 2005 to December 2011. This is equivalent to a savings of around 206.9 GWh and 7.2 million litres in electricity and fuel, respectively. The energy audit services of the DOE also help companies and businesses across all energy consuming sectors determine their energy use patterns and identify energy conservation. In 2011, a total of eight buildings were audited and recorded an equivalent of 3.8 mmbtoe in energy savings.

To promote active energy savings and further efficiency in the private sector, the Don Emilio Abello Energy Efficiency Award (DEAEEA) was established. At the annual ceremony held on 6 December 2011, 59 industrial and commercial establishments, 33 energy managers and two

power-generating plants received honours for their significant contributions to the government's energy efficiency and conservation (EE&C) initiatives. DEAAAA generated an estimated aggregate energy savings of around 92 million litres of oil equivalent amounting to PHP 3.6 billion and CO₂ avoidance of 148 000 mt.

Another program, the Philippine Energy Efficiency Project (PEEP), has three key components: 1) Energy Efficiency in Government Buildings; 2) Efficiency Initiatives in Buildings and Industries; and, 3) Communication and Social Mobilisation. The project was able to accomplish the following in 2011:

- Completed retrofitting of 314 parklights in Burnham Park in Baguio City. Potential savings of 269 MWh/year (PhP 2.7 million annual cost savings)
- Completed retrofitting of 2008 streetlights in CDO. Potential savings of 782 MWh/year (PhP 6.2 million annual cost savings)
- Retrofitted of 159 traffic light intersections with LEDs. Potential savings of 5,043 MWh/year (PhP 50.43 million annual cost savings)
- Awarded installation of the LED SHS in 223 off-grid HH in Palawan, Antique, Davao del Norte and Aklan
- CFL Distribution; distributed 4,896,238 (under Lot 1)
- Retrofitting of government buildings; completed retrofitting of 35 buildings. Potential savings of 1,373 MWh/year (PhP 13.7 million annual cost savings).

With these programmes, the government is likely to save an estimated 27.48 MTOE of energy, which is equivalent to PHP 220 billion.

RENEWABLE ENERGY

The passage of the Renewable Energy Act of 2008 (RA 9513) further promotes the development, utilisation and commercialisation of renewable energy resources of the economy. The passage of this Act has also spurred investor interest in the development of renewable energy sources. At the end of 2011, the total installed electricity generating capacity from renewable energy sources stood at 5 391 MW. Of the total capacity, hydropower contributed the biggest share with 3 521 MW, of which 3 324 MW is grid-connected, while the remaining is off-grid. Geothermal is the second biggest contributor with 1 783 MW, followed by biomass with 117 MW. Biomass has its own distinct characteristics, typified by area-based or site-specific generating facilities due to the availability of resources. For solar, a total of 4.16 MW of off-grid installations are already providing electricity to communities not connected to the grid.

The Renewable Energy Portfolio Standards (RPS) has already been formulated and is currently under final review. The RPS is the minimum percentage of generation from eligible RE resources provided by the generators, distribution utilities and electric suppliers necessary in the application of FiT on a per technology basis. Initial installation target for RPS until 2015 covers the following:

- Solar– 50 MW
- Wind – 200 MW
- Biomass – 250 MW
- Run-of-river hydro – 250 MW
- Ocean – 10 MW.

NUCLEAR

In the Philippines, nuclear energy is among the long-term options being considered by the government for power generation, to curb the impact of energy imports on its economy.

In 2009, based on the recommendation of the International Atomic Energy Agency's Expert Mission in February 2008, an Inter-Agency Core Group on Nuclear Energy (the Core Group) composed of officials and staff from the Department of Science and Technology and the Department of Energy was created by a Joint Department Order. The primary mandates of the Core Group are: (a) to study the prospect of introducing nuclear power into the economy's energy system; and (b) to undertake or commission a feasibility study to determine whether the Bataan Nuclear Power Plant (BNPP) can be rehabilitated, and the attendant costs required. The Korean Electric Company conducted a feasibility study on the possible rehabilitation of the BNPP; its report is presently being validated.

As mandated, the Core Group has successfully conducted a series of regional IEC campaigns in the economy's key cities, including Metro Manila. The campaigns were aimed at addressing the benefits of nuclear technology applications in the Philippines, specifically in the areas of medicine, agriculture and research, as well as how nuclear safety and security are ensured by way of effective regulation. The possible benefits of harnessing nuclear energy for power generation were also discussed during the IEC campaigns.

The final objective of these IEC campaigns is the development of a Public Communication Plan for Nuclear Energy. The plan will emphasise and make it a priority to educate key policy makers in government, including legislators, as well as communities, the media, non-government organizations, religious groups, youth and academia.

While there are no legal impediments for the Philippine Government to pursue a nuclear energy programme, there are significant concerns which will have to be addressed in determining the economy's readiness for a nuclear option.

CLIMATE CHANGE

In October 2009, the Philippine Climate Change Act of 2009 (RA 9729) was passed, creating the Climate Change Commission. The Commission is a policy-making body attached to the Office of the President and tasked with coordinating, monitoring and evaluating programmes and action plans relating to climate change. Headed by the President, the four-member commission will have the same status as a central government agency.

Cognizant of its role in ensuring that policy and program mechanisms are in place to mitigate the impacts of global warming, the Department of Energy incorporated in the PEP 2009–30 a universal framework for showcasing a low carbon strategy. This will ensure the full-scale development and commercialisation of renewable energy and alternative fuels. The government will also intensify the use of natural gas, as it provides a structural change in the economy's energy mix, strengthens the economy's fuel diversification program and contributes to emissions reductions.

NOTABLE ENERGY DEVELOPMENTS

ENERGY REFORM AGENDA

In line with the launching of the 2012-2030 Philippine Energy Plan (PEP), the Department has placed on the drafting boards the regional energy plans for Mindanao, Visayas, and North and South Luzon to tailor fit the energy plans and programs to regional challenges and perspective. The plans will be developed in consultation with the respective Regional Development Councils (RDCs) and complement the regions' Regional Development Plans (RDP). By 2013, the Mindanao Energy Plan (MEP) will be presented to stakeholders in the six (6) regions of Mindanao for their comments and recommendations. The MEP will contain the policy and program framework for a sustainable solution to Mindanao's power supply problems (DOE, 2012a).

RENEWABLE ENERGY

In support of the Renewable Energy Act, the National Renewable Energy Program (NREP) serves as the economy's roadmap for renewable energy planning. Its long-term goal is to increase renewable energy-based capacity for power generation as well as its non-power contribution to the primary energy mix. The NREP seeks to increase the RE-based power capacity of the country to 15 304 MW by the year 2030, almost triple its 2010 capacity of 5 439 MW.

To achieve the goals of the NREP, the following will be done:

1. Institutionalize a comprehensive approach to addressing the challenges and gaps that might prevent and/or delay wider application of RE technologies in a sustainable manner; and
2. Outline the action plans necessary to facilitate and encourage greater private sector investments in RE development.

On an individual technology basis, the NREP intends to:

- Increase geothermal capacity by 75.0%
- Increase hydropower capacity by 160%
- Deliver an additional 277 MW in biomass power capacities
- Attain wind power grid parity with the commissioning of 2 345 MW of additional capacity
- Mainstream an additional 284 MW of solar power capacity and pursue the achievement of a 1 528 MW aspirational target
- Develop the first ocean energy facility for the economy.

The NREP is initially focused on the addition of RE-based capacity for power generation. The programme for non-power applications shall be incorporated later.

Last 27 July 2012, the Energy Regulatory Commission (ERC) has approved the initial Feed-in-Tariff (FiT) rates which shall apply to generation from RE sources as follows:

- Solar – P9.68/kWh
- Wind – P8.53/kWh
- Biomass – P6.63/kWh
- Hydro – P5.90/kWh.

Likewise formulated is the enabling rules for the Net Metering Program on RE, which was endorsed by the National Renewable Energy Board (NREB) to ERC on 20 April 2012. As provided by law, net-metering is a consumer-based renewable energy incentive scheme wherein electric power generated by an end-user from an eligible on-site RE generating facility and delivered to the local distribution utility (DU) may be used to offset electric energy provided by the DU to the end-user during the applicable period.

Further, guideline on the payment and collection of FiT Allowance has been submitted (April 2012) to ERC for review and approval.

PENDING ACTIONS

In support of various plans and programs of the government, the DOE has pushed for the passage of a number of relevant bills for the energy sector in both lower and upper houses to increase incentives for those engaged in all energy activities, thus enhancing private sector participation. Among the energy bills now pending in Congress that urgently need to be passed are:

- Energy Efficiency and Conservation Act

- Amendments to Republic Act No. 9 136 or the Electric Power Industry Reform Act of 2001
- Liquefied Petroleum Gas (LPG) Industry Regulation and Safety Act
- An Act Amending Republic Act No. 387, otherwise known as “The Petroleum Act of 1949 and Directing the Department of Energy to Provide for Pipeline Inspection, Protection, Enforcement & Safety, and Appropriating Manpower and Funds Thereof;
- Downstream Natural Gas Industry Development Act
- Draft bill on the amendments to PD 87 or the Oil Exploration and Development Act of 1972.

MARKET REFORMS

The economy will continue to push for market reforms to achieve a 90.0% household electrification level by 2017 and 100% sitio electrification by 2015. To achieve this, the government hopes to formulate the Household Electrification Development Plan and pursue the development and implementation of innovative service delivery mechanisms.

Ten years following the implementation of the EPIRA, R.A. 10150 was signed into law in June 2011, extending the implementation of the lifeline rate, which refers to the subsidized rate given to low-income captive market end-users who cannot afford to pay at full cost (DOE, 2011), for another ten years, unless further extended by law. However, there are reservations about the current lifeline rate implementation, specifically regarding how beneficiaries are identified and how much subsidy goes to those who are not really marginalized. With this in mind, the DOE is currently working with other government agencies, specifically the ERC and NEA, to review the current implementation with the objective of coming out with a more appropriate and feasible mechanism.

CLEAN TECHNOLOGY FUND PROJECT

In November 2009, the Philippine Government developed a business plan in agreement with the Asian Development Bank, the International Bank for Reconstruction and Development, and the International Finance Corporation. The plan is called the Clean Technology Fund (CTF) Country Investment Plan (CIP). The CIP is a proposal to use CTF resources in the Philippines, and includes a potential pipeline of projects and required resources.

The sectors considered for using the CTF fall into three subsectors:

- energy efficiency
- renewable energy
- urban transport.

However, the programmes proposed for CTF financing do not involve new technology. Rather, they involve technology that is readily available to the Philippines, but that faces institutional, regulatory, or cost barriers, especially upfront investment cost barriers, that must be overcome for replication and up-scaling.

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USEFUL LINKS

Asian Development Bank—www.adb.org
 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/

THE RUSSIAN FEDERATION

INTRODUCTION

With a land area of more than 17 million square kilometres, the Russian Federation is the world's largest economy. It is the only APEC economy located in both Europe and Asia, bordered by the Arctic and the North Pacific oceans. Its territory is characterized by broad plains west of the Urals, vast coniferous forests in Siberia, tundra along the Arctic seaboard, and uplands and mountains in the southern regions. The Russian Federation has a vast natural resource base that includes major deposits of coal, natural gas, oil and other minerals. Despite its land area advantage, the economy lacks an optimal climate for agriculture—most of its area has a continental climate, and is either too cold or too dry. Central heating is common for up to 6 to 8 months of the year, while cooling during the summer is not widely used.

According to EDMC (2013), from 1990 to 2009, the Russian population declined from 147.7 million people to 142.7 million people. However, from 2009 to 2012 there was an increase of 1.06 million people in total population to 143.3 from 142.7 million people. Shares of urban and rural population remain unchanged, at 74% and 26% respectively. Russia's average population density of only 8.4 people per square kilometre is very low, with the majority of the population living in the European part of the economy (Federal State Statistics Service (Rosstat), 2013).

The Russian Federation's economy continued to develop strongly, achieving 4.26% growth in 2011 and an average growth rate of 4.78% for the period 2001–2011. In 2009 the global economic and financial crisis affected the Russian economy, with the GDP declining by 7.81% in 2009 from the 2008 level. The recovery in 2010–2011 was driven by soaring world prices for oil and natural gas.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|------------------------------------|----------|--|-------|
| Area (million sq. km) | 17.1 | Oil (billion barrels) | 87.2 |
| Population (million) | 143.0 | Gas (trillion cubic metres) | 32.9 |
| GDP (USD (2000) billion at PPP) | 1 670.74 | Coal (billion tonnes) | 157.0 |
| GDP (USD (2000) per capita at PPP) | 11 687 | Uranium (kilotonnes of uranium metal) ^b | 181.4 |

a. Proven reserves at the end of 2012 (BP, 2013).

b. Reasonably assured resources (NE, 2010).

Source: EDMC (2013)

The Russian Federation's major industries include oil and gas production, petroleum refining, mining, iron and the steel, chemicals, machinery and motor vehicles industries. In particular, Russia maintained its place in the top three automobile markets in Europe, following Germany and the UK. Vehicle production in 2011 was 1.7 million units. The energy sector's output accounts for about 26% of Russia's GDP, which is more than 40% of the tax and custom duty payments and 30% of the total investment in the national economy, and is important not only to Russia's economic development but to the survival of its population during harsh winters.

In terms of proved reserves, in 2012 the Russian Federation holds 17.6% of the world's gas, 5.2% of its oil reserves, 18.2% of its coal reserves, and about 14% of its uranium ore reserves (BP,

2013). Even more resources remain to be discovered, but the formidable obstacles of climate, terrain and distance hinder their exploitation.

Russia's oil resources in the traditional oil producing regions are believed to be heavily depleted, with more than 50% of the economically-recoverable resources already produced. In the Urals and Volga regions, resource depletion is believed to exceed 70%. The share of remaining resources that are more complex to recover is constantly growing. Nearly 80% of Russia's oil production comes from large fields with remaining lives of 8 to 10 years. Newly developed resources are often concentrated in medium- and small-size deposits (ME, 2012).

Russia's gas industry is in a more favourable resource situation than its oil industry. The proved natural gas resources in Russia, estimated at 32.9 trillion cubic metres, should be adequate to meet both domestic market and export demands for the foreseeable future.

The remaining proved reserves of coal in Russia amount to more than 157 billion tonnes, or 18.2% of the world reserves. At current rates of coal consumption in the economy, these reserves should be sufficient for 800 years.

The refining industry in Russia includes about 30 major refineries with a total capacity for the primary processing of about 277.1 million tonnes of crude oil per year (ME, 2012).

Russia has the world's largest and oldest district heating system, with centralized 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, 2012).

In 2011, exports of crude oil, petroleum products and natural gas accounted for two-thirds of the total economy's exports. The Russian Federation holds leading positions in each of the world's energy markets: 40% of uranium enrichment, about 20% of natural gas trading, almost 20% of reactor construction, 15% of spent nuclear fuel conversion, more than 10% of crude oil and petroleum products trading, and about 10% of coal trading.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The Russian Federation's total primary energy supply in 2011 was 719 million tonnes of oil equivalent (Mtoe), comprising natural gas (54.4%), crude oil and petroleum products (22%), coal (14.7%) and others, including nuclear and hydro (8.9%).

By destination, more than 90% of Russia's total energy exports are directed to Western and Eastern Europe, including the Commonwealth of Independent States—CIS. To secure its future energy exports, since 2008 the Russian Federation has actively been diversifying its export routes towards regional markets in the Asia–Pacific region, aiming to deliver oil, natural gas and coal to China, Japan and Korea in East Asia, and to economies in North America.

The Russian Federation produced 512.39 million tonnes of crude oil and gas condensate in 2011. The oil heartland province of West Siberia accounted for about two-thirds of the total production. Refiners consumed 258.2 million tonnes of crude oil as feedstock, producing 249.0 Mtoe of petroleum products, including 36.7 million tonnes of gasoline and 70.3 million tonnes of diesel oil.

Oil exports reached 242 million tonnes of crude oil and 125 million tonnes of petroleum products. Prospective oilfields are onshore in the Timano–Pechora and East Siberia regions and offshore in the Arctic and Far East seas, and on the North Caspian shelf.

Natural gas production increased from 540.2 Mtoe in 2010 to 546.3 Mtoe in 2011. Net exports of natural gas in 2011 accounted for 154.1 Mtoe (113% of the 2010 level) or 28.5% of production. Nearly all natural gas exports were destined for Western and Central Europe, including Turkey, with small amounts piped to the Transcaucasian states. Huge but undeveloped reserves of natural gas are located in remote regions, where the lack of infrastructure prevents the start-up of upstream operations.

The Russian Federation produced 158 Mtoe of coal in 2011. Coal exports reached almost 90 Mtoe. From 2000 to 2011, the proportion of the total coal production volume that was exported increased from 17.1% to 46%, despite the fact that the main coal-producing areas (the Kuznetsky and Kanskó–Achinsky basins) are landlocked in the south of Siberia, some 4 000–6 000 kilometres from the nearest coal shipping terminal for the Atlantic/Pacific markets. Enormous prospective coal deposits have been found in even less-developed and more remote areas of eastern Siberia, south Yakutia and the Russian Far East.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|-----------|---------------------------------|---------|--------------------------|-----------|
| Indigenous production | 1 314 872 | Industry sector | 132 645 | Total | 1 054 765 |
| Net imports and other | –583 880 | Transport sector | 98 416 | Thermal | 710 912 |
| Total PES | 718 898 | Other sectors | 231 780 | Hydro | 167 608 |
| Coal | 105 580 | Total FEC | 462 841 | Nuclear | 172 941 |
| Oil | 158 565 | Coal | 19 908 | Geothermal and others | 3 304 |
| Gas | 391 354 | Oil | 116 248 | | |
| Others | 63 399 | Gas | 137 989 | | |
| | | Electricity and others | 188 696 | | |

Source: EDMC (2013).

The Russian Federation produced 1 055 TWh of electricity in 2011, of which 67.7% was from thermal power plants, 15.9% from hydropower and 16.4% from nuclear energy. Geothermal and others represent only 0.05% of the total electricity generation. The economic potential of hydropower is estimated at 852 TWh per year, but only 20% of this has been developed. The Russian Federation has enormous technical potential for renewable energy production, such as hydro and biomass in Siberia, wind along its Arctic and Pacific shores and geothermal in Kamchatka and the Kuril Islands. However, the use of this potential is constrained by the huge distances over which the renewable energy would have to be delivered to consumers.

FINAL ENERGY CONSUMPTION

In 2011, the total final energy consumption in the Russian Federation was 462 Mtoe, an increase of 3.8% compared with the previous year. By sector, industry accounted for 28.8%, transport for 21.2% and other sectors for 50.0%. By energy source, coal accounted for 4.4%, petroleum products 25.1%, natural gas 29.8% and electricity and others, including heat, 40.7%. Because of Russia's extremely cold climate, the most important energy use is for space heating, about one-quarter of the total final energy consumption.

The traditional energy-intensive industrial structure has been one of the major drivers of economic development. New measures to improve energy efficiency in existing industries, increase the share of less energy-intensive services, and improve the efficiency of the heat supply to the residential and commercial sectors will have a significant impact on energy policy. Estimates suggest that the Russian Federation has a huge untapped technical potential for energy savings, ranging from one-third to almost half of its total final energy consumption.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The adoption in August 2003 of the Energy Strategy of Russia for the period up to 2020 (IES, 2010) was a milestone in Russia's energy sector development. The strategy identifies the economy's long-term energy policy and the mechanisms for its realisation. A revised version of the strategy was adopted by the government in November 2009—the Energy Strategy of Russia for the period up to 2030 (Energy Strategy 2030) (IES, 2010). The new version of the strategy was updated to take into account new realities and priorities in the energy sector as affected by the global recession. The strategy is a framework within which more detailed industry-oriented medium-term and short-term programmes can be developed.

The strategic objective of Russia's external energy policy is to use its energy potential effectively to maximise its integration into the world's energy markets, strengthen Russia's position in those markets and maximise the benefits of energy resources to the economy.

To achieve this, Russia will implement a number of measures to improve the security of domestic energy consumption and energy export obligations, and will make efficiency improvements along the entire energy supply chain. This will include the development of new hydrocarbon provinces in remote areas and offshore. It will also include the rehabilitation, modernisation and development of an energy infrastructure, including the construction of additional trunk oil and gas pipelines, to enhance the economy's energy export capacity. Furthermore, to better integrate Russia into the world energy markets, export delivery markets will be diversified. At least 27% of Russia's total energy exports in 2030 are expected to be delivered to the Asia–Pacific region (IES, 2010).

Russia's nuclear energy industry remains a priority of Russia's development despite the Fukushima nuclear accident that occurred in Japan in 2011. Nuclear energy will comprise a larger share of the power generation domestically, while the industry as a whole will expand abroad. Russia will remain a key player in the practical implementation of improved nuclear fuel technology. Particularly and in spite of the existing programmes for renewable energy development outlined in the Energy Strategy 2030, the economic potential of renewable energy in Russia is low. Fossil fuels in Russia are so abundant that renewables have difficulty competing.

The Energy Strategy 2030 calls for a 40% reduction in the energy intensity of the economy by 2030 (IES, 2010). Lowering Russia's relatively high energy intensity (about 335 tonnes of oil equivalent per million USD PPP in 2009) needs to be one of the main objectives of Russian energy policy. Without significant progress in this area some industries may not be globally competitive, thus impeding Russia's economic development.

Perhaps the most important measures in the Energy Strategy 2030 are directed toward developing energy market institutions, such as fair pricing mechanisms and transparent trading principles, and making sure there is a sufficient energy transportation infrastructure. State participation in energy sector development will consist mainly of 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 to 2030, medium- and long-term programmes and industry-wide schemes are being developed. These include the Federal Program for Development of the Nuclear Industry to 2015, approved in October 2006, and the general scheme of electric energy objects placement—a scheme relating to electricity network infrastructure and electricity plant locations—to 2020, approved by the federal government in February 2008 and currently being amended to extend it to the year 2030.

On 12 April 2011, at a meeting of the Governmental Commission on the fuel and energy complex and development of mineral resources and the energy efficiency of the economy, a general scheme for the development of the oil industry up to 2020 was approved. This provides for the comprehensive development of all subsectors of the oil sector—exploration and utilisation of associated petroleum gas, crude oil and petroleum products, crude oil refining and transportation infrastructure.

The general scheme for the development of the gas industry up to 2030 was reviewed and approved on 11 October 2010 at the meeting “About the Master Plan for Gas Industry Development up to 2030” under Prime Minister Vladimir Putin. The document represents a complex project, which defines a path for Russian gas industry development in the long term. This strategic document covers all the components of the industry: exploration, drilling, production, storage and transport of gas supply to consumers of hydrocarbons and refined products.

In 2007, the federal government approved the East Gas Programme to develop natural gas fields and build extensive trunk gas pipelines in Eastern Siberia and the Russian Far East up to 2030. The programme also includes building export pipelines to the East Asian economies. Gazprom, the state gas monopoly and owner of the economy-wide gas pipeline system, is the coordinator of the programme and is responsible for conducting long-term sales contracts for natural gas deliveries.

In November 2011, the Ministry of Energy sent to the Russian Government the second phase development plan for the economy’s gas and petrochemical industry to 2030. The working group for this plan included relevant government authorities, industry representatives, research and consulting companies, and input from the people of the Russian Federation. The second phase includes an updated general plan for the development of key oil–gas investment projects, an updated programme for the positioning 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 the Russian Federation approved a long-term programme for the development of the coal industry to 2030. This document specifies the basic provisions of the energy strategy to 2030 relating to the coal industry. The main task of the programme is the realization of potential competitive advantages for Russian coal companies in the implementation of the long-term national energy policy.

Regarding energy policy formulation, the Federal Targeted Programme on Energy Saving and Energy Efficiency Improvement to 2020 (FTP) was approved by the government in November 2010. The draft General Scheme for the Natural Gas Industry Development to 2030 will be a major development stimulus for Russia’s energy sector, considering the soaring importance of the gas industry on the international stage and the importance of natural gas in the economy’s primary energy supply. In addition, the mid-term Scheme on the Unified Energy System Development is a tool to coordinate federal, regional, and local governments with private businesses and industry regulators. The scheme is amended on an annual basis and serves as a seven-year outlook for generation and transmission line projects. It includes an outlook for electricity demand by region, maximum loads, generation capacity reserves, power exchange, retirement of old facilities,

maintenance, retrofitting, and commissioning of new generation and transmission facilities with more than 5 MW capacity/110 KV and higher voltage, respectively.

LAWS AND REGULATIONS

The basic laws on specific energy-related industries are either being implemented or developed. This set of acting laws includes Subsoil (since February 1992), Price Control for Electricity and Heat Supply (since April 1995), Natural Monopolies (since August 1995), Production Sharing Agreements (since December 1995), Energy Conservation (since April 1996), Gas Supply (since March 1999), Power Industry (since March 2003), Nuclear Industry (since February 2007), Heat Supply (since July 2010), and Energy Conservation and Increase of Energy Efficiency (since August 2010). The latter is the logical extension of the Power Industry law, due to the fact that the major source of heat supply in the Russian Federation is from cogeneration plants (CHP), where electricity is a by-product of residential and industrial heat supply. However, while crude oil extraction and refining is an important industry in Russia, the draft of the oil law is still being developed in light of its international influence and the growing domestic economic and social challenges.

As a rule, the Ministry of Energy is responsible for issuing regulations and instructions, etc., to enforce the smooth implementation of the basic energy laws and to coordinate current economic development with long-term energy policy. Other major government institutions actively participate in the development and implementation of the regulatory framework regarding energy consumption and energy supply, and the export and import of energy. The major federal government institutions involved in the development and endorsement of Russia's energy policy and its regulatory framework include:

- Ministry of Energy
- Ministry of Natural Resources and Environmental Protection
 - Federal Subsoil Resources Management Agency
 - Federal Water Resources Agency
 - Federal Supervisory Natural Resources Management Service
- Ministry of Industry and Trade
- Federal Antimonopoly Service
- Federal Customs Service
- Federal Tariff Service.

ENERGY SECURITY

The Russian Federation considers issues related to energy security as 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, the Russian Federation has made a proposal to develop a Convention on International Energy Security that would cover all aspects of global energy cooperation, taking into account the balance of interests of all actors in the international market.

The infrastructure projects, including new oil and gas export trunk lines from the Russian Federation to its European and Asian markets, provide a solid contribution to improving 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 global energy security.

ENERGY MARKETS

MARKET LIBERALISATION

One of the main issues in the Russian Federation is the gradual move from state-regulated energy pricing to free market institutions for natural gas and electricity pricing. Coal and petroleum prices have already been fully liberalised. The federal government will keep control over 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). The Federal Tariff Service is authorized to set the maximum allowable regional tariffs for natural gas, electricity and centralised heat supply. One of the objectives of the Energy Strategy of the Russian Federation to 2030 is to complete the full liberalisation of domestic energy markets, where at least 20% of energy should be traded on commodity exchanges.

In December 2006, the government approved the liberalisation of natural gas and electricity prices to take place simultaneously in 2011, ensuring the smooth development of the natural gas industry and the restructuring of the power industry. The synchronisation of price liberalisation is important for both industries, as 70% of the thermal power plants' fuel mix is provided by natural gas, while more than 40% of total domestic natural gas consumption comes from the power industry. However, due to social issues, the regulated tariff for residential energy supply will remain until 2014.

The oil market in the Russian Federation has been deregulated since the 1990s, but crude oil and petroleum trading is not based on commodity exchanges. Most crude oil in the domestic market is traded on a term basis, in which prices are linked to international benchmarks. Petroleum is traded in irregular tenders, which allows producers to control the market. Regional petroleum storage plays an important role in establishing fuel markets. The government intends to make up to 25% of the compulsory purchases of the government's petroleum products supply by means of commodity exchanges, such as the St. Petersburg Oil Exchange established in late 2006. The Federal Antimonopoly Service has an element of control over oil and gas prices through its role in monitoring the market share of sellers, but it has no responsibility for regulating prices.

The government's control over coal pricing was removed in the early 1990s and the coal market was liberalised, with similar institutions to the crude oil and petroleum product markets.

Access to Gazprom's gas transportation system by independent producers, as well as the wholesale gas price system, is regulated by federal government decree. In August 2006, tariff regulations for new pipelines came into force, a move that was important for independent companies' access to Gazprom's pipeline system. In July 2007, new regulations for natural gas sales in the Russian Federation were introduced to create a net-back pricing mechanism for international gas markets; it included a schedule for contracted industrial gas prices that ran until 2011. Upper limits for tariff growth were set at 15% in 2007, 25% in 2008, 14% in each half of 2009 and 40% in 2010.

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 to 1 January 2014. However, independent gas producers provide about 15% of the natural gas produced in Russia; they do not fall under the price regulations and currently enjoy free contract prices. Regulated prices will remain for the residential and commercial sectors for some time, as the pace of tariff increases for such consumers should be lower than that for industrial users.

INDUSTRY RESTRUCTURING

Oil and gas

The oil and gas industry was privatised in the 1990s. However, the state still has a controlling stake in the major oil companies, crude oil and petroleum trunk pipelines, and it owns 50.002% of Gazprom's shares.

The oil sector is heavily controlled by the Russian Government and this control will increase after the state-owned Rosneft takeover of TNK-BP. The merger will create the world's largest listed oil company with a daily output of 4.6 million barrels in oil-equivalent terms (Reuters, 2012). As of 2012, the oil industry in the Russian Federation consists of nine large producing companies with more than 90% of the crude oil output, and more than 300 small-scale enterprises, along with operators of three production-sharing agreements. The refining sector consists of 27 large and more than 83 small refineries. After the merger of the crude oil and petroleum products pipeline companies Transneft and Transnefteprodukt, the state controlled 75% of the combined company's shares. Private oil pipelines do exist in Russia—the most important is 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 Russian Federation and in Siberia.

The federal government remains the key shareholder in the economy's gas monopoly, Gazprom, which is the extractor of 84% of the natural gas in the Russian Federation and owner of the economy-wide gas pipeline system. Independent companies produce the other 16% and supply about 25% of domestic consumers.

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 the Russian Federation 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 of 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 million tonnes in 2006. In July 2009, work began on the construction of BTS-2, which will be able to deliver 50 million tonnes to the new oil export facilities at Ust-Luga port on the Baltic Sea.

Refining volumes are expected to stay flat over the next decade, but quality will be a key issue. Gas developments are planned to increase the share of independent producers, i.e. other than Gazprom, from 16% in 2010 to about 30% in 2030. The Nord Stream pipeline is already under construction and should help to 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 at the Shtokman field and on the Yamal Peninsula, are considered an important means of delivering natural gas to international markets.

Coal

The Russian coal sector was restructured in the 1990s, and foreign participation in the sector is practically absent. Unlike the oil and gas sector, the coal industry has no large state-controlled company and is almost 100% privatized.

As of 2011, 228 coal enterprises operate in the Russian coal industry (91 mines and 137 open-pit mines), with a total annual production capacity of more than 380 million tonnes of coal. Coal processing is carried out by 51 processing plants and mechanical installations.

Industry development is based two-thirds on equity and one-third on loans. In recent years, there has been an active renewal of the fixed assets of the coal industry. There are no restrictions on

exporting coal, but the geographical size of Russia's vast economy requires coal be transported over long distances. Coal is the single largest commodity transported by Russia's railway network, accounting for almost 30% of its total freight.

Electricity

The Russian Federation started restructuring the power industry in 2000. Federal laws and federal 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 the Russian Federation 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, as far as installed capacity, asset value and average equipment are concerned. Each WGC has power plants sited in different regions of the Russian Federation 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 in charge of monitoring the long-distance power transportation market, in which the threshold is less than 20% of transmission line capacity per company. The wholesale power market infrastructure includes the following organizations:

- Non-profit Partnership Administrator of Trading System
- System Operator – Central Dispatch Administration of the Unified Energy System
- 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 purposes of NP ATS are to organize 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, to the wholesale power market, ensuring the execution and closing of transactions and the fulfilment of mutual obligations. The System Operator with 100% state ownership exercises technological control within the power grids and provides dispatching services to wholesale market participants. The Federal Grid Company, which was established in 2002, with 77.7% state control, owns and operates the transmission lines, provides consistency of technological management and is responsible for the reliability of power transmission services.

In monetary terms, the market shares needed to maintain the system's power reliability are 48% of electricity sales, 47% of power sales and 5% of services sales.

The free electricity trading market (one-day forward) was launched in November 2003 within the framework of the Federal Wholesale Electricity Market (FOREM). In September 2006, the regulated sector of the wholesale market was replaced by a system of contracts to be concluded between the buyers and sellers of electricity and electric power. In the FOREM, power generators and importers sell electricity and power to guarantor suppliers and distribution companies, as well as to large consumers and exporters. In the distribution market, guarantor suppliers and distribution companies sell electricity and power to end-use consumers in the residential, commercial and industrial sectors.

Since 2008, the share of tariffs established by the regulatory asset base methodology for distribution grids has been increasing. It is expected to become the major method for calculating

middle-term tariffs. The methodology is regarded as transparent and provides incentives for investors to rehabilitate and improve the operations of the energy service companies.

Heat supply

Residential and commercial heat supplies have important social implications and are a major concern for local governments in the Russian Federation. Historically, the heat supply industry was subsidised by local budgets and thus has room 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 enormous 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 February 2007, a 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 those materials are still under state control.

In April 2007, a single vertically-integrated, state-owned nuclear energy company was established. The new corporation—AtomEnergProm (AEP)—includes 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 the Russian Federation, 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 for and slows the performance of air transportation services. Further modernization of air and rail transport is planned in connection with Russia's programs for hosting the 2014 Winter Olympic Games, the 2018 Football World Cup and the 2020 World Expo.

The total length of Russian roads in 2009 was 982626 kilometres (km), 79% of which were paved. The country had only 30146 km of high-speed divided highways connecting big cities (GKS, 2012). Further development of highways will be necessary if big cities are to be connected.

Russia has a state railway system with a total length of 85641 km, but only some cities have high-speed train services. Almost all towns in Russia, regardless of size, are served by regional bus services. Subway systems have been introduced in seven of Russia's major cities, and all cities have extensive city bus systems.

Russia's pipeline transport is underdeveloped relative to the potential oil and gas supply. The total length of the pipeline system in the economy was 232981 km in 2010, 167868 km of which was gas pipeline, 49240 km was oil pipeline and 15873 km was oil products pipeline.

FISCAL REGIME AND INVESTMENT

In 2007, dozens of oil and gas fields were decreed to be 'strategic' fields. Strategic status makes the hydrocarbon deposits inaccessible to foreign companies unless they establish joint project operations with Russian companies. Under the current regulations, strategic status is applied to oilfields with reserves larger than 70 Mt and gas fields with reserves larger than 50 bcm. In March 2009, regulations were adopted for the compensation of costs associated with the discovery and exploration of deposits under exploration licenses, the further development of which is prohibited due to their strategic status.

From January 2009, tax holidays from the mineral extraction tax for crude oil production in East Siberia were extended to areas north of the Arctic Circle, the Azov Sea, the Caspian Sea, and the Nenetsk and Yamal regions. In addition to the existing tax reductions for East Siberian oil, this creates favourable conditions for the development of new capital-intensive projects in remote areas that lack an energy infrastructure. From 1 January 2010, zero export duty was introduced for crude oil extracted from East Siberia oilfields to maintain a stable market for Russian crude exported eastward to the Asia-Pacific region.

A draft plan for a new tax regime was prepared in 2011 as a part of the development of the new Law on Oil. On 1 October 2011, a new tax regime for the oil industry called the '60-66' came into force in the Russian Federation. Under the new rules, the duty on oil exports decreased by 7.4% to USD 411.4 per tonne, and fees for light and heavy petroleum products were set at 66% duty on crude oil. For a number of fields in Eastern Siberia and the North Caspian, there will be a preferential export duty, which, as of October 2011, is set at USD 204.5 per tonne. A reduced duty on crude oil is achieved by changing the formula for calculating the duty. According to the norms of '60-66', from now on duty on crude oil will be at 65% and 60% of the difference between market price and a standard price of oil at a rate of USD 182.5 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. With the introduction of effective energy efficiency (EE) measures, it is estimated that the energy savings from improvements in Russia's energy intensity could exceed 300 Mtoe, including more than 160 Mtoe from the energy extraction, transformation and transportation industries alone.

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% in 2020, compared with 2005. The improvement of EE and energy savings has become one of the priority areas of the Energy Strategy to 2030.

On 23 November 2009, the federal government adopted a Law on Energy Conservation and Increase of Energy Efficiency to take effect from 1 August 2010. To supplement and make the new EE law more effective, about 40 sub-laws amending some existing laws and technical regulations were drafted. The new federal law sets a legal framework and targets for the use of energy resources in the Russian Federation by promoting the rational use of energy resources and alternative fuel resources for electricity and heat generation. The law introduces various measures to improve EE and energy conservation across all sectors of the economy. These measures include EE standards for equipment and buildings (including mandatory energy passports, EE labelling of goods and the compulsory commercial inventory of energy resources); improvements in EE monitoring (focusing on mandatory energy audits and the compulsory installation of metering systems); creating a single and unified interagency information network and analytical EE system; and other measures to help achieve energy savings (promoting energy service contracts, prohibiting incandescent light bulbs, introducing incentives and tax benefits for Russia's heavy industries to replace highly energy-inefficient machinery and equipment, and so on).

In addition to the new federal law, on 27 December 2010 the federal government adopted the State Program on Energy Saving and Energy Efficiency Improvement to 2020 (FTP). The Program will be carried out in two stages: from 2011–15 and from 2016–20. The energy intensity of Russia's economy is expected to decline by at least 7.4% by 2015 and 13.5% by 2020. In addition, the programme outlines measures to achieve the federal target of an 'at least 40%' decrease in the economy's energy intensity by 2020, compared to 2007, through the rational use of energy resources and other measures to encourage EE and energy conservation. These measures include the enhancement and coordination of federal, regional and municipal energy-efficiency and energy-saving programmes; the establishment of information dissemination, public awareness and the promotion of education initiatives; the introduction of financial measures to promote the efficient use of energy; and a 4.5% target for the share of renewable energy in power generation by 2020.

In accordance with the EE federal law and the Program, all regions are required to prepare their own respective regional programmes on energy efficiency improvements. The implementation of these programmes will be financed jointly by regional governments and the federal government.

On 22 December 2009, the government established the Federal Energy Agency within the Ministry of Energy. The Federal Energy Agency has 70 regional branches. Its key tasks focus on operating the federal EE and energy-saving information system; and administering, monitoring and coordinating efforts for the effective implementation of the EE law, the FTP and other measures for improving EE and energy conservation efforts in the budgetary, power generation, industrial and residential sectors of Russia's economy. In addition to these measures and policies for strengthening the EE legal framework, the federal government launched the following six pilot Presidential energy efficient projects in several regions:

- metering (installing metering devices and automation);
- EE in the budget 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;
- new energy sources (renewable and other non-carbon energy resources).

Upon their successful completion, these projects are expected to be applied across all regions. In addition, technical potential exists to save almost half of Russia's primary energy demand through energy conservation. However, a major impediment for businesses to improve their energy efficiency is the absence of appropriate financial mechanisms.

The regulatory framework described in the FTP on Energy Saving and Energy Efficiency Improvement to 2020, adopted in January 2011, estimates that the total investments into energy efficiency to 2020 will be approximately RUB 9.3 trillion (USD 320 billion), with 8% coming from governments and 92% from private investments. The economic effect of such investments up to 2030 is expected to exceed RUB 26.5 trillion (over USD 880 billion). Governments at different levels will provide more than USD 10 billion in guarantees on loans for businesses involved in activities to improve energy efficiency in either the industrial, residential or commercial sectors.

RENEWABLE ENERGY

The technical potential for renewable energy in the Russian Federation is estimated at 4 400 Mtoe per year, or almost eight times more than Russia's current total final energy consumption. However, the economic potential is much smaller (about 240 Mtoe/year, less than 1% of the total electricity production). In 2010, renewable energy capacity totalled 2 200 MW; of this, less than 25 MW was hydro.

The government's policy goals and mechanisms to promote renewable energy were introduced in January 2009 through the federal government's order, The Basic Directions of a State Policy of Renewable Energy Utilization to 2020. Renewable energy is expected to provide 2.5% of the electricity in the Russian Federation in 2015 and 4.5% in 2020. The major mechanisms to increase the share of renewables are feed-in tariffs and subsidies for grid connection. The government is expected to develop regulations for feed-in tariffs and grid connection subsidies, for the compulsory share of renewable energy in the wholesale market to be purchased by electricity consumers, and for bringing together renewable energy generators, transmission lines and guarantor suppliers of energy.

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 renewable energy generators should not exceed 25 MW, and that owners should not be under bankruptcy proceedings. The ruling paves the way for financial mechanisms for renewable energy.

NUCLEAR

The Russian Federation holds important stakes in the international nuclear fuel market. All of the Russian, Commonwealth Independent States and Eastern European nuclear reactors are supplied by Tenex—the state company responsible for the nuclear fuel cycle business. In addition, Tenex meets 40% of the United States', 23% of Western Europe's, and 16% of the Asia-Pacific region's nuclear fuel requirements.

In the Global Nuclear Infrastructure Initiative, announced by the Russian Federation in early 2006, the Russian Federation 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 the 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 the Russian Federation 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 programme for the IUEC's expansion at Angarsk to 2015 was developed. The programme includes three phases:

- Use part of the existing capacity in cooperation with Kazatomprom and under the IAEA's supervision;
- Expand capacity with funding from new partners;
- Full internationalization with the involvement of many customer economies under the IAEA's auspices.

The Russian Federation also announced that guaranteed reserves of low-enriched uranium hexafluoride—the equivalent to two 1 000 MW reactor loads—would be created at the IUEC as a fuel bank available under the IAEA's control. The first phase of the capacity enhancement was scheduled for 2011, when 1 million separation work units were expected to be commissioned, with a target of 5 million expected to be achieved in 2017.

In November 2009, the IAEA's Board of Governors adopted a resolution supporting a Russian initiative to establish and maintain in the Russian Federation a stock of low-enriched uranium, and to carry LEU supplies for the IAEA member states. This was a breakthrough in the establishment of an international system guaranteeing reliable nuclear energy plant fuel supplies and lowering the risks of the proliferation of sensitive nuclear technologies. It is suggested that the stock will be managed by the IUEC and transferred under contract from the IUEC to the IAEA when an appropriate supply request arrives from the IAEA.

One major concern for world energy development is nuclear safety, which has become a key agenda item after the Fukushima accident in Japan. The Russian Federation has adopted the 'closed' fuel cycle, which includes spent nuclear fuel processing and the mandatory return of fissionable nuclear materials to the fuel cycle. To provide the legal framework for managing spent nuclear fuel and radioactive waste, the laws On Environmental Protection and On the Use of Nuclear Energy were amended in June 2010. Since 2007, expired contracts for depleted uranium hexafluoride enrichment/conversion have not been extended.

Rosatom's long-term strategy up to 2050 involves moving to inherently safe nuclear energy plants, using fast reactors with a closed fuel cycle and mixed oxide fuel. In the period 2020–2025, fast neutron reactors will 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 kWh. The prospects for future international cooperation in the nuclear energy industry are promising; the construction of 35 reactors in 15 economies is in the pipeline, and contracts have been signed for 19 reactors in seven economies.

For the next 20 to 25 years, three core reactor technologies have been chosen for nuclear energy development in Russia:

- water reactors, VVER type, and their modification and advanced development;
- sodium fast neutron reactors;
- high-temperature helium reactors.

CLIMATE CHANGE

In November 2004, the Russian Federation ratified the Kyoto Protocol. That decision confirmed Russia's strong commitment to addressing climate change and to working with the international community on dealing with this global problem. Ratification by the Russian Federation satisfied the '55%' clause and brought the Kyoto Protocol into force, effective from 16 February 2005.

The Russian Federation is considered to be the world's largest potential host for 'joint implementation' projects under the Kyoto Protocol. In May 2007, procedures for the approval and verification of Russia-based joint implementation greenhouse gas (GHG) reduction projects were adopted. Responsibilities were assigned for setting up and keeping the Registry of Carbon Units, thus paving the way for the implementation of GHG mitigation projects in Russia.

At the Conference of Parties 15 in December 2009, the Russian Federation pledged to reduce its GHG emissions by 25% from 1990 levels by 2020, a figure comparable to the targets of the European Union member states, and by 50% from 1990 levels by 2050. These emission reductions are contingent on these 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 greenhouse gas emissions caused by human activities.

In December 2012, the Russian Federation refused to endorse extended pollution limits under the Kyoto Protocol at the United Nation's climate change conference in Doha, since the biggest polluters—US, China and India have not joined it.

NOTABLE ENERGY DEVELOPMENTS

ENERGY EFFICIENCY IMPROVEMENT

Programme on energy saving and energy efficiency improvement to 2020

The main objective of the State Programme on Energy Saving and Energy Efficiency Improvement to 2020 is to reduce the energy intensity of the gross domestic product of the Russian Federation by 13.5%. This is expected to combine with other factors to provide an overall reduction of 40% in the energy intensity of the GDP in the period 2007–2020. Other expected results of the programme are savings of 330 bcm of natural gas over the life of the program, energy savings of 630 billion kWh, heat savings of 1 550 million Gcal and petroleum product savings of 17 million tonnes.

The programme also aims for a significant reduction in energy costs and to ensure the competitiveness and financial stability of the Russian economy, the provision of high quality energy services at affordable prices and the lowering of greenhouse gas emissions, thereby strengthening the health of the population. The funding of the program is split between RUB 70 billion from the federal budget, RUB 625 billion from budgets of the regions of the Russian Federation and RUB 8.8 trillion from extrabudgetary sources.

Gazprom has adopted the FTP on Energy Saving and Energy Efficiency Improvement to 2020, which should lead to a 1.2% annual decline in energy consumption by this giant energy company to 2020. Gazprom's current energy demand for natural gas extraction, processing and transportation is close to 10% of the total economy's extracted energy. The major share of improvements will come from measures related to its pipeline operations (estimations are up to 85%).

POWER MARKET DEVELOPMENT

The Ministry of Energy presented concepts for a programme of power sector modernisation for the period up to 2020. The central theme of the modernisation is to introduce new technologies, both domestic and imported, increasing the reliability of the electricity supply and energy security.

OIL AND GAS DEVELOPMENT

The oil sector is heavily controlled by the Russian Government and this control will increase after the state-owned Rosneft takeover of TNK-BP. The merger will create the world's largest listed oil company with a daily output of 4.6 million barrels in oil-equivalent terms.

The Russian Federation has continued dialogue with China on natural gas supplies. Both economies addressed the current status of the bilateral cooperation in the energy sector, placing an emphasis on issues surrounding the set-up of providing Russian gas supplies to China (Gazprom 2012). At present, gas supplies from Russia in the amount of 68 billion cubic meters are being discussed with China, and in the amount of 10 billion cubic meters with the Republic of Korea, while negotiations are ongoing with Japan. Meanwhile, Sakhalin LNG is being exported to the Asia-Pacific countries.

Gazprom and Japan continue to strengthen their cooperation. In 2012, the parties discussed the current status of and prospects for cooperation between the Gazprom Group and the relevant Japanese companies. The discussion also focused on progress in the construction of an LNG plant near Vladivostok, and emphasised the importance of successful cooperation between Gazprom and Japanese energy companies within the Sakhalin II project.

The Russian Federation and the Republic of Korea continue to discuss the terms of Russian natural gas supply to the Republic of Korea via the Democratic People's Republic of Korea. State controlled Gazprom and Kogas conciliate approaches to contract on Russian gas supply to Republic of Korea. Interest in the project has underlined the importance of reaching an agreement as soon as possible to secure efficient Russian gas supplies to Korea. As a result of creating a new Russian gas export centre within the Eastern Gas Programme, gas supplies from Russia to the Asia-Pacific countries may be comparable to or even exceed Russian gas exports to Europe.

In November 2012, the world's first shipment of LNG via the Northern Sea Route (NSR) took place. The carrier left the Port of Hammerfest, Norway, on 7 November and arrived at the regasification terminal in the Port of Tobata, Japan, delivering a Gazprom Group-owned LNG cargo to Japanese consumers. The successful voyage of the first LNG carrier will make it possible to supply Russian LNG to Asia-Pacific and the European market via the Northern Sea Route.

Gazprom will begin the second stage of the Eastern Gas Program, establishing a large gas production centre in the Republic of Sakha (Yakutia) with Gazprom's Management Committee adopting the final investment decision on the investment rationale for the Chayandinskoye field pre-development, transmission and processing of gas.

COAL INDUSTRY DEVELOPMENT

In January 2012, the Government Presidium of the Russian Federation approved a long-term programme for the development of the coal industry to 2030. The programme presupposes that by 2030, coal production will rise to 430 million tonnes across 82 pits and 64 mines, with a five-fold increase in the level of labour efficiency over the 2010 rate. Over the entire period of the programme, 505 million tonnes of new and modernized coal production capacity will be put into operation, while removing from operation 375 million tonnes of non-prospective and loss-generating enterprises. The realisation of this programme will lead to a reduction in transport expenditures and a rise in coal supply efficiency. The average distance required to haul the coal production supply will be reduced by 1.2 times, and by 1.4 times in the domestic market, and to reduce the impact of transport distances, local uses for produced coal will be developed.

The establishment of a number of energy technology complexes is also planned, which will allow the industry to address the complex development of coal resources, extraction and the use of methane. In general, coal production sites will shift to the East in conformity with accepted rates for forming new centres of coal production. Eastern Siberia's stake will rise from 25.8% to 32% by 2030, and that of the far east of the Russian Federation from 9.7% to 15.2%.

NUCLEAR AND RENEWABLE ENERGY DEVELOPMENT

The Ministry of Energy and Ministry of Regional Development have drafted a set of measures for the implementation of state policy in the field of efficient electric power generation, using renewable energy sources to 2020. Currently, the project aims at the harmonisation of relevant federal agencies. The Ministry of Energy has also prepared a draft programme for improvements in power generating facilities using renewable energy sources in the Russian Federation.

ENERGY SECURITY IMPROVEMENTS

The Ministry of Energy approved a joint statement of the Russian Federation and the International Energy Agency, agreeing on regular bilateral consultations. Those consultations will strengthen their collaboration in an effort to maximise the contribution of the energy sector in reconstruction and economic development, enhance energy security in the world, and reduce the environmental impact of energy production and consumption.

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USEFUL LINKS

OFFICIAL BODIES OF THE RUSSIAN FEDERATION

Structure of the Government of the Russian Federation—<http://government.ru/eng/power/>
 Ministry of Energy—www.minenergo.gov.ru/
 Ministry of Natural Resources—www.mnr.gov.ru/
 Federal Service on Ecological, Technological and Nuclear Supervision—www.gosnadzor.ru/

Ministry of Economic Development—www.economy.gov.ru/minec/main/
Federal State Statistics Service—www.gks.ru/
Ministry of Industry and Trade—www.minprom.gov.ru/
Federal Agency on Technical Regulating and Metrology—
www.gost.ru/wps/portal/pages.en.Main
Federal Antimonopoly Service—www.fas.gov.ru/
Federal Customs Service—www.customs.ru/en/
Federal Tariff Service—www.fstrf.ru/

ENERGY-RELATED NON-PROFIT AND STATE-OWNED BUSINESS INSTITUTIONS

AtomEnergoProm—www.atomenergoprom.ru/en/
Federal Power Grids—www.fsk-ees.ru/
Non-commercial Partnership of the Wholesale Power Market—www.np-ats.ru/
Gazprom—www.gazprom.ru/
Rosneft—www.rosneft.ru/
RusHydro—www.rushydro.ru/
Transneft—www.transneft.ru/
Transnefteprodukt—www.transnefteprodukt.ru

STATE ENERGY-POLICY-RELATED RESEARCH CENTRES

Institute of Energy Strategy—www.energystrategy.ru/
Centre for Energy Policy—www.cenef.ru/
Energy Research Institute of the RAS—www.eriras.ru/
Energy Systems Institute of the SB of RAS—www.sei.irk.ru/eng/index.htm

MAJOR ENERGY-RELATED MEDIA IN THE RUSSIAN FEDERATION

Official newspaper, *Rossiyskaya Gazeta*—www.rg.ru/
Central Dispatching Unit of the Fuel and Energy Complex—www.riatec.ru/

SINGAPORE

INTRODUCTION

Singapore is an economy situated in Southeast Asia, south of the Malaysia Peninsula between the Strait of Malacca and the South China Sea. In 2011, Singapore had a total land area of 714.3 square kilometres and a population of 5.2 million, of which 1.394 million were non-residents. Despite its small land area and population, Singapore is one of the most highly industrialised and urbanised economies in Southeast Asia.

Singapore is a highly developed and vibrant free-market economy. In 2011, its gross domestic product (GDP) increased by 5.2% from 2010 to USD 247.77 billion; per capita GDP was USD 47 797 (both in USD 2000 at PPP).

The services sector accounted for 69.0% of the overall value added to Singapore's GDP in 2011, with production of goods accounting for 26.6% and ownership of dwellings accounting for the remaining 4.4%. In 2011, the largest subsectors of the service industry were wholesale and retail trade, which accounted for 17.4% of the value added, with business services at 14.1% and financial services at 11.9%. Manufacturing in the goods production industry is Singapore's single largest economic subsector, accounting for 20.9% of GDP (SingStat, 2012).

In 2011, Singapore's exports were worth USD 514.74 billion; of this, 54.7% were domestic exports and the remainder were re-exports. The biggest category of exports was electronics (30.7%), followed by mineral fuels (26.6%), other machinery and equipment (15.0%), chemicals and chemical products (12.6%), and other manufactured goods, crude materials, food and beverage, and tobacco (the remainder). Most of Singapore's manufacturing output is exported (SingStat, 2012).

In spite of its lack of domestic energy resources, Singapore's shipping ports' intense activity, its growing role as a regional petroleum hub and supplier of equipment for the oil and gas industry, its emerging leadership in the biotechnology industry, in addition to its strategic geographical position, have contributed to making it one of the most thriving economies in the world.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves | |
|------------------------------------|--------|-----------------|---|
| Area (sq. km) | 714.3 | Oil | – |
| Population (million) | 5.2 | Gas | – |
| GDP (USD (2000) billion at PPP) | 247.77 | Coal | – |
| GDP (USD (2000) per capita at PPP) | 47 797 | | |

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Singapore's total primary energy supply (TPES) in 2011 was 20 587 kilotonnes of oil equivalent (ktoe). Singapore relies almost entirely on energy imports to meet its domestic energy needs. In 2011, the economy imported 41 468 ktoe of crude oil and 103 526 ktoe of petroleum products. Crude oil refined in Singapore's oil refineries produced 43 659 ktoe of petroleum products (EDMC, 2013).

Some 80.9% of the total petroleum products, both those imported and those produced in Singapore's refineries, were intended for export and international bunkers—the total exported or sent to bunkers was 83 770 ktoe. Natural gas supply grew by 0.5% between 2010 and 2011, to 6 605 ktoe, which was the smallest rate of increase after the 4.0% between 2009 and 2010. Petroleum product supply increased by 7.3% from the 2010 figures, to 27 586 ktoe, when oil supply slightly increased by 0.7% (EDMC, 2013).

In 2011, 45 994 gigawatt-hours (GWh) of electricity were generated, a 1.4% increase over the 45 360 GWh generated in 2010. Peak demand for electricity was 6 570 megawatts (MW) in 2011 compared with 6 494 MW in 2010. Singapore's power generation is based entirely on thermal power plants, with the exception of small photovoltaic installations connected to the grid. In 2011, the licensed power generation capacity of thermal power plants was 10 216 MW, three large combined cycle gas turbine (CCGT) power plants. In 2011, Singapore had residential and non-residential grid-connected solar photovoltaic systems installations with a total capacity of 5 938 kilowatt peak kWp—the power from a solar module with full solar radiation present—consisting of 305 kWp of residential and 5 633 kWp of non-residential capacity (EMA, 2013).

The fuel mix for power generation in 2011 was dominated by natural gas (78.0%), with some petroleum products (18.4%) and other fuels (biogas, waste & solar; 3.6%). The power generation reserve margin is in excess of Singapore's 30% minimum reserve margin for power system security (EMA, 2013).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|--------|------------------------|--------|
| Indigenous production | 120 | Industry sector | 8 478 | Total | 45 999 |
| Net imports and other | 67 809 | Transport sector | 1 523 | Thermal | 45 366 |
| Total PES | 20 587 | Other sectors | 2 445 | Hydro | – |
| Coal | – | Total FEC | 12 446 | Nuclear | – |
| Oil | 13 862 | Coal | – | Geothermal | – |
| Gas | 6 605 | Oil | 8 766 | Others | 633 |
| Others | 120 | Gas | 123 | | |
| | | Electricity and other | 3 556 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (FEC) was 12 446 ktoe in 2011, an increase of 0.6% from 2010 (12 368 ktoe). Petroleum products accounted for 70.4% of the energy used, electricity 28.6% and natural gas 1.0%. The energy consumption share by sector was: industry 68.1%, other sectors 19.6% and transport 12.2% (EDMC, 2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In 2010, the Economic Strategies Committee's (ESC) Subcommittee on Ensuring Energy Resilience and Sustainable Growth released a report recommending the following 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, will help diversify energy sources as it will allow 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 to make its energy markets more efficient, open new areas for economic development and strengthen energy security. Singapore is currently conducting an Intelligent Energy System (IES) pilot that is testing and evaluating smart grid technologies and related applications that will enable consumers to manage their electricity use more efficiently.
- *Strategy 3: Improve energy efficiency.* Energy efficiency (EE) underpins Singapore's efforts to reduce its energy and carbon footprint. Businesses and households can benefit from energy and cost savings through various EE measures. However, market barriers such as lack of awareness and limited financing schemes are impeding EE implementation and investments by businesses. To address these barriers and promote more efficient energy use among consumers, the Government administers several programmes coordinated by the Energy Efficiency Programme 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 will continue to invest in research, development and demonstration, facilities and manpower development as key enablers. This effort is through inter-agency collaborations on energy research, development, and demonstration (RD&D) such as the Energy National Innovation Challenge (NIC) and the Energy Innovation Programme Office (EIPO), and also through private-public partnership initiatives to enhance manpower capabilities for the power utilities sector.
- *Strategy 5: Pricing Energy Right.* Price signals influence energy consumption and investment decisions to achieve efficiency and conservation. Singapore does not subsidize 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.

Energy security

Natural gas has become the major fuel for electricity generation in Singapore. Four offshore natural gas pipelines supply Singapore's natural gas needs. The first gas pipeline, located in the northern part of the main island, was commissioned in 1991 and supplies 4.2 million cubic metres per day (150 million cubic feet per day (MMcf/D)) of natural gas from Malaysia. Senoko Energy Ltd (formerly known as Senoko Power Ltd) imports the gas from Malaysia for power generation plant. Since January 2001, the second pipeline, from the West Natuna gas field in Indonesia, has supplied 9.2 million cubic metres per day (325 MMcf/D) of natural gas. The third pipeline, from South Sumatra, Indonesia, started supplying gas to Singapore in September 2003, and the fourth pipeline, from Malaysia, started operations in 2007, supplying 3.1 million cubic metres per day (110 MMcf/D) of natural gas mainly for power generation. Keppel Gas Pte Ltd is the importer of the natural gas from the fourth pipeline.

PowerGas Ltd is the licensed gas transporter in Singapore that owns and manages the gas pipeline network for conveying natural gas and town gas. As the gas transporter, it provides open and non-discriminatory access to the gas pipeline network. PowerGas Ltd has appointed SP PowerGrid Ltd as the agent to convey gas and manage the gas pipeline network for and on behalf of PowerGas Ltd. SP PowerGrid Ltd is licensed by EMA as the gas transport agent.

With gas representing a large share of electricity production, the diversification of supply became an important issue. Following a feasibility study, the Singapore Government, in 2006, announced a plan to import LNG and build the first LNG receiving terminal to meet the rising demand for electricity and to diversify its sources of natural gas. The LNG receiving terminal was completed and commenced commercial operations on 7 May 2013. The LNG receiving terminal

has an initial capacity of 3.5 million tonnes per annum (Mtpa). This will increase to 6 Mtpa by 1Q 2014 when a third tank, a second jetty and additional regasification facilities are added. The terminal's throughput capacity will further rise to 9 Mtpa when the fourth tank and additional regasification facilities are constructed. The LNG receiving terminal is located at an approximately 40-hectare site on the south-western part of Jurong Island.

PowerGas Ltd, a subsidiary of Singapore Power, was appointed the developer of the LNG terminal in 2007. However, due to the difficulty of proceeding with the project on a commercial basis, the Singapore Government announced its decision to take over the development and ownership of the Singapore LNG terminal in June 2009. With this development, the Energy Market Authority (EMA) formed the Singapore LNG Corporation Pte Ltd (SLNG) to develop, build, own and operate the LNG terminal. On 8 February 2010, SLNG awarded the contract for the engineering, procurement and construction of Singapore's first LNG terminal. A decision was made to increase the design capacity of the LNG terminal to 3.5 Mtpa, with provisions to expand it to 6 Mtpa by 1Q 2014 when a third tank, additional jetties and regasification facilities are completed.

EMA appointed the BG Singapore Gas Marketing Pte Ltd (BG) as the aggregator of LNG demand for the Singapore market with the two parties signing an Aggregator Agreement in June 2009. BG will be responsible for supplying up to 3.5 Mtpa of LNG. Initial deliveries are expected to begin in when the LNG import terminal is completed (The LNG receiving terminal was completed and commenced commercial operations on 7 May 2013).

Beside the LNG terminal, Singapore has also 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. These "megafloat" platforms, coupled with the utilities and amenities support, will boost the Singapore industry's competitiveness in providing additional logistic capacity for the refining and petrochemicals, and oil trading sectors (EMA, 2012).

Moreover, Singapore has also initiated a project to build Southeast Asia's first underground liquid hydrocarbon storage facility that is called the "Jurong Rock Caverns," which is located at a depth of 130 m under the Banyan Basin on Jurong Island. This project can be used for other higher value-added petrochemical processes. Phase one of the project, when completed by 2014, has a storage capacity of approximately 1.47 million cubic metres (EMA, 2012).

Energy technology/R&D

Singapore's energy research, development (R&D) and demonstration strategies are motivated by two considerations: 1) to develop capabilities to support the clean energy sector as a key growth area, and grow a viable industry that will create jobs; and 2) to meet Singapore's energy challenges and its sustainable development objectives. EIPO, formerly known as the Clean Energy Programme Office, was formed in 2007 to develop the clean energy industry with an initial funding of SGD 170 million from the National Research Foundation (NRF). In 2011, another SGD 195 million was made available to EIPO to catalyse the growth of the industry, by strengthening research capabilities and accelerating commercialisation in the energy sector in the five-year period to 2015.

The EIPO has launched several initiatives, including the Clean Energy Research Programme, a graduate scholarships programme, and a Quickstart programme to nurture Singapore-based clean energy start-ups. Resources are being channelled into a variety of growth areas such as solar energy and other renewables, smart grids, green building, clean mobility and carbon capture and utilisation. Under the EIPO, the government has supported the establishment of Research Centres for Clean Energy. 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 photovoltaic (PV) electricity generation and energy-efficient buildings.

EIPO 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 programme 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 testbeds or commercialisation.

To meet the economy's long-term energy challenges, the government allocated SGD 300 million for 2011-2015 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.

ENERGY MARKETS

Electricity

Singapore began restructuring its energy sector in 1995 with the corporatisation of the electricity and gas industries as vertically integrated companies. Notable milestones since mid-1995 have included corporatisation and industry structural reforms, the creation of an institutional regulatory framework, and market rules for the contestable parts of electricity generation and retail, separate from the natural monopoly of electricity transmission at the ownership level. The Singapore Electricity Pool was established in 1998 to facilitate the trading of electricity between generation and retail companies in a competitive environment.

In 2000, the government undertook further reforms. It separated the natural monopoly or non-contestable part of the electricity market (that is, the electricity transmission and distribution grid) from the competitive or contestable parts (that is, power generation and retail) of Singapore Power Ltd. The electricity grid—PowerGrid Ltd (now known as SP Power Assets Ltd) and Power Supply Ltd (now known as SP Services Ltd)—remained under Singapore Power Ltd; the power generation companies Senoko Power Ltd and PowerSeraya Ltd would compete with one another and with other power generation companies in Singapore. The government also established an independent power system operator and liberalised the electricity retail market.

In April 2001, EMA was formed to regulate the electricity and gas industries and to promote competition in these industries. In 2003, the National Electricity Market of Singapore (NEMS) commenced operations. In the NEMS, generation companies compete to sell electricity at half-hourly intervals to the wholesale electricity market. The liberalisation of the retail market has been implemented in phases, with plans to open up the market to full retail contestability.

The final phase of retail market liberalisation (full retail contestability) is under review. This phase covers the remaining non-contestable consumers, mainly small businesses and household consumers—more than 1 million in number—that represent 25% of total electricity sales. EMA is continuing to study how best to introduce retail competition, which would leverage smart meter technology.

In June 2007, Temasek Holdings (Temasek) confirmed its plan to divest all three of its wholly-owned Singapore power generation companies—PowerSeraya Ltd, Senoko Power Ltd and Tuas Power—over the following 12–18 months. The sale of PowerSeraya Ltd in December 2008 concluded Temasek's divestment of its three power generation companies. It marked the completion of the transition to a fully competitive power generation market in Singapore, a process which began with the restructuring of Temasek's generating assets into three independent operating companies in 1995.

Gas

The restructuring of the gas industry began when the Gas Act (Act 11 of 2001) was passed in 2001. The Gas Act sets the legal basis for the separation of the contestable part of the gas industry, namely, gas retail and gas imports, from the monopolistic part, i.e. gas transportation. The gas transmission and distribution network will be owned by a gas grid company that will provide market players with open and non-discriminatory access to the network.

In January 2002, PowerGas Ltd divested its contestable businesses of gas import, production and retail. The manufactured gas production and gas retail business undertaken by City Gas Ltd and the natural gas import business undertaken by Gas Supply Ltd were transferred to Temasek Holdings. With this divestment, PowerGas Ltd became a gas transporter. Under the new gas industry framework, the transportation of natural gas will be regulated.

Singapore's newly restructured gas market became operational with the Gas Network Code (GNC) coming into effect from 15 September 2008. The GNC was developed and enacted by the EMA in consultation with industry players. The GNC's rules govern the activities of gas transportation, providing open and non-discriminatory access to Singapore's onshore gas pipeline network. The GNC outlines the common terms and conditions between the gas transporter (PowerGas Ltd) and those industry players who engage the transporter to transport gas through the pipeline network. To ensure the gas transporter is not in commercial conflict with common interests, PowerGas Ltd is banned from participating in those parts of the electricity and gas businesses open to competition, such as gas import, trading and retailing businesses. No other gas industry participant will be allowed to transport gas (EMA, 2008).

On 15 September 2008, Sembcorp Gas, which had diversified interests in gas transportation, import and retail businesses, exited the gas transportation business and transferred its gas pipelines to PowerGas Ltd, via a statutory transfer under section 98 of the Gas Act. The exit of Sembcorp Gas from the gas transportation business affirms PowerGas Ltd as the gas transporter monopoly.

The restructuring of the gas market is largely to support the liberalisation of the electricity industry by providing a competitive source of natural gas for electricity generation. The 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.

Transport

In the interests of fuel efficiency and conservation, Singapore promotes the use of public transport and has innovative policies to discourage car ownership and usage, such as a vehicle quota system and electronic road pricing. Since 2001, the government has offered a green vehicle rebate to encourage the take-up of green vehicles such as hybrid, compressed natural gas and electric cars. In January 2006, the rebate was increased from 20% of the open market value to 40% of the open market value, to offset the additional registration fee.

EMA and Land Transport Authority (LTA) co-lead a multi-agency Electric Vehicle (EV) Taskforce, comprised of members across different ministries and statutory boards, to testbed EVs in Singapore.

Launched on 25 Jun 2011, the testbed aims to evaluate the feasibility of using EVs in Singapore once the cost of EVs becomes commercially viable. Vehicular tax exemptions under the enhanced Transport Technology Innovation and Development Scheme (TIDES-PLUS), which aims to support automotive companies in knowledge-based manufacturing and R&D activities, are provided as an incentive for testbed participants. The testbed will be completed by the end of 2013. Data collection has ended on 31 Dec 2013 and a review of collated data is currently underway.

There are four EV models currently available under the EV testbed: the Daimler smart electric drive (ed), the Mitsubishi i-MiEV, the Renault Fluence Z.E. and the Nissan Leaf. Robert Bosch (SEA) Pte Ltd was appointed by EMA as the Charging Service Provider (CSP) to provide a nationwide charging infrastructure for this testbed. Other CSPs can set up an EV charging

infrastructure on a commercial basis, as long as they comply with the safety requirements prescribed by the Technical Reference (TR25:2010) for EV Charging Systems.

As of 31 December 2013, there are 89 registered EVs under the test-bed, involving 53 organisations. To cater to the charging needs of the EVs, 68 normal charging stations (full charge within 7-8 hours) and 3 quick charging stations (full charge within 30-45 minutes) have been deployed.

ENERGY CONSERVATION

The Energy Conservation Act (ECA) was passed in Parliament on 9 April 2012. It will be jointly administered by the Ministry of the Environment and Water Resources and the Ministry of Transport.

The ECA, which came into force in 2013, requires large users of energy to implement energy management initiatives. Companies which consume more than 15 GWh or 1.29 ktoe of energy annually will be 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 will also consolidate 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.

ENERGY EFFICIENCY

The Energy Efficiency Programme Office (E2PO), a multi-agency committee, promotes and facilitates the adoption of energy efficiency in Singapore under the following four strategic goals:

- Stimulate demand for energy efficiency
- Develop human and institutional capabilities
- Promote emerging energy-efficient technologies and innovation
- Profile and promote energy efficiency internationally.

The energy efficiency efforts are targeted at various sectors, such as power generation, industry, transport, buildings and households.

Power generation

The implementation of a competitive electricity market has enabled greater efficiency to be achieved in the power generation sector. Singapore's overall power generation efficiency improved from 39% to 44% over the 2001–12 period. This efficiency improvement was driven mainly by a move in the power generation mix from oil-based thermal plants to combined cycle gas turbines. The E2PO expects further improvements in Singapore's generating efficiency in the future, and it is promoting cogeneration and tri-generation in the economy.

Industry

Energy efficiency measures for industry include:

- *The Energy Efficiency Improvement Assistance Scheme (EASe)*. A programme to encourage and help 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*. A programme to encourage companies to invest in energy-efficient equipment. The Economic Development Board administers the Investment Allowance Tax Scheme, which is a capital allowance on qualifying equipment costs that allows a deduction against chargeable income.

- *Design for Efficiency Scheme (DfE)*. A programme introduced in 2008 to encourage 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)*. 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 programme and grant*. The programme provides a thorough understanding of the key energy issues facing the building and industry sectors. It helps participants develop the technical skills and competencies needed to manage energy issues of the organisations that they serve. A training grant is also offered to cover about 80% of the training costs.
- *Energy Efficiency National Partnership (EENP) Programme*. A voluntary outreach programme to assist companies in improving their energy efficiency and reducing energy wastage. The EENP promotes the adoption of energy management systems such as ISO50001 at the organizational 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 recognized through the EENP Award.

Transport

Singapore's land transport strategies are characterized by integrating transport and land-use planning, promoting the greater use of public transport and applying intelligent transport systems to manage road use. In addition, the Singaporean government has pioneered innovative policies such as a vehicle quota system and electronic road pricing to reduce congestion, a green vehicle rebate to encourage more fuel-efficient vehicles, and trials of green technologies such as diesel hybrid buses and electric vehicles.

- *Carbon Emissions-Based Vehicle Scheme (CEVS)*. Since 2001, a green vehicle rebate (GVR) was offered to encourage the adoption of green vehicles such as hybrid, compressed natural gas and electric cars. The government is planning a new Carbon Emissions-Based Vehicle Scheme (CEVS), which will adopt a broader outcome-based approach that takes into consideration vehicles' carbon emissions and fuel efficiency to encourage consumers to shift to low-emission models. This new scheme will replace the GVR scheme for cars and taxis from 1 January 2013.
- *Fuel Economy Labelling Scheme (FELS)*. From 2009, passenger cars and light goods vehicles that are sold in Singapore must be affixed with the Fuel Economy Label. With the fuel economy information, car buyers are able to make better-informed decisions on fuel efficiency when purchasing new cars.
- *Green Mark for Rapid Transit System*. The Rapid Transit System (RTS) is the backbone of Singapore's public transport system and is also the most energy-efficient means of transporting a large number of commuters. By 2020, the RTS network will be doubled to 278km. The objectives of the Green Mark for RTS framework are to promote sustainable and environmentally friendly RTS design, as well as to provide guidance in the formulation of engineering standards for conceptualisation, design and construction of new RTS lines. The framework has three key pillars—i.e. the effective use of energy, water conservation, and environmental protection and sustainable development—and covers various aspects of an RTS line (rolling stock, electrical & mechanical systems, civil works, station design, as well as operational considerations).
- *Trial of diesel hybrid buses*. LTA and public transport operators are collaborating on a trial of diesel hybrid buses. Diesel hybrid buses have been found to be effective in other cities in bringing down both the carbon emissions and particulate matter (PM) emissions of the bus fleet. If the trial is found to be successful, more of these diesel hybrid buses may be deployed in the future.

- *Facilitating Cycling.* Cycling does not consume external energy. To facilitate cycling as an alternative mode of transport for short-distance intra-town trips, programmes are progressively being rolled out to design and construct dedicated cycling paths in seven selected Housing Development Board (HDB) towns (Tampines, Yishun, Sembawang, Pasir Ris, Taman Jurong, Bedok, and Changi-Simei), as well as Marina Bay. More and better-designed bicycle parking facilities are being provided near MRT stations to help cyclists transfer to the public transport system for longer distance travel. Foldable bicycles are allowed on buses and trains during off-peak hours.
- *Park and Ride (P&R) Scheme.* The scheme allows people who have vehicles to park their vehicles at designated car parks located near an MRT station, bus interchange or bus stop, and continue their journey hassle-free by bus, MRT or LRT. The purpose of this scheme is to allow motorists to switch to the more energy efficient public transport for part of their journeys in a convenient way.

Buildings

Sustainable development remains a key national priority for Singapore. Energy efficiency is one of the main considerations for achieving a sustainably-built environment. To realise this vision, the Building and Construction Authority (BCA) and the National Environmental Agency (NEA) set out to accelerate the adoption of environmentally-friendly green building technologies and building design practices, and to encourage energy efficiency in buildings. Energy efficiency initiatives include:

- *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 programme and grant, is available to professionals who wish to build their careers as energy managers in the building sector.
- *BCA Green Mark Scheme.* The BCA Green Mark Scheme was launched in January 2005. This green building rating system promotes the adoption of green building design and technologies that improve energy efficiency and reduce the impact of buildings on the environment. Under the BCA Green Mark Scheme, buildings are assessed for energy efficiency, water efficiency, indoor environmental quality and environmental protection as well as other green features and innovations. In April 2008, the Building Control (Environmental Sustainability) Regulations 2008 took effect, requiring new buildings and existing ones undergoing major retrofitting with a gross floor area greater than 2 000 square metres to achieve the minimum Green Mark Certified level.
- *Green Mark Gross Floor Area (GM GFA) Incentive Scheme.* To encourage the private sector to develop buildings that attain higher tier Green Mark ratings (i.e. Green Mark Platinum or Green Mark Gold Plus), BCA and URA introduced the Green Mark Gross Floor Area Incentive Scheme on 29 April 2009 for a period of five years. For developments attaining Green Mark Platinum or Gold^{PLUS}, URA will grant additional floor area over and above the Master Plan Gross Plot Ratio (GPR) control.
- *Green Mark Incentive Scheme for New Buildings (GMIS-NB).* A sum of SGD 20 million was set aside for the Green Mark Incentive Scheme for New Buildings (GMIS-NB) on 15 December 2006 for a period of three years. The scheme offers cash incentives to developers, building owners, project architects and engineers who make efforts to achieve at least a BCA Green Mark Gold rating or higher in the design and construction of new buildings. The fund is 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 (GMIS-EB) 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 it 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% 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 will provide loans to building owners and energy services companies to enable them to carry out energy retrofits. BCA and participating financial institutions will commit to sharing the risk of any loan default. The pilot scheme takes effect from 1 October 2011 for a period of two years.
- *Higher Green Mark Standards for Land Sales Conditions at Strategic Growth Areas*. To achieve higher Green Mark standards (i.e. Green Mark Platinum or Green Mark Gold^{Plus}) for projects developed on government sales sites, the higher Green Mark standards will be set as part of the land sales conditions for all new developments in selected new strategic growth areas. This will ensure these land sales 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.

Households

Households account for about a sixth of the electricity consumed in Singapore. Households are encouraged to purchase energy-efficient appliances and adopt energy-efficient habits. Programmes for households include:

- *10% Energy Challenge*. To increase public awareness of ways to be more energy efficient, the 10% Energy Challenge was launched in April 2008. Households are taught 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 mandatory energy labelling scheme (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 that are sold in Singapore must be affixed with an Energy Label.
- In addition, minimum energy performance standards (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.* From 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

As part of its strategy to meet its energy policy objectives, Singapore is pursuing growth opportunities in clean and renewable energy, including biofuels and solar energy. Several renewable energy initiatives are underway to deal with the economy's energy challenges.

Singapore's modern, electricity-generating incineration plants make use of renewable waste-to-energy technologies, annually consuming about 2.7 million tonnes of waste (biomass and wastes), which generate about 200 MW of green energy from four incineration plants (Tuas IP 46 MW, Senoko WTE Plant 2 x 28 MW, Tuas South IP 80 MW, and Keppel Seghers Tuas WTE Plant 22 MW).

In terms of solar power, Singapore has embarked on R&D and test bedding initiatives to help companies and researchers advance the development of solar technologies. Singapore's test bedding efforts seek to improve the understanding of the best practices for optimising the performance of solar PV systems in tropical, urbanised environments.

- The Housing Development Board (HDB) has test bedded solar PV systems at two existing public housing precincts in Serangoon and Wellington, generating 220kWh of electricity per day for each precinct in the process. As of the end 2011, there were 120 grid-connected commercial solar PV installations with a total capacity of 5.6 MWp. There were also 36 households with solar PV installations connected to the grid, making up 0.3 MWp of capacity
- Under a solar leasing model a private company will design, finance, install, operate and maintain 2MWp 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.
- The Economic Development Board (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 as an alternative to rooftop-based installations.
- The "Handbook for Photovoltaic (PV) Systems" has been published by EMA and 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.

NUCLEAR

Singapore currently does not have a nuclear energy industry. In 2010, Singapore embarked on a pre-feasibility study of nuclear energy, to objectively evaluate the opportunities, challenges and risks involved with 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, are not suitable for deployment given that Singapore is small and densely populated.

CLIMATE CHANGE

Singapore is a small and highly urbanised city-state with no rural hinterland, accounting for less than 0.2% of global emissions. The economy has limited access to alternative, low-emission energy sources such as wind, hydro, biomass, geothermal and nuclear power, marking it as an alternative-energy disadvantaged city-state. However, as a responsible global citizen Singapore continues to play its part in addressing climate change by reducing emissions. Hence, in 2009, Singapore pledged in the context of the United Nations Framework Convention on Climate Change 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. 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.

NOTABLE ENERGY DEVELOPMENTS

SUSTAINABLE DEVELOPMENT BLUEPRINT

Singapore's Sustainable Development (SD) Blueprint was unveiled on 27 April 2009 by the Inter-Ministerial Committee on Sustainable Development (IMCSD). The SD Blueprint contains strategies and initiatives for achieving both economic growth and a good living environment for Singapore over the next 20 years.

It details new targets and initiatives to improve resource efficiency and to enhance Singapore's urban environment. Being more efficient 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 to live, 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 (consumption per dollar of GDP) by 35% from the 2005 levels by 2030, with an intermediate goal of 20% from the 2005 levels by 2020.

LNG TERMINAL CAPACITY INCREASE

The Singapore LNG Corporation (SLNG) announced that Singapore's LNG terminal on Jurong Island will have a third 180 000 cubic metre LNG tank, in addition to the two tanks already being built, by 1Q 2014. The terminal will have the capacity to handle up to 6 Mtpa of throughput. The terminal's throughput capacity will further be increased to 9 Mtpa when a fourth tank and its related regasification facilities are constructed. The investment in the fourth tank will give Singapore greater flexibility to meet its future gas needs and to pursue new business opportunities in the LNG market.

The increased storage capacity is expected to cope with the new demand and to act as a catalyst for new business opportunities. It will allow LNG traders to store and re-load LNG cargoes. International LNG traders have expressed a keen interest in using the LNG terminal for the trans-shipment of LNG cargoes throughout the region.

LNG

In March 2010, BG signed the first tranche of LNG gas sales agreements with six Singapore power generation companies. The initial volume of gas being sold is approximately 1.5 Mtpa for up to 20 years. BG will source LNG supplies for Singapore from its large, growing and diversified portfolio. It is envisaged that BG's proposed Queensland Curtis LNG facility in Australia will serve as one of the sources of supply for Singapore.

The power generation sector is expected to increase their uptake of regasified LNG from the initial tranche to about 2 Mtpa. Generation companies have either started or are planning to build more than 3 000 MW of Combined Cycle Gas Turbine (CCGT) capacity, comprising both new and repowered generating capacity, over the next few years starting from the second half of 2012. There is also keen interest by industrial companies outside the power generation sector.

START UP OF NExBTL RENEWABLE DIESEL REFINERY

In March 2011, the Finnish oil refining and marketing company Neste Oil opened its 800 000 tonnes per year renewable diesel refinery in Singapore, currently the world's largest of its kind. The refinery uses Neste's proprietary NExBTL technology to produce a renewable diesel

product superior to regular biodiesel and fossil-based diesel. Renewable diesel achieves a 40–80% reduction in greenhouse gas emissions compared to fossil-based diesel (Neste Oil 2010). Unlike biodiesel, which is produced by a process of esterification, renewable diesel entails catalytic hydrogenation that does not produce a glycerol side stream. The renewable diesel product is a clear and colourless paraffin, with a high cetane number (85–99).

BIOMASS CLEAN COAL COGENERATION PLANT

Currently, Tuas Power operates the Biomass Clean Coal (BMCC) cogeneration plant. It is 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.

NEW GENERATION CAPACITY

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 will make extensive re-use of the existing equipment and infrastructure and have entered commercial operation in 2012 (Senoko, 2012).

Keppel Energy secured financial closure in 2011 for its 2 x 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 have entered into commercial operation in 2013 (Keppel Energy, 2011).

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. Excess power will be sold to the power grid. Tuaspring signed a Water Purchase Agreement to supply the Public Utilities Board (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).

Keppel Seghers won the 25-year construct and operate contract for Singapore's fifth incinerator, which began commercial operations in October 2009. The plant can generate up to 22 MW of power for the national grid. It is the first incineration plant to be built and operated by the private sector. It is also smaller than its predecessors, with a capacity of 800 tonnes per day of solid waste. Previously all of Singapore's incinerators have been constructed and operated by the National Environmental Agency (NEA). The plant was built under the NEA's Public Private Partnership (PPP) initiative through a DBOO contract. With the operation of this incinerator, Singapore's waste incineration capacity is 3.28 million tonnes a year (Keppel Seghers, 2010). In addition, EMA is exploring the import of 600 MW of electricity from other economies (EMA, 2012a). With this, Singapore would be able to further diversify its energy mix by tapping into new energy options that would have been unavailable or economically unfeasible in Singapore, thereby reducing the demand for valuable land to build power plants.

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CHINESE TAIPEI

INTRODUCTION

Chinese Taipei, mainly formed by Taiwan, Penghu, Kinmen and Matsu, is a chain of islands stretching from Japan in the north to the Philippines in the south. With an area of around 36.2 thousand square kilometres, and located just 160 kilometres off the south-eastern coast of China, Chinese Taipei represents a natural gateway to East Asia. Although only one-quarter of the land is arable, the subtropical climate permits the multi-cropping of rice and the growing of fruit and vegetables all year round.

In 2011, Chinese Taipei's gross domestic product (GDP) was USD 717.5 billion, and its per capita income was USD 30893 (USD 2000 at PPP). GDP increased at an average growth rate of 3.87% from 2009 to 2011. Chinese Taipei's rapid economic development over the past decade has substantially changed the economic structure of the economy, shifting the emphasis from industrial production to the services sector. In 2011, the services sector contributed 69.1% of GDP, followed by the industrial sector (28.9%) and the agriculture sector (1.9%) (DGB, 2013). Chinese Taipei is one of the most densely populated areas in the world, but its rate of population increase has been relatively sedate. The economy's population of 23.22 million grew at a rate of 0.27% in 2011 compared with 2010. This was slower than the average annual population growth rate of 0.38% between 2000 and 2011 (EDMC, 2013).

Chinese Taipei has very limited domestic energy resources and relies on imports for most of its energy requirements. There is no coal reserve in Chinese Taipei, but the economy has oil and gas reserves of around 2.4 million barrels and 6.23 billion cubic metres respectively (EIA, 2013). In 2011, installed electricity generation capacity totalled 41.67 gigawatts (GW) (EIA, 2013).

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^b | |
|------------------------------------|--------|------------------------------|------|
| Area (sq. km) ^a | 36 189 | Oil (million barrels) | 2.4 |
| Population (million) | 23.22 | Gas (billion cubic metres) | 6.23 |
| GDP (USD (2000) billion at PPP) | 717.5 | Coal (million tonnes) | – |
| GDP (USD (2000) per capita at PPP) | 30893 | | |

a. DGB (2013).

b. EIA (2013).

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Traditionally, a lack of domestic energy and mineral resources has forced Chinese Taipei to import nearly all of its energy requirements, with imports accounting for 97.8% of its primary energy supply in 2012 (BOE, 2013a). The dependent nature of its energy supply systems has resulted in fragile energy security for the economy. Improving self-reliance with respect to energy supply is thus an important goal for energy security. In addition, Chinese Taipei's energy supply structure is highly dependent on fossil fuels such as coal, oil and natural gas. Its primary energy supply grew at an average rate of 4.1% between 1992 and 2012.

This growth has mainly been concentrated in fossil fuels such as coal, oil and gas, which have increased from 86.5% of the primary energy supply in 1985 to more than 89.8% in 2012 (BOE, 2013b). In 2011, Chinese Taipei's total primary energy supply was 107 622 kilotonnes of

oil equivalent (ktoe), a decline of 3.5% from the previous year. By fuel, oil contributed the largest share (46.3%), followed by coal (21.8%), natural gas (19.4%) and other fuels (12.5%) (EDMC, 2013).

In 2012, Chinese Taipei imported almost its entire crude oil requirements. The Middle East represents its major supplier, accounting for 80.8% of the total oil imports of a million tonnes of crude oil in 2012. To prevent supply disruption, the Petroleum Administration Act requires Chinese Taipei's refiners to maintain stocks of more than 60 days of sales volumes. Chinese Taipei also imported almost its entire coal requirement. Australia and Indonesia are its major suppliers, accounting for 81.6% of the total coal imports in 2012. In 2012, Chinese Taipei imported 64.63 million tonnes of coal. Most coal (72.8%) was used for power generation (BOE, 2013a; BOE, 2013c).

Since Chinese Taipei's natural gas resources are also very limited, its demand is met almost entirely by imports of liquefied natural gas (LNG). Malaysia, Qatar, and Indonesia are its major suppliers, accounting for 83.9% of the total natural gas imports in 2012. LNG imports in 2012 amounted to 12.49 million tonnes, a 4.43% increase from 2011 (BOE, 2013c).

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|-------|------------------------|--------|
| Indigenous production | 13 782 | Industry sector | 22564 | Total | 252169 |
| Net imports and other | 96691 | Transport sector | 12025 | Thermal | 196380 |
| Total PES | 107622 | Other sectors | 31239 | Hydro | 6902 |
| Coal | 36990 | Total FEC | 65827 | Nuclear | 42116 |
| Oil | 41591 | Coal | 6944 | Other | 6771 |
| Gas | 15532 | Oil | 37225 | | |
| Other | 13510 | Gas | 2378 | | |
| | | Electricity and other | 19280 | | |

Sources: EDMC (2013), BOE (2013b).

In 2011, electricity generation in Chinese Taipei reached 252,169 gigawatt-hours (GWh). Of the total electricity production, Taiwan Power Company's (TPC) hydro power comprised 2.7%, thermal power 47.7% (coal shared 26.9%, oil 2.9%, LNG 17.9%), nuclear power 16.7%, wind power 0.3%, cogeneration 15.8%, and independent power producers (IPP) 16.8%. In terms of the generating capacity, TPC dominates Chinese Taipei's electric power sector and IPPs account for 16.59% of the total capacity. IPPs are required to sign power purchase agreements with 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. Currently, two 1 350 MW Advanced Boiling Water Reactor (ABWR) units in the fourth nuclear energy project are under construction to boost electricity generation (EDMC, 2013; BOE, 2013a).

FINAL ENERGY CONSUMPTION

Final energy consumption in Chinese Taipei was 65 827 ktoe in 2011, 3.32% lower than in 2010. The industry sector consumed 34.3% of the total energy used, followed by the transport sector (18.3%). The other sectors, including residential and services consumed 30.9% of the total energy used. By energy source, petroleum products accounted for 51.4% of total final energy consumption, followed by electricity (27.6%), coal (11.3%) and gas (9.7%).

In 2011, energy used in the industry and transport sectors increased by 0.39% and 1.44% due to the global economic recovery, while energy consumption in other sectors decreased by 7.47% (EDMC, 2013).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Policy

The Bureau of Energy is responsible for formulating and implementing Chinese Taipei's energy policy. It is also charged with enforcing the Energy Management Law and the Electricity Law; regulating natural gas utilities and petroleum and liquefied petroleum gas (LPG) filling stations; regulating the importation, exportation, production and sale of petroleum products; maintaining an energy database; evaluating energy demand and supply; promoting energy conservation; implementing research and development programs; and promoting international energy cooperation.

The Bureau of Energy released the Framework of Taiwan's Sustainable Energy Policy in July 2008 (BOE 2012a). The framework includes:

- Policy objectives—to achieve a win-win-win solution for energy, 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—a cleaner energy supply and rationalised energy demand.
- Follow-up work—for government agencies to formulate concrete action plans which clearly set carbon-reduction targets, to build monitoring and follow-up mechanisms to regularly review the effectiveness and performance of the action plans, and to establish quantitative objectives for each task to measure its performance and to facilitate implementation.
- Targets for energy conservation: reduce energy intensity 20% by 2015 (based on 2005), with a further reduction of 50% by 2025 through technology breakthroughs and proper administrative measures.
- CO₂ emissions could drop back to the 2008 level between 2016–2020 and be further reduced to the 2000 level in 2025.
- A secure energy supply system to meet economic development goals.

Chinese Taipei established the year 2010 as the “Year for Energy Conservation and Carbon Reduction.” In order to push forward the Framework of Taiwan's Sustainable Energy Policy, Chinese Taipei has set up a Committee of Energy Conservation and Carbon Reduction in the Executive Yuan (the executive branch of government) as the highest authority for and monitor of the State Energy Conservation and Carbon Reduction Projects. The committee is chaired by the Vice Premier of the Executive Yuan with members from each ministry. The State Energy Conservation and Carbon Reduction Projects cover 10 major fields and 35 landmark projects to emphasize and implement key energy policies.

In response to the nuclear disaster in Fukushima, Japan in 2011, on 3 November 2011 Chinese Taipei released a New Energy Policy to “Ensure Nuclear Security, Steadily Reduce Nuclear Dependence, Create a Low-carbon Green Energy Environment & Gradually Move Towards a Nuclear-free Homeland”. The major strategies concerning nuclear power are (BOE, 2012b):

- Conduct a comprehensive safety examination of nuclear power plants to ensure nuclear safety;

- Steadily reduce nuclear energy dependence by actively reducing electricity demand and peak loads, and promote alternative energy sources to ensure a stable power supply;
- No extension to the life spans of existing plants, with the decommissioning plan launched as planned;
- Ensure the security of the 4th Nuclear Power Plant prior to its commercial operation;
- Early termination of operations at the First Nuclear Power Plant, if the two reactor units of the 4th Nuclear Power Plant continue to operate steadily up to 2016.

In April 2012, the Bureau of Energy also released an Energy Industry Technology White Paper. The white paper sets up a roadmap for the development of the energy industry. It addresses the important policies and strategies established in the Framework of Taiwan's Sustainable Energy Policy 2008, the conclusions of the 2009 National Energy Congress and action plans for the promotion of the green energy industry (BOE 2013d, BOE 2009).

Reducing its excessive dependence on conventional energy imports is crucial to enhancing the safety and stability of Chinese Taipei's energy supply. In order to secure the energy supply and meet demand in the future, in September 2012 Chinese Taipei released the "Key Strategy for Energy Development" (BOE 2013e). It re-addresses issues of security, efficiency and clean policies for the 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 via new technologies. High costs and the stability of supply are the two problems that remain to be solved through the development of new energy technologies. The development of accessible and affordable clean energy domestically has become a major challenge for technological research and will require new technology breakthroughs.

ENERGY SECURITY

As Chinese Taipei is almost completely dependent on fossil fuel imports, the government has been working to secure supply. To stabilise the oil supply, private oil stockpiling is expected to satisfy the Petroleum Administration Act's requirement that refiners and importers maintain 60 days of sales volumes (calculated from the average domestic sales and private consumption over the preceding 12 months). Using the Petroleum Fund to finance the storage of oil, the government is also responsible for stockpiling 30 days of oil demand. Under the Act, the LPG stockpile should be more than 25 days of supply (BOE, 2013a).

For many years, the Chinese Petroleum Corporation (CPC) has engaged in cooperative exploration with governments and large international oil companies under the name of the Overseas Petroleum and Investment Corporation (OPIC), in operations throughout the Americas, the Asia-Pacific region and Africa. Following the rising cost of oil in recent years, 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, CPC has engaged in international cooperation in exploration and development in the hope of discovering new reserves of oil and natural gas. By 2012, CPC had engaged with international oil companies in cooperative exploration in 22 fields in seven economies. Within Chinese Taipei, CPC continued to rejuvenate old oilfields, which delivered positive results by the end of 2012. CPC's drilling at several areas around the midsection and south part of Taiwan Island uncovered large amounts of natural gas, with 502 million cubic metres produced in 2012.

In its future strategic deployment, CPC will seek to create a more promising situation in overseas exploration and production by heightening the value of its existing overseas oil and gas field assets, establishing core areas with high rates of growth, participating actively in bidding for open blocks, seeking opportunities to take over fields from large oil companies, and pursuing opportunities for mergers and acquisitions in new oil and gas fields so as to add further reserves (CPC, 2013a).

ENERGY MARKETS

MARKET REFORMS

The Petroleum Administration Act has been amended to further liberalise the petroleum market. The government is coordinating with the relevant agencies to implement the amendments. Key progress at the end of 2012 included the following (BOE, 2013a):

- Two companies were granted petroleum refining business licenses, two companies were granted LNG import licenses, and 205 companies were granted gasoline and diesel wholesale licenses. A total of 1 685 oil import and export agreements were also approved in 2012.
- The number of gasoline refilling stations totalled 2 698 in 2012; the number of natural gas refilling stations totalled 60, reflecting the growth of LNG and hybrid vehicles.
- Twenty-five natural gas companies economy-wide provided natural gas to about 3.12 million users, including residential, business, service and partial industry customers. The market coverage rate was about 44.3%.

ELECTRICITY MARKETS

The Chinese Taipei Government aims to have a total electricity supply that provides a reserve capacity of 15% (BOE 2013a), 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. This kept the total electricity supply below the required reserve capacity between 1990 and 2004. Reserve capacity was only about 5% between 1990 and 1995. In 1995, to stabilise the power supply, Chinese Taipei's electricity market was opened to the IPPs when the reserve capacity fell below 16%. Electricity produced by IPPs is sold to TPC through TPC's transmission lines. TPC provided 66.6% of power generation capacity in 2012, with 17 % from IPPs and 16.4% from cogeneration plants.

In order to enhance the stability of the electricity supply, TPC continues to improve its transmission and distribution system. In 2012, the substation and transmission facilities that underwent retrofitting were 121 units of transformers, 308 transmission towers, 88.347 ckt-km of overhead transmission lines, 149.652 ckt-km of ground lines, and 47.613 ckt-km of overhead transmission lines that were changed to underground cables. In terms of the distribution system, the number of newly expanded feeders reached 500. At the end of 2012, the total number of feeders being automated reached 19,657(44.97% of the total coverage). These improvements are expected to greatly reduce the duration of forced power outages. The SAIDI (System Average Interruption Duration Index) was 19.05 minutes/customer-year and the SAIFI (System Average Interruption Frequency Index) was 0.298 freq./customer-year in 2012. Despite the increase in power supply from the south to the north, the line loss was controlled at a high standard of 4.42%. (TPC, 2013a, 2013b)

To comply with the schedule for privatising TPC and promoting the liberalisation of the domestic power market, the Ministry of Economic Affairs (MOEA) has completed a programme for the liberalisation of the electricity industry. Based on this programme, a draft amendment to the Electricity Act was submitted to the Legislative Yuan for review. The implementation strategy of liberalization included:

- The generator sector will be able to set up and sell power to consumers directly.
- An independent system operator (ISO) in charge of dispatching power will be set up.
- Transmission and distribution will not be operated by the public or private sectors.

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 state-owned CPC. Chinese Taipei also welcomes the participation of foreign investors in bidding in the IPP electricity market.

ENERGY EFFICIENCY

In 2012 the total energy consumption classified by sector are as follows: the energy and industrial sectors consumed 45.25%, transportation sector, 11.89%, agriculture, forestry and fishery sectors, 0.89%; services sector, 11.04%; residential sector, 10.88%, non-energy uses 20.05%. 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 to establish an energy development and utilization evaluation mechanism to foster gradual improvements in energy efficiency in newly constructed or expanded factory plants via advanced management mechanisms (BOE 2013a, 2013b).

In 2012, Chinese Taipei's energy intensity was 7.44 litres of oil equivalent per TWD 1000, a 21.7% reduction over the 2001 rate. This indicates Chinese Taipei's energy intensity has improved in recent years, but there is still room for the economy to improve its energy efficiency. Although Chinese Taipei's energy intensity is lower than most of the other APEC economies, it is still high compared with Japan, the EU and other advanced economies.

Major activities and achievements of Chinese Taipei as the economy sought to reduce its energy intensity and reach government targets included (BOE, 2013a):

- Carried out energy audits of the major energy users and helped them to set up internal energy auditing systems and reported the results to the government. A total of 4 685 high-energy users (3 261 manufacturers and 1 424 non-manufacturers) were audited by the government in 2012. The audits showed energy savings of 55 million litres of oil equivalent (MLOE) for the 3 261 manufacturers and 3.37 MLOE for the others.
- Established an energy service team and provided energy technology services to help energy users diagnose their energy systems and improve their energy efficiency. A total of 1.114 companies were visited in 2012, which potential energy savings of 18MLOE, with 9.1 MLOE being achieved.
- Since 2001, promoted the voluntary accreditation of high energy-efficient products and an energy labelling system. A total of 38 product categories were included in the energy labelling system, with 373 manufacturers and 6 639 brands gaining accreditation by the end of December 2012. In addition, more than 130 million labels were issued in 2012.
- Since July 2010, enforced a mandatory multi-level energy efficiency labelling mechanism. Four product categories were included in this first stage—air conditioning units, refrigerators, vehicles and motorcycles. Humidifiers were included from March 2011 and fluorescent lamps in July 2011. The programme was scheduled to be expanded to gas stoves and instantaneous gas water heaters in December 2012. There were 6 727 air conditioner models, 1 019 refrigerator models, 209 dehumidifier models and 1 585 CFL models for which mandatory energy label applications were completed in 2012.
- Chinese Taipei began to employ LED signalised traffic lights to replace existing incandescent traffic light from 2005. By the September 2011, all the traffic lights (about 700 000 sets of traffic lights across Chinese Taipei) had been replaced by the LED type. It is estimated that the energy saving from this move amounts to 247 million kWh per year. Another application of LED street lights was also promoted by Chinese Taipei to replace existing mercury vapour street lights from 2009. The power consumption of LED street lights is about half that of the mercury vapour street lights at the same lighting intensity.
- Two rounds of the Energy Efficient Appliance Rebate Programme have provided residents with a rebate of TWD 2 000 on each purchase of an energy-efficient appliance in 2012. It covers air conditioners and refrigerators with energy rating labelling grades of 1 or 2, energy conservation-labelled clothes washers, and TVs and monitors above 32

inches. The total budget is about USD 45 million. Through the rebate programme, the economy expects to save 387 million kWh per year, promote sales totalling TWD 36.6 billion, and maintain or create more than 200 jobs.

- Promoted energy service companies (ESCOs) by supporting the operations of the Taiwan Association of Energy Service Companies and the Taiwan ESCO Business Association. An office to promote the ESCO industry was established in 2006. A total of 87 projects were conducted under the Energy Saving Performance Contract (ESPC) mechanism by the end of 2011, with an average energy savings of up to 53.2% compared with the pre-improvement performance. Since 2010, Chinese Taipei has also expanded subsidies to cover the development of a low-carbon community.
- Continued to focus on technology research and development (R&D) programmes. The major programmes and achievements included (BOE 2013a):
 - Key technologies for smart energy-saving network systems: This program integrates energy management technology, sensing and monitoring technology and information communication technology to develop the key technologies, products and components for smart energy network systems. The technology can be employed in existing systems without changing any equipment to enable more flexible management of energy-efficient living environments and efficiency in the industrial manufacturing process. By 2012, this system was already employed in 1 245 convenience stores in Chinese Taipei and is ready for export or technology transfer to other economies. There are a total of 91 manufacturers involved in this area, with revenue at TWD 140 billion in 2012.
 - Air conditioning and refrigeration technology: This technology development involves the gradual integration of the capacities of different industries. It includes upstream magnetic materials and IC (integrated circuit) chips, middle stream motors, compressors, and inverter controllers, and downstream heat pumps, air conditioning and refrigeration products. R&D efforts have focused on patent ideas, prototype designs, manufacturing capabilities, and systems testing and analysis. The programme gradually established industry capabilities in inverter-fed technology and products, and improved the energy efficiency of air conditioning and refrigeration systems in Chinese Taipei. The major achievements in 2012 were:
 - Completion of the prototype testing of an inverter centrifugal chiller with a capacity of 500RT (refrigeration ton) using environmental refrigerant R-134a, achieving an target of COP (coefficient of performance) larger than 6.2 and integrated part load value (IPLV) COP larger than 9.7. Completion of the prototype testing of a centrifugal compressor water chiller with a capacity 80RT using magnetic bearings, achieving a target of COP equal to 5.3 and IPLV COP equal to 8.5.
 - Development of the first prototype of a CO₂ heat pump (employing its own CO₂ compressor) with COP = 4.25 at rated conditions and COP = 3.76 at winter condition.
 - Establishment of manufacturing capability and a key-components supply chain for inverter-fed air conditioning units (both single and multi-unit systems). The domestic parts for this unit comprise more than 90% of the total. The improvements mean that the new system exceeds Chinese Taipei's 2011 energy standards. This technology can also be deployed in DC inverter-fed cranes.
- Combustion and heat recovery technology: The key R&D effort here is to develop industrial energy-saving technologies and products to reduce energy consumption by and the environmental impact of the industry sector. It will also help the domestic industry to increase its global market competitiveness. The major achievements in 2012 were:
 - Development of oxygen-rich combustion technology and its use in heavy-oil combustion systems. This can reduce NO_x gases to lower than 200 parts per million and increase efficiency more than 10% due to the lower exhaust temperature.

- Completion of reliability testing for an inverter-fed air-fuel control system. The system can reduce the electricity consumption of a combustion system by up to 80%, compared with a traditional control system.
- Advanced lighting technology: The new generation of lighting systems emphasizes energy savings, environmental protection and user-friendliness. To respond to global developments in advanced solid-state lighting and to keep pace with domestic industrial development to exceed the current lighting limit, the R&D effort focuses on developing long-life LED lighting products and modules in a variety of styles. The objective is to replace traditional lighting systems, with their high levels of environmental pollution and energy consumption. The major achievements in this area in 2012 were:
 - Development of a smart lighting control system with a digital addressable lighting interface (DALI) mechanism. This offers a graphical user interface to allow effective and user-friendly operation of the lighting control system.
 - Establishment of LED testing and verification laboratories, including three National Voluntary Laboratory Accreditation Program (NVLAP) international accreditation laboratories, six Energy Star accreditation laboratories, and 10 Taiwan Accreditation Foundation (TAF) accreditation laboratories. There were a total of 22 Chinese National Standards (CNS) by the end of 2011, of which four are harmonized with international IEC standards. The standards cover LED chips, components, modules, systems and lighting fixtures.

RENEWABLE ENERGY

To effectively promote renewable energy and to respond to the requirements of the private sector for institutionalised incentive measures, in July 2009 Chinese Taipei passed the Renewable Energy Development Act. The essence of the Act was based on fixed feed-in tariffs and grid-connecting obligations to secure the market for electricity generated from renewable energy. The Act also proposed the subsidisation of photovoltaic systems, hydrogen energy and fuel cells. Because of the differences between the non-renewable electricity generating costs of power utilities and the renewable electricity feed-in tariffs, a fund was established to subsidise utilities when they produce or purchase renewable electricity.

Chinese Taipei has set an ambitious target and expects that 12 502 MW of renewable power generation units will be installed by 2030, of which 4 200 MW will be wind power units through the “1000 on-and off-shore wind turbines” project, and 3 100 MW will be solar power units under the “million solar roofs” project. It is expected that the power generation capacity from renewable resources will account for 16.1% of total power generation capacity by 2030 (BOE, 2012; BOE, 2013a).

PROMOTION OF RENEWABLE ENERGY INDUSTRIES

The main three green energy industries for renewable energy in Chinese Taipei are photovoltaic power, wind power and bioenergy. Chinese Taipei has chosen Penghu Island as a low-carbon demonstration site for the economy. The government’s major efforts to promote renewable energy industries in 2012 included the following (BOE, 2013a, 2013b, 2103f):

- The application of photovoltaic (PV) systems
 - After the Renewable Energy Development Act was passed in 2009, a feed-in tariff mechanism replaced the subsidies formerly used to promote renewable energy. The new mechanism has attracted more private sector investment to install PV systems. At the end of 2011, the total installed capacity was 222 MW with electricity generated reaching 173.1 GWh in 2012.

Chinese Taipei’s PV industry is based on crystalline silicon solar cell materials and components, combined with upstream semiconductor materials and downstream industrial power systems. In 2012, there were about 257 companies with a total revenue of about TWD132.2 billion. To increase the value and competitiveness of its PV industry

in the global market, the government has provided partial subsidies for the application of a building integrated photovoltaic (BIPV) demonstration system.

- The promotion of wind power systems

The development of a wind power industry is mainly for the domestic market. TPC and private wind-energy developers continued to develop onshore wind turbine systems. By the end of 2012, Chinese Taipei had installed 286 sets of wind turbines economy-wide, with a total installed capacity of 571 MW, and an annual output of 1.414 billion kWh of electricity. This is sufficient to supply electricity for one year to 357,000 households. For offshore wind energy, a demonstration incentive program was announced in July 2012. By the end of December 2012, Chinese Taipei had selected three companies to receive subsidies to build demonstrative offshore wind farms with a generating capacity of 300 MW by 2020. The output value of the wind farms when completed in 2020 will be TWD 48 billion.

- The promotion of a bioenergy

The bioenergy industry includes bio-diesel, bio-methane, and bio-heat and the power industries. Chinese Taipei has mandated an added 2% of biodiesel in its diesel for transportation vehicles from June of 2010. By the end of 2012, 11 companies were approved as qualified biodiesel manufacturers with a production of about 8.4 MLOE. The biodiesel industry mainly uses waste cooking oil as its raw material (BOE, 2013a). Chinese Taipei also has a demonstration project for adding 3% of methane to gasoline for transportation vehicles in major cities. There were a total of 14 gasoline stations that can provide bio-methane in 2012.

In addition to the application of biodiesel in the transportation sector, Chinese Taipei has a total of 822 MW of power generation capacity employing bioenergy or waste as the input fuel with a total electricity generation of 349 million kWh in 2011.

RESEARCH AND DEVELOPMENT PROGRAMS

The Chinese Taipei Government will continue to focus on technology R&D programs. The major programs and achievements in 2012 were (BOE, 2013a):

- The application of solar heating

Solar heating R&D priorities included continuous sputtering process performance, the small-scale development of solar thermal power generation systems, the design of large-scale solar hot water systems and optimisation, structural safety and anti-wind damage technology for solar water heating systems. The major achievements in 2012 were:

- A solar heat collection system with GPS and solar orbit-tracing mechanisms. Heat collection efficiency can reach more than 85% for power generation with a capacity of 300 W.
- The development of evaluation technology for large-scale solar hot water system designs.

- Photovoltaic technology

The R&D focus included the development of high-efficiency silicon solar cells and thin-film devices, next-generation silicon solar cells and modules, and dye-sensitized solar cell technology. An international verification technology for PV modules and facilities was also set up in 2012. The major achievements in 2012 were:

- New high-efficiency hetero-junction solar cells were developed through the integration of interface processing technology, a p-type amorphous silicon layer to enhance conductivity and optimisation of the transparent conductive layer to improve solar cell efficiency to 19% and modules to 16.9%.
- A new generation of thin-film solar modules, 150 μm thick, was developed that can achieve 18.9% efficiency.

- A prototype of dye-sensitized solar modules with glass substrate was developed with an efficiency of 8.5%, and one with a flexible substrate was also developed with an efficiency of 5.4%.
- A copper indium gallium selenide (CIGS) was developed using vacuum technology and slurry print production technology. The conversion efficiency of the CIGS using vacuum technology can reach 16%, while the module efficiency with flexible stainless steel sheets can reach 14.2%.
- Bioenergy
 - This R&D focus involved the development of key energy technologies, including microalgae oil production and biomass pyrolysis.
- Wind power
 - This R&D focus included the development of offshore wind power engineering technology and equipment, and the establishment of a comprehensive systems analysis and integration design capacity. Chinese Taipei also focuses on the requirements for product differentiation and energy security to develop specific projects for enhancing the global competitiveness of the local wind power industry. The major achievements in 2012 were:
 - Based on typhoon data from the APEC region and following the IEC specification to specify design loading conditions and parameters, a 5 MW wind power system simulation model was set up.
 - Evaluations conducted on the potential for off-shore wind power systems along the Taiwan Strait revealed that the potential for a depth below 50 m is around 57 GW, while the potential for actual development is about 7.4 GW.
- Fuel cell and hydrogen applications
 - To promote hydrogen and distributed power generation technologies, the first priority of R&D was the development of fuel cell applications using hydrogen, supported by advanced production and storage technologies for hydrogen. The major achievements in 2012 were:
 - Continue the life testing for a 3 kW fuel cell cogeneration system. The overall system efficiency is 78% with power generation at 32% and heat recovery at 43.9%. Cumulative testing time reached 8,087 hours as of the end of 2012.
 - Continue to put efforts into system integration for the application of fuel cells and enhancing capabilities for the development of key components, including the membrane electrode assembly, a gas diffusion layer/electrode, recombinant, etc. There were a total of 51 manufacturers with total revenue of about TWD 1136 million in 2012.

NUCLEAR

To diversify the economy's electricity generation mix, the government encourages the development of nuclear energy. At the end of 2010, there were three nuclear power plants with six units and a total installed capacity of 5 144 MW. The Fourth Nuclear Power Project, which is adopting two 1350 MW Advanced Boiling Water Reactor (ABWR) units, are still under construction. The units were supplied by GE-Hitachi Nuclear Energy Americas LLC (AEC 2013). There will be 7 844 MW of installed nuclear energy generation capacity in the near future. However, in November 2011, Chinese Taipei also established a no-extension policy for its existing nuclear energy power generation capacity, in response to the Fukushima Daiichi nuclear plant disaster in Japan that occurred in March 2011.

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 as a consequence is not eligible to sign the Kyoto Protocol or directly required to adhere to its emissions reduction requirements. Unlike UN member nations, Chinese Taipei is unable to conduct carbon emissions trading in the international market to achieve cross-border cooperation in carbon reduction, or to seek carbon reduction plans that are cost-effective. It is thus necessary for Chinese Taipei to seek alternative ways to reduce the impact of its carbon emissions (BOE, 2012a).

- In 2011, Chinese Taipei established the “Energy Conservation and Carbon Reduction Service Team,” which includes a “Technology Service Group,” an “Advocacy Group,” and a “Volunteer Group” to provide technology consulting services to all the energy users and the public. By the end of 2011, the Service Team had acted on 2 860 calls for assistance in the field, organized 198 training workshops and seminars, and answered 12 128 remote help calls via the telephone or internet.
- In 2008 and 2009, total CO₂ emissions showed negative growth for the first time in 20 years. Carbon intensity also showed a decrease of 3.55% for 2010 and 1.7% for 2011.
- The potential cumulative carbon emissions reductions were estimated to be 37.5 million tonnes/CO₂e with 17.8 million tonnes/CO₂e verified by the end of 2012.

Emissions from fossil fuel combustion are the major source of greenhouse gas (GHG) emissions in Chinese Taipei. The economy emitted 248.7 million tonnes of CO₂ in 2012, down 1.9% over 2011. This is a reflection of efforts by Chinese Taipei toward energy conservation and carbon reduction over the past couple of years. It also shows that the average growth rate of CO₂ emissions has slowed significantly in the past decade. CO₂ emissions grew 1.2% annually after the year 2000, slower than the economic growth rate (3.1% annually), and the economy’s CO₂ intensity has steadily declined since 2003. It appears that the rates of CO₂ emissions and economic growth have started to decouple in the economy over the past three years (2008–2010). To reduce the environmental impact of its development, Chinese Taipei must seek the most advantageous development objectives for the economy from among the various policies on environmental protection, industrial development and energy supply (BOE, 2013a).

PROMOTION OF LOW-CARBON ENERGY TECHNOLOGY AND INDUSTRY

Chinese Taipei has a developing green energy industry. However, if it is to respond to future developments and competition, it will need to gain full access to key and innovative technologies. Faced with fierce competition globally, the economy is strengthening its R&D and innovation capabilities so that it can master niche technologies and enhance the economy’s competitiveness. Chinese Taipei has been ranked sixth by the International Institute for Management Development in the area 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 focus from export processing (as in the past) to an industrial model that involves the aggressive development of key technologies. This latter focus 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 of 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 to promote the philosophy that value creation is worth more than production output.

To create an energy-efficient society and low-carbon economy, in 2009 Chinese Taipei selected seven green energy industries in which it sees development potential. These are based on

its existing IT industry and human resources. Of those seven green energy industries, the PV and LED lighting industries are regarded as the pillar. 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 373.1 billion in 2012 with a growth of 133% compared with 2008. Cumulative new investment from 2009 to 2012 was TWD 237.7 billion, with the creation of new employment opportunities for 65,100 people from 2008 to the end of 2011.

NOTABLE ENERGY DEVELOPMENTS

10th MEETING OF APEC ENERGY MINISTERS

The 10th APEC Energy Ministerial Meeting took place on June 24-25, 2012, in St. Petersburg, the Russian Federation. The event was attended by the energy ministers of the APEC economies, representatives of the Pacific Economic Cooperation Council (PECC), the Pacific Islands Forum (PIF) and the Association of Southeast Asian Nations (ASEAN). Minister of Energy of Russia Alexander Novak chaired the event. The meeting entitled “Energy Security: Key to Sustainable Growth” discussed energy security, energy efficiency and the development of the nuclear and gas industries.

During the meeting Chinese Taipei proposed an initiative that would focus on nuclear safety and severe nuclear accident protection in the APEC region. Despite the tragic accident at the Fukushima Daiichi Nuclear Power Station in March 2011, a number of economies recognize the importance of the safe and secure uses of peaceful nuclear energy to diversify their energy mix, satisfy growing energy demand and reduce greenhouse gas emissions in the APEC region. To ensure the safe uses of peaceful nuclear energy, economies that already have nuclear power programs should share expertise, knowledge and best practices at the request of economies interested in developing nuclear power programs. Particular attention should be given to strengthen cooperation between the interested member economies of APEC and the relevant international organizations, notably the International Atomic Energy Agency (IAEA) through its Action Plan on Nuclear Safety. Such cooperation includes sharing knowledge and experience on nuclear technologies and safety at nuclear power stations and related facilities to improve nuclear safety standards, and coordinate emergency response and preparedness mechanisms.

APEC EWG43 AND ASSOCIATED MEETINGS

EWG43 was held in Kuala Lumpur, Malaysia on 5-10 March 2012. Over those five days, three main meetings were organized including the 3rd Meeting of Low-Carbon Model Town Task Force, the APERC Workshop and the 43rd Meeting of the APEC Energy Working Group.

During the EWG43 meeting week, Chinese Taipei made two presentations that did the following:

- Outlined a comprehensive green energy plan that would include a low-carbon community, infrastructure development, energy smart buildings, and a Greenhouse Gas Reduction (GHG) Act. In addition, substantial wind and solar photovoltaic capacity would be added to the power grid.
- Reported on progress in developing the Energy Smart Communities Initiative (ESCI) and the Knowledge Sharing Platform (KSP) website, which had already been launched. EWG members were encouraged to visit the website and share their experiences.

APEC EWG44 AND ASSOCIATED MEETINGS

EWG44 was held in Washington, DC United States on 5-9 November 2012. Over those five days, three main meetings were organized including the 4th Meeting of Low-Carbon Model

Town Task Force, the Smart Grid Workshop and the 44th Meeting of the APEC Energy Working Group.

During the EWG44 meeting week, Chinese Taipei reported on its New Energy Policy, the promoting of the capacity building of green products market development, the development of renewable energy and future renewable energy programs.

MASTER PLAN ON ENERGY CONSERVATION AND GHG EMISSIONS REDUCTION

In May 2010, the Executive Yuan of Chinese Taipei approved the Master Plan on Energy Conservation and GHG Emissions Reduction. The targets of this master plan are:

- To increase energy efficiency by 2% per year and reduce energy intensity by 20% by 2015 and by 50% by 2025 (based on 2005 levels);
- To reduce CO₂ emissions to the level of 2005 by 2020 and to the level of 2000 by 2025.

This master plan will be implemented through action plans proposed by ministries that cover all aspects of Chinese Taipei's energy and climate policies. The action plans will be merged into Sustainable Energy Policy Action Plans and will be regularly reviewed together with other action plans under the supervision of the Council for Economic Planning and Development. The master plan has 10 landmark programs and 35 projects, which cover a legal framework, energy supply systems, industry, transport, architecture, technology and public education. Through the implementation of these action plans, Chinese Taipei expects to transform itself into a low-carbon society and create a sustainable low-carbon economy.

FINANCIAL AND ECONOMIC MEETINGS

In August 2012, the Executive Yuan of Chinese Taipei hosted a series of five meetings to discuss the current financial and economic situation and seek solutions for overcoming current problems. One of the meetings was focused on energy policy, and the major conclusions from that meeting were:

- Chinese Taipei should ensure the safety of nuclear power generation and slowly decrease dependence on nuclear power generation. However, stable and reasonable electricity prices should be kept in mind.
- Efforts should be made to develop new energy technologies for alternative power generation. The shift in power generation from high-carbon emissions to low-carbon emissions cannot be avoided. Aside from natural gas and renewable energy, clean coal technology (CCT) should be employed to solve the problem of carbon emissions from coal-fired power plants.
- A "Key Strategy for Energy Development" should be planned as soon as possible. The energy tax should also be discussed in greater detail through consultation with related stakeholders.
- Everyone should be aware of the importance of energy conservation and carbon reduction, and make contributions to this mission. The related issues, such as water recycling, carbon foot prints, ESCO, green and low-carbon industrial parks, clean coal and carbon reduction, energy security, etc., should be given first priority and a strategy and action plan created. The issue of green buildings and building materials can be incorporated into the "Green Energy Industry Promotion Programme".
- The promotion of smart grid technology should include smart generation, management, transmission and distribution. Low-voltage smart meters for residential use should also be gradually pushed forward.

2012 UNITED NATIONS CONFERENCE ON SUSTAINABLE DEVELOPMENT (Rio+20)

The United Nations convened the decennial United Nations Conference on Sustainable Development (Rio+20) in June 2012 in Rio, Brazil. This summit included participation by 188

countries, three observing members and 9,856 major groups. A total of 57 heads of state, 31 heads of government, 487 ministers and 45,000 people in all attended the convention, coming together to find resolutions for advancing global prosperity, reducing poverty, and promoting social equity and environmental protection. Two major themes were discussed: building a green economy to achieve sustainable development and lift people out of poverty, and creating an institutional framework for sustainable development.

Mr. Shin-Cheng Yeh, Deputy Minister of Environmental Protection Administration, led the Chinese Taipei's 35-member delegation comprised of government officials from the Ministry of Foreign Affairs, the Council for Economic Planning and Development and Industrial Development Bureau of the Ministry of Economic Affairs, Council of Agriculture, Forestry Bureau, Ministry of the Interior, Urban and Rural Development Branch and National Parks, and representatives from various industrial and academic organizations. The city governments of Taipei City, Taichung City, Tainan City, the Kaohsiung City Environmental Protection Bureau, the Environmental Quality Protection Foundation, the Taiwan Institute for Sustainable Energy Research Foundation, and the Taiwan Environmental Protection Union also sent participating members. Aside from attending Conference meetings, the delegation actively participated in side meetings and activities, and engaged in bilateral dialogue with numerous nations and international bodies (NCSO, 2013).

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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 a Southeast Asian economy with an area of 513 115 square kilometres and a population at the end of 2011 of about 66.6 million. Thailand shares borders with Malaysia to the south and with Myanmar, the Lao People's Democratic Republic and Cambodia to the north and east. In 2011, Thailand's GDP reached USD 470.9 billion (USD 2000 at PPP), a 0.08% increase from USD 470.5 billion in 2010. In the same period, GDP per capita decreased 0.18%, from USD 7 086 (USD 2000 at PPP) to USD 7 073 (USD 2000 at PPP).

At the end of 2011 Thailand had proved reserves of 442 million barrels of oil, 285 billion cubic metres of natural gas and 1 239 million tonnes of coal. Notwithstanding its resources, Thailand is highly dependent on energy imports, particularly oil, with more than 85% of its oil supply coming from imported stock in 2011 (DEDE, 2013)

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|----------------------------------|---------|------------------------------------|-------|
| Area (sq. km) | 513 115 | Oil (million barrels) | 442 |
| Population (million) | 66.6 | Natural gas (billion cubic metres) | 284.9 |
| GDP (USD 2000 billion at PPP) | 470.9 | Coal (million tonnes) | 1 239 |
| GDP (USD 2000 per capita at PPP) | 7 073 | | |

a. Proved reserves. Source: BP (2013).

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in 2011 was 104 254 kilotonnes of oil equivalent (ktoe), which represented an increase of 5.1% from 2010. Oil accounted for 43% of the total primary supply, while gas, coal and others accounted for roughly 38%, 8% and 10%, respectively. As most of Thailand's proved coal reserves are of lignite type with lower calorific values, imported stock is needed to meet energy demand for both electricity generation and the industry sector. In 2011, coal supply was 8 364 ktoe, down 8% from the previous year.

Natural gas supply in 2011 was 39 913 ktoe, a 10% increase from 36 307 ktoe in 2010. Although natural gas is mostly used for power generation in Thailand, its use is also promoted in the transport sector, as a replacement for conventional petroleum products such as fuel oil, diesel and gasoline. As world oil prices have increased in recent years, more industries have switched from oil to natural gas and Thailand has followed suit, increasing its reliance on imported natural gas, both in the form of piped gas and liquid natural gas (LNG). The Thai Government has an ambitious plan to diversify the economy's energy sources. Under the 3rd Revision of Thailand Power Development Plan (PDP2010), approved in 2010, renewable energy, nuclear power and coal (with clean coal technology) will be the main sources of energy diversification by 2030.

However, following the damage to Japan's Fukushima Daiichi nuclear plant after the earthquake and tsunami of March 2011, the Thai Government has faced serious opposition to nuclear power plants from its citizens, and thus construction of these plants is pending.

In 2011, total electricity generation was 159 518 GWh. Thermal generation, mostly from natural gas and coal, accounted for nearly all of the power generation (96%), with hydropower and others accounting for the remainder. In addition to its domestic capacity, Thailand purchased power from the Lao People's Democratic Republic and from Malaysia.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|---------|---------------------------------|--------|------------------------|---------|
| Indigenous production | 58 488 | Industry sector | 17 329 | Total | 159 518 |
| Net imports and other | 52 548 | Transport sector | 21 640 | Thermal | 138 817 |
| Total PES | 104 254 | Other sectors | 24 210 | Hydro | 5 537 |
| Coal | 8 364 | Total FEC | 63 179 | Nuclear | – |
| Oil | 45 222 | Coal | 6 479 | Other | 15 164 |
| Gas | 39 913 | Oil | 37 472 | | |
| Other | 10 754 | Gas | 6 414 | | |
| | | Electricity and other | 12 813 | | |

Source: EDMC (2013).

FINAL ENERGY CONSUMPTION

Thailand's total final energy consumption in 2011 was 63 179 ktoe, an increase of 2.5% from the previous year. The transport sector was the largest energy-consuming sector, accounting for 21 640 ktoe, or 34% of the total final energy consumption. The second largest consumer of energy was the industry sector, which consumed 17 329 ktoe in 2011, a decrease of 5.7% from 2010. By fuel type, oil accounted for a 60% share (37 472 ktoe) of the total energy consumption in 2010, followed by electricity and others (20%), coal (10%) and gas (10%).

Oil demand increased 5% from 35 853 ktoe in 2010 to 37 472 ktoe in 2011. Natural gas consumption significantly increased by 27%, mainly due to the economy's promotion of natural gas for vehicles. Coal consumption decreased significantly by 18% from 7 929 ktoe in 2009 to 6 479. Domestic electricity demand in 2011 remained the same with that of the previous year. The growth in demand was mainly due to increased consumption in the transport, residential and commercial sectors.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Energy's aim is to support sustainable energy management that will ensure the economy has sufficient energy to meet its needs. The Ministry is responsible for establishing energy security; promoting the use of alternative energy; monitoring energy prices and ensuring prices are at levels appropriate to the wider economic and investment situation; effectively saving energy and promoting energy efficiency; and supporting energy developments domestically and internationally, while simultaneously protecting the environment and mitigating climate change.

Organisations also responsible for energy include the following:

- Office of the Minister—responsible for coordination with the Cabinet, the parliament and the general public;
- Office of the Permanent Secretary—establishes strategies, translates policies of the ministry into action plans, and coordinates international energy cooperation;
- Department of Alternative Energy Development and Efficiency (DEDE)—promotes the efficient use of energy, monitors energy conservation activities, explores alternative energy sources, and disseminates energy-related technologies;
- Department of Energy Business—regulates energy quality and safety standards, environment and security, and improves the standards to protect consumers' interests;
- Department of Mineral Fuels—facilitates energy resource exploration and development;
- Energy Policy and Planning Office (EPPO)—recommends economy-wide energy policies and planning;
- Electricity Generating Authority of Thailand (EGAT)—the state generation enterprise;
- Petroleum Authority of Thailand (PTT) Exploration and Production (E&P) Public Company Limited and the Bangchak Petroleum Public Company Limited—two autonomous public companies;
- Energy Fund Administration Institute—a public organisation;
- Energy Regulatory Commission (ERC) and the Nuclear Power Program Development Office—two independent organisations.

The government's energy policy seeks to build an energy sufficient society; achieve a balance between food and energy security; build a knowledge-based society; promote Thailand's role in the international arena; and enhance economic links with other economies in the region to harmoniously cooperate in energy and other sectors.

Currently, Thailand's energy policy is based on the following five strategies: energy security, alternative energy, supervising energy prices and safety, energy conservation and efficiency, and environmental protection.

Energy security

The government's energy security policy is to intensify energy development for greater self-reliance, with a view to achieving a sufficient and stable energy supply. It will do this by advancing the exploration and development of energy resources at domestic and international levels; negotiating with neighbouring economies at the government level for the joint development of energy resources; developing an appropriate energy mix to reduce risks to supply, price volatility and production costs; encouraging electricity production from potential renewable energy sources, particularly from small-scale or very small-scale electricity generating projects; and investigating other alternative energy for electricity generation.

Alternative Energy

The government's alternative and renewable energy policy is to encourage the production and use of alternative energy, particularly biofuel such as gasohol—a mix of ethanol into gasoline in different percentages: E10, E20 and E85—biodiesel, biomass, solid waste and animal manure, to enhance energy security, reduce pollution and benefit farmers. It will do this by encouraging the production and use of renewable energy at the community level using appropriate incentive measures, and by promoting research and development in all forms of alternative energy.

Six strategies to achieve the policy under the current 10-year Renewable and Alternative Energy Development Plan (AEDP) 2012–2021 are:

1. Promoting the community to collaborate in broadening the production and consumption of renewable energy;

2. Adjusting the incentive measure on investment from the private sector to be appropriate to the situation;
3. Amending the laws and regulations that do not benefit renewable energy development;
4. Improving the infrastructure as system of transmission lines, power distribution lines, including the development of a Smart Grid System;
5. Public relations and building up comprehensive knowledge for the people;
6. Promoting research work as a mechanism to develop an integrated renewable energy industry.

Energy safety

The Thailand Government's energy safety policy is to improve service quality and safety in energy-related businesses, facilities, service stations and equipment. It will do this by promoting 'absolute zero accident' information; establishing Provincial Energy Offices (PEO) for the protection of energy consumers; establishing NGV quality standards to ensure safety, including the supervision of the installation costs of the NGV kits to ensure the costs are appropriate, fair and in line with economic conditions; and establishing an energy technology development institute, including procuring product-testing equipment, developing safety standards suitable for Thailand's energy businesses, and disseminating those safety standards to provincial areas and local administrative organisations.

The actions to achieve this include:

- Building the capacity of the PEOs so they can perform their duties efficiently, particularly the protection of energy consumers;
- Upgrading the Regional Energy Coordination Offices of the PEOs to Regional Energy Learning Centres, to create knowledge and understanding of the government's energy policies;
- Establishing quality and safety standards for the entire NGV business chain;
- Regulating the safe use of liquefied petroleum gas (LPG), by preventing the misuse of LPG and the transfer of household LPG for use in the transport sector, and ensuring the regulations have the least impact on taxis.

FISCAL REGIME AND INVESTMENT

Energy Prices

The government's energy price policy is to supervise and maintain energy prices at appropriate, stable and affordable levels. It will do this by setting an appropriate fuel price structure that supports the development of energy crops 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 is to supervise energy prices through market mechanisms to ensure domestic energy prices are stable, fair and affordable, and reflect the actual production costs. The energy cost for Thai people must not be higher than that in neighbouring economies. The government is supervising the pricing policies and price structures of oil, LPG and natural gas to align them with world market mechanisms and to reflect actual costs; ensuring fairness for the general public through the efficient use of the Oil Fund; and monitoring refining and marketing margins to maintain them at appropriate levels. For LPG and NGV, prices will reflect the resolutions of the NEPC and Cabinet, which will not place a burden on consumers. For ethanol and biodiesel, the EPPA is soliciting the Ethanol Producer Association and Biodiesel Producer Association for a more suitable pricing formula to monitor domestic ethanol and biodiesel prices.

Investment

The Government is keen to encourage competition and investment in energy businesses by creating a favourable environment for investment, transparent competition and internationally-accepted energy-related standards. It will do this by designating an agency, the Investor Relation Office, to be responsible for investment procedures and processes in the energy industry; and by creating a mechanism for a company to be a 'service company' in the operations and maintenance of the electricity industry, refineries, gas separation plants and both domestic and overseas oil and gas rigs.

ENERGY EFFICIENCY

Thailand 20-Year Energy Efficiency Development Plan (EEDP) was launched in 2011 with a target to reduce energy intensity, that is, EI (energy consumption/GDP) by 25% in 2030, compared with that in 2010, or equivalent to a reduction of the final energy consumption by 23.5% in 2030 or 38,200 ktoe. The EEDP sets the targets of energy reduction for major economic sectors including transportation, industry, commercial and residential sectors with six strategic packages and 16 specific measures as follows:

- The application of a number of combined measures, i.e. mandatory measures via rules, regulations and standards, and promotional and supportive measures via incentive provision;
- The introduction of measures that will have a wider impact in terms of raising awareness and changing behavior related to the energy consumption of consumers, including the decision-making behavior of business operators, as well as market transformation;
- Support the potential and important role of the private sector in the public-private partnership to promote and implement energy conservation measures;
- Delegate tasks related to the promotion of energy conservation to public and private agencies/organizations that are readily equipped with resources and expertise, such as power utilities and industrial associations, with backup support from the Ministry of Energy;
- The use of professionals and Energy Services Companies (ESCO) as an important tool to provide consultancy and to implement energy conservation measures in which the use of more advanced technology is involved;
- Increase in self-reliance in indigenously developed technology to reduce technological costs and to increase access to energy-efficiency technology, including promotion of highly energy-efficient product manufacturing processes.

To implement the plan, there are 16 specific measures under five strategic approaches, which will be introduced. The strategic approaches and measures are as follows:

(1) Mandatory Requirements via Rules, Regulations and Standards

- (1.1) Enforcement of the Energy Conservation Promotion Act, which would put in effect an energy management system based on energy consumption reporting and verification imposed on designated buildings and factories;
- (1.2) Introduction of mandatory energy efficiency labelings to provide options for consumers to buy or use highly energy-efficient equipment/appliances, vehicles and buildings;
- (1.3) Enforcement of the Minimum Energy Performance Standards (MEPS) for equipment/appliances, buildings and vehicles to prevent the distribution and use of low energy-efficient products;
- (1.4) Determination of the Energy Efficiency Resource Standards (EERS), or the minimum standards for large energy businesses to implement energy conservation measures, encouraging their customers to use energy efficiently, which will be an

important mechanism for providing both technical and financial assistance to small and medium enterprises (SMEs).

(2) Energy Conservation Promotion and Support

- (2.1) Promote a “voluntary agreement” to save energy between the public and commercial/industrial sectors, especially various business associations and large-scale businesses;
- (2.2) Support and incentive provision to encourage voluntary energy-efficiency labeling for highly energy-efficient equipment/appliances, buildings and vehicles;
- (2.3) Promote traveling by mass transit systems, as well as goods transportation by highly energy-efficient logistics systems;
- (2.4) Subsidize investment in the implementation of energy conservation measures by (a) providing subsidies for the amount of energy saved that can be verified, as per the project proposals approved under the DSM (demand-side management) Bidding scheme for large-scale businesses, and (b) providing subsidies for the amount of energy saved and/or reduction of peak load that can be verified or accurately assessed for SMEs, as per the project proposals submitted under the Standard Offer Program (SOP) scheme, which requires no bidding;
- (2.5) Support for the operation of ESCO companies, (e.g. the use of funding from the Energy Conservation Promotion Fund to increase credit lines given by the ESCO Fund), to alleviate technical and financial risks of entrepreneurs wishing to implement energy conservation measures.

(3) Public Awareness Creation and Behavioral Change

- (3.1) Public relations and provision of knowledge about energy conservation to the general public, via the teaching/learning process in educational institutions, fostering youth awareness and other public awareness activities, such as eco-driving;
- (3.2) Putting forth the concepts and promoting activities related to the development of a low carbon society and low carbon economy; this will bring about cooperation between local administration organizations and the business sector in the planning and implementation of activities that will lead to a reduction of GHG emissions and efficient use of energy;
- (3.3) Determination of energy prices to reflect the actual costs and application of tax measures as an important tool to promote energy conservation with a view to fostering public awareness and changing their energy consumption behavior.

(4) Promotion of Technology Development and Innovation

- (4.1) Promote research and development to improve energy efficiency and reduce technological costs, particularly those related to equipment/appliances with large markets and manufacturing bases in Thailand, including the production process, materials as well as buildings and housing that are energy efficient;
- (4.2) Promote demonstrations of energy-efficiency technologies that have been technically proven but have not been commercialized in the domestic market, including support for necessary preparation to implement wide commercial deployment of such technologies.

(5) Human Resources and Institutional Capability Development

- (5.1) Support the development of professionals in the energy conservation field so that they will be responsible for energy management and operation, verification and monitoring, consultancy and engineering services provision and the planning, supervision and promotion of the implementation of energy conservation measures;

- (5.2) Support the development of the institutional capability of agencies/organizations in both the public and private sectors, responsible for the planning, supervision and promotion of the implementation of energy conservation measures.

Recently, the Energy Efficiency Action Plan (EEAP) has been developed under the strategic framework of the EEDP. The EEAP has been approved by the National Energy Policy Committee (NEPC) and was endorsed by the cabinet in early 2013. There are 67 major measures/projects under the plan. Most of measures are sector-wide. The rest is sector-specific measures that include 18 measures for the transport sector and five measures for each of industry sector, large commercial building sector, and small commercial building and residential sector. 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, 3 630 ktoe from the large commercial building sector, and 3 635 ktoe from the small commercial building and residential sector. Moreover, EPPO has completely developed the 10-Year R&D master plan for energy efficiency to guide research and development directions in line with the EEDP and EEAP.

RENEWABLE ENERGY

The Ministry of Energy, by the DEDE is very keen to develop alternative and renewable energy to secure energy resources and provide affordable energy to all Thais. There were several revisions of the renewable and alternative development plan during the last decade. The 10-Year Renewable and Alternative Energy Development Plan 2012–2021 (AEDP), formerly the 15-Year Renewable Energy Development Plan 2008–2022 (REDP), sets a target to increase the share of renewable and alternative energy up to 25% of total energy consumption by 2021 (DEDE, 2011). The plan states the Thai government will encourage the use of indigenous resources including renewable and alternative energy (particularly for power and heat generation), and supports the use of transport biofuels such as ethanol-blended gasoline (gasohol) and biodiesel. The plan also strongly promotes community-scale alternative energy use, by encouraging the production and use of renewable energy at a local level, through appropriate incentives for farmers. It also rigorously and continuously promotes research and development in all forms of renewable energy.

To achieve these targets, Thailand has set up incentive programmes and mechanisms to encourage investment, such as the Fund for Energy Services Companies, which act as special-purpose vehicles for renewable energy development projects, and investment grants from the Energy Conservation Fund. Some of successfully self-workable measures, such as the Revolving Fund that provides low interest rates, will be terminated.

The 2021 targets of the AEDP have been clearly allocated based on technologies related to power generation, heat generation and biofuels for transportation. The breakdown of those targets is as follows:

- (1) Renewable energy for power generation
 - (1.1) *Solar power*: target is 3,000 MW. Power generation from solar will focus more on small system projects at the house and community level, including Solar PV Rooftop, for 1,000 MW within 10 years. To achieve the target, a Feed-in Tariff (FiT) system for the Solar PV Rooftop has been recently introduced. The Fit rate for residential units with less than 10kWp capacity is set at THB6.96/unit, while that of the small business buildings with less than 250 kWp capacity is set at THB6.55/unit. The Fit rate for medium- and large-scale business buildings/factories with less than 1,000 MWp is fixed at THB6.16/unit, while those with a capacity larger than 1MWp has yet to be determined. The subsidy period is set for 25 years.
 - (1.2) *Wind energy*: target is 1,800 MW. To do this, installation of wind turbines in remote areas and non-electrified islands will be promoted. Promotion of private investment and development of the appropriated type of wind turbine for Thailand are crucial

to achieving the target. There is also a need to enact amendments to regulations and acts regarding some issues such as land utilization in restricted areas.

- (1.3) *Small hydropower*: target is 324 MW. Support to construct hydropower plant projects at the community level and support the local administrative organizations so that they can collaborate as project owners and to be capable of further self-management and maintenance.
 - (1.4) *Biomass*: target is 4,800 MW with a total current capacity at 1,988 MW as of March 2012. The development will focus on promoting communities to collaborate in broaden production and consumption of renewable energy, so-called “Distributed Green Generation (DGG)”. The state utilities, i.e., EGAT and PEA (Provincial Electricity Authority) are to extend transmission and distribution lines to support the development of biomass power plant projects, especially in areas with a high potential for feed stocks.
 - (1.5) *Biogas*: target is 3,600 MW. The target of 3,000 MW will be power generation from Napier Grass, the latest energy crop being promoted by the Thai government. DEDE has granted THB350 million from its research budget for producing biogas from Napier Grass.
 - (1.6) *Municipal Solid Waste (MSW)*: target in 2021 is 400 MW. The development will focus on promoting the production of energy from MSW in small communities including schools, temples and local organizations. There is also a need to enact amendments to laws and regulations that will allow government enterprise to co-invest with the private sector.
 - (1.7) *New energy*: target is 3 MW. The two types of new energy that will be promoted in Thailand by 2021 are power from geothermal energy (1 MW) and power from wave and tidal current (2 MW).
- (2) Renewable energy for heat generation
- (2.1) *Solar thermal*: target is 100 ktoe. This target will be achieved by promoting the installation of solar heating/cooling in government buildings, solar hot water for households, solar drying system for SMEs, and development of a compulsory mechanism such as a building energy code that will require large buildings to install solar hot/cool water system.
 - (2.2) *Biomass*: target is 8,500 ktoe with a total present capacity at 4,510 ktoe as of March 2012. This target will be achieved by promoting the production system of biomass pellets and the co-generation system of combined heat and power for broaden use.
 - (2.3) *Biogas*: target is 1,000 ktoe. Promoting compress biogas (CBG) projects for broaden use, in particular using it as natural gas in the transport sector with a target of increasing its use by 5%.
- (3) Biofuels for transportation
- (3.1) *Ethanol*: target is 9.00 million litre/day. This target will be achieved by increasing the national average production of cassava and sugarcane, as well as promoting other alternative crops, such as sweet sorghum, etc. In addition, on the demand side, preparations will be made to terminate the use of 91 benzene and promote E20, and E85, along with introducing ED95 (95% Ethanol blended with 5% additives for modified diesel engines), for example.
 - (3.2) *Biodiesel*: target is 7.20 million litre/day. This target will be achieved by increasing the yield from crude palm oil plantations, mandating B7 and introducing B10 and B20 for fleet trucks and fishery boats.
 - (3.3) *New fuels for future diesel substitution*: target is 3.00 million litre/day. This target will be achieved by introducing other alternative feedstock, such as Jatropha, Seaweed-

algae, and also new technologies, such as Bio-hydrogenated diesel (BHD), Biomass to liquid (BTL), etc.

NUCLEAR

Nuclear power is one of the selected energy resources in the Thailand 20-Year Power Development Plan (PDP2010), which aims to ensure sufficient energy supply and diversify the power energy mix. The 2nd Revision PDP2010 has postponed the scheduled commercial operation date (SCOD) of the first unit of the nuclear power project by 3 years from 2020 to 2023, after the Fukushima Daiichi Nuclear Power Plant disaster by earthquake and tsunami in March 2011. Currently, the 3rd Revision PDP2010 has again 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 will comprise 5% of the total generation capacity.

CLIMATE CHANGE

Thailand has a strong policy of protecting the environment from the impact of energy production and consumption, especially the impact of the transport sector. The government's environmental protection policy is to encourage energy procurement and consumption and to attach importance to the environment, along with public participation. It does this by setting relevant standards and promoting Clean Development Mechanism (CDM) projects to reduce social and environmental impact as well as greenhouse gas emissions. The strategies employed include the following targets and actions, which are designed to achieve the policies:

1. Monitor the environmental impact of energy production, conversion and use. Set a target and develop a plan to boost the management of greenhouse gas (GHG) emission rates in the energy sector, with the aim of reducing Thailand's CO₂ emissions by at least 1 million tonnes per year. The actions proposed are:
 - Select pilot power plants and conduct a study on the reduction of GHG emissions from one natural gas-fired thermal power plant, one coal-fired thermal power plant and one combined cycle power plant;
 - Devise a plan to reduce GHG emissions in the energy industry, e.g. determine the baseline and develop a clear response plan.
2. Promote the CDM in the energy sector to reduce greenhouse gas emissions. The objective is to enable Thailand to submit energy projects for certification under the CDM, at a total of 1 million tonnes of CO₂ per year, and enhance the economy's role as a leading exporter of carbon credits in Asia. The following actions are proposed:
 - Promote the wider use of flare gas, e.g. as a substitute for LPG in the production process of community products or as fuel in community-scale power generation;
 - Manage energy production to keep the level of flare gas at the minimum, or prepare to announce a Zero Flare policy, particularly for onshore petroleum sites;
 - Promote study and research into carbon capture and storage (CCS) technology to compress and store carbon dioxide underground;
 - Conduct a feasibility study on the application of CCS technology in Thailand and develop a pilot project for an operational trial.
3. Control and monitor volatile organic compound (VOC) emissions from petrochemical and refining industries to minimise environmental impact. This measure strives to control the emissions of all factories to meet standards in force and to create low-cost 'appropriate technology' innovations that are environmentally friendly and easy to operate and that can be maintained at a rate of at least five innovations per year, with support from the Energy Conservation Promotion Fund. In order to achieve this objective, it will be necessary to:

- Further expand implementation of the policy on vapour recovery units from four provinces to an additional seven provinces in areas where a large number of oil reserve depots are located;
- Enforce the schedule for EURO 4 standards from 1 January 2012.

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USEFUL LINKS

- Department of Alternative Energy Development and Efficiency (DEDE)—www.dede.go.th
- Electricity Generating Authority of Thailand (EGAT)—www.egat.co.th/en
- Energy Policy and Planning Office (EPPO)—www.eppo.go.th
- Ministry of Energy (MoEN)—www.energy.go.th/en
- Prime Minister's Office—www.opm.go.th

UNITED STATES

INTRODUCTION

The United States (US) is the world's largest economy with a GDP of USD 11.7 trillion (USD 2000 at PPP) in 2011 (EDMC, 2013). The US spans 9.8 million square kilometres and had a population of 311 million people in 2011, which has grown at a rate of around 1% per year since 1990, although this growth rate has steadily fallen each year since 2006 (EDMC, 2013).

The US enjoyed a long economic expansion from 1991 through to 2000. Growth was particularly robust from 1995 to 2000, averaging 4.1% per year in real terms. A brief recession slowed growth to 1.1% in 2001, but growth then gradually recovered to 3.6% by 2004, before slowing to 2.7% in 2006 (EDMC, 2013). In 2009, the US was caught at the centre of the global financial crisis and real GDP contracted 1.8% (World Bank, 2010). Economic growth has since been sluggish by historical standards with consistently high unemployment. In 2011, real economic growth was 1.8% (EDMC, 2013).

The US is the largest producer and consumer of energy in the world. It is also rich in energy resources. In 2011, the US had 35 billion barrels of proven oil reserves, 8 800 billion cubic metres of natural gas reserves and 237 billion tonnes of coal reserves (BP, 2013). According to the US Department of Energy's Energy Information Administration (EIA), total (net summer) electricity generating capacity across all sectors was 1 054.8 GW in 2011, of which 75.0% was fossil fuels, 9.6% was nuclear, 9.6% was hydro (conventional and pumped storage), 4.3% was wind, and 1.5% was other renewable energy (biomass, geothermal, solar, etc.) (EIA, 2012a). The US consumed about 7.9 tonnes of oil equivalent primary energy per capita in 2011, close to three times the APEC average and in excess of domestic energy production (APEREC, 2013).

Table 1 Key data and economic profile, 2011

| Key data 2011 | | Energy reserves 2011 ^a | |
|------------------------------------|-----------|---|---------|
| Area (sq. km) | 9 826 675 | Oil (billion barrels) | 35.0 |
| Population (million) | 311 | Gas (billion cubic metres) | 8 800 |
| GDP (USD (2000) billion at PPP) | 11 733 | Coal (million tonnes) – recoverable | 237 295 |
| GDP (USD (2000) per capita at PPP) | 37 656 | Uranium (million tonnes) – recoverable ^b | 0.472 |

a. BP (2013).

b. NEA (2012) At a production cost of less than 260 USD per kg.

Source: EDMC (2013).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2011, the total primary energy supply in the US was 2 198 million tonnes of oil equivalent (Mtoe). By fuel type, 36% of supply came from crude oil and petroleum products, 22% from coal, 26% from natural gas and 17% from nuclear, hydro, geothermal and other fuels. Net imports provided about 21% of the economy's primary energy requirement in 2011 (EDMC, 2013).

In 2011, oil provided 785 Mtoe of the primary energy supply. This was a decline to pre-1995 levels with a substantial reduction in import dependence. In 1990, 42% of crude oil and products

demand was met by net imports; the net import share peaked at 60% in 2005 and in 2011 net imports declined to 46% (EIA, 2013a). The decline in imports is the result of several factors, including a decline in consumption resulting from the economic crisis, strictly improving efficiency, and changing consumer behaviour. In addition, domestic oil production has increased significantly in recent years. Canada is the single largest supplier in 2011 with a 24% share of imports (EIA, 2012a). The US maintained its position in 2011 as the third-largest crude oil producer in the world, including natural gas liquids and condensates, with production averaging 6.8 million barrels per day (EDMC, 2013). Of the states, Texas, North Dakota, Alaska and California are the largest oil producers. In 2011, oil production in North Dakota from unconventional shale oil accelerated rapidly, and production has now surpassed both Alaska and California (EIA, 2012b).

The US primary natural gas supply totalled 568 Mtoe in 2011. Consumption growth was assisted by a period of falling wellhead gas prices following deregulation in the 1980s and by an expanding pipeline network that made gas more widely available. From 1990 to 2000, the annual growth rate of the natural gas supply, including net imports, was about 2.2%. Then, amid high gas prices and supply constraints, primary gas supply declined at an average annual rate of 1.4% between 2000 and 2006. In 2005, power generation passed industry, including industry's non-energy gas use, to become the largest user of gas in the US, and in 2011 total primary gas supply was above the peak recorded in 2000 (EDMC, 2013). The fast growth of gas use by power producers has been driven in part by the fuel's low emissions compared with other fossil fuels. In recent years, rapid production of cheap unconventional gas reserves from tight geological formations has resulted in an abundant supply and low wellhead prices.

Table 2 Energy supply and consumption, 2011

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|-----------|---------------------------------|-----------|------------------------|-----------|
| Indigenous production | 1 793 278 | Industry sector | 283 973 | Total | 4 346 123 |
| Net imports and other | 456 431 | Transport sector | 605 263 | Thermal | 2 961 379 |
| Total PES | 2 198 539 | Other sectors | 627 381 | Hydro | 344 679 |
| Coal | 478 456 | Total FEC | 1 516 617 | Nuclear | 821 405 |
| Oil | 784 772 | Coal | 21 465 | Other | 218 660 |
| Gas | 568 886 | Oil | 788 938 | | |
| Other | 366 125 | Gas | 326 883 | | |
| | | Electricity and other | 379 331 | | |

Source: EDMC (2013).

The US held about 4.1% of the world's natural gas reserves in 2011 (BP, 2012). It transports gas through an extensive pipeline network with more than 492 384 kilometres of transmission pipeline and 6.1 billion cubic metres per day of transmission capacity (EIA, 2007). Underground gas storage capacity in the US has grown only slightly since the mid-1970s, and the total end-of-year storage volume stood at approximately 36% of annual consumption in 2011 (EIA, 2012c).

From 2006, the introduction of horizontal drilling in combination with hydraulic fracturing has enabled the economic extraction of unconventional gas, largely from shale formations. In particular, US shale gas production has increased rapidly from about 2% of production in 2006 to 39% of production in 2012 (EIA, 2013c). Further increases in shale gas production are anticipated, with total production expected to increase around threefold from 2010 to 2035 and to account for almost half of US gas production. The size of unconventional gas reserves, which include shale gas, tight gas and coalbed methane, is still uncertain; however, the Energy Information Administration (EIA) estimates that technically recoverable unconventional gas reserves may exceed 33 trillion cubic metres or over 50% of total reserves. Interest in liquefied

natural gas (LNG) has grown in the US as a means to export excess unconventional gas production and to support gas prices to encourage further investment. Proposals to construct new LNG exporting facilities are facing environmental and regulatory hurdles although several proposals have now received approval and the first LNG exporting terminals to likely to be commissioned in 2017 (EIA, 2012d).

The primary energy supply of coal in the US totalled 479 Mtoe in 2011 (EDMC, 2013). US coal reserves are concentrated east of the Mississippi River in Appalachia and in several key western states. Eastern coal, which accounted for 42% of production in 2011, is mainly high-sulphur coal from underground mines. Western coal, which accounted for most other production, is mainly low-sulphur coal from surface mines (EIA, 2012a, 2012e).

In 2011, the US was the fourth largest coal exporter in the world, behind Australia, Indonesia and Russia (EIA, 2013b). In 2011 coal exports were 108.3 million short tonnes or an increase of over 30% from 2010. Coal imports have steadily declined from 38.8 million short tonnes in 2007 to 14.5 million short tonnes in 2011 (EIA, 2013b). Europe is the largest importer of US coal, accounting for around 50% of net exports (EIA, 2012e).

The US produced 4.1 million gigawatt-hours of electricity in 2011; of that total, 68% came from fossil fuel plants, 19% from nuclear power, 8% from hydropower and 5% from new renewable energy and other sources (EIA, 2012a).

The US generates more nuclear power than any other economy, but no new nuclear reactors have been ordered since 1977 (CRS, 2007a). The Three Mile Island accident in 1979 raised concerns about nuclear power plant safety, while ad hoc regulatory responses to those concerns made some new plants very expensive; both factors deterred further expansion. In 2007 work began again on the partially built Watts Bar 2, where construction had ceased in 1985; completion of this reactor is expected in 2015 (TVA, 2012). In 2002, the average utilization rate of the 104 operable commercial nuclear units (down from a peak of 112 units in 1990) rose to over 90%, where it has largely remained since (EIA, 2012a). Many nuclear plants have applied to the Nuclear Regulatory Commission (NRC) for 20-year extensions of their operating licences, to 60 years. In late 2012, the NRC had approved licence extensions for 74 nuclear reactor units and had applications for another 13 extensions under review, while 11 other units had informed the agency of their intention to seek extensions between 2013 and 2017 (NRC, 2012a).

Recently, nuclear energy has suffered a major setback with the first closures of operating plants in 15 years. Four nuclear power plants were closed earlier than expected. Two of the reactors in Vermont and Wisconsin cited stiff economic conditions as the reason for their closing, and the other two plants in California and Florida closed due to structural damage and safety concerns. At the same time at least the plans for five proposed reactors were abandoned due to the regulatory and economic uncertainty.

Total renewable energy production in the US in 2011 was approximately 231 Mtoe, or 10.5% of total primary energy supply, according to the EIA. Production from non-hydro (or new and renewable) sources increased 7.7% from the previous year and has seen an annual growth rate of 9.1% since 2005 (EIA, 2012a, 2012d).

By consumption of renewable energy type, biomass as a whole represented 49.3% of the total, hydroelectric power 33.8%, geothermal 2.3%, wind 12.7% and solar/photovoltaic 1.9%. There has been a particularly rapid expansion of wind power, which between 2005 and 2011 recorded a 37% average annual growth rate (EIA, 2012d). Government incentives, including subsidies and renewable energy mandates as discussed below, in addition to cost reductions relative to fossil-fuelled alternatives, spurred the growth of renewable energy production.

FINAL ENERGY CONSUMPTION

In 2011, total final energy consumption in the US was 1 517 Mtoe, a decrease of 0.2% from the previous year. By sector, transport consumed 40%, industry accounted for 19%, and other

sectors (including non-energy uses) consumed 41%. By fuel, petroleum accounted for 52% of final consumption, natural gas 22%, coal 2%, and electricity and other fuels 25% (EDMC, 2013).

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) are under the auspices of the Department of Energy. The Federal Energy Regulatory Commission (FERC) oversees the interstate transmission of energy, and the Environmental Protection Agency (EPA) regulates the environmental impacts of energy transformations throughout the economy. The Department of Transportation (DOT) also plays an important role as the regulator of vehicle fuel economy. A new White House Office of Energy and Climate Change Policy was created in 2009 to coordinate some of the activities of these agencies.

While all of 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 been introduced to define US energy policy. The National Energy Act of 1978 included legislation to promote energy conservation, shift towards alternative energy sources, create a market for independent power producers and give the FERC greater authority over natural gas markets (DOE, n.d.). The Energy Policy Act of 1992 further opened electricity markets to competition, encouraged integrated resource planning by utilities, targeted improved energy management in federal agencies, promoted alternative transportation fuels, and required RD&D of technologies to enhance the production and efficient utilisation of renewable, fossil and nuclear energy resources (US House, 1992).

In 2005, a new comprehensive Energy Policy Act (EPA 2005) was introduced as the successor to the 1992 Act. This was followed shortly after by the Energy Independence and Security Act of 2007 (EISA 2007). Together, these recent legislative packages substantially define the current US federal energy policy. The American Recovery and Reinvestment Act of 2009 (Recovery Act) is also noteworthy for having dramatically increased funding for many federal energy programmes. Key elements of these recent acts are described in the following thematic discussions.

Energy Security

Given the high dependence of the US on imported oil, policies meant to improve energy security have often focused on three areas: efficiency in the transportation sector, where more than 70% of oil products are consumed; enhancing domestic production of liquid fuels; and advancing transportation technologies that are less dependent on liquid fuels, such as hybrid electric vehicles.

EISA 2007 mandated a 40% increase in combined car and light truck fleet fuel economy (CAFE) standards by 2020, to reach 14.9 kilometres per litre (35 miles per gallon), and required further study into commercial vehicle fuel economy (CRS, 2007b). In 2009, the administration proposed a plan to speed the introduction of the new CAFE standards. Under that plan, the EPA and the Department of Transportation's National Highway Transportation Safety Administration (NHTSA) jointly developed vehicle greenhouse gas (GHG) emissions standards and fuel economy standards that will increase average fuel economy from 11.6 kilometres per litre (27.3 miles per gallon) in 2011 to 14.5 kilometres per litre (34.1 miles per gallon) in 2016 (EPA & NHTSA, 2009). Recently, the DOT and EPA have also announced plans to regulate the fuel efficiency of heavy duty vehicles beginning in 2014 (NHTSA, 2011).

The 2005 EPAct promoted enhanced 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 regulation under the Safe Drinking Water Act, which cleared an obstacle to the exploitation of tight sand and shale hydrocarbon resources. In this Act, Congress also made a clear statement that development of unconventional oil resources should be encouraged in order to reduce US dependence on foreign oil imports (US Congress, 2005).

Biofuels represent another avenue for improving US energy security and have received strong policy support. Development of vehicles powered by alternative fuels and biofuel production were promoted by the 2005 EPAct, but EISA 2007 brought biofuels to the forefront of US energy security policy. EISA mandated a fivefold increase from previous biofuel use targets by 2022, requiring fuel producers to use a minimum of 136 billion litres (36 billion gallons), up from 34 billion litres (9 billion gallons) in 2008. To meet environmental objectives, from 2016, new biofuel production towards the mandated target is to be derived from cellulosic or other advanced biofuels that reduce lifecycle greenhouse gas emissions by at least 50%. Most of the new biofuel is to be produced domestically, and the target includes provisions to reduce the required volumes if costs are judged too high or supplies are inadequate (CRS, 2007b). Since this law was passed, US consumption of oil has, in fact, been reduced in recent years causing the biofuel blend ratio in gasoline to rise unexpectedly. The current blend ratio is fast approaching 10 percent. Many auto manufacturers have said 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.

The Recovery Act sought to advance the commercialisation of electric vehicles by investing in facilities that manufacture batteries and other electric vehicle components. The government invested more than USD 2 billion in nearly 50 different electric vehicle and component manufacturing projects (DOE, 2010a). Electric vehicles offer energy security benefits by shifting transportation energy demand from oil to electricity.

Just under half of US electricity is provided by coal-fired power plants, and coal is a domestically abundant resource and thus provides energy security benefits. However, coal's high CO₂ emissions present a challenge for US climate policy, which is discussed below.

ENERGY MARKETS

In 2010, US consumers spent an estimated USD 1.2 trillion on energy purchases (EIA, 2012a). The government plays many roles in this large market, including as an owner of resources, regulator of industry, and supporter of research and development.

Upstream development

The Department of Interior's Bureau of Land Management (BLM) administers over 2.8 million square kilometres of mineral estate, of which about 180 000 square kilometres is currently leased for oil and gas development (BLM, 2010). The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), another office of the Department of Interior, leases another 174 000 square kilometres of offshore energy and mineral resources (BOEMRE, 2010). The BLM and BOEMRE also lease public lands and offshore areas for the development of above-ground energy resources such as solar and wind. While the US Government plays a large role in leasing surface and mineral rights, it is not the sole owner of such rights. States and individuals also own and lease surface lands and underground mineral rights for energy extraction (BLM, 2009).

Regulation of upstream development is shared by state and federal governments. In some cases, the division between state and federal responsibility is clear. For example, state oil and gas commissions prevent the waste of resources and protect public safety in state territory (IOGCC, n.d.). In the federal offshore territory, offices of the Department of Interior exercise

similar responsibilities. But such clear divisions are not always the case. For example, state offices of environmental protection monitor environmental impacts and enforce state environmental laws. At the same time, the EPA acts as a backstop on environmental issues, ensuring that, at minimum, upstream activities comply with such federal laws as the Clean Air Act and the Clean Water Act. In such cases where state and federal regulatory responsibilities overlap, coordinating the activities of state and federal agencies is an important task (EPA, 2012a).

Electricity and gas markets

The federal government regulates the interstate transmission of electricity and gas, as well as wholesale sales of electricity, under the Federal Energy Regulatory Commission (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 and thereby allowing wholesale customers to meet their needs with purchases from any number of wholesale suppliers connected across a regional grid. Competitive wholesale electricity markets function using distinct models in different regions. Regional transmission organizations and independent system operators administer transmission networks and operate wholesale markets across a large part of the US and Canada. In other regions, bilateral contracting between consumer and supplier 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. Most retail customers are served by regulated, investor-owned utilities (69%), but public power systems (14%) and cooperatives (12%) also serve millions of customers (DOJ et al., 2007). State regulators ensure that these providers serve their customers at rates that are 'fair, reasonable and non-discriminatory' (NARUC, 2009). In the 1990s, many states began to explore options for restructuring retail electricity markets to create competition among electricity providers while continuing to regulate distribution networks as natural monopolies. Fifteen states now allow some customers a choice of electric service provider, but efforts to deregulate retail electricity markets slowed when, in 2000 and 2001, California's newly deregulated retail market proved vulnerable to abuse, leading some customers' bills to quickly triple and forcing some distribution utilities into bankruptcy (EIA, 2010a; DOJ et al., 2007).

Natural gas markets are similar to electricity markets, with competitive wholesale markets supplying federally regulated transmission pipelines and delivering into state regulated distribution networks. The Federal Energy Regulatory Commission once set natural gas prices, but wellhead prices were fully deregulated in 1993.

Now FERC's pricing activities for natural gas are limited to determining pipeline rates for gas transmission. The Department of Transportation's Pipeline and Hazardous Materials Safety Administration regulates gas transmission pipelines to ensure they are operated safely. Pricing and safety on natural gas distribution networks is regulated by state agencies (FERC, n.d.; EIA, 2009a).

Research and development

The scope of energy-related research and development (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, energy R&D spending more than tripled. New support for fossil energy, renewable energy, and efficiency absorbed much of the increase. Though the amount of spending then declined sharply during the 1980s, the broader scope was preserved (Dooley, 2008).

The Department of Energy (DOE) is the lead agency for research and development activities. The DOE funds 21 laboratories and technology centres, as well as research conducted at universities across the US. Currently supported research ranges from particle physics to pilot projects for carbon capture and sequestration (DOE, 2010b). Total government spending for

energy-related research and development remained relatively stable at around USD 3 billion a year (in USD 2005 terms) from the 1990s until 2009 with the enactment of the Recovery Act (Dooley, 2008). The Recovery Act changed this by investing billions more in R&D facilities, pilot projects and the new Advanced Research Projects Agency for Energy (DOE, 2010c). However, the Recovery Act was a one-time economic stimulus and R&D spending may soon return to previous levels. Some US business leaders have argued that to confront the energy challenges that the US faces, the government should more than triple spending on clean energy research and development (AEIC, n.d.)

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 paid to the owner of mineral resources, which is often the government. The US Office of Natural Resources Revenue collected USD 11.9 billion in royalty payments in 2012 (ONRR, 2012). Downstream, sales of some important energy commodities, such as gasoline and diesel, are taxed by state and federal governments. The federal tax on gasoline is about USD 0.049 per litre (18.4 cents per gallon) and on diesel is USD 0.064 per litre (24.4 cents per gallon). 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 go to funding energy efficiency programmes.

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 and production tax credits. Investment tax credits allow taxpayers investing in certain qualified energy facilities to reduce their tax burden by some fraction of the amount invested. Production tax credits similarly reduce a 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 investment tax credits range from coal gasifiers to hydrogen refuelling stations.

Products eligible for production tax credits range from certain coal-derived fuels to electricity produced from wind energy. The two most expensive energy-related federal tax provisions are estimated to be the deductions allowed for oil and gas exploration and development, and for depletion of oil and gas properties. These are followed by the production tax credit for wind and a deduction for refiners (Joint Committee on Taxation, 2009).

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, 2012). Some of these incentives are described in the following sections on energy efficiency and renewable energy.

ENERGY EFFICIENCY

Incentives to promote energy efficiency exist at federal, state and local levels. Federal tax credits and loans support residential efficiency improvements. Taxpayers could claim a tax credit for up to 30% of the cost of a residential efficiency measure through the end of 2010. Homeowners can also obtain loans from the federal government to finance energy-efficiency measures in new or existing homes (DSIRE, 2012). Much of the Recovery Act allocation for energy efficiency will be distributed through state energy programmes that provide loans, grants and other assistance for energy-efficiency projects in homes, businesses and public facilities (CRS, 2009). Locally, utilities

are generally required to consider energy efficiency on an equal basis with new generation in their planning, and many utilities administer demand-side management programmes that provide incentives and technical assistance to reduce demand for electricity and natural gas (DSIRE, 2012; US House, 1992).

RENEWABLE ENERGY

During the third quarter of 2012, US cumulative wind energy capacity reached 51 630 megawatts (MW) or approximately 2.5% of US electricity demand. The total 2011 wind energy installations were 6 816 MW, and from 2007 to 2011 wind installations accounted for roughly 35% of all new US electricity generating capacity (AWEA, 2012). The production of wind, geothermal, bioenergy and marine power is currently eligible for a Federal Renewable Energy Production Tax Credit (PTC) of USD 0.022 per kilowatt hour (inflation-adjusted for 2011), generally for a period of 10 years. This credit has historically been renewed and adjusted by Congress every few years, and this process has led to boom–bust cycles in new renewable energy (NRE) investment, particularly in the wind industry, as the credit has been allowed to expire on a few occasions. The most recent PTC extension was passed early in 2012. Thus, an important provision of the Recovery Act was the extension of PTC eligibility for wind facilities through 2012, and for other eligible facilities through 2013. Another significant change under the Recovery Act is that new NRE facilities may select either the PTC, a 30% business energy investment tax credit (ITC) or, for a limited period, a cash grant equal to the value of the ITC. Manufacturers of renewable energy technologies are also eligible for tax credits under the Recovery Act to offset investments in new or expanded manufacturing capacity. New solar facilities do not qualify for the PTC as a result of the 2005 EPAct, but they are eligible for the ITC. A related individual tax credit of 30% is available for residential solar electric system expenditures without cap, as are similar tax credits for residential small wind and geothermal systems. Several federal loan and loan guarantee programmes also exist to encourage the development of renewable energy and other advanced energy facilities (DSIRE, 2012).

Many state and local governments have in place financial measures that complement federal incentives for NRE investment. In addition to subsidies, state legislation has also provided significant indirect incentives for NRE development through the establishment of policy frameworks such as renewable portfolio standards (RPS), which mandate that a certain share of electricity sales be sourced from renewable energy. Thirty-seven states and the District of Columbia had enacted RPS legislation, with varying degrees of stringency, by the end of 2011.

Other measures have also been introduced to support NRE development, such as generation disclosure rules, mandatory utility green power options and the use of public benefit funds (DSIRE, 2012).

NUCLEAR

Support for the nuclear industry has continued under recent legislation. The 2005 Energy Policy Act included several provisions considered important to revitalizing the domestic nuclear power industry. It extended the Price–Anderson Act limiting the legal liability of nuclear operators, introduced loans to cover costs incurred by legal or regulatory project delays, and established a public–private project to design and construct a pilot Next Generation Nuclear Plant. The Act also continued support for nuclear energy research and development and established a loan guarantee programme intended to improve access to financing for new nuclear plants and other projects that reduce air pollution emissions or introduce new technologies (US Congress, 2005).

Since the Energy Reorganization Act of 1974, responsibility for the development and promotion of nuclear energy has been held by the Department of Energy, and regulatory oversight of the industry has been provided by the Nuclear Regulatory Commission. The federal government is also required to provide a site for the permanent disposal of high-level radioactive waste, with disposal costs to be paid by nuclear operators. However, a suitable site remains to be found (NRC, 2011b). The partially completed waste depository facility in Yuka Mountain,

Nevada was recently abandoned and there remains no viable long term storage option for nuclear waste. The US government maintains the financial burden of storing spent fuel and currently compensate utilities for storing the waste on-site. In fact, a recent court ruling has blocked the Nuclear Regulatory Commission, temporarily issuing new reactor licenses or renewals until it sufficient assesses the risk of storing spent radioactive fuel at nuclear plant sites.

The US is active promoting safe and reliable nuclear energy for civilian use through the Global Nuclear Energy Partnership (GNEP) and the Generation IV International Forum (GIF). GNEP was established in 2006 and now has 25 partner economies. The partnership aims to increase access to clean, non-GHG-emitting nuclear energy throughout the world, to increase the amount of energy generated by nuclear fuel while decreasing the amount of material that must be disposed of in waste repositories, and to reduce the risk of proliferation by providing fuel cycle services to developing economies so they do not need to develop uranium enrichment or spent-fuel reprocessing capabilities (GNEP, 2009). In 2009 the US DOE announced that it had halted the domestic commercial reprocessing GNEP programme, although research would continue to focus on proliferation-resistant fuel cycles and waste management. GIF is a cooperative international research and development establishment of 13 economies to investigate the feasibility and capabilities of the next generation of nuclear energy systems. Depending on technical maturity, Generation IV systems are anticipated to reach commercial introduction in the period between 2015 and 2030 or beyond (GIF, n.d.).

CLIMATE CHANGE

The US pledged to reduce economy-wide GHG emissions in the range of 17% by 2020 from 2005 under the 2009 Copenhagen Accord. However, this pledge also states that the final US target will be determined by domestic legislation (Department of State, 2010). To date, no climate legislation has been passed by Congress, so an economy-wide emissions goal has yet to be conclusively defined. Nonetheless, the administration has declared its commitment to reducing GHG emissions, and state and local governments have developed their own goals and action plans.

Greenhouse gas endangerment finding

There are two ways that GHGs may be regulated at the federal level in the US. First, Congress may pass legislation to control GHG emissions. Alternatively, the EPA may issue a ruling (an 'endangerment finding') that carbon dioxide poses a danger to human health and should therefore be regulated under existing air quality legislation. The former solution offers a more flexible approach to reducing emissions. However, a 2007 decision by the Supreme Court judged that GHGs are pollutants that should be covered under the Clean Air Act. This decision required the EPA to determine whether or not to issue an endangerment finding. In December 2009, the EPA issued an endangerment finding, which gave the EPA the authority to issue rules to limit GHG emissions (EPA, 2009). EPA has used this authority to move forward vehicle emission standards and to define GHG permitting requirements for large CO₂ emitters (EPA, 2012b). The EPA engenderment finding was challenged through the Court of Appeals but upheld in mid-2012. Further appeals are under consideration in the US Supreme Court. The outcome of this ruling and subsequent plans to limit GHG emissions will have major implications for US energy developments in future.

Principally, the EPA is proposing to limit CO₂ emissions in the power sector. The proposed standard restricts CO₂ emissions to a limit of 454 kilograms (1000 lb) for every megawatt-hour of electricity produced. These proposed restrictions apply to new generating units and currently exclude existing units in operation or under construction. However, the EPA is also investigating CO₂ emission limits for existing generating units. The emission regulation is aimed at limiting climate change by enforcing the use of modern and more efficient fossil fuel generation technologies (EPA, 2012c). The carbon restriction will essentially require new coal plants to operate using the latest high efficiency technology, employ biomass co-firing fuels or utilize carbon sequestration.

In addition to GHG emissions limits, the EPA has enforced emission standards on mercury and toxic pollutants in 2012. The strict emission standards will be fully enforced by 2015. This will have a major impact on reducing toxic emissions from coal, primarily in the electricity sector (EPA, 2012b). The new standards will require expensive technological retrofits to existing facilities and will affect almost half the coal generating capacity. Most of the affected coal facilities are over 40 years old and the new standards are likely to result in extensive capacity retirements which may exceed 50 GW.

State and city level climate change initiatives

In the absence of an economy-wide plan to reduce US GHG emissions, a number of regional, state and city level initiatives have been formed and were active in 2010.

In California, the Global Warming Solutions Act (AB 32) was signed into law in September 2007. This law builds upon the 2000 California Climate Action Registry and the 2005 Executive Order S-3-05, in which it was noted that the state was particularly vulnerable to the impact of global warming, citing impacts to 'water supply, public health, agriculture, the coastline, and forestry'. The Act sets a mandatory state-wide GHG emissions cap equal to 1990 levels by 2020, with penalties for non-compliance (COG, 2007). In December 2008, the California Air Resources Board approved the implementation of a climate action plan, which includes regulations, market mechanisms, voluntary actions and other measures, with the option of adopting a cap-and-trade programme in the 2012–2020 period (ARB, 2008).

Ten states in the north-eastern US are members of the Regional Greenhouse Gas Initiative (RGGI). This initiative has a narrower scope than the California plan, focusing on reducing carbon dioxide emissions from the power sector by 10% by 2018. The first permit auction for the cap-and-trade system was conducted in September 2008, and the first three-year compliance period began in January 2009 (RGGI, 2009). Six New England states are also party to the New England Governors/Eastern Canadian Premiers Climate Change Action Plan, whose 11 members have resolved to reduce the region's GHG emissions to 10% below 1990 levels by 2020 (NEG & ECP, 2008).

The Midwestern Greenhouse Gas Reduction Accord, signed in November 2007, with members including six US states and one Canadian province, aims to establish GHG reduction targets and the regulatory or market mechanisms that might be used to achieve them (MGA, 2007).

A host of other regional initiatives focused on climate change or clean energy have now also been formed across the US with Mexican states and Canadian provinces, including the Western Governors Association Clean and Diversified Energy Initiative, the Southwest Climate Change Initiative, the West Coast Governors' Global Warming Initiative, and the Western Climate Initiative (six states and two Canadian provinces, aiming for 15% below 2005 levels by 2020) (WCI, 2007). These regional initiatives represent attempts to actively collaborate on goal setting and the development of action plans. Except for the RGGI in the north-east, all the initiatives are still in the design phase.

Municipal governments have undertaken other GHG initiatives, notably the US Mayors' Climate Protection Agreement, launched in Seattle in 2005. By December 2009, there were 1016 signatories to the voluntary agreement, under which US mayors strive to meet or beat the Kyoto Protocol targets in their own communities, urge state and federal governments to meet the US Kyoto Protocol GHG emissions targets, and commit to taking actions within their own communities that will help to meet or beat Kyoto Protocol targets (USCM, 2009).

FutureGen initiative

FutureGen is a public–private partnership undertaken by the US Department of Energy and the FutureGen Industrial Alliance that focuses on the sequestration of carbon dioxide from coal-fired power plants. When it was first announced in 2003, its aim was to build a single smaller-than-commercial scale demonstration of a near-zero emissions power plant that could produce electricity and hydrogen from coal and serve as a laboratory for further R&D. Construction was

scheduled to begin in 2009 on a plant using integrated gasification combined cycle technology. The initiative was restructured to focus on a large-scale commercial demonstration. The preferred site is a recently retired coal plant in Illinois State owned by Ameren Energy Resources. The Department of Energy may contribute more than USD 1 billion, made available through the Recovery Act (DOE, 2009, 2010b, 2010d). Recently, the Department of Energy approved the final permitting and design activities that precede a decision to start construction (Future Gen Alliance, 2013).

Vehicle emission standards

In July 2011, a new US national car and light truck fleet fuel economy (CAFE) standard was agreed to with 13 major automakers and in cooperation with the State of California, to harmonize economy-wide fuel standards to 23.2 kilometres per litre (54.5 miles per gallon) for cars and light-duty trucks by 2025. The supportive automakers together account for over 90% of all vehicles sold in the US (NHTSA, 2011). In addition, the EPA and NHTSA recently proposed the first fuel economy standard for heavy-duty vehicles. In the absence of standards, the average fuel economy of heavy-duty trucks has improved, in absolute terms, 16% in the past four decades from 2.3 kilometres per litre (5.5 miles per gallon) in 1970 to 2.7 kilometres per litre (6.4 miles per gallon) in 2008 (EIA, 2012a). The newly proposed standards are expected to reduce the fuel consumption of heavy-duty vehicles by 10–20% between 2014 and 2018, depending on the heavy vehicle type. Based on projected fuel savings, vehicle owners are expected to recover the additional upfront costs of the more efficient vehicles in one to five years (NHTSA, 2011).

The new standards have several loopholes which may inhibit their effectiveness. The chief concern is the use of a size-weighted average fuel economy, where larger vehicles have lower fuel efficiency targets. This policy was included to eliminate penalties which favour the sales of small vehicles over large vehicles. However, sales of larger vehicles may increase in market share and reduce real fuel efficiency improvements. A published study suggests average vehicle sizes, particularly for light trucks, may increase between 2% and 32% under the new standards. This would result in a net reduction in the average fuel economy of between 1 and 4 miles per gallon (between 0.4 and 1.7 kilometres per litre) (Whitefoot & Skerlos, 2011). Other uncertainties which may reduce the standards' effectiveness include low fees for non-compliance, overstated fuel economy ratings and low targets for heavy trucks. These negative effects are expected to be limited and real efficiency improvements are likely to accelerate under these rules, but perhaps at a rate lower than anticipated.

Recovery act programmes

Of the USD 32.7 billion in funding authorized for energy under the 2009 Recovery Act, USD 32.6 billion has been awarded to specific projects/recipients and USD 22.3 billion has been spent. Major investment programmes include the Weatherization Assistance Program, which invests in energy efficiency improvements for the homes of low-income families. Other notable projects include the development of electric vehicle and smart grid technology and greater support for renewable energy. The EIA estimated that the Recovery Act funding would achieve 50% more generation of renewable electricity (excluding hydro) by 2012, as well as efficiency measures that will reduce residential and commercial energy expenditures by 2.6% in 2020 (EIA, 2009b).

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Department of Energy—www.energy.gov
Department of Interior—www.doi.gov
Energy Information Administration—www.eia.doe.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 economy located in South-East Asia that shares borders with Cambodia and Laos to the west and China to the north. It has an area of 331 501 square kilometres and a marine exclusive economic zone stretching 200 nautical miles from its 3 260 kilometre coastline. With a population of 87.8 million in 2011, Viet Nam has been transformed since 1986 when it began rapid economic development. In 2011, Viet Nam had a GDP of USD 234.9 billion and an income per capita of USD 2675 (both in USD 2000 at PPP). GDP grew at an average annual rate of 7.1% from 2000 to 2011.

The government has set a target for an average annual GDP growth of 6.5% from 2011 to 2015, based on export growth increasing by 10% per year, with a total annual capital investment in the economy reaching around 35% of GDP, and population growth staying at 1.0%. In addition, in January 2007, Viet Nam joined the World Trade Organization, taking the organization's membership to 150.

Energy contributes greatly to Viet Nam's economic development, supporting industrial growth and generating foreign revenue from exports. Viet Nam's territory has a significant endowment of fossil energy resources such as oil, gas and coal, as well as renewable sources such as hydro, biomass, solar and geothermal. In 2010, Viet Nam's proved energy reserves consisted of 615 million tonnes (Mt) of oil, 600 billion cubic metres (bcm) of gas, 6 140 Mt of coal, and a hydropower potential of 20 000 megawatts (MW). Natural gas and crude oil are found mainly offshore in the southern region, while coal reserves (mainly anthracite) are in the northern region. Since 1990, Viet Nam has become a net energy exporter, mainly of crude oil and coal.

Table 1 Key data and economic profile, 2011

| Key data | | Energy reserves ^a | |
|------------------------------------|---------|------------------------------|-----|
| Area (sq. km) | 331 501 | Oil (million tonnes) | 615 |
| Population (million) | 87.8 | Gas (billion cubic metres) | 600 |
| GDP (USD (2000) billion at PPP) | 234.9 | Coal (billion tonnes) | 6.1 |
| GDP (USD (2000) per capita at PPP) | 2675 | | |

a. In the case of oil and gas, refers to proved reserves as of 2005. GSO (2011).
Source: EDMC (2013).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Viet Nam's total primary energy supply in 2010 was 45 910 kilotonnes of oil equivalent (ktoe), an increase of 15.9% from 39 600 ktoe in 2009. By energy source, 44% of this came from oil, 32% from coal, 18% from natural gas and 6% from other resources.

Viet Nam's proved oil reserves of 615 Mt in 2005, the latest year for which figures are available, are likely to increase following increased exploration activity. Crude oil production has grown rapidly, from only 2 749 ktoe in 1990 to 16 053 ktoe in 2010. From 2000 to 2010, oil production and exports decreased at an average annual rate of 0.3%. By the end of 2012, Viet Nam drilled 82 wells, among them 11 for exploration, 10 for appraisal and 61 for production, leading to a total recoverable reserve increase of 35 million toe. In the period of 2011 – 2015, Viet Nam will expedite the exploration and production activities both in Viet Nam and overseas,

aiming to increase recoverable resources by 35-40 million toe and achieve a sustainable production of 25-28 million toe per year (PVN, 2013).

Oil product imports increased from 8 882 ktoe in 2000 to 12 703 ktoe in 2010 at an average annual growth rate of 3.6%. Oil is still the most important energy source in Viet Nam, accounting for 44% of the economy's primary supply in 2010, compared to 43% in 2009.

Viet Nam's gas reserves are more promising than its oil reserves. In 2005, the most recent year for which reserves figures are available proved gas reserves were estimated at 600 bcm, although that figure is likely to increase as more oil and gas are discovered. While gas resources are found in many parts of Viet Nam, nearly all of the largest reserves are found offshore.

Viet Nam has two large coal fields. In the Quang Ninh Province in northern Viet Nam, anthracite coal is found, with about 5.9 billion tonnes of reserves. In the Red River Delta there is a brown (sub-bituminous) coal basin with reserves of hundreds of billions of tonnes. Survey work has been ongoing for that basin, which Viet Nam will mine using foreign investment in the next 10 years. Viet Nam's commercial coal production increased steadily from 4.6 Mt in 1990 to 44.8 Mt in 2010, matched by a growth in exports and domestic demand. In 2010, Viet Nam exported 19.876 Mt, a decrease of 5.1 Mt compared to 2009. Primary coal supply increased by 12.9% per year from 2000 to 2010, from 4 397 ktoe to 14 743 ktoe.

Electricity generation increased at an average annual rate of 13.7% between 2000 and 2010, from 26 562 GWh in 2000 to 95 523 GWh in 2010. The structure of the primary energy use in Viet Nam's power plants has changed drastically within the past decade. Oil-product use in generation decreased substantially, while the share of gas in electricity generation increased from 7.6% of total generation in 1995 to 48% in 2010. The share of coal declined from 33% in 1995 to 19% in 2010. In the meantime, hydropower decreased from 72% of total generation to 29% in 2010 due to the rapid expansion of natural gas use and the increased involvement of foreign companies in Viet Nam's growing power market. In 2010, the economy's installed generating capacity was 21 500 MW; of that total, 54% was managed by Viet Nam Electric Power Group (EVN) and 46% was managed by others. In addition, more than 5 500 GWh was imported from China.

Table 2 Energy supply and consumption, 2010

| Primary energy supply (ktoe) | | Final energy consumption (ktoe) | | Power generation (GWh) | |
|------------------------------|--------|---------------------------------|--------|------------------------|-------|
| Indigenous production | 51 277 | Industry sector | 14 926 | Total | 95523 |
| Net imports and other | -6 998 | Transport sector | 11 164 | Thermal | 66981 |
| Total PES | 45 910 | Other sectors | 9 903 | Hydro | 28542 |
| Coal | 14 743 | Total FEC | 35 992 | Nuclear | - |
| Oil | 20 203 | Coal | 9 893 | Other | - |
| Gas | 8 123 | Oil | 18 131 | | |
| Other | 2 841 | Gas | 493 | | |
| | | Electricity and others | 7 476 | | |

Source: EDMC (2013)

FINAL ENERGY CONSUMPTION

In 2010, Viet Nam's total commercial final energy consumption (FEC) was 35 992 ktoe, up 12.2% from 2009. By fuel source, oil contributed the largest share (50%), followed by coal (27%), electricity and others (21%) and gas (1%). Between 2000 and 2010, consumption of electricity grew rapidly, at an annual growth rate of 13%.

Industry remains one of the biggest energy consumers, accounting for 41% of final energy consumption in 2010. The steel, construction materials, pulp and paper, and fertilizer manufacturing industries consumed the most energy. From 2000 to 2010, the annual average growth rate of energy consumption in industry was 12%.

The transport sector's share was 31% in 2010 compared to 32% in 2009. Oil products (diesel, gasoline and fuel oil) are mainly used in transportation. Other sectors (electricity, excluding biomass) consumed 21% of Viet Nam's FEC, which no change compared with 2009.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Industry and Trade (MOIT) was formed after the merger of the Ministry of Industry and the Ministry of Trade. MOIT is in charge of activities related to the energy sector and other industries, in accordance with Decree 189/2007/ND-CP issued by the Prime Minister on 27 December 2007.

MOIT is responsible for the state management of all energy industries, including electricity, new renewable energy, coal, and the oil and gas industries. It is in charge of the formulation of law, policies, development strategies, master plans and annual plans for those sectors, and submits them to the Prime Minister for issue or approval. The Ministry is also responsible for directing and supervising the development of the energy sector and reporting its findings to the Prime Minister.

Inside MOIT, the General Department of Energy administers the Viet Nam Electric Power Group (EVN), the Viet Nam National Coal and Mineral Industries Group (Vinacomin) and the Viet Nam Oil and Gas Group (PetroVietnam, or PVN).

Apart from that, many other ministries also have responsibilities relating to energy. The Ministry of Planning and Investment sets the Socio-Economic Development Strategy and Plan, coordinates the distribution of economy-wide capital investment among projects submitted by ministries and agencies, and distributes foreign direct investment. The Ministry of Finance has jurisdiction over tariffs and taxation related to energy activities. The Ministry of National Resources and Environment plays an important role in research and development in energy and environmental protection, including evaluating environmental issues in all kinds of projects at the national level.

The National Energy Development Strategy was approved by the Prime Minister in December 2007. The strategy set up the following main targets for energy development (PMVN, 2007a):

- Ensuring sufficient supply of energy to meet the demands of socioeconomic development, in which primary energy is expected to reach 100–110 Mtoe in 2020 and 310–320 Mtoe in 2050;
- Ensuring the phased development of refineries to meet domestic demand for petroleum products, and increasing the capacity of refineries to about 25–30 Mt of crude oil in 2020;
- Ensuring strategic oil stockpiling adequate for 60 days in 2020 and 90 days in 2025;
- Achieving a share of renewable energy in the total commercial primary energy supply of 5% in 2025 and 11% in 2050;
- Completing the rural electrification program for rural and mountainous areas, and increasing the proportion of rural households with access to electricity to 100% in 2020;
- Changing the electricity, coal and oil–gas sectors to operate in competitive markets with state regulation; establishing a competitive electricity retail market in the period after 2022; establishing a coal and petroleum product business market by 2015;

- Actively preparing the conditions for putting the first unit of a nuclear power plant into operation in 2020, and then gradually expanding the role of nuclear power in the economy's energy structure.

In terms of nuclear power development, the government of Viet Nam is carefully reviewing the safety issues and considers them the first priority for review.

Energy security

Viet Nam is diversifying its consumption of energy by developing regional indigenous resources and expanding regional cooperation. It hopes to minimize its dependence on oil, and places priority on ensuring that energy supplies are adequate to meet the needs of a growing population and to support socioeconomic development.

Beyond 2015, Viet Nam expects a transformation from being a net energy exporting economy to being a net importing economy. This inevitable change requires special consideration of energy security policies and the preparation of a long-term policy to ensure the supply of energy.

The economy needs to overcome many challenges to ensure energy security. Oil products, for example, will still have to be imported, although Viet Nam's first oil refinery was completed in 2009. The economy currently has no strategic oil stockpiling in place and the power sector is still in the process of reform. In addition, electricity shortages are improving but still occur on occasion and the power systems operate without adequate reserves. Investment in energy development, especially in electricity generation, is insufficient to meet the rapid growth in demand. In the coal sector, there are still many challenges: the need for greater environmental protection, declining coal reserves, and the need to develop new coal reserves and supply infrastructure to meet the increasing demand. Although the potential for oil and gas discoveries is high, the size of those reserves is relatively small. In addition, relatively large oilfields that are in production (such as Bach Ho, Block 06.1 and other fields) are in decline, and are estimated to be depleted within the next 10 to 15 years.

To lessen dependency on oil product imports and to ensure energy security, Viet Nam is implementing the following policies (PMVN, 2007a):

- Strengthen domestic energy supply capacity through legislative reforms and the expansion of the 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;
- Strengthen the exploitation and use of domestic energy resources to reduce dependence on imported energy that is prone to price volatility, especially petroleum;
- Improve energy efficiency, reduce energy losses and implement extensive measures for the conservation of energy;
- Encourage Viet Nam's oil companies in investing in exploration and the development of oil and gas resources overseas;
- Intensify regional and international energy cooperation and diversify energy import sources;
- Develop clean energy, especially new and renewable energy.

ENERGY MARKET

Power sector

Electricity of Viet Nam (EVN) is a state-owned utility founded in 1995 and now called Viet Nam Electric Power Group. The group is engaged in the generation, transmission and distribution of electricity for the whole of Viet Nam. EVN is responsible for the electricity supply that supports economic development and provides power to meet the consumption needs of the people. EVN also has the key responsibility of ensuring that the investments in power generation and network expansion meet the power demands of the economy. Apart from EVN, other companies are also responsible for much of this, supplemented by the Build–Operate–Transfer and independent power producer schemes run in partnership with private investors. In 2010, over 53% (53 131 GWh) of the power supply system in Viet Nam was owned by companies other than EVN.

The Electricity Law outlines the major principles for the establishment of the power market in Viet Nam. The Electricity Regulatory Authority of Viet Nam (ERAV) (PMVN 2005a) has the following responsibilities: to assist the Minister for Industry and Trade in implementing regulatory activities in the electricity sector; to contribute to a market that is safe and stable, and that provides a high-quality supply of electricity; to foster the economical and efficient consumption of electricity; and to uphold the equity and transparency of the sector in compliance with the law.

In January 2006, the Prime Minister approved the development of a competitive electricity market that attracts investment from foreign and domestic companies operating in the electricity sector (PMVN 2006a). Under this legislation, Viet Nam’s power market will be established and developed at three levels, each of which will be implemented in two steps:

- Level 1 (2005–2014): a competitive generation power market will replace the current monopoly and subsidised power;
- Level 2 (2015–2022): the establishment of a competitive wholesale power market;
- Level 3 (after 2022): the realisation of a competitive electricity retail market.

The other main aims of the legislation are to reinforce the effects of production and business activities within the electricity sector, to decrease upward pressure on electricity prices, to ensure the stable supply of reliable electricity and an increase in quality over time, and to ensure the robust development of the electricity sector.

As for electricity pricing, the current average electricity price (0.06 to 0.065 USD/KWh in 2012) is still lower than long run marginal cost (LRMC). Therefore, a set price adjustment schedule continues to be implemented with the goal of reaching an LRMC of about 0.075 to 0.08 USD/KWh by 2015.

In terms of power development, the Prime Minister approved the national power development plan for the 2011–2020 period with a vision that extends to 2030 (the “Power Master Plan VII”) on 21 July 2011. The Power Master Plan VII sets out four specific targets for Viet Nam’s power development in the next 20 years:

- Increase the aggregate output of imported and produced electricity from 194–210 billion kWh by 2015 to 330–362 billion kWh by 2020 and 695–834 billion kWh by 2030;
- Give priority to the development of power generation from renewable energy so that the proportion of electricity generated from renewable energy will be increased from the present 3.5% of the total electricity production to 4.5% in 2020 and 6% in 2030.
- Reduce the average energy elasticity ratio (the ratio between the growth rate of energy consumption and the growth rate of GDP in the same period) from the current 2.0 to 1.5 in 2015 and 1.0 in 2020;

- Promote the rural electrification program in rural, mountainous and island areas so that most of the rural households will have access to electricity by 2020.

As part of the reform of the electricity sector, EVN has been proceeding with plans to corporatise member enterprises since the early 2000s. So far, the restructuring of the generating and distributing companies has been completed and four power transmission companies have been merged into one national company, the National Transmission Company, which is separate from EVN. However, large hydropower plants, including Hoa Binh, Tri An, Yaly and Son La, and nuclear power plants (in the future), remain under the management of EVN.

Coal sector

The Prime Minister's Decision No. 199/2005/QĐ-TTg transformed the state-owned Viet Nam National Coal Corporation (Vinacoal) into the new Viet Nam National Coal and Mineral Industries Group (Vinacomin), which operates in the form of a holding company and is Viet Nam's first state-owned enterprise with diversified business interests (PMVN 2005b). Vinacomin was formed by restructuring Vinacoal and its subsidiaries into a robust economic group with advanced technology, modern management methods and diversified fields of business, including the coal industry, energy engineering, mining, shipbuilding, the automobile industry, and mineral exploitation and processing.

In July 2008, the Prime Minister approved the Viet Nam Coal Development Strategy to 2015, with an outlook to 2025 (PMVN 2008a). One of its main aims is to accelerate the corporatisation of coal production companies and the creation of a coal market with diversified ownership and business activities.

The government of Viet Nam has at times, in the interests of economic stability, requested that Vinacomin supply coal to the market at below cost price. This subsidising has had a positive impact on the development of industries that are fuelled by coal, but it has also resulted in reduced profit for Vinacomin and re-investment difficulties. The government has now begun the gradual deregulation of domestic coal prices. Since July 2009, Vinacomin has been allowed to set the price for local customers, except power generators, at the market price. In addition, the government has been preparing a strategy to deregulate the price of coal used for power generation. As a first step on this matter, in 2012, the government allowed the coal price for power production to be raised according to the latest electricity price adjustment. It is to be adjusted to not less than the coal production cost in order to ensure funding for the renovation, expansion and improvement of the capacity of the existing mines and building of new mines to meet coal demand and contribute to improvements in energy efficiency.

Oil and gas sectors

In August 2006 the Prime Minister approved a scheme to reform the Viet Nam Oil and Gas Group (PVN) by reorganizing the core business and its subsidiary units. PVN has multiple owners, but the government holds the dominant share.

The restructured PVN is a state-owned company, which will hold 100% of the assets: PetroVietnam Exploration Production Corporation, PetroVietnam Oil Corporation, PetroVietnam Power Corporation, Binh Son Refining and Petrochemical Company Limited, Dung Quat Shipbuilding Industry Company Limited, and PetroVietnam Camau Fertilizer Company Limited. PVN also includes joint stock companies, joint venture enterprises, scientific and technological enterprises, and training organisations.

Viet Nam's gas and oil upstream sector is open to all, while the downstream functions such as transmission, distribution (except that for petroleum products), and marketing are almost all within the PVN monopoly. Oil and gas production is carried out by PVN and private companies, including foreign companies and joint ventures with PVN, but all are required to sell through PVN.

Natural gas pricing is based on negotiation with PVN on a project-by-project basis, while the control of petroleum product prices by the government was removed in 2009.

FISCAL REGIME AND INVESTMENT

Power sector

According to the national electricity development plan for the 2010–30 period approved by the Prime Minister in July 2011 (Vnexpress, 2011), the electricity sector was in need of a total investment of approximately VND 929.7 trillion (about USD 465 billion) through to 2020. The capital is sourced from EVN and other domestic state-owned companies, foreign direct investment, the government's annual budget and loans.

Oil and gas sector

Upstream

In regard to overseas exploration and production activities, by the end of 2012, PVN had engaged in a number of new petroleum contracts, increasing the total number of effective exploration and production projects to 20 in 14 countries, including the Russian Federation, SNG countries, Middle East, Northern and Central Africa, Latin America and ASEAN countries. PVN plans to speed up exploration work inside and outside the economy in a bid to achieve the target of increasing access to reserves.

PVN strives to attract more foreign investment in exploration. It also seeks greater opportunities to invest in foreign economies and to increase the construction speed of key projects, such as the Nghi Son oil refinery, Nam Con Son Gas Pipeline Project No.2 (Hai Thach-Vung Tau), the gas pipeline Block B-Omon and the Ca Mau gas–electricity–fertilizer complex.

Regulations on direct investment abroad in the oil and gas sector by Viet Nam-based foreign investors have been stipulated in a decree signed by Viet Nam's Prime Minister in July 2007 (PMVN 2007b). The regulations contain detailed provisions on investment procedures and the state management of direct offshore investment in the oil and gas sector, as well as the implementation of oil and gas projects overseas. The new regulations are applicable to limited liability companies, partnership and private companies, state-owned companies, foreign-invested companies, cooperatives, household businesses and individuals.

Viet Nam has started to build a 398-kilometre pipeline from gas fields in Blocks B and 52 to O Mon, Can Tho Province. The pipeline capacity is to be 7 bcm per year, and the project is expected to be operational in 2014. For the long-term security of gas supply, the connection between Viet Nam and the Trans-ASEAN Gas Pipeline is within the framework of cooperation and is under discussion. Gas will be imported and exported via this gas network.

Downstream

The construction of Viet Nam's first oil refinery, the Dung Quat Refinery, began in June 2005 and the refinery commenced operation in 2009. The refinery is designed to have a capacity of 6.5 Mt of oil per year, sufficient to produce 33% of the economy's entire demand for petroleum products.

Although Viet Nam has exported crude oil for the past two decades, its petrochemical industry is still only in its preparatory phase. Almost all fuel and other oil products consumed have to be imported, as the Dung Quat Refinery does not yet meet domestic demand. This constraint is considered a potential threat to energy security in particular and to the stability of the economy in general. According to the development strategy for the oil and gas industry, Viet Nam plans to build three oil refineries with a total capacity of about 25–30 Mt of crude oil. A second refinery, Refinery Nghi Son, with a capacity of about 10 Mt of petroleum products per year, was directed to commence construction in the first quarter of 2013.

Four petrochemical centres will be completed by 2020. Three will be combined with oil refinery plants and the other, in the western area of southern Viet Nam, will use natural gas resources in the region to produce fertilizer and other products from ammonia.

Coal sector

According to the decision on a national coal development plan for the 2020–2030 period approved by the Prime Minister in January 2012 (PMVN 2012a), the coal sector needs a total investment of approximately VND 691 trillion (about USD 345 billion) through to 2030. The capital will be sourced from Vinacomin and other domestic state-owned companies, foreign direct investment, the stock market, the government's annual budget, and loans.

ENERGY EFFICIENCY

In April 2006, the Prime Minister approved the Viet Nam National Energy Efficiency Programme (VNEEP) for the 2006–15 period (PMVN 2006b). The programme'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 programme is to save 3%–5% of the total energy consumption over the 2006–10 period and 5%–8% in the 2011–15 period.

The programme includes six components: 1) strengthen state management of energy efficiency and conservation by developing a management system for energy saving; 2) strengthen education, disseminate information and enhance public awareness to promote energy efficiency and conservation (EE&C) as well as environmental protection; 3) develop and popularise highly energy-efficient equipment by phasing out low-efficiency equipment; 4) promote EE&C in industry; 5) promote EE&C in building; and 6) promote EE&C in transportation. Phase one of the VNEEP for the period 2006–11 has been successfully implemented, saving about 4 900 ktoe in total energy consumption for the period 2006–2010, equivalent to 3.4% of the total energy consumption in the respective period; phase two is now underway for the 2012–15 period (PMVN 2012b).

MOIT is the focal coordinator of the EE&C and is authorised to administer the implementation of the VNEEP. As part of this mechanism, the Energy Efficiency and Conservation Office was established within MOIT on 7 April 2006 (MOIT 2006). The main work of the office is to develop organizations and systems for improving energy efficiency and conservation at the government level from the central government to the local government.

A National Steering Committee chaired by MOIT was established to monitor the VNEEP. The committee includes representatives from the Union of Vietnam Associations of Science and Technology and the Ministries of Construction; Transport; Education and Training; Culture and Information (renamed the Ministry of Culture, Sports and Tourism in August 2007); Science and Technology; Planning and Investment; Justice; and Finance.

The United Nations Development Programme (UNDP) and the Viet Nam Ministry of Science and Technology have recently finished a project to raise the effectiveness of energy use in small and medium enterprises (SMEs). The project was funded by the Global Environmental Fund through the UNDP. Over the five years of the project, from 2006 to 2010, USD 29 million was provided for implementation at 500 SMEs operating in the areas of clean production, ceramics, weaving, paper and pulp manufacture, and food processing. The project included six sub-programmes: supporting policy and institutional development; improving communications and awareness; building technical capability; supporting providers of energy-saving services; providing financial assistance; and providing guidance in using energy economically and effectively. The project saved about 136 000 tonnes of fuel oil and reduced CO₂ emissions by 0.96 million tonnes annually during 2006–10.

The Promotion of Energy Efficiency and Conservation project, funded by Japan, began in 2000 and finished successfully in 2010. This project was jointly implemented by the Association of South East Asian Nations (ASEAN) Centre for Energy, ASEAN economies and the Energy Conservation Centre, Japan. The project has focused on the building, industry, energy management and transport sectors.

RENEWABLE ENERGY

Viet Nam is relatively rich in renewable energy resources. Those suitable for electricity generation include small hydro, solar, biomass, wind and geothermal. The potential for small hydropower resources with a capacity of less than 30 MW per site is estimated to be about 4 000 MW; the total capacity of geothermal is estimated at 300–400 MW; and power from biomass at about 800 MW. Wind is relatively abundant with a potential capacity of nearly 2 000 MW (IOE 2011).

Key government organizations studying or developing renewable energy are MOIT, the Ministry of Science and Technology (MOST), EVN, PVN and the Institute of Energy. MOIT is responsible for establishing and monitoring the implementation of energy policies such as the National Renewable Energy Development Strategy and the National Electricity Development Master Plan. In addition, many private companies, including foreign companies, have in recent years shown interest in developing renewable energy in Viet Nam.

In Viet Nam, renewable energy plays an important role in rural development. About 70% of the economy's 86 million people live in rural areas, but about 4% of households in those regions did not have access to electricity by 2012.

The government has provided significant support and legislated a number of policies to promote rural electrification and renewable energy development, such as the National Energy Development Strategy (PMVN 2007a), which addresses the following matters:

- The 'basis for development,' which includes giving priority to developing new and renewable energy resources, such as wind, solar and hydropower; and motivating the power development programme for rural areas;
- Development objectives including the developing of new and renewable energy, increasing its proportion from its currently inconsistent level to around 9.02 Mtoe (5% of total energy consumption) by 2025 and 35 Mtoe (11% of energy consumption) by 2050, and providing 100% of rural households with access to electricity by 2020.

The conditions for encouraging the development of renewable energy in Viet Nam in the coming years are favourable. The target is to increase the share of renewables in total electricity production to 6% by 2030. To reach the targets set for increasing the share of renewable energy sources in power generation, the government of Viet Nam has been developing policy to support the use of renewable energy since 2008. Government documents in this area include the Decision by the Minister of Industry and Trade on "Regulation on avoided cost based on electricity tariff and power purchase agreement" (MOIT, 2008), and the decision by the Prime Minister on "Mechanism for supporting wind power development" (PMVN, 2011b). The key elements of the decision on wind power development are the provision on the incentives for capital investment, and the provisions about related land use, transmission fees and electricity tariffs called the Fit-In Tariff (FIT). The FIT is equal to 0.078 USD/KWh and Electricity of Viet Nam (EVN) is responsible for purchasing electricity from all wind power plants. The Government will provide a subsidy of 0.01 USD/KWh of the power price for EVN through the Viet Nam Environment Protection Fund.

NUCLEAR

In June 2010, the Prime Minister approved a plan to build and develop a nuclear technology industry and to actively contribute to socioeconomic development and the strengthening of the economy's nuclear scientific and technological capacity (PMVN 2010).

MOIT submitted to the government for approval a 2005 pre-feasibility study on the building of a 2 000 MW nuclear power plant in Ninh Phuoc or Ninh Hai (two districts of Ninh Thuan Province in central Viet Nam). In mid-2009, MOIT submitted a revised version of the study (now called an investment report), which was approved by the National Assembly in November 2009.

In July 2010, the Prime Minister also approved a project entitled “Planning Orientation on Nuclear Power Development in Vietnam up to 2030”. This proposes that one unit with a capacity of 1 000 MW would be operating by 2020.

The construction of both plants will begin in 2014–15, and would be followed by the further development of the economy’s nuclear energy capacity to reach 8 000–10 000 MW by 2030 (IOE 2011). However, after the March 2011 Fukushima nuclear power plant accident in Japan, safety issues in the development and operation of nuclear power plants became a top priority for Viet Nam, and the programme’s timeframe and the amount of capacity to be developed over the long term are under careful review.

CLIMATE CHANGE

Sustainable development objectives began to be truly realised in Viet Nam in the 1990s. A series of policies have been adopted in the economic, social and environmental areas in parallel with the implementation of international commitments on sustainable development to which Viet Nam is a signatory.

Viet Nam signed the United Nations Framework Convention on Climate Change in November 1994 and ratified the Kyoto Protocol in August 2002. Viet Nam fulfils all requirements to be a host economy for the development of clean development mechanisms (CDMs) under the protocol.

The government considers climate change due to anthropogenic greenhouse gases to be a real threat and Viet Nam to be one of the economies most vulnerable to climate change. By participating in CDMs, Viet Nam has shown its willingness to contribute to global environmental protection while seeking additional investment and opportunities for technology transfer. In June 2003, the government designated the National Office for Climate Change and Ozone Protection (part of the International Cooperation Department of the Ministry of Natural Resources and Environment, or MONRE) as Viet Nam’s CDM National Authority. The CDM National Executive and Consultative Board, comprising officials from MONRE and other ministries, was established in April 2003. One year later, in August 2004, the Vietnamese Government adopted the “Strategic Orientation for Sustainable Development in Viet Nam” (Viet Nam Agenda 21). Soon after that, a number of ministries and local authorities also designed and enacted their respective versions of Agenda 21.

In December 2008, the Prime Minister of Viet Nam approved a budget of about VND 1965 billion for the National Targeting Programme for Protection from Climate Change (PMVN 2008b). At the same time, a National Steering Committee was established, with the Prime Minister as its chair. This programme aims to achieve two general objectives: to evaluate the potential impact of climate change in each sector and region at different time intervals; and to identify effective responses which are based on the close, reasonable and harmonious coordination of economic, social development and environmental protection goals. In addition, every five years the Vietnamese government issues its “National Target Programme to Respond to Climate Change” (NTP-RCC) to assess the climate change impact on sectors and regions over specific periods, and to develop feasible action plans that can effectively respond to climate change in the short and long term in order to ensure the sustainable development of Viet Nam.

Particularly, at the High-Level United Nations Conference on Sustainable Development (RIO+20) held in June 2012, the Viet Nam Government presented to the Conference a report titled “Implementation of Sustainable Development in Viet Nam in the Past 20 Years”. With this report, Viet Nam aimed to share with the international community its own experience in sustainable implementation, while looking forward to the international community’s continued cooperation and support, especially financial and technical support, with a view to continuing its efforts for sustainable development given the new situation in the 21st century (MPI, 2012).

Many international financial institutions and developed economies in the APEC region, including the World Bank, the Asian Development Bank, and the governments of Australia, Canada, Japan, the US and others are helping Viet Nam to build specific projects aimed at

reducing the impact of climate change. These include risk management for natural disasters and responses to climate change; land management for sustainable forestry under climate change conditions; the reduction of greenhouse gas emissions through efforts to combat deforestation and forest degradation; and rural development in the Cuu Long River Delta to cope with climate change.

Notable energy developments

ENERGY EFFICIENCY

In a statement to the Energy Working Group (EWG 2010) in November 2010, Viet Nam highlighted these achievements in the area of energy efficiency in the economy:

- Approval by the National Assembly in June 2010 of a law on energy efficiency and conservation;
- Creation of a standard for energy efficiency for electrical equipment including refrigerators, air conditioners, electrical cookers, street lights, and six sets of energy efficiency standards and testing procedures for household appliances (Centre for Vietnamese Standard);
- Survey of energy consumption in 500 key enterprises.

In order to bring the law on energy efficiency and conservation into efficient and easy implementation, the government of Viet Nam also issued a number of related legal documents in 2011 and 2012, such as the Decree on Detailed Regulations and Measures for Implementation of the Law; Regulation of Administrative Punishment on the Use of Energy Saving and Efficiency; the Road Map for Labelling Energy Equipment; and the Decree on Public Lighting Management.

RENEWABLE ENERGY

A 15 kW solar PV/wind power hybrid system in a 40-household village has been operating since 2000. This project was implemented by the Institute of Energy with a grant from Tohoku Electric Company of Japan. Another is an 800 kW wind power generator in Bach Long Island, financed completely by the government of Viet Nam in 2004. Some recent wind power developments include a 30 MW wind farm in Binh Thuan province, the first phase of which began with 20 wind turbines of 1.5 MW each. In the second phase from 2012 to 2015, the capacity of this plant will increase by 120 MW. The investor for this project is the Viet Nam Renewable Energy Joint Stock Company (REVN). A 9 MW wind/diesel power hybrid system with 3 wind turbines, each 2 MW, and 6 diesel generators, each 0.5 MW, is under construction by PVN in Phu Qui island.

Future wind energy developments, with a total installed capacity of 331 MW, include the Ly Son and Con Dao island projects (5 MW), the Phuong Mai wind farm in the Binh Dinh province (65 MW), the wind power projects in the Ninh Thuan province (126 MW), a wind farm in the Phu Yen Province (15 MW) and a wind farm in the Mekong River Delta (120 MW).

The biggest hydro power plant in South East Asia, the Son La Hydro Power Plant with a total capacity of 2 400 MW and six generators has been completed. The plant was officially put into operation on December 23, 2012 after seven years of construction, three years earlier than scheduled. The plan will provide a national grid with over 10.2 billion kWh of electricity each year and save over five million tonnes of coal.

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