

APEC ENERGY  
OVERVIEW

2012

Prepared by

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APEC#212-RE-01.12

## 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. For more information please see [http://www.apec.org/Meeting-Papers/Ministerial-Statements/Annual/2011/2011\\_amm.aspx](http://www.apec.org/Meeting-Papers/Ministerial-Statements/Annual/2011/2011_amm.aspx).

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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March 2013



## ACKNOWLEDGEMENTS

The *APEC Energy Overview* could not have been accomplished without the contributions of many individuals and organisations. We would like to thank all those whose efforts made this overview possible, in particular those named below.

We would like to thank APEC member economies for their efforts to improve the accuracy and timeliness of the information provided. We also would like to thank members of the APEC Energy Working Group (EWG), APEC Expert Group on Energy Data and Analysis (EGEDA), and APERC Advisory Board, along with numerous government officials, for their helpful information and comments.

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### ADMINISTRATIVE SUPPORT

Masatsugu Kamakura, Kaori Najima and Tomoyo Kawamura

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## ABBREVIATIONS AND SYMBOLS

<b>Abbreviation</b>	<b>Term</b>
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**

<b>Code</b>	<b>Currency</b>	<b>Economy</b>
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, averaging 3.1% over the period 2000–10. In 2010, Australia's GDP reached USD 683.54 billion (USD 2000 PPP), a 2.3% increase from 2009.

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, 2012).

In 2010-11, Australia's energy production was 16 640 petajoules. Australia produces energy for both domestic consumption and for export. Net energy exports accounted for 67% of domestic energy production in 2010-11, while domestic consumption accounted for the remaining 33% (BREE 2012, Australian Energy Statistics). In 2010 Australia was the world's ninth largest energy producer, accounting for around 2.4% of world energy production (IEA, 2012). 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 at a strong rate of 9% per year on average between 2000–2001 and 2010–2011.

From 2010 to 2011, coal accounted for 59% of Australia's primary energy production, in energy content terms, followed by uranium (20%) and gas (13%). Crude oil and LPG represented a further 6% of total energy production in energy content terms, and renewables 2%. From 2010 to 2011, Australia's export earnings from total mineral resources increased by 27%, in comparison to the period from 2009 to 2010, to a record AUD 175 billion. The increase in export values was supported by higher earnings from most mineral and energy commodities (BREE, 2012). Australia is the world's ninth-largest energy producer, the 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, 2010

Key data		Energy reserves <sup>a</sup>	
Area (million sq. km)	7.69	Oil (billion barrels)	4.1
Population (million)	22.3	Gas (billion cubic metres)	2 900
GDP (USD (2000) billion at PPP)	683.5	Coal (million tonnes)	76 400
GDP (USD (2000) per capita at PPP)	30 654		

a. BP (2012)

Source: EDMC (2012)

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**ENERGY SUPPLY AND DEMAND**


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**PRIMARY ENERGY SUPPLY**

In 2010 Australia's total primary energy supply was 124 725 kilotonnes of oil equivalent (ktoe). Around 41% of supply came from coal, 32% from oil, 21% from gas and the remainder from other sources. Australia accounts for around 6% of the world's black coal production and is the fourth largest producer after China, the United States and India. 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. Coal is Australia's largest commodity export, earning AUD 44 billion in 2010–11 (BREE, 2012a) and is also an important component of domestic energy supply, with around 75% of the energy used in electricity generation.

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 gas is sourced from three basins: the Carnarvon Basin in Western Australia, the Gippsland Basin in Victoria and the Cooper–Eromanga Basin that straddles South Australia and Queensland. Production of coal-seam methane (CSM), which is produced only in New South Wales and Queensland, has been expanding rapidly since 2000. CSM production is expected to continue to grow, and a number of projects are under development. In 2010–11, gas production increased by 9%, relative to 2009–10, to total 53.4 billion cubic metres. Australia is a net importer of crude oil and petroleum products, but a net exporter of liquefied petroleum gas (LPG). Around 79% of crude oil and condensate production is exported, while around 83% of Australia's refinery feedstock was imported in 2010–11. 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, 2012d).

In 2010, 241 584 gigawatt-hours (GWh) of electricity were generated, mostly from thermal sources (91%). Given its abundance, coal is expected to remain the most commonly used fuel in electricity generation. However, given the large number of gas-fired and renewable projects underway, especially wind and solar, those energy sources 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 2010 was 75 436 ktoe. The transport sector accounted for roughly 38% of the total, the industry sector 30% and the other sectors, which include residential and commercial, 32%. By energy source, petroleum products accounted for roughly 51% of consumption, electricity and other 27%, natural gas 17% and coal 4%.

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**Table 2** Energy supply and consumption, 2010

<b>Primary energy supply (ktoe)</b>		<b>Final energy consumption (ktoe)</b>		<b>Power generation (GWh)</b>	
Indigenous production	310 617	Industry sector	22 408	Total	241 584
Net imports and other	–185 635	Transport sector	28 775	Thermal	220 081
Total PES	124 725	Other sectors	24 254	Hydro	12 522
Coal	51 427	Total FEC	75 436	Nuclear	–
Oil	39 867	Coal	3 039	Other	8 981
Gas	26 491	Oil	38 513		
Other	6 940	Gas	13 153		
		Electricity and other	20 730		

Source: EDMC (2012).

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## POLICY OVERVIEW

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### ENERGY POLICY FRAMEWORK

Australia's system of government has three tiers—the Australian Government (federal); the six state governments and two territory governments; and local governments. Australian energy resources are owned either by the Australian 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 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 Australian Government is preparing a new Energy White Paper to set new policy directions (the most recent such White Paper was released in 2012). The new Energy White Paper will focus on the provision of clean, secure, reliable and competitively-priced energy supplies by 2030. It will examine energy exploration, gas development, low-emissions energy technologies, transport fuels, an integrated Australia-wide energy market, and capacity building and skills. See also the 'Notable energy developments' section.

In 2001, the Council of Australian Governments (COAG) established the Ministerial Council on Energy (MCE) to provide policy leadership and oversight to ensure the Australian energy sector could take advantage of opportunities and address emerging challenges. The council comprises the ministers with responsibility for energy from all the Australian states and territories. It is responsible for delivering economic and environmental benefits within the COAG energy policy framework, and is the policy and governance body for Australia's energy markets (MCE,2003). At the end of 2011 the COAG developed the Standing Council on Energy and Resources (SCER) which has formally commenced and will carry on key reform elements of the Ministerial Council on Mineral and Petroleum Resources and the Ministerial Council on Energy.

The standing council will:

- progress 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 (RET, 2012).

### ENERGY SECURITY

In 2009, the Australian Government released the National Energy Security Assessment (NESA), which assessed the challenges that could affect Australia's current and future energy security. Energy security was defined to be the adequate, reliable and affordable provision of energy to support the functioning of the economy and social development, where '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 (Australian Government, 2009).

The findings of the Australian Government's 2011 NESA show that energy security does not depend on energy independence or the ability to be self-sufficient. Instead, the growing interconnectedness of the global energy trade provides Australia with flexibility and energy security benefits, as the economy is both a buyer and seller of liquid fuel and other energy commodities in global markets. The international trade in energy resources is like the trade in other commodities: the benefits unambiguously increase national development options and boost national and global wealth (RET, 2011a).

## 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 petroleum sector, the government relies on an annual acreage release to create opportunities for investment. The release, distributed worldwide, is a comprehensive package that includes details of the acreage, bidding requirements and permit conditions.

## ENERGY MARKETS

### MARKET REFORMS

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

The Australian Government does not undertake or finance energy resource exploration or development. In the petroleum sector, the government relies on an annual acreage release to create opportunities for investment. The release, distributed worldwide, is a comprehensive package that includes details of the acreage, bidding requirements and permit conditions. All foreign investment proposals in Australia are subject to assessment and subsequent government approval through the Foreign Investment Review Board.

The approvals process for unconventional gas exploration is overseen by each responsible state government, under the Environment Protection and Biodiversity Conservation Act 1999. In this process each state assesses applications from each company looking to explore in their area, and then declines or grants access; this can be quite a lengthy process. Similarly, the assessment of safety requirements and environmental regulations for the coal industry is carried out by the state each project is based in.

### 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.

A key component of 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 managing 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 (to provide more information to market participants and potential investors), as well as the electricity Statement of Opportunities and the new Gas Market Statement of Opportunities (to 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, as the rule-making body, and the Australian Energy Regulator, as the regulating body.

### FISCAL REGIME AND INVESTMENT

The taxation treatment of corporations 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 taxed at a flat rate of 30%; they are also required to pay other indirect taxes, such as payroll tax, fringe benefits tax, fuel excise and land taxes. Some capital expenditure incurred by energy companies, such as exploration expenditure and royalty payments, is tax deductible. In addition, the Research and Development (R&D) Tax Concession is a broad-based, market-driven tax concession which allows companies to deduct up to 125% of qualifying expenditure incurred on R&D activities when lodging their corporate tax return. A 175% Incremental (Premium) Tax Concession and R&D Tax Offset are also available in certain circumstances. In May 2009, the Australian Government announced it would replace the existing R&D Tax Concession with a new R&D Tax Credit. The R&D Tax Credit came into effect from 1 July 2010. The two core components of the package are:

- A 45% refundable tax credit (equivalent to a 150% concession) for companies with a turnover of less than AUD 20 million per year.
- A 40% standard tax credit (the equivalent of a 133% deduction).

The new tax credit is decoupled from the corporate tax rate, thereby creating certainty in the level of assistance provided.

Corporations involved in energy extraction activities are also required to pay royalties to the governments for the use of their community's natural resources. Royalties on onshore production (excluding petroleum) are collected by the state and Northern Territory governments. 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 offshore production (excluding petroleum), 60% of the royalties are directed to the state or territory government and the remaining 40% to the Australian Government (RET 2010a, 2010b).

Different royalty rates apply to petroleum. Royalties for onshore production are collected by the state and Northern Territory governments. The rate is generally 10% of the net wellhead value of production. A Commonwealth excise applies to crude oil and condensate production, with the first 30 million barrels being excise exempt and the rate varying with production. The Petroleum Resource Rent Tax (PRRT) applies to offshore petroleum projects except for the North West Shelf production area and the Joint Petroleum Development Area in the waters between Australia and East Timor, which have their own separate arrangements. The PRRT is levied at a rate of 40% of the net project income after accumulated general project and

exploration expenditures have been deducted. Project expenditures are classified as either Class 1 or Class 2 expenditures, the former being expenditure incurred before 1 July 1990 and the latter on or after 1 July 1990. Under Class 1, both exploration expenditure and general project expenditure incurred no more than five years before a production license is in force are accumulated at the long-term bond rate (LTBR) plus 15 percentage points; all expenditure incurred more than five years after a production license is in force is accumulated at the gross domestic product (GDP) factor. Under Class 2, exploration expenditure incurred no more than five years before a production license is in force is accumulated at the LTBR plus 15 percentage points; general project expenditure incurred no more than five years before a production license is in force is accumulated at the LTBR plus 5 percentage points; and all expenditure incurred more than five years after a production license is in force is accumulated at the GDP factor (RET 2010a).

The Australian Government has completed a comprehensive review of the taxation system through the Australia's Future Tax System Review. The review team made recommendations on the structure of a future tax system to accommodate demographic, social, economic and environmental changes. It delivered its report to the government in December 2009, and the government released the final report and its initial response in May 2010 (Treasury, 2010). In its response, the government indicated the report may provide the foundations for a long-term plan for tax reform, and signalled changes to the taxation treatment of resource companies. In November 2011 the Minerals Resource Rent Tax (MRRT) regime was passed through Parliament. The MRRT will apply to the mining of iron ore and coal in Australia. The Petroleum Resource Rent Tax (PRRT) regime, already in place, will be extended to all Australian onshore and offshore oil and gas projects, including the North West Shelf. This will provide certainty for oil and gas projects and ensure all oil and gas projects are treated equitably.

Some key features of the MRRT include:

- Taxpayers with small amounts of MRRT assessable profits (i.e. AUD 50 million per year) will be excluded from the MRRT.
- The MRRT will apply an internationally competitive rate of 30%.
- New investment will be given generous treatment in the form of immediate write-off, rather than depreciation over a number of years. This allows mining projects to access the deductions immediately, and means a project will not pay any MRRT until it has made enough profit to pay off its upfront investment.
- The MRRT will carry forward unutilised losses at the government long term bond rate plus 7%.
- The MRRT will provide transferability of deductions. This supports mine development because it means a taxpayer can use the deductions that flow from investments in the construction phase of a project to offset the MRRT liability from another of its projects that is in the production phase.
- The MRRT will also provide a full credit for state royalties paid by a taxpayer in respect of a mining project. Unused credits for royalties paid will be uplifted at the long term government bond rate plus 7%, as per other expenses. Unused royalty credits will not be transferrable between projects or refundable.
- The MRRT will provide generous recognition of past investments through a credit that recognises the market value of those investments, written down over a period of up to 25 years. Unlike other costs, this starting base will not be uplifted. (Treasury 2010)

The Australian energy sector faces an unprecedented investment challenge over the next decade. The investment requirements are primarily driven by the need to maintain the reliability and security of the system and Government climate change and related policies (such as the Renewable Energy Target (RET)). The Australian Energy Market Operator's (AEMO) National Transmission Development Plan (NTNDP) forecasts between AUD 72 billion and AUD 82 billion for new generation and electricity transmission expenditure by 2030. This compares to an estimate of about AUD 12 billion that has been invested in generation since the commencement



of the NEM in 1998. AEMO's estimate excludes further investments in shared transmission and distribution networks, and investment in gas pipelines, production and associated works which could exceed AUD 140 billion to 2030, meaning that overall investment in the sector could exceed AUD 240 billion. (RET, 2010c).

### 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 the overarching programme of work for promoting energy efficiency in Australia. The NSEE is a coordinated approach to accelerating energy efficiency efforts to help households and businesses reduce their energy costs and prepare for the emissions reduction measures and targets in the Clean Energy Act 2011.

The NSEE incorporates and builds on measures already agreed by COAG and the MCE 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 Resources, Energy and Tourism is working with the Department of Climate Change and Energy Efficiency to develop an Energy Savings Initiative (ESI), a market-based tool for driving economy-wide improvements in energy efficiency. The Clean Energy Future (CEF) plan (the Australian Government's comprehensive plan for securing a clean energy future) states that further work on a national ESI will be 'the subject of detailed policy analysis, economic modelling and consultation with the community, industry and State and Territory governments' (RET, 2011b).

The Energy Efficiency Opportunities (EEO) programme is designed to address organisational barriers to efficient energy use by building the energy management capacity of companies. The programme requires participant firms using more than 0.5 petajoules (PJs) 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 220 businesses are currently registered with the programme, accounting for more than 60% of the total energy used by business and around 45% of all energy used in Australia. Results from reporting to date indicate that corporations plan to implement energy savings equivalent to about 1% of Australia's energy end use (RET, 2011c).

BREE (2012c) 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. If continued, and based on this measure, Australia is on track to achieve the energy intensity targets set by APEC.

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. Australian production of renewable energy (including electricity generation and direct use) is dominated by wood and wood products, bagasse and hydroelectricity, which combined accounted for around 76% of renewable energy production in 2010–11. In 2010–11, the strongest growth in renewable energy production occurred in solar-powered electricity generation, which increased by 204%, albeit from a small base. Wind-powered electricity generation and solar hot water also increased considerably, by 15% and 8%, respectively (BREE, 2012b).

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 Small-scale Renewable Energy Scheme (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 offers a number of programmes to encourage the development of renewable energy resources. The Australian Centre for Renewable Energy (ACRE) was established to promote the development, commercialisation and deployment of renewable energy and enabling technologies, and to improve their competitiveness. In 2012, the Australian Renewable Energy Agency (ARENA) will consolidate administration of AUD 3.2 billion in Government support for renewable energy technology innovation, assuming management of funding previously administered by ACRE, the Australian Solar Institute and the Department of Resources, Energy and Tourism.

There is no Australia-wide feed-in tariff scheme to support small-scale renewable technologies. Most state and territory governments have implemented, amended or closed their feed-in tariff schemes. Several states governments have recently completed reviews of, or are in the process of reviewing, their jurisdictional feed-in tariff arrangements for small-scale renewable technologies.

Over the long term, renewables are important energy sources. Following BREE 2012(e) 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 from 21 PJ in 2010–2011 to 282 PJ in 2049–2050.

#### ENERGY TECHNOLOGY AND RESEARCH AND DEVELOPMENT

The Australian Government is promoting the development of clean energy technologies through the programs that make up the Clean Energy Future plan. Further details are provided in the 'Notable energy developments' section.

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 Energy Flagships program is a focus for energy research and development in Australia, and the Australian Solar Institute supports research and development into both solar thermal and photovoltaic technologies.

## NUCLEAR

Australia does not have any commercial nuclear reactors. It currently has no plans to develop a nuclear energy industry.

## CLIMATE CHANGE

The Australian Government's climate change policy is built on three pillars:

- reducing Australia's emissions of greenhouse gases
- adapting to unavoidable climate change
- helping to shape a global solution.

The Clean Energy Act 2011 sets up a mechanism to deal with climate change by encouraging the use of clean energy, and reaffirms the government's commitment to the long-term goal of reducing Australia's net greenhouse gas emissions to 80% below 2000 levels by 2050 (DCCEE2011). For more details about the Act, see 'Notable energy developments'.

## CLEAN ENERGY

To complement the Renewable Energy Target (RET), in May 2009 the AUD 4.5 billion Clean Energy Initiative (CEI) was announced, to support the research, development and deployment of low-emissions technologies. The CEI had four major components:

- AUD 2 billion Carbon Capture and Storage Flagships Programme;
- AUD 1.5 billion Solar Flagships Programme;
- AUD 100 million Australian Solar Institute (ASI);
- AUD 560 million Australian Centre for Renewable Energy (ACRE).

On 10 July 2011, the Australian Government announced the Clean Energy Future plan which transitioned the previous Clean Energy Initiative and other Government programmes into a comprehensive plan to reduce Australia's greenhouse gas emissions, including:

- the introduction of a carbon price;
- the promotion of innovation and investment in renewable energy
- the encouragement of energy efficiency
- the creation of opportunities in the land sector to cut pollution.

Under the Clean Energy Future plan, the Government will also establish two new institutions to support the development of low emissions technologies: the AUD 10 billion Clean Energy Finance Corporation (CEFC) and the AUD 3.2 billion Australian Renewable Energy Agency (ARENA). ARENA will take over management of the business and contracts of ACRE, the ASI, and Solar Flagships initiatives.

The Carbon Capture and Storage Flagships Programme continues, managed by the Department of Resources, Energy and Tourism. The Flagships programme is complemented by the national low emissions coal initiative, and Australian Government support for the Global Carbon Capture and Storage Institute. Progress with these low emission coal initiatives is discussed further under 'Notable energy developments'.

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## NOTABLE ENERGY DEVELOPMENTS

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### CLEAN ENERGY ACT 2011

In November 2011, the Australian parliament passed the Clean Energy Act 2011, which establishes the structure of and process for introducing an economy-wide carbon price on 1 July 2012, and the transition to an emissions trading mechanism on 1 July 2015.

The Act covers the following:

- liable entities' obligations to surrender emissions units corresponding to their emissions
- limits on the number of emissions units that will be issued
- the nature of carbon units
- the allocation of carbon units, including by auction and the issue of free units
- mechanisms to contain costs, including the fixed charge period and price floors and ceilings
- links to other emissions trading schemes
- assistance for emissions-intensive trade-exposed activities and coal-fired electricity generators
- monitoring and enforcement.

The Clean Energy Future package incorporates the carbon pricing mechanism, along with a commitment to renewable energy, energy efficiency and action in the land sector.

The agricultural sector is exempt from the proposed carbon pricing mechanism. However, farmers will be able to participate in emissions mitigation activities through the Carbon Farming Initiative (CFI), which will give farmers and other land managers an opportunity to generate income from taking action on their emissions.

The Clean Energy package contains three separate targets for emissions reduction in Australia:

- To meet Australia's obligations under the Climate Change Convention—5% reduction from 2000 levels by 2020 regardless of what other economies do, and by up to 15% or 25% depending on the scale of global action.
- To meet Australia's obligations under the Kyoto Protocol—restraining the economy's emissions to an average of 108% of 1990 levels over the first commitment period (2008–12).
- The Australian Government's long-term target of reducing Australia's net greenhouse gas emissions to 80% below 2000 levels by 2050.

The government estimates that meeting Australia's commitment under the Climate Change Convention to reduce emissions by 5% from 2000 levels by 2020 will require an abatement of at least 159 million tonnes of CO<sub>2</sub>-e (or 23%) in 2020.

#### CARBON PRICE

The carbon pricing mechanism establishes a fixed carbon price of AUD 23 (USD 24) per tonne (rising at 2.5% per year in real terms) for the period 1 July 2012 to 30 June 2015. The carbon price will apply to around 500 of Australia's largest greenhouse gas emitters. Around 60% of Australia's emissions will be directly covered by the carbon pricing mechanism, and around two-thirds will be covered by a combination of the mechanism and equivalent carbon pricing arrangements. From 1 July 2015, the carbon price will become flexible under a 'cap and trade' emissions trading scheme, with the price largely determined by the market.

This cap and trade scheme differs from the traditional emissions trading system in that there will be a fixed-price period for the first three years of the scheme. Emissions units will be able to be traded from 1 July 2015, and a lower and upper limit of emissions unit prices will apply for the first three years beyond 1 July 2015 (DCCEE, 2011a).

The carbon pricing mechanism covers emissions from stationary energy, industrial processes, fugitive emissions (except from decommissioned coal mines) and non-legacy waste. Amendments to other legislation – which cover fuel tax and synthetic greenhouse gases (GHG) – apply an equivalent carbon price to some business transport emissions, to the non-transport use of transport fuels, and to synthetic GHG. The introduction of a carbon pricing mechanism is likely to result in the reduction in the consumption of high GHG-emitting resources such as coal, and instead promote the use of more environmentally-friendly sources of energy such as renewables

and natural gas. This is timely given Australia's significant role in the 'golden age of gas' as described above.

#### CLEAN ENERGY FINANCE CORPORATION

The commercially-oriented AUD 10 billion Clean Energy Finance Corporation (CEFC) will invest in businesses seeking funds for the commercialisation and deployment of renewable energy, energy efficiency and low-emissions technologies. It will also invest in manufacturing businesses that provide inputs for these sectors, for example those manufacturing wind turbine blades.

A number of funding tools will be used to support projects, including loans on commercial or concessional terms and equity investments. Capital returned from its investments will be reinvested. CEFC's investments will be divided into two streams, each with half of the allocated funding:

- a renewable energy stream
- a clean energy stream, which will invest more broadly, for example, in low-emissions cogeneration technology, but will still be able to invest in renewable energy.
- While CEFC's is the responsibility of the Treasury, in order to support its implementation, on November 2012 CEFC's Board appointed its Chair, with the main task of preparing CEFC to start investing from the second half of 2013 (CEFC, 2012)

#### AUSTRALIAN RENEWABLE ENERGY AGENCY (ARENA)

- ARENA will be an independent statutory body managing AUD 3.2 billion in funding in existing and new Australian Government renewable energy grants supporting research and development of renewable energy technologies and initiatives to bring them to market. ARENA will have oversight of existing renewable energy grant funding currently administered by the Department of Resources, Energy and Tourism, the Australian Centre for Renewable Energy (ACRE) and the Australian Solar Institute (ASI).

- ARENA will have an independent decision-making board (the Board) consisting of seven members appointed by the Minister for Resources and Energy and will also have a CEO appointed by the Minister for Resources and Energy, on the recommendation of the Board. Membership of the Board will reflect the skills required to meet the objectives of ARENA.

- Around AUD 1.7 billion in uncommitted funding from the range of consolidated programmes will be available to ARENA to invest in accordance with a funding strategy to be developed by the Board. This strategy will aim to increase the deployment of renewable energy and drive down its costs in an Australian context.

- ARENA will have responsibility for managing a range of existing initiatives including:
  - Solar Flagships Programme
  - Renewable Energy Demonstration Programme
  - ACRE Solar Projects
  - Geothermal Drilling Programme projects
  - Australian Biofuels Research Institute (ABRI) initiatives
  - Emerging Renewables Programme
  - Renewable Energy Venture Capital Fund
  - Australian Solar Institute
  - Low Emissions Technology Demonstration Fund (Solar)
  - Second Generation Biofuels Research and Development Programme
  - unallocated funding from the Connecting Renewables Initiative.

Legislation to establish ARENA was passed through parliament on 12 October 2011. It is intended that ARENA will commence operation from 1 July 2012.

#### SOLAR FLAGSHIPS PROGRAMME

This AUD 1.5 billion programme, to be managed by ARENA, supports the construction and demonstration of large-scale, grid-connected solar power stations operating within a competitive electricity market. The first Solar Flagships funding round targets up to 400 MW split across one photo voltaic (PV) project and one solar thermal project.

#### CLEAN TECHNOLOGY PROGRAMME

The AUD 1.2 billion Clean Technology Programme will provide support for manufacturers through three components: the Clean Technology Investment Programme; the Clean Technology Food and Foundries Investment Programme; and the Clean Technology Innovation Programme. While the carbon price will provide incentives for these manufacturers to reduce energy consumption, the Government will also help manufacturing businesses invest in energy efficient equipment, processes and products to reduce their exposure to changing electricity prices.

#### CARBON CAPTURE AND STORAGE FLAGSHIPS PROGRAMME

The AUD 1.7 billion Carbon Capture and Storage (CCS) Flagships Programme is funding research, development and demonstration in CCS, an important technology for the future of low emissions fossil fuel energy generation. The program is already funding the development of:

- a detailed storage viability study for the Collie South West Hub project, which is an integrated CO<sub>2</sub> capture, transport and storage hub that has the potential to make significant CO<sub>2</sub> emissions reductions from industrial processing and power generation in Western Australia's South West.
- the feasibility work leading to demonstration of low emission brown coal electricity generation in the Latrobe Valley Region in Victoria as part of the CarbonNet Project. The CarbonNet Project incorporates the development of a CO<sub>2</sub> transport network and storage hub that could capture and store emissions from a range of emitters in the region and could be a forerunner for annual storage of CO<sub>2</sub> totalling tens of millions of tonnes.

Complementing this programme is the National Low Emissions Coal Initiative, which aims to accelerate the development and deployment of technologies to reduce emissions from coal use with a focus on carbon capture and storage. These technologies will enable coal to make a major contribution to reducing Australia's greenhouse gas (GHG) emissions by 80% of 2000 levels by 2050. Over eight years, the Australian Government will provide funding of AUD 370 million to support the initiative.

In addition, the Government has contributed to the creation of, and continues to support, the Global CCS Institute, which was established in 2009 to accelerate the global deployment of commercial scale CCS projects. Total international funding for the Institute stands at AUD 315 million through 2016–17.

#### DRAFT ENERGY WHITE PAPER

The Energy White Paper (EWP) 2012 sets out the Australian Government's policy framework to guide the transformation of Australia's energy and energy resource sectors. The EWP promotes well-functioning markets supported by efficient and effective regulatory frameworks to deliver competitively priced energy. The core objective is to build a secure, resilient and efficient energy system that provides accessible, reliable and competitively priced energy for all Australians; enhances Australia's domestic and export growth potential; and delivers clean and sustainable energy. The four key priority areas outlined in the draft EWP are strengthening the resilience of Australia's energy policy framework; delivering better energy market outcomes for consumers; developing Australia's critical energy resources – particularly gas resources; and accelerating clean energy outcomes.

An update to the 2009 National Energy Security Assessment (NESA) was released in December 2011. The 2011 NESA found that Australia's overall energy security situation is expected to remain adequate and reliable, but it will increasingly be shaped by the strength of new investment going forward and the price of energy, which are both materially influenced by global trends (RET, 2011d). The 2011 NESA was a key input into the development of the draft Energy White Paper.

### NEW ENERGY PROJECTS

Australia's production and infrastructure capacity will be expanded in the future (BREE, 2012b), following the completion of investment decisions and construction of numerous projects, details of which can be found at [www.bree.gov.au/publications/mimp.html](http://www.bree.gov.au/publications/mimp.html)

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#### USEFUL LINKS

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- Australian Bureau of Statistics—[www.abs.gov.au](http://www.abs.gov.au)
- Australian Energy Market Commission—[www.aemc.gov.au](http://www.aemc.gov.au)
- Australian Energy Market Operator—[www.aemo.com.au](http://www.aemo.com.au)
- Australian Energy Regulator—[www.aer.gov.au](http://www.aer.gov.au)
- Australian Government—[www.australia.gov.au](http://www.australia.gov.au)
- Australian Government Department of Climate Change and Energy Efficiency—  
[www.climatechange.gov.au](http://www.climatechange.gov.au)
- Australian Government Department of Resources, Energy and Tourism—[www.ret.gov.au](http://www.ret.gov.au)
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- Commonwealth Law—[www.comlaw.gov.au](http://www.comlaw.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; with its capital, Bandar Seri Begawan 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 measures and village tradition.

In 2011, Brunei Darussalam's GDP was USD 16.3 billion and its GDP per capita PPP was USD 45 707 (Constant 2005 International Dollar). Since their discovery in 1929, oil and gas activities 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 67.7% 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 <sup>b</sup>	
Area (sq. km) <sup>a</sup>	5 765	Oil (billion barrels)	1.1
Population (thousand)	393	Gas (trillion cubic metres)	0.3
GDP (Billion US\$)	16.3	Coal (million tonnes)	–
GDP (USD (2005) per capita at PPP)	45 707		

a. DEPD (2011)

b. Proven reserves at the end of 2011 BP (2012).

Source: EDMC (2012)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

The total primary energy supply of Brunei Darussalam in 2011 was 3 196 kilotonnes of oil equivalent (ktoe). Natural gas represented about 77% of the total primary energy supply and oil 23%. Oil and gas production was 20 353 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 2011 amounted to 1.1 billion barrels, and its natural gas reserves reached 0.3 trillion cubic metres (BP, 2012). The Champion field is the largest contributor to Brunei Darussalam's oil production whilst the South-West Ampa field is the largest gas field, supplying 75% of Brunei Darussalam's annual gas production. In 2011, crude oil and condensate production averaged 165,800 barrels per day (Mbbl/D), the majority of which was exported (93%). The main export destinations for Brunei Darussalam's oil and condensate are the ASEAN economies, Australia, Korea, India, New Zealand, China and Japan.



Gas production was around 35 million cubic metres a day, most of which was exported as liquefied natural gas (LNG) to the major markets of Japan and Korea (DEPD, 2011, p.140).

Brunei Darussalam's total installed electricity generation capacity for public utilities reached 808 megawatts (MW) in 2011. In the same year, total electricity generated was 3 395 gigawatt-hours with almost all of the electricity generated was supplied by natural gas (DEPD, 2008).

Table 2 Energy supply and consumption, 2011

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	20 353	Industry sector	221	Total	3395
Net imports and other	-17,001	Transport sector	432	Thermal	3393
Total PES	3 196	Other sectors	289	Hydro	–
Coal	–	Total FEC	942	Nuclear	–
Oil	740	Coal	–	Geothermal	–
Gas	2456	Oil	624	Others (Solar)	1.6
Others	–	Gas	27		
		Electricity and other	291		

Source: EDMC (2012).

#### FINAL ENERGY CONSUMPTION

Brunei Darussalam's total final energy consumption in 2011 reached 942 ktoe. The transport sector topped the economy's energy demand at 432 ktoe, or 45.9% of the total amount. The other sectors (residential, commercial and non-energy) consumed 30.6% of the total energy used; the industry sector 23.4%. In terms of energy source, oil was the fuel most consumed, accounting for 66.2% of final consumption, followed by electricity and other sources (30.8%) and gas (2.9%). 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 thousand 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 the 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, 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 electricity 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 dan 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 its energy matters. 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 implements a five-year economic development plan 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, the Vision Brunei 2035. The Vision Brunei 2035 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, both in 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 regularly measuring 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 the economy's energy security.

#### 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 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 power generation plants with a co-generation power plant, constructing new LNG storage tanks, replacement of 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 was officially opened on 25th May 2010. The plant is targeted to produce at least 850,000 metric tons of product methanol a year for export.

#### ENERGY MARKETS

The government regulates the energy market in Brunei Darussalam and no dedicated energy regulator currently exists in the economy. While energy prices are subsidised, in the wake of an increase in the smuggling of fuels to neighbouring economies, the government has considerably raised the prices of motor 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 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 2005 as the base year. 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 under 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 improvement of energy efficiency and conservation are detailed below.

- Revision of residential sector electricity tariff structure to encourage the use of high-efficiency appliances, avoid waste and to provide subsidies to the right groups of people.
- 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 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 building through seminars and workshops on energy management and energy audit, 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 energy efficiency 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.

#### **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 of 340 kilolitres of crude oil and avoiding 940 tonnes of CO<sub>2</sub> emission annually. Actual electricity recorded in 2010 was 808 Mwh, i.e. saving an equivalent 205 kilolitres of crude oil and avoiding 566 tonnes of CO<sub>2</sub> emission into the atmosphere.

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

#### **NUCLEAR**

Brunei Darussalam does not have 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 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 18<sup>th</sup> 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 lifestyle and resource efficiency
- Promoting green building initiatives
- Increasing the utilization of renewable energy with the aim for renewable energy share to reach 10% of the energy mix by 2030

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## NOTABLE ENERGY DEVELOPMENTS

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### ENERGY PROJECTS

The Brunei Darussalam Government 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 thousand barrels per day. The first phase will comprise the production of petroleum products such as gasoline, diesel and jet A-fuel, as well as paraxylene and benzene 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 addition of 66 MW. This is to meet the growing energy demand for the next 15 years and beyond from the expected increase in 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 Darussalam's newly established energy research centre, the Brunei National Energy Research Institute (BNERI) is almost 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.

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**USEFUL LINKS**


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



# CANADA

## INTRODUCTION

Canada is a North American economy with vast natural resources whose land area is the second largest in the world after Russia. Canada's population in 2010 was slightly greater than 34 million, with approximately three-quarters living in the provinces of Ontario (38.7%), Quebec (23.2%) and British Columbia (13.3%) (EDMC, 2012; Statcan, 2012). Canada's gross domestic product (GDP) in 2010 grew 3.2% from 2009 to amount to USD 1 052 billion, and in per capita terms (with 2000 as a base) increased 2%, to amount to roughly USD 30 838 (both in USD (2000) at PPP) (EDMC, 2012). 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-intense 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 that is the highest among the APEC economies in 2010, at nearly 5.8 tonnes of oil equivalent (EDMC, 2012).

Canada is also one of the world's top energy producers. Due to its huge oil reserves, estimated at 173 billion barrels (NEB, 2011a), Canada is a major oil producer and exporter, and particularly, the largest source of imports for the United States, accounting for 21% of the total oil imports to that economy in 2010 (USEIA, 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. The economy also holds significant offshore oil and gas reserves near Nova Scotia and Newfoundland (NEB, 2011a). Accordingly, energy production is important to the Canadian economy, making up nearly 7% of its GDP, providing 264 000 direct jobs and representing 23% of total merchandise exports (NEB, 2011b).

Table 1 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (million sq. km)	9.98	Oil (billion barrels)	773
Population (million)	34.1	Oil sands (billion barrels)	169
GDP (USD (2000) billion at PPP)	1 052	Gas (trillion cubic metres) <sup>b</sup>	1.75
GDP (USD (2000) per capita at PPP)	30 838	Uranium (thousand tonnes of uranium metal) <sup>c</sup>	485

a. Remaining oil reserves (proven, probable and possible) at the end of 2010. NEB 2011a.

b. BP (2012).

c. Refers to-Reasonably Assured Resources plus Inferred Resources, to USD 130/kg U, 1/1/11. NEA (2012)

Source: EDMC (2012).

## ENERGY DEMAND AND SUPPLY

### PRIMARY ENERGY SUPPLY

In 2010, Canada's domestic energy production reached nearly 399 million tonnes of oil equivalent (Mtoe), with a predominance of fossil fuels. Oil, natural gas and coal represented the largest shares of Canada's primary energy production, with 41%, 33% and 9%, respectively, while the remainder was made up by hydropower, other renewable sources and nuclear (IEA, 2011). On the other hand, since a large proportion of the energy produced is exported, Canada's primary energy supply in 2010 totalled 253 Mtoe, equivalent to 63% of its production (EDMC, 2012).

Natural gas marketable production in 2010 amounted to 144.5 billion cubic metres (bcm), a fall of 2.1% from the previous year and of 15% since 2002, when production peaked at 172.2 bcm (Statcan, 2011c). Specifically, drilling levels began to decrease in mid-2006 due to increasing capital and labour costs, which reduced the producers' profitability. The decline in drilling grew steeper in the fourth quarter of 2008, as the recession took hold and the price of gas plummeted. In addition, the success in development of shale gas resources in the United States has led to a drop in reference prices, and producers began targeting wells richer in oil, overlooking dry gas wells.

In connection with the shale gas boom in the US and thus its lower natural gas imports, net natural gas exports from Canada have followed a declining trend, and in spite of the fact that exports remained nearly unchanged from 2009 to 2010, the decrease in output from 2005 to 2010 reached 13%.

Table 2 Energy supply and consumption, 2010

Primary energy supply (ktoe) <sup>a</sup>		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	398 716	Industry sector	53 298	Total	607 952
Net imports and other	-149 842	Transport sector	60 122	Thermal	147 253
Total PES	252 601	Other sectors	82 689	Hydro	351 591
Coal	21 836	Total FEC	196 109	Nuclear	90 659
Oil	87 230	Coal	53 298	Other	18 449
Gas	78 615	Oil	60 122		
Other	64 920	Gas	82 689		
		Electricity and other	196,109		

a. Excludes stock changes and international marine bunkers.

Source: EDMC (2012).

In 2010, Canada's production of crude oil and natural gas liquids (NGLs) amounted to 3.3 million barrels per day (bpd) which marked a 5.0% increase from 2009 and was very close to the output reported in 2007. Exports represented approximately 61% of that volume, amounting to 2.0 million barrels per day (Statcan, 2011a, 2011b). Nonetheless, as oil sands output is sustained, total oil production is expected to increase in the future. Canada is also a net exporter of petroleum products and NGLs, predominantly to the United States.

Canada generated nearly 608 terawatt-hours (TWh) of gross electricity in 2010, slightly less than the 614 TWh output of 2009, mainly as a result of a reduction in hydropower generation, which fell 4.7% from the previous year. Nevertheless, hydropower plants continued to dominate electricity generation in Canada on a gross basis in 2010, at nearly 59%, followed by thermal, nuclear and other types of power generation (IEA, 2012b). 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 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 2010, Canada exported 43.6 TWh of electricity and imported 18.8 TWh, making Canada the world's third largest exporter of electricity (NEB, 2010; IEA, 2012d).

Canada's coal production in 2010 was 21.8 Mtoe, a significant decrease of 31% from 2009 (EDMC, 2012). From the domestic production in 2010, which amounted to nearly 68 million tonnes, around 43% was made up of thermal coal, 41% of steel-making coal and the remainder of lignite (IEA, 2012a, p. 244). Most of the thermal coal produced is intended for domestic use, especially electricity generation. Conversely, coking coal production is predominantly exported to Asia, with increasing demand from Asian economies to meet their energy needs.



With nearly 9% of identified global uranium resources and reserves of nearly 485 thousand tonnes of uranium metal (tU) in 2010, Canada is a major source of uranium among the 22 different economies that produced the mineral in 2010. The economy's output totalled 9 783 tU in 2010, representing 18% of worldwide production; in spite of this volume being 4% lower than the previous year's production, Canada was the world's second-largest producer after Kazakhstan (NEA, 2012). Canada's uranium production is mostly located in northern Saskatchewan and encompasses 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, but their share in Canada's total primary energy supply increased only 0.2% in 2010 as a result of significant growth of the other primary energy sources (EDMC, 2012). However, in light of Canada's abundant natural resources, there are promising expectations for certain renewable sources such as wind, use of which has grown rapidly in recent years. The contribution of wind energy to electricity generation is expected to grow steadily, and at the end of 2012 Canada was ranked ninth in the world in terms of totalled installed wind energy capacity. The Canadian wind industry installed a record level of over 936 MW in 2012, for a total installed capacity of 6 500 MW (CanWEA, 2012).

### FINAL ENERGY CONSUMPTION

In 2010, total final energy consumption in Canada was slightly greater than 196 Mtoe, an upturn of 2.7% in comparison to the previous year. The residential, commercial and agriculture sectors together were the main consumers of Canada's final energy consumption (31%), with energy primarily used for space and water heating, residential appliances, and commercial lighting (NRCan, 2009b). Transport accounted for 31% and industry for 27%, followed in importance by remaining amounts used for non-energy purposes (11%). By source, petroleum products accounted for 46% of the final energy consumption, natural gas 26%, electricity 21%, and coal 2% (IEA, 2012c).

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## POLICY OVERVIEW

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### ENERGY POLICY FRAMEWORK

Canada's energy policy, including resource development policies, is market-based and incorporates a mix of domestic and foreign-owned companies. As per the Canadian Constitution, the provinces are the jurisdictional owners and managers of their energy resources (except for uranium), while the 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 National Energy Board (*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, NRCan is involved in the oversight of areas in which the market does not adequately meet these policy objectives, with its focus emphasising 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 Western Accord and the Agreement on Natural Gas Markets and Prices between the federal government and energy-producing provinces were agreed to in 1985. The agreements 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, 2009c; NEB, 1996).

As a federal regulatory body reporting to Parliament through the Minister of Natural Resources, the NEB has 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, 2012b).

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 provinces with an abundant supply of hydro-electricity having the lowest prices. In most provinces, prices are set by the regulator according to a cost of generation plus a reasonable rate of return formula. 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 were 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 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, FERC, NRCan and provincial energy ministries can discuss issues of mutual concern (FERC, 2005).

### **NUCLEAR POWER**

Nuclear energy is an important component of Canada's energy mix, and in 2010 accounted for 14.5% of the economy's total electricity generation (EDMC, 2012). The federal government regulates the development and application of nuclear energy and the provinces and the provincial electric power utilities are authorised to plan and operate nuclear energy plants. Most of the nuclear electricity plants are located in the province of Ontario, where nuclear energy accounts for more than half of the generation mix. Nuclear licensing and regulation is exclusively handled at the federal level, through the Canadian Nuclear Safety Commission (CNSC) (NRCan, 2009d).

Atomic Energy of Canada Limited (AECL), which is wholly owned by the Canadian Government, is the economy's premier nuclear and science organization. AECL also 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 Canada Deuterium Uranium (CANDU) nuclear power 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.

During 2010, overall uranium exploration and development expenditures in Canada totalled USD 585 million, with exploration expenditures alone amounting to USD 355 million. While uranium exploration is active in the Otish Mountains of Québec through Strateco Resources Inc., which aims to conduct underground exploration on the Matoush deposit, there are also two main uranium projects in Labrador, involving the Michelin and Jacques Lake deposits. Other exploration activities have led to new high-grade uranium discoveries in the Athabasca basin in Saskatchewan that include projects known as Centennial (UEM Inc.), Shea Creek (AREVA Resources Canada Inc.), Wheeler River (Denison Mines Inc.), Midwest A (AREVA Resources Canada Inc.) and Roughrider (Rio Tinto) (NEA, 2012).

### **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-efficiency, cost-effective ones. Provincial governments are also major contributors to 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 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, 2011b). 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, 2011a). 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 coordination of these programs, the Office of Energy Efficiency 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 use is a significant contributor to Canada’s greenhouse gas and air pollutant emissions, 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 US goals.

The federal government is pursuing a number of actions to reduce emissions from and the environmental impact of the energy sector for the benefit of the population. 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 the previous two years, in 2011 the Canadian government agreed to finalise the system’s major elements, with the aim to implement it by 2013 (Treasury Board, 2012).

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 works included tracking of the new U.S. labelling regulations for new light-duty vehicles in order to develop a matching policy measure in Canada. The link of the energy sector 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).

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--equivalent 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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 to continue 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 is endowed with large oil sands resources. As of 2011, the remaining ultimate oil sources were estimated to total as much as 343 billion barrels, with oil sands accounting for 90% of this volume, a figure which indicates the huge oil potential underlying parts of Canada. In terms of total reserves, Canada has 173 billion barrels, with 169 billion barrels alone comprised of oil sands (NEB, 2011a), placing the economy third in the world after Saudi Arabia and Venezuela (OGJ, 2012).



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 the province of Alberta. Production from oil sands in Canada has grown continuously since its beginning in 1967, and by 2010 amounted to 1.6 million barrels per day, accounting for as much as 57% of Canada's total oil production. According to domestic industry projections, oil sands supply is likely to grow 2.3 times by 2030, to reach 5.3 million barrels per day (about 265 Mtoe per year) representing 85% of Canada's total oil production (CAPP, 2012).

In recent years, the run-up in oil prices and technological improvements have dramatically improved the economics of oil sands production and resulted in a boom going into the 2009 recession. While the economic downturn contributed to delays in several oil sands projects, the NEB forecasts oil sands crude production will rise to 2.8 million barrels per day by 2020. This will contribute to a rise in Canada's overall crude oil production, forecast to reach 3.8 million barrels per day by 2020, despite declining production from other sources (NEB, 2009). Apart from the large investments required to develop the potential of these unconventional resources, the role of technology in increasing their sustainability will be critical in determining their future contribution.

As a reference, technology has enabled a 26% reduction in carbon emissions per barrel of oil produced in 2012 compared to 1990 levels (IPIECA, 2012) and this trend is expected to continue. In addition, federal and provincial governments alike are investing (e.g. in carbon capture and sequestration technology) to utilise this strategic resource in a more sustainable way, leading to new technologies 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 for some years. Nonetheless, in February 2012, the NEB awarded 20-year LNG export permits to BC LNG Export Co-operative LLC and in February 2013 another to LNG Canada Development Inc., with both terminals to be located at Kitimat, British Columbia (NEB, 2012a, 2013). 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 terminal approved in 2013, 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, 2013).

#### **OTHER PROJECTS**

In an effort to expand Canada's current oil pipeline infrastructure given the growth in oil production, in December 2011 the National Energy Board 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 northeast 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**

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Atomic Energy of Canada Ltd—[www.aecl.ca](http://www.aecl.ca)

Canada Gazette—[www.gazette.gc.ca](http://www.gazette.gc.ca)

Canadian Association of Petroleum Producers —[www.capp.ca](http://www.capp.ca)

Canadian Nuclear Association—[www.cna.ca](http://www.cna.ca)

Environment Canada—[www.ec.gc.ca](http://www.ec.gc.ca)

National Energy Board—[www.neb.gc.ca](http://www.neb.gc.ca)

Natural Resources Canada—[www.nrcan-rncan.gc.ca](http://www.nrcan-rncan.gc.ca)

Statistics Canada—[www.statcan.ca](http://www.statcan.ca)

Transport Canada—[www.tc.gc.ca](http://www.tc.gc.ca)

# CHILE

## INTRODUCTION

Chile is one of three APEC economies in Latin America. An APEC member since November 1994, Chile borders Peru to the north, Bolivia to the north-east and Argentina to the east, and has a coastline of 6 435 kilometres along the Pacific Ocean to the west. With a land area of nearly 756 102 square kilometres, the economy is 4 300 kilometres long and averages 175 kilometres wide. Administratively, Chile is divided into 15 regions, which are subdivided into 53 provinces. The economy's population was above 17 million in 2010, most of them living in urban areas. The three largest urban regions alone (Santiago-metropolitan, Bío Bío and Valparaíso) respectively concentrated 40.3%, 11.9% and 10.3% of the Chilean population in 2010 (INE, 2012). Given the size of its territory and total population, Chile's general population density is low, with less than 9 inhabitants per square kilometre in 2010, although in metropolitan areas it is much higher, with Santiago and Valparaíso having 446 and 107 inhabitants per square kilometre, respectively (INE, 2011).

Chile's economic growth has been remarkable. Since 1990, the Chilean economy has almost doubled in per capita terms and it has been one of the fastest growing economies in Latin America. In 2010, Chile's gross domestic product (GDP) reached USD 195.56 billion and its GDP per capita was USD 12 213 (USD 2000 at PPP) .. By economic sectors, Chile's GDP in 2010 was composed of agriculture and mining (21%), manufacturing and industry (22%) and services, transport and communications (57%) (BCL, 2012). Particularly, copper extraction accounts for 92% of the mining GDP, and is one of the pillars of the Chilean economy, being a significant driver for foreign private investment, as its production is well developed and export-oriented. For this reason, Chile's economy is significantly dependent on commodity prices, namely copper prices.

The Chilean Government has focused on maintaining the high level of openness of its economy through trade liberalisation and the pursuit of bilateral free trade agreements. These efforts, in addition to regulatory stability, have enabled Chile to promote foreign direct investment inflows, mostly focused on the mining sector . By 2012, Chile had signed trade agreements (not all of them full free trade agreements) with 60 economies, including the European Union, Mercosur (a regional trade group comprising Argentina, Brazil, Paraguay, Uruguay and Venezuela), India, China, Japan, Korea, Mexico and the United States. These agreements grant the Chilean economy preferential access to many markets across the world, which represent 93% of Chile's total trade volume (DIRECON, 2012).

Table 3 Key data and economic profile, 2010

Key data		Energy reserves	
Area (sq. km)	756 102	Oil (million barrels) <sup>a</sup>	150
Population (million)	17.11	Gas (billion cubic metres) <sup>b</sup>	98
GDP (USD 2000 billion at PPP)	209.02	Coal (million tonnes) <sup>c</sup>	155
GDP (USD 2000 per capita at PPP)	12 213		

a. Proved reserves at the end of the year (OGJ, 2011).

b. Refers to total proved reserves (EIA, 2012a)

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

Source: EDMC (2012).

In spite of its abundant renewable resources, Chile's energy security is challenged by its scarce availability of oil, natural gas and coal. Chile is a net energy importer and is dependent on crude oil imports. In 2009, energy imports met 65% of Chile's internal energy demand, and crude oil made up 69.1% of these energy imports. As a consequence, the government has carried out new policies, partially due to the reduction in the natural gas supply from Argentina in 2004.

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## ENERGY SUPPLY AND DEMAND

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### PRIMARY ENERGY SUPPLY

Chile's total primary energy supply (total PES) increased 4.9% between 2009 and 2010 to reach 30 928 kilotonnes of oil equivalent (ktoe). Of this total, 48.5% came from crude oil (and its by-products), 14.8% from coal, 14.5% from natural gas and the remaining 22.2% from other sources, mainly biomass and hydropower. Due to the limitations on its domestic hydrocarbons supply, the economy is a net importer of primary energy, namely of oil, gas and coal. Net primary energy imports in 2010 grew 7.5% from 2009, amounting to 22 270 ktoe and accounting for 72% of the total PES. Therefore, Chile's domestic energy production not only accounts for less than a third of its total PES, but dropped 9.6% from 2009 to 2010 as a result of a lower output from coal, gas and hydropower (MINERGIA, 2010a). Chile's energy production from non-conventional renewable sources though, was able to grow, with wind energy increasing more than three times from 2009 (MINERGIA, 2010a).

In the case of fossil energy resources, Chile's crude oil reserves amounted to 150 million barrels in 2010 (about 20.7 million tonnes of oil equivalent - OGJ, 2012), with the majority being located both onshore and offshore at its southern Magallanes region. In order to meet its crude oil demand, nearly all of the economy's crude oil supply of 15 008 ktoe in 2010 was imported. Chile's imports of petroleum products in 2010 were predominantly made up of diesel (67.7%), gasoline (10.5%), liquefied petroleum gas (LPG-12%), fuel oil (5%), and other products (MINERGIA, 2010a).

Concerning natural gas, Chile produced 1.9 billion cubic metres (bcm) and imported 3.5 bcm in 2010 (MINERGIA, 2010a). As for coal, domestic production is mainly located at Bío Bío in the Golfo de Arauco region as well as in Pecket and Isla Riesco in the Magallanes region. Total recoverable coal reserves are estimated to be roughly 155 million tonnes (Mt) (EIA, 2012b). Coal production decreased 36% from 2009, accounting for 6% of Chile's total coal energy supply (MINERGIA, 2010a).

In 2010, Chile's total installed electricity capacity was 16 954 MW, including public service suppliers (91.8%) and self-suppliers (8.2%). This represented an increase of 801 MW (5%) from 2009, 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 33% in 2010 (MINERGIA, 2010a). According to the Energy Data and Modelling Center (EDMC, 2012), during 2010 electricity generation in Chile increased 0.57% in comparison to the previous year, to reach 60 434 gigawatt-hours (GWh), with 59.6% coming from thermal power generation and 40.4% from hydropower.

Owing to the scant availability of conventional energy resources, the contribution of renewable energy (hydro, wind, biomass and biogas) to Chile's total PES is particularly high, totalling 6 854 ktoe and representing almost three-quarters of the economy's total domestic energy production in 2010 (EDMC, 2012). Chile's renewable energy primary supply in 2010 was mainly made up of biomass and wood, with 71.2%; hydropower, with 28.3%; wind energy, with 0.4% and biogas, with 0.1%. Biogas production began in 2009 and by 2010 had reached 15 million cubic metres, which represented a jump of 25.6% (MINERGIA, 2010a).

Table 4 Energy supply &amp; consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	9 218	Industry sector	8,679	Total	60 434
Net imports and other	22 270	Transport sector	7,143	Thermal	36 026
Total PES	30 928	Other sectors	7,966	Hydro	21 717
Coal	4 591	Total FEC	23,788	Nuclear	–
Oil	15 008	Coal	389	Geothermal	–
Gas	4 475	Oil	12,079	Others	2 691
Others	6 854	Gas	2,370		
		Electricity and other	8,949		

Source: EDMC (2012).

### FINAL ENERGY CONSUMPTION

Chile's total final energy consumption grew 5.9% from 2009, reaching 23 788 ktoe by the end of 2010. Energy demand was fairly balanced between the industry (36.5%), residential, commercial and public –other– (33.5%) and transport (30%) sectors. By energy source, more than half of Chile's final energy demand was met by petroleum products (50.8%), followed by electricity and other sources (37.6%), natural gas (10%) and coal (1.6%). Compared with 2009, the energy demand for each of these sources expanded, particularly in the case of coal with 85.3%; in contrast, the energy demand for electricity and other sources shrank 2% (EDMC, 2012).

### POLICY OVERVIEW

#### ENERGY POLICY FRAMEWORK

Chile's energy policy is based on the development of a free market economy, and oriented towards enhancing its energy security by reducing its vulnerability to supply shocks and high dependence on imports, taking into consideration its increasing energy demand. In particular, the government through its Ministry of Energy developed a new long-term energy policy, with the release of the National Energy Strategy 2012-2030 (ENE in Spanish) in early 2012. The ENE's main objective is to guide the energy sector and set its policies and objectives for the long term. Focused on electricity issues, the document looks ahead to a goal of supplying clean, competitively-priced and reliable energy to Chile in the coming decades in order to support the economy's development and sustain economic growth. To accomplish this, the ENE establishes six priorities, as follows (MINENERGIA 2012):

- 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.

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.

## ENERGY MARKETS

Chile has embarked on the development of an economy based on international trade and the rules of the free market. Since 1990, the economy has grown impressively. It has almost doubled its income per capita and has been one of the fastest-growing economies in Latin America. 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.

Chile offers a business-friendly environment for foreign investors. At the top of the Latin American economies, Chile's business environment is ranked in the top positions, being first in terms of easiness and tax payment during 2012 (World Bank, 2013); Chile also ranked 15th among the most attractive economies to do business and invest in over the next five years, according to the Best Places to do Business 2009–2013 index published by The Economist Intelligence Unit.

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 dominated by private companies. The government's role is restricted to being a regulator, policy-maker and technical consultant in such efforts as identifying the requirements to meet projected demand growth. The principal state organisation involved in the regulation of the electricity industry in Chile is the Ministry of Energy, supported by the National Energy Commission (*Comisión Nacional de Energía*, or CNE). The main law governing the operation and regulation of the electricity sector is the Ley General de Servicios Eléctricos (General Electric Services Law) of 1982, which was amended by the Ley Corta I (Short Law I or Law 19.940) of 2004 and the Ley Corta II (Short Law II or Law 20.018) of 2005 and complemented by the Law 20.257 of 2008, to provide adequate incentives for private sector investments in electricity projects and to improve conditions for entry of non-conventional renewable energy into the electricity system.

Based on ENE's goals issued in 2012, the electricity market in Chile faces 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 strategies that encompass the creation of power utility corridors that will be listed as facilities of 'national interest', improvement in access for small power producers to the grid, and the use of smart grid technology to promote the expansion of distributed generation. In addition, changes to increase the autonomy of the electricity dispatch centres, improvements to supply and transmission bidding schemes, regulatory modifications involving transmission and sub-transmission issues, and the introduction of net metering into the residential sector's electricity rates are considered priorities by the ENE (MINERGIA, 2012).

Even though most of Chile's oil and gas sector has been liberalised and is privately owned, its National Oil Company, (*Empresa Nacional del Petróleo*, or ENAP) is in control of the bulk of oil production and 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. Moreover, 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.

More specifically, in December 2009 ENAP began implementing a new policy that strives to ensure a highly efficient and competitive market for the distribution of petroleum products, and to ensure sufficient supply for the whole economy. This has set the basis for parity pricing of petroleum product imports, as well as incentives for distribution companies. As a consequence, the new price structure establishes a competitive market in Chile because it considers only the variable costs of refineries, based on costs for refineries in the Gulf of Mexico (ENAP, 2009).

In the case of coal, domestic production is limited, accounting for little more than 5% of Chile's coal demand in 2010 (MINERGIA, 2010a). The Isla Riesco project in the south of Chile is expected to significantly increase the domestic supply, with its annual output of approximately 6 Mt of coal. It is expected to start operation in the first half of 2013 (Mina Invierno, 2012a, 2012b).

### FISCAL REGIME AND INVESTMENT

Chile's fiscal policy since 2000 has been developed in accordance with a structural surplus rule, which emphasises medium-term fiscal responsibility. The 2006 Fiscal Responsibility Law introduced new rules on the investment of accumulating assets; it covers central government agencies, but not the central bank, public non-financial enterprises, the military sector, or municipalities (IMF, 2009).

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, a mechanism 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 five 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 (CNE, 2012).

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 in the pre-investment stage and long-term credits for financing. It also helps consortiums to develop biofuels projects and solar energy pilot projects.

### ENERGY EFFICIENCY

Energy efficiency represents one of Chile's priorities towards its key goal of enhancing its energy security. The government's dual approach in recent years – increasing the share of electricity produced from hydro and new renewable energy (NRE) sources while reducing demand growth through energy efficiency – has been strengthened through the ENE published in 2012. In this document, the Ministry of Energy has established a main energy efficiency goal consisting of a 12% reduction in the energy demand forecasted for 2020.

The Ministry of Energy, through its Energy Efficiency Division, is responsible for the development of energy efficiency policy and guidelines, as well as the promotion and enhancement of efficient energy use in the economy, as a means of contributing to the achievement of this goal. The strategic objectives of this Division are to:

- establish the institutional foundations and regulatory framework for energy efficiency
- develop incentives and support tools for energy efficiency
- develop useful and accessible information for public and private decision-makers, as well as collective and individual ones
- take advantage of international experiences and instruments to accelerate the development of energy efficiency
  - set minimum energy performance standards for energy equipment and appliances and strengthen the current labelling program
  - develop efficient lighting programmes in the residential and public sectors.
  - due to energy efficiency's cross-institutional nature, create a government commission that includes public agencies and ministries in order to develop energy efficiency policies, where reports are to be submitted directly to the President of the Republic.



Furthermore, in the development of these objectives, the Ministry of Energy has a main ally in the Chilean Energy Efficiency Agency, which is responsible for implementing many of the policies, a complex task that requires great responsibility and efficiency in executing the resources. The strategic objectives of this Agency are to:

- promote, disseminate and implement programs defined by the Ministry of Energy, that help make a good use of energy in the best way possible
- open new markets and explore various possibilities in the area of energy efficiency, both in the consumer sectors and other areas such as education, as necessary.
- strengthen institutional management through quality control processes (ISO).
- develop energy efficiency marks, to recognize and award 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 the Law 19.940 (2004) and Law 20.018 (2005). It aims to establish the obligation for the electricity companies to include a percentage of non-conventional renewable energy (renewable energy excluding large hydropower plants, NCRE) as a share of the total energy sold.

The law requires electricity generators that obtain energy from electric systems with an installed capacity greater than 200 MW to guarantee that 5% of the total annual withdrawals come from non-conventional sources between 2010 and 2014. The required level of non-conventional energy sources rises by 0.5% annually to reach 10% of 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 this energy will increase its share 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, 2012). Currently, there are two on-going public contests, the first will subsidise the implementation of a Concentration Solar Power plant, and other for NCRE pilot projects. In addition to the above, 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.

### NUCLEAR

Although Chile created in 1964 its Commission on Nuclear Energy (*Comisión Chilena de Energía Nuclear*, or CCHEN) to address the operation and regulation of its two nuclear reactors located in the Santiago metropolitan region, in the practice CCHEN operates these reactors solely for research purposes.

In 2007, Chile created the Nuclear Power Working Group to contribute to an analysis of the opportunities, advantages, challenges and risks of using nuclear energy. Although in early 2012 with the publication of ENE Chile confirmed its decision not to develop any nuclear projects as part of its long-term energy policy (MINERGIA, 2012), the economy is developing knowledge conducive to support its further decision on whether or not employ nuclear power generation in the long-term (MINERGIA, 2010b).



## 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 is 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 tools as energy and macroeconomic quantitative models.

While Chile's contribution to global carbon emissions are very low, with 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 melt, 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. This will in turn have an impact on Chile's socio-economic development and its 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. Mitigation is seen as possible by targeting sectors with the highest levels of greenhouse gas emissions and working to reduce emissions in those sectors, and by strengthening research and development. The government considers action on climate change to be directly connected to the education of the population on environmental issues and climate change, and its plan incorporates a climate change educational campaign.

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## NOTABLE ENERGY DEVELOPMENTS

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All energy sector public services are now integrated by the oversight of the Ministry of Energy, including the National Energy Commission (CNE), the Superintendence of Electricity and Fuel (SEC), and the Commission on Nuclear Energy. These institutions are charged with applying, clarifying and interpreting macro policies, technical analysis, tariffs, rules and regulations, and 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.

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#### USEFUL LINKS

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- Empresa Nacional del Petróleo (ENAP)—[www.enap.cl](http://www.enap.cl)
- Government of Chile—[www.gobiernodechile.cl](http://www.gobiernodechile.cl)
- Ministry of Economy, Development and Reconstruction—[www.economia.cl](http://www.economia.cl)
- Ministry of Energy—[www.minenergia.cl](http://www.minenergia.cl)
- Nuclear Energy Chilean Commission (CCHEN)—[www.cchen.cl](http://www.cchen.cl)
- National Energy Commission (CNE)—[www.cne.cl](http://www.cne.cl)

Chilean Energy Efficiency Agency —[www.acee.cl](http://www.acee.cl)

Ministry of Environment—[www.mma.gob.cl](http://www.mma.gob.cl)

National Institute of Statistics (INE)—[www.ine.cl](http://www.ine.cl)

Superintendence of Electricity and Fuel (SEC)—[www.sec.cl](http://www.sec.cl)

Economic Load Dispatch Centre of Central Interconnected System —[www.cdec-sic.cl](http://www.cdec-sic.cl)

Economic Load Dispatch Centre Norte Grande Interconnected System —[www.cdec-sing.cl](http://www.cdec-sing.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, Korea Bay 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 mainly of mountains, deserts and river basins. Its total maritime area is 4.73 million square kilometres and the length of its coastline reaches 3.2 thousand kilometres (NBS, 2011).

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 China's 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 9.7% in 2010 (WTO, 2011). In the same year, China overtook Japan to become the world's second-largest economy, ranking after the United States. Its gross domestic product (GDP) was USD 8092 billion (USD 2000 billion at PPP), with the primary, secondary and tertiary industries accounting for 10.1%, 46.8% and 43.1%, respectively (EDMC, 2012; NBS, 2011).

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 2011 and accounted for 71% of global energy consumption growth in 2011 (BP 2012). However, its per capita primary energy supply, at 1.7 tonnes of oil equivalent (toe) in 2009, 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 (OECD, 2011).

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 14.8 billion barrels and proven natural gas reserves of 2.8 trillion cubic metres (tcm) at the end of 2011 (BP, 2012). 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 resourceful. 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 2010, 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, 2011). 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, 2010

Key data		Energy reserves <sup>a</sup>	
Area (sq. km)	9 600 000	Oil (million barrels)	14 784
Population (million)	1338.3	Gas (billion cubic metres)	2 808
GDP (USD (2000) billion at PPP)	8 092.70	Coal (billion tonnes)	114.5
GDP (USD (2000) per capita at PPP)	6 047		

a. Proved reserves at the end of 2010. BP (2012).

Source: EDMC (2012)

## ENERGY SUPPLY AND DEMAND

## PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001, driven mainly by rapid growth, especially in energy consumption by heavy industry. In 2010, the total primary energy supply increased 8.5% compared with 2009, reaching 2299 million tonnes of oil equivalent (Mtoe), including net imports and other. Of this, coal was the dominant source, accounting for 73.1%, followed by oil (19.1%), gas (4.4%) and other (3.5%) (EDMC, 2012).

Table 6 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 087 116	Industry sector	848 602	Total	4 207 160
Net imports and other	333 657	Transport sector	166 547	Thermal	3 331 928
Total PES	2 299 404	Other sectors	340 731	Hydro	722 172
Coal	1 681 031	Total FEC	1 355 881	Nuclear	73 880
Oil	438 085	Coal	541 999	Other	79 180
Gas	100 062	Oil	389 977		
Other	80 225	Gas	66 293		
		Electricity and other	357 612		

Source: EDMC (2012).

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 2010, China's total energy production reached 2087 Mtoe, of which coal accounted for 81.1%, followed by oil (9.7%), gas (4.2%) and other (5.0%) (EDMC, 2012). 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 2011, coal production reached 1956 Mtoe, 8.8% higher than the previous year. Total coal consumption reached 1839 Mtoe, 8.7% higher than the previous year and 49.4% of global coal consumption in 2011 (BP, 2012).

In 2011, China's domestic crude oil production reached 203.6 million tonnes (mt), rising 0.3% compared to 2010. At the same time, crude oil imports reached 253 mt. Since 1993, China has been a net oil and oil product importer, and net oil and oil product imports increased to 297 mt in 2011. Total oil consumption reached 461.8 mt, 5.5% higher than the previous year and 11.4% of global oil consumption in 2011 (BP, 2012).

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 2011. Since 2001, gas production in China has grown 13.0% a year, on average, to reach 102.5 bcm in 2011 (BP 2012). The expansion of natural gas pipelines has also been rapid (NBS 2011). At the same time, China imported 16.6 bcm of liquid natural gas (LNG) and 14.3 bcm of pipeline gas in 2011. Total gas consumption reached 130.7 bcm, 21.5% higher than the previous year and 4.0% of global gas consumption in 2011 (BP, 2012).

In terms of installed electricity generation capacity, China has been the world's second-largest economy 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 shortage of electricity supply 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, 2102).

The power supply structure is becoming more diversified, with wind power and nuclear energy generation increasing rapidly. In 2010, total power generation in China was 4207.16 terawatt hours (TWh). Thermal power accounted for 79.2% (3331.93 TWh) of total generation, hydropower 17.2% (722.17 TWh), nuclear energy 1.8% (73.88 TWh) and other 1.9% (79.18 TWh) (EDMC, 2012).

### FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1355.88 Mtoe in 2010, 6.0% higher than in the previous year. The industry sector was the largest consumer, accounting for 62.6% of total final energy consumption, followed by the transport sector (12.3%) and other sectors, including residential, commercial, and agriculture (totalling 25.1%) (EDMC, 2012).

Power generation increased 13.3% to 4207 TWh in 2010, compared to the previous year (EDMC, 2012). Demand rate growth was, as in previous years, based mainly on increased consumption in the commercial and residential, transport and industry sectors. In 2010, the industry sector accounted for the majority of electricity consumption (69.3% or 205.71 Mtoe), followed by the residential and commercial sector (25.7% or 76.27 Mtoe, including non-specified), agriculture (2.8% or 8.40 Mtoe) and transport (2.1% or 6.32 Mtoe). In terms of growth, electricity consumption in the transport sector in 2010 increased by 19.1% compared with the previous year, the industry sector by 16.0%, the residential and commercial sector by 7.4%, and the agriculture sector by 3.9% (EDMC, 2012).

Coal consumption, excluding coal consumption to generate electricity, was 542 Mtoe in 2010 (EDMC 2012). The electricity 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 2010, total final oil consumption was 390 Mtoe. Diesel accounted for 37.0%, while gasoline accounted for 17.9%, liquefied petroleum gas (LPG) 7.3%, fuel oil 6.6% and others 39.5%. The transportation sector was the largest oil-consuming sector, accounting for 38.2% of total final oil consumption, or 147.90 Mtoe. The industry sector was the second largest in terms of consumption, and accounted for 31.0% of total oil consumption or 119.80 Mtoe. (EDMC, 2012).

The market for gas is moving to the north and east of China with the completion of the Shaanxi–Beijing and the West–East gas pipelines. With the larger-scale application of gas, residential consumption grew from 4.81 Mtoe in 2000 to 22.47 Mtoe in 2010; commercial consumption grew from 0.38 Mtoe in 2000 to 2.54 Mtoe in 2010. However, the industry sector was still the largest sector in total final gas consumption, accounting for 38.3% or 25.37 Mtoe (EDMC, 2012).

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 2010, the proportion of coal used was 68% (compared to 76.2% in 1990), the proportion of oil and natural gas used rose from 18.7% in 1990 to 23.4%, and hydropower, nuclear energy and wind power rose from 5.1% in 1990 to 5.6% (NBS, 2011).



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## POLICY OVERVIEW

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### 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 12th Five-Year Plan for National Economic and Social Development (the 12th Five-Year Plan), which clarifies the national strategic intent, 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*). The NEA comprises 10 departments, with an authorized staff size of 152 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, the Environmental Protection Law, and the Cleaner Production Promotion Law. A comprehensive legal basis for the energy sector, the Energy Law, is currently under review by the State Council. 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 power grid and power generation enterprises, and emphasizes 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 Protection of Oil and Pipelines 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 Tax 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. In offshore exploitation, since 1989, production of up to 1 mt of crude oil 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, since 1990, the collection of royalties is according to the annual production of each oil field or gas field. 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' characterises China's energy resources. The most efficient use of available resources is accepted as the economy's necessary guiding principle. 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 were 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 resource 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 which are prohibited by laws and regulations. China will encourage private capital to participate in the exploration and development of energy resources, oil and gas pipeline network construction, power plant construction, coal processing, energy conversion, the refining industry and a comprehensive, new renewable energy industry.

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 11th 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. 58% of production came from 661 sites with annual production more than 1.2 mt.
- 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, 9616 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.

- The coal industry continues to be opened up. 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 12th 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 producing 100 mt/year and 10 companies producing 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 and strengthen the railway and shipping transportation system. Additional efforts will go toward creating an energy supply centre in coal production regions through promotion of a district energy system (DES).
- Strengthen the development of coalbed methane. This is expected to result in the creation of 36 sites with annual production of coalbed methane in excess of 100 million cubic meters. Encourage the application of coalbed methane in district power generation and for household use through the construction of a district pipeline network.
- Gradually shift the domestic coal market to link with the international coal market per instructions issued by the NDRC in December 2009, which also declared that the government would gradually exit the price negotiation mechanism between coal buyers and sellers.

To have the ability to respond the supply disruptions or a serious shortage of coal due to natural disasters or other emergencies, 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. 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 started 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 allowance from CNY 0.2 a litre to CNY 1 a litre for gasoline and from CNY 0.1 to CNY 0.8 for diesel; the unit tax on other oil products similarly increases. For gasoline and diesel oil, the aim is to implement a fixed-amount consumption tax rather than an added 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 will adjust domestic oil product prices accordingly. From December 2008 to October 2011, the price has been adjusted 16 times; it has risen 10 times and fallen six times (NDRC, 2011).

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 a 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, deepening the pricing reform and classification of gas users (NDRC 2012).

In 2010, China's natural gas demand reached 130 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 between 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).

The National Standardization Management Committee issued a standard for determining natural gas energy (GB/T22723-2008) in 2008, in effect from 1 August 2009. The committee also provided metering methods based on international practices. The Emission Standard for Coalbed Methane/Coal Mine Gas was issued in 2008. The standard calls for the better use of coalbed methane/coal mine gas and the development of small-scale power sources based on the use of the gas.

China has estimated technically recoverable shale-gas resources of 36.1 tcm, 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, equivalent to 2–3% of projected Chinese gas production in 2015; and more than 60 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, is another administrative agency for the electricity industry, in addition to the NDRC and the NEA. The *SERC*'s main aims are to:

- continue the construction of regional electricity market platforms and complete the regional electricity market model
- deepen cross-provincial power transaction standardisation
- promote direct transactions between power-generating companies and large users and independent power transmission and distribution companies, thus creating bilateral trading markets
- build up the joint factory system for information sharing
- improve the early warning system for the demand and supply of power and thermal coal

However, according to a plan of institutional restructuring and functional transformation of the State Council, approved by the National People's Congress in March 2013, the *SERC* will be merged into the NEA. 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 *SERC*, 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. In this regard, two concerns are stressed. 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; 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. By the end of 2010, the installed capacity of nuclear energy reached 10 824 MW. At the same time, 28 units of plants with a total capacity of 33 954 MW were under construction, giving the economy the biggest nuclear energy program in the world. According to the 12th Five-Year Plan for Energy Development, the installed capacity of nuclear power is expected to reach 40 000 MW by 2015. However, according to the most recent announcement, due to the 2011 nuclear disaster in Japan, China will now approve nuclear power plants only along the coast during the period of 12th Five-Year Plan (2011-2015) (SCC, 2013).

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 Reporting System for Construction of Nuclear Energy Projects and the Reporting System for Nuclear Power Plants in Operation were also issued by the NEA. 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, the sale of electric power generation products, after the month that commercial nuclear energy generating units are put into operation, follows a unified policy of 'reimburse 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.

After the crisis at Japan's Fukushima Daiichi nuclear plant early in 2011, China is paying more attention to the safety of nuclear energy. Some measures were determined immediately, including carrying out comprehensive safety checks and enhanced management over 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 12th 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 home-grown 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 with 190 billion kWh of electricity generation, and the capacity of installed solar power plants is expected to be more than 21 GW with 25 billion kWh of electricity generation.

After the enactment of the Renewable Energy Law in 2005, China has doubled its installed capacity every year for renewable energy. In 2009, the thermal power supply accounted for 74.6% of total power generation capacity, hydro for 22.5% and (grid connected) wind power for 1.8%. 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 hydro power. China's approach in increasing wind power came 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. 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 for 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 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 roof-top 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 promote 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

Two programmes were carried out that made a particular contribution to the recent reduction in energy intensity China. The first is the Top-1000 Energy-Consuming Enterprise Programme, which focused on improving energy efficiency in China's largest 1000 companies, responsible for one third of the economy's total energy use. The second is a programme of plant closures, whereby China has closed down the smallest, dirtiest and least efficient factories in a number of heavy industry sectors including power, steel, cement, other metals and paper. Shutdowns of inefficient electric power plants over the last five years (2007~2011) totalled 72 GW or approximately 8% of China's total installed capacity. This type of shutdown of inefficient power plants is truly unprecedented globally and is a significant part of the reason that the Chinese coal-fired power plant fleet is now more efficient than that of the United States. Energy efficiency management has provided the major portion of China's carbon emissions control to date, and the most significant achievements have come from the improvement efforts of the largest and

the smallest enterprises. In order to move forward, China has expanded its programmes to include the very large number of medium-sized companies. Significantly, in the 12th Five-Year Plan, the 1000 Enterprises Programme is being expanded to a 10 000 Enterprises Programme.

The essence of this programme has been to provide clear guidelines, technology recommendations and benchmarks to the participating companies, so they can carry out the proper measures to improve their energy efficiency, after which the results are audited by the government. The 12th Five-Year Plan also encourages new approaches to energy and carbon savings. These include encouraging experiments with market-based mechanisms, such as cap and trade systems and carbon taxes. China also promotes new approaches to energy efficiency, such as demand-side management and encouraging Energy Service Companies (or ESCOs), a financing mechanism specifically mentioned in the plan (DS, 2011).

To promote energy conservation activities in the industry sector, the China Government 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. They generally operate under energy performance contracts which compensate them with a share of the savings they produce for their customers. From 2005–2010, 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, China published its Development Plan for Energy Saving and New Energy Automobile Industry (2012–2020) to introduce more environmentally-friendly vehicles into the domestic market. The plan 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, 2012). China is considering the introduction of a carbon tax in the future, which could provide another incentive. 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 mechanism from March, 2011 to enhance and strengthen the vehicle energy efficiency management. In this mechanism, China published a list of vehicle models that satisfy the fuel consumption standards (CAA, 2011).

China has released a total of 186 key economy-wide energy-efficient technology promotion catalogues in five batches, and promoted seven energy-efficient technologies in the iron and steel, building material and chemical industries. During the 11th Five-Year Plan period, a large variety of high-efficiency energy technologies were widely applied, including low-temperature waste heat power generation, new-type cathode aluminium reduction cells, high-voltage frequency conversions, rare earth permanent magnet motors and plasma oil-less ignition.

The government has improved energy-efficient design standards for residential buildings in three climate zones (freezing cold and cold in winter, hot in summer and cold in winter, and hot in summer and warm in winter), energy-efficient design standards for public buildings, and a code of acceptance inspections for energy-efficient building construction. Since 2007, China has issued 46 economy-wide standards supporting the Energy Conservation Law, including 27 mandatory standards for energy consumption quotas in high energy-consuming products and 19 mandatory energy efficiency standards for major terminal energy-using products. By the end of October 2011, China had issued the eighth batch of catalogues of products for energy-efficiency labelling covering 25 products. In addition, there is a voluntary energy-efficiency endorsement label in China, encouraging more enterprises to achieve higher levels of energy-efficiency.

The government 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. China has carried out energy conservation and new-energy vehicle demonstrations and promotions, and taken the lead in using mixed-power vehicles, electric vehicles and fuel cell vehicles. 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 CO<sub>2</sub> 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, the change, taken by China alone, would only reduce global temperature by 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).

China plans for pilot cap-and-trade systems and feed-in tariffs for wind and biomass for some provinces. In the transportation sector, rebates for electric cars and small cars are envisioned. Natural gas production and use has also received special attention. China has set a target of increasing the share of natural gas in primary energy consumption to 7.5% by 2015 in the 12th Five-Year Plan for Energy Development.

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 sink 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 transfer technologies 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 leads 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).

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## NOTABLE ENERGY DEVELOPMENTS

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### MAJOR ACTIVITY

The China energy working meeting was held by the NEA in January 2012 to highlight future major efforts. During this meeting, eight major tasks were determined, including: (1) enhance the establishment of energy supply capability; (2) promote adjustments to the energy structure; (3) deepen and expand international energy cooperation; (4) promote innovation in energy technology and mechanisms; (5) strengthen building of an eco-friendly environment for people's livelihoods; (6) control total energy consumption at a reasonable level; (7) strengthen management of the energy industry; and (8) raise the level of energy-related work. The aim for these eight tasks is to reach the targets of "Three Stability and Three Progress (TSTP)."

Specific TSTP goals include: (1) maintain a stable increase in energy production; (2) maintain a stable energy supply for stable economic development; (3) maintain stable energy prices; (4) maintain progress in adjustments to energy structure, increase in energy conversion efficiency, and establishment of a clean energy industry; (5) maintain progress in control of overall energy consumption and raising of energy consumption efficiency; (6) maintain progress of innovation in energy technology and energy mechanisms (BOE, 2012).

### 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 consider mutual ties between a coal enterprise and its relevant upstream and downstream industries will be a trend, and 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 12th 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. The first round of reserves with capacity of 5 mt is expected to 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 2010, 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 146 mt in 2010, up 40.9% from the previous year (NEA, 2011).

### 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); 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 first independent design and the sixth generation of a 3,000 meter deep water semi-submersible drilling platform by China. 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 8 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 China's major deep-sea oil and gas producing areas (CEN, 2011).

The development and expansion of the refined oil market is advancing stably in China. On 12 July 2011, NDRC announced market-oriented aviation kerosene pricing; it will adjust prices for aviation kerosene monthly from 1 August 2011. The refined oil electronic trading platform at the Beijing Petroleum Exchange began 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).

### 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 matched 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 2170 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 became effective. 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 became effective on 1 March 2011.

On 3 December 2010, four ministries jointly issued a notice announcing further expansion of international cooperation on coalbed 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 Coalbed 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 1328 km. This is the longest pipeline for a coalbed methane transportation system in China. It will be used to support the “Gasification Shanxi” strategy and speed up the development of coalbed 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 3300 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 8704 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 China’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, ranking it second-largest 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 1038 km. The network includes DC transmission lines and two  $\pm 400$  kV converter stations, and 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  $\pm 30$  kV level, and a transport distance of 8.6 km. It represents completely independent intellectual property of China (CEN, 2011).

The 4 GW of clean energy generated in eastern Ningxia was transmitted to the Shandong power grid through the over 1300 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  $\pm 660$  kV DC transmission line. The Ningdong DC

transmission project is the world's first DC transmission project at the  $\pm 660$  kV voltage level. It was also a central project in the construction of China's west to east power grid. The creation of a power grid to connect between the Northwest Power Grid and 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 meter, and that all thermal power plants in key regions should emit less than 100 mg/cubic meter 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 meter, 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 2011 (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 12th 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, main pumps, etc. It has proven that China already possesses the capability to construct a million-kilowatt nuclear power plant on its own (CEN, 2011).

#### ENERGY CONSERVATION AND ENVIRONMENTAL PROTECTION

China has accomplished the energy conservation goals listed in its 11th 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 at 11.2%, while its energy consumption grew only 6.6% annually on average. The energy consumption elasticity coefficient dropped from 1.04 in the 10th Five-Year Plan period (2001-05) to 0.59 in the 11th 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 Cancun 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 to 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 converged political impetus. Before the Cancun Conference was summoned, 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, Mexico, and provided beneficial suggestions and full support. In October 2010, before the opening of the Cancun Conference, China hosted a United Nations climate change meeting in Tianjin, which laid the basis for the Cancun Conference to achieve positive results.



In 2011, the Chinese Government released the Comprehensive Work Plan for Energy Conservation and Emission Reduction during the 12th Five-Year Plan period (2011–15) and made an overall arrangement for energy conservation, emissions reduction and greenhouse gas emissions control during that period.

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#### USEFUL LINKS

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- Central People's Government of PRC—[www.gov.cn](http://www.gov.cn)
- China Electricity Council (CEC)—[www.cec.org.cn](http://www.cec.org.cn)
- Energy Research Institute of National Development and Reform Commission (ERI)—[www.eri.org.cn](http://www.eri.org.cn)
- Ministry of Environmental Protection (MEP)—[www.zhb.gov.cn](http://www.zhb.gov.cn)
- Ministry of Housing and Urban-Rural Development—[www.mohurd.gov.cn](http://www.mohurd.gov.cn)
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- National Development and Reform Commission (NDRC)—[www.ndrc.gov.cn](http://www.ndrc.gov.cn)
- National Energy Administration (NEA)—[www.nea.gov.cn](http://www.nea.gov.cn)
- Standardization Administration—[www.sac.gov.cn](http://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 <http://www.censtatd.gov.hk/hkstat/sub/so20.jsp> shows 7.174 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 2010, the per capita GDP of Hong Kong, China, was USD 37 005 (USD (2000) at PPP), among the highest of the Asia–Pacific Economic Cooperation (APEC) economies. GDP increased 7.0% in real terms in 2010, to USD 261.6 billion (USD 2000 at PPP). The services sector remained the dominant driving force of overall economic growth, accounting for 93.0% of GDP in 2010 (EDMC 2012)

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 advance 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 emphasize strengthening its cooperation with Guangdong (Policy Address 2011–12; TID, 2011).

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)	261.6	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	37 005		

Source: EDMC (2012)

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**ENERGY SUPPLY AND DEMAND**


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**PRIMARY ENERGY SUPPLY**

Hong Kong, China, has no domestic energy reserves or petroleum refineries; it imports all of its primary energy needs. It generates some electricity. Total primary energy supply in Hong Kong, China, was 13.4 million tonnes of oil equivalent (Mtoe) in 2010, about the same amount as in 2009. Coal maintained the highest share of the total primary energy supply (46.6%), followed by oil (24.0%), gas (23.5%) and other sources (5.9%) (EDMC, 2012).

In 2010, the total installed electricity generating capacity in Hong Kong, China, was 12 624 megawatts (MW) (EDMC, 2012). 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. CLP Power has also commissioned a feasibility study for an offshore wind farm development in Hong Kong, China, involving an initial phase of 90 MW with a potential expansion up to a total of 180 MW (CLP 2012a, 2012b). 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 (550 kW) since 2010 (PAH, 2012a, 2012b).

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**Table 8 Energy supply and consumption, 2010**

<b>Primary energy supply (ktoe)</b>		<b>Final energy consumption (ktoe)</b>		<b>Power generation (GWh)</b>	
Indigenous production	54	Industry sector	382	Total <sup>a</sup> (gross)	38 290
Net imports and other	31 116	Transport sector	2 145	Thermal	38 290
Total PES	13 358	Other sectors	4 166	Hydro	–
Coal	6 225	Total FEC	6 693	Nuclear	–
Oil	3 202	Coal	–	Other	–
Gas	3 145	Oil	2 394		
Other	786	Gas	659		
		Electricity and other	3 640		

a. Total does not include electricity generated by hydro and nuclear energy facilities located in mainland China.

Sources: EDMC (2012)

While natural gas and liquefied petroleum gas (LPG) are the main types of gaseous fuels used in Hong Kong, China, there is as well 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 2010, the total final energy consumption in Hong Kong, China, was 6 693 ktoe, a decrease of 2.8% from the previous year. The other sectors (residential and commercial) accounted for the largest share of energy used at 62.2%, followed by the transport sector (32.0%) and the industry sector (5.7%). By energy source, electricity and others made up 54.4% of end-use consumption, followed by petroleum products (35.8%), and gas (9.8%) (EDMC, 2012).

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 performance 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).

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 energy efficiency for 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. It ensures the long-term and stable supply of nuclear-generated electricity, and the supply of natural gas from three different sources: offshore gas, piped gas and LNG from an LNG terminal to be built as a joint venture on a neighbouring mainland China site. To improve air quality and to address the challenges posed by global warming, the Government is exploring ways to gradually increase the use of clean energy.

The inter-governmental MOU contemplates the delivery of gas for electricity generation in Hong Kong, China, from three sources:

- New gas fields planned for development in the South China Sea
- A second West-to-East Gas Pipeline, bringing gas from Turkmenistan
- 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 the 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. Three major areas are regulated by the Ordinance (EMSD, 2012a).

- The developers or building owners of newly constructed 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).
- Persons responsible for 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 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 have only taken 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 (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 air conditioning cooling towers in non-domestic buildings. As at the end of February 2013, 439 installations were completed under the Scheme. It is estimated that these installations could save up to 284 million kWh of electricity and 199,000 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 20 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 one type of domestic instantaneous gas water heater. 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 vehicles in 2007 and 2008, respectively. Vehicles meeting the energy efficiency and exhaust emissions criteria can have the First Registration Tax reduced. 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 2010 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 in the economy have started to explore the feasibility of offshore wind farm projects. They are planning to install a total of about 100 offshore wind turbines in the waters of Hong Kong, China, to generate electricity of up to 560 million kWh at a total capital cost of about HKD 8–10 billion. The wind farms are expected to meet 1%–2% of Hong Kong, China's total electricity demand by 2020 (EPD, 2012b; EMSD, 2012e).

CLP Power is continuing the feasibility study for an offshore wind farm of up to 200 MW. An offshore meteorological wind mast was installed to collect site environmental data. CLP Power plans to install 67 wind turbines at a capital cost of about HKD 5–7 billion, with an estimated generation capacity of up to 200 MW, producing electricity of up to 390 million kWh per year. CLP Power installed 19.8 kW PV in 2010 for use by the local community in Town Island and the capacity was extended to 180 kW PV and two 6 kW wind turbines in 2012 (CLP, 2012a, 2012b).

Power Assets Holdings Ltd.'s (PAH's) renewable energy assets also performed well, with Lamma Winds generating 5 300 MWh of electricity since commissioning in 2006, offsetting 4 400 tonnes of carbon dioxide emissions. Another 550 kW thin-film photovoltaic (TFPV) solar power system was installed on building roofs at Lamma Power Station. They generated 691 MWh of electricity in 2011, offsetting 576 tonnes of carbon dioxide emissions (PAH 2012a, 2012b).

To increase its renewable energy portfolio, PAH is expanding the solar power system to 1 MW, with the work scheduled for completion in 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 2011, PAH commenced a wind monitoring station at its offshore wind farm site to collect meteorological and oceanographic data for detailed design purposes.

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 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 which do not require 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 waste water treatment.
5. *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%.

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#### NOTABLE ENERGY DEVELOPMENTS

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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):

- 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 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.
- New installations of high-efficiency equipment (air-conditioning, electrical systems, lifts and escalators, and lighting installations) and conducting of energy audits.

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#### USEFUL LINKS

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Census and Statistics Department—[www.censtatd.gov.hk](http://www.censtatd.gov.hk)

Electrical and Mechanical Services Department—[www.emsd.gov.hk](http://www.emsd.gov.hk)

Environment Bureau—[www.enb.gov.hk](http://www.enb.gov.hk)

Environmental Protection Department—[www.epd.gov.hk](http://www.epd.gov.hk)

Transport Department—[www.td.gov.hk](http://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 (including 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 239.9 million in 2010.

Indonesia had a gross domestic product (GDP) of around USD 826 billion and a per capita GDP of USD 3 447 in 2010 (USD 2000 at PPP). Excluding the oil and gas sector, manufacturing accounted for the largest component of GDP in 2010 (24.8%), followed by agriculture, livestock, forestry and fisheries (15.3%); retail, hotel and restaurant (13.7%); mining and quarrying (11.1%); construction (10.3%); other services (10.2%); finance, leasing and corporate services (7.2%); transport and communications (6.6%); and electricity, gas and water supply (0.8%). In 2010, Indonesia attained economic growth of 6.2%, an increase of 4.6% from 2009 (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 2010, oil and gas exports contributed 17.7% and coal exports contributed 11.9% of Indonesia's total exports of about USD 157.8 billion. Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 49.8% of the Indonesian Government's budget in 2010 (Kemenkeu, 2010).

Indonesia's proven fossil energy reserves at the end of 2010 comprised 4 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, 2010

Key data		Energy reserves <sup>a</sup>	
Area (million sq. km)	7.9	Oil (billion barrels)	4.0
Population (million)	239.9	Gas (trillion cubic metres)	3.0
GDP (USD (2000) billion at PPP)	826.8	Coal (billion tonnes)	5.5
GDP (USD (2000) per capita at PPP)	3447		

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

Source: EDMC (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

In 2010, Indonesia's total primary energy supply (TPES) was 166 980 kilotonnes of oil equivalent (ktoe) of commercial energy—made up of oil (43.6%), coal (23.7%), natural gas (27.0%) and other energy (mainly hydropower and geothermal) (5.7%)—and 40 102 ktoe of biomass. Indonesia is a net exporter of energy; overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal totalled 181 840 ktoe in 2010. Total energy exports in 2010 increased by 14.6% from 2009 (131 799 ktoe), an increase driven primarily by coal exports.

## OIL

In 2010, Indonesia produced 47 939 ktoe of crude oil and condensates; of this, 18 692 ktoe (39%) was exported, representing an increase of 1.7% from 2009. Since oil production has declined significantly over the past decade (in 1997 Indonesia produced 72 474 ktoe of crude oil and condensates) in order to meet its domestic oil requirements, the economy imported 14 052 ktoe of crude oil and 21 698 ktoe of petroleum products in 2010, up 1.6% from total of 35 176 ktoe in 2009 (KESDM, 2011).

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 85 068 ktoe of natural gas in 2010, an increase of 11.3% from the 76 414 ktoe in 2009. Of the total natural gas production, 41.9% was converted to LNG for export shipping. The economy produced 35 647 ktoe of LNG in 2010, an increase of 16.9% from 30 494 ktoe in 2009. In 2010, Indonesia also exported 8 338 ktoe of natural gas (9.8% of its total natural gas production) through pipelines to Singapore and Malaysia. Overall, 51.7% of Indonesia's natural gas production is exported; the balance is made available for domestic requirements (KESDM, 2011).

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 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 2010, Indonesia produced 164 466 ktoe of coal, an increase of 7.4% from 153 119 ktoe in 2009. Most of Indonesia's coal production in 2010 (124 322 ktoe, or 75.6%) was exported with domestic demand (40 046 ktoe in 2010) being allocated for power generation (51.4%), and industry (48.6%) uses (KESDM, 2011).

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. In consequence, while Indonesian coal's heating value can range from 5000 to 7000 kilocalories per kilogram, it is generally distinctive for its low ash and sulphur content (typically less than 1%).

## ELECTRICITY

Indonesia had 32 898 MW of electricity generation capacity in 2010, which was owned by the state-owned electricity company (PLN) and independent power producers (IPPs). In 2010, 169 786 GWh of electricity was generated, of which 22.4% was supplied by IPPs. In 2010, electricity generation was based on coal (40.1%), natural gas (32.5%), renewable energy (16.0%), and oil (11.4%) (KESDM, 2011).

## FINAL ENERGY CONSUMPTION

Total final energy consumption of final energy was 111 705 ktoe in 2010, an increase of 21.2% from 92 182 ktoe in 2009. The share of the final energy consumption by sector in 2010 was 42.3% for industry, 32.9% for transport and 24.7% for other sectors. Indonesia's economy is highly dependent on oil; final energy consumption of oil in 2010 was 63 774 ktoe (57.1% of the total final energy consumption).

Table 10 Key data and economic profile, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production <sup>a</sup>	306007	Industry sector	47262	Total	169786
Net imports & other	-140748	Transport sector	36805	Thermal	142657
Total PES	166980	Other sectors	27637	Hydro	17677
Coal	39525	Total FEC	111705	Nuclear	-
Oil	72828	Coal	19116	Others	9452
Gas	45062	Oil	63774		
Others	9565	Gas	16139		
		Electricity	12675		

a. Excludes biomass.

Source: EDMC (2012).

## 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 enterprises.

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 (*Devan 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 conditions of energy crisis and energy emergency
- 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, and has due regard to input from the public.

The assembly of DEN members is chaired by the President. As an institution, DEN is headed by the minister responsible for energy affairs. DEN 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 which 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 enterprise 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.

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), was rejected by the Constitutional Court in 2004.

#### 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 undertake all BP Migas roles and responsibilities. Furthermore, on 14 January 2013, the government issued the 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 enterprises, *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 on permit holders to build smelters
- an obligation on foreign companies to divest shares to the government, or state-owned enterprises and private companies registered in Indonesia
- payment of taxes, fees and allocation of profits
- reclamation and post-mining costs.

The 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, *Izin Usaha Penyediaan Tenaga Listrik* (IUPTL). The IUPTL could either be in integrated electricity supply, power generation, transmission, distribution or retailing of electricity. Indonesia's electricity systems would retain vertically integrated configurations; however, these could comprise 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 supply of electricity to the public) would participate in the vertically integrated systems.

By law, the government and regional governments would 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 policy, regulation, and licensing of geothermal exploration and exploitation.

Geothermal exploration and exploitation is based on the award of licences. The process involves the government offering geothermal work areas for competitive bidding to prospective business investors; 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 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 could 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 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 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, production sharing contracts 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; 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 PSC, and is typically used for established producing areas; therefore, 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 PSC 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 which 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 3 years after 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 <sup>st</sup> Generation PSC (1965-1975)	2 <sup>nd</sup> Generation PSC (1976-1988)	3 <sup>rd</sup> Generation PSC (1988-recent)	4 <sup>th</sup> Generation - 1995 East Indonesia*	5 <sup>th</sup> Generation Post Law No. 22/2001	New Contracts (2008 – present)
• Oil	No distinction between oil and gas. DDB or SLD as follows: <ul style="list-style-type: none"> <li>• 14 years for production facilities</li> <li>• 3-18 years for moveable equipment</li> <li>• 14-20 years for others</li> </ul>	• 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 to provide for abandonment	Non. Post 1995 PSCs require the Contractor to provide for abandonment	PSCs require the Contractor to provide for abandonment	PSCs require the Contractor to provide for abandonment

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

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 would advise the contractor, on request, of the domestic gas supply requirement about a year prior to production. The contractor and prospective domestic buyers will 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 coalbed 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 of coal methane gas; the method of determining and 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 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 enterprises (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 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 transition of existing concessions is yet to be formulated.

#### GEOHERMAL

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 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 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 conduct 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 conduct energy management and/or implement energy savings
- energy conservation programmes consist of short term programmes (improvements to 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/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/majors 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, in the form of energy audit partnerships funded by the government and/or being recommended for priority access to energy supplies by ministers, governors and regents/majors within their respective jurisdictions. Disincentives shall be given to energy source users and energy users who have not implemented energy conservation through energy management, in the form of 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 extension possible)

#### BARRIER REMOVAL

Indonesia is participating in a UNDP–GEF project which involves six developing Asian economies. This project, Barrier Removal to the Cost Effective Development and Implementation of Energy Efficiency Standards and Labelling 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 become less than 20%
  - natural gas—to become greater than 30%
  - coal—to become greater than 33%
  - biofuels—to become greater than 5%
  - renewable energy and other energy including nuclear—to become greater than 10%
  - liquefied coal—to become 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) is 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. The regulation sets mandatory targets in terms of the percentage share that biofuel has in the fossil fuels share of total fuel consumption (biofuel blend), as shown in the following table.

Table 4 Minimum obligations for biofuel use (% blend)

Sector	2009	2010	2015	2020	2025
<b>Biodiesel</b>					
PSO transport	1.00	2.5	5	10	20
Non-PSO transport	1.00	3.0	7	10	20
Industrial and commercial	2.50	5.0	10	15	20
Electricity generation	0.25	1.0	10	15	20
<b>Ethanol</b>					
PSO transport	1.00	3.0	5	10	15
Non-PSO transport	5.00	7.0	10	12	15
Industrial and commercial	5.00	7.0	10	12	15
<b>Straight vegetable oil fuel</b>					
Industry	–	1.0	3	5	10
Marine	–	1.0	3	5	10
Electricity generation	0.25	1.0	5	7	10

PSO = public service obligation.

Source: GSI (2008).

The Global Subsidies Initiative (2008) estimates the volume of biodiesel (fatty acid methyl ester, or FAME) to fulfil this requirement would be about 10 780 million litres in 2025, while the volume of ethanol (anhydrous denatured bio ethanol) to fulfil the requirement would be about 5 695 million litres in 2025.

## GEOTHERMAL

The 2006 energy policy implicitly calls for Indonesia to increase total geothermal capacity to 9 500 MW by 2025. In 2010, Indonesia's total geothermal capacity was 1 189 MW, which is 4.1% of the total geothermal potential of 29 038 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, in 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 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 2011–2020 (*Rencana Usaha Penyediaan Tenaga Listrik, or RUPTL*), a further increase in geothermal capacity by 1 299 MW is expected between 2012 and 2020 (PLN, 2011).

## HYDROPOWER

In 2010, Indonesia's total hydropower capacity was 5 940 MW (including 228.7 MW of mini hydro), which was 7.9% of the total hydropower potential of 75 GW. Under the 10 000 MW Accelerated Development of Electricity Generation—Phase II programme over 2011–19, Indonesia is committed to develop additional hydropower with 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 3 970 MW to Indonesia's hydropower capacity during 2012–20 (including mini hydro); of this capacity, 3 239 MW would be developed by PLN and 731 MW by IPPs. The hydropower capacity addition includes three pump-storage power plants in Java—specifically Upper Cisokan (1 040 MW) in West Java, Matenggeng (900 MW) at the border of West and Central Java, and Grindulu (500 MW) in East 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 11 663 MW, or 15.6% 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 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 related 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 less 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 which 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 in the G20 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 action 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 action 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 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-emitting activities, 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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 natural gas reserve 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 averted 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 were 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 entity 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 Guarantor.

Government guarantee for the PPP Central Java power plant project is 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 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 fact that the final energy mix will be mostly from renewable and environmentally-friendly sources. In 2012, MEMR established a new final energy mix for the 10 GW Phase II, with total capacity of 10 047 MW, 49% of which will be developed from geothermal, 30% from coal, 17% from hydropower, 3% from gas, and 1% from gasified coal. The scheduled completion date for the 10 GW Phase II is 2014.

### **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. The project is expected to be completed in 2016. The Upper Cisokan Pumped Storage Hydropower 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, 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 Indonesia, the Head of State Police Republic of Indonesia, Heads of Non-Ministerial Government Agencies, Heads of State Secretariat Institutions, Governors, and Regents/Mayors, to take measures and innovate to save energy and water within their institutional domains and/or in the domains of State Owned Enterprise and Regional Government Owned Enterprise within their jurisdiction.

The Presidential Instruction assigns an electricity savings target of 20% from average electricity use over the 6 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 average water use over the 6 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 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 which 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 valid for purchasing geothermal power in geothermal mining work areas, derived from holders of valid geothermal mining work areas following 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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Directorate General of Taxes (Pajak)—[www.pajak.go.id/eng/](http://www.pajak.go.id/eng/)

Ministry of Energy and Mineral Resources (KESDM)—[www.esdm.go.id](http://www.esdm.go.id)

Ministry of Energy and Mineral Resources (DIM)—[www.dim.esdm.go.id/English/](http://www.dim.esdm.go.id/English/)

PT PLN (Persero)—[www.pln.co.id](http://www.pln.co.id)

SKKMIGAS, Satuan Kerja Khusus Pelaksana Kegiatan Usaha Hulu Minyak dan Gas Bumi — [www.skspmigas-esdm.go.id](http://www.skspmigas-esdm.go.id)

Statistics Indonesia (Badan Pusat Statistik, BPS),—[www.bps.go.id](http://www.bps.go.id)

# JAPAN

## INTRODUCTION

Japan, located in East Asia, 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. Japan's real GDP in 2010 was about USD 3 547.63 billion (USD 2000 at PPP). Japan's population of 127.5 million people in 2010 had a per capita income of USD 27 836. Japan's GDP increased by 4.4% in 2010 compared to 2009.

Since indigenous energy resources are modest, Japan imports nearly all of its fossil fuels to sustain economic activity. In 2010, proven energy reserves included approximately 44 million barrels of oil, 21 billion cubic metres of natural gas and 350 million tonnes of coal.

Table 12 Key data and economic profile, 2010

Key data		Energy reserves	
Area (thousand sq. km)	377.8	Oil (million barrels)—proven	44
Population (million)	127.5	Gas (billion cubic metres)	20.9
GDP (USD (2000) billion at PPP)	3 547.6	Coal (million tonnes)—proven	350
GDP (USD (2000) per capita at PPP)	27 836		

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

Sources: EDMC (2012), Oil & Gas Journal (2010).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

In 2010, Japan's total primary energy supply was about 498 million tonnes of oil equivalent (Mtoe), 7.0% more than in 2009. By fuel types, oil contributed the largest share (40%), followed by coal (23%) and natural gas (17%). In 2010, net imports of energy sources accounted for 82% 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 2010, Japan was the world's third largest oil consumer after the United States and China (BP, 2011) and almost all of the oil was imported. The bulk of the imports (79.7% in 2010) came from economies in the Middle East such as the United Arab Emirates, Saudi Arabia, Iran, Qatar and Kuwait (BP, 2011). In 2010, the primary oil supply was 201.779 Mtoe, an increase of 1.8% from the previous year.

Japan is endowed with only limited coal reserves (350 million tonnes). Japan is the world's largest importer of steam coal for power generation, pulp and paper and cement production, and of coking coal for steel 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 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, 2011), which come from Malaysia (19.8% of imports in 2010), Australia (18.9%), Indonesia (18.2%), Qatar (10.9%), Russia (8.8%), Brunei Darussalam (8.3%), the United Arab Emirates (7.3%), Oman (4.1%) and other economies. In 2010, LNG imports to Japan comprised 31.4% of 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 2010, primary natural gas supply was 85 Mtoe, an increase of 7.8% from the previous year.

Japan has 281.082 GW of installed generating capacity and generated 1 156 010 GWh of electricity in 2010. Electricity is generated from thermal fuels (coal, natural gas and oil—63.0%), nuclear (25.3%) and hydro (8.2%); geothermal, solar and wind technologies produce the remainder (3.4%).

Table 13 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	100 648	Industry sector	144 865	Total	99 319
Net imports and other	407 949	Transport sector	80 977	Thermal	56 070
Total PES	497 966	Other sectors	98 457	Hydro	8 197
Coal	114 596	Total FEC	328 570	Nuclear	25 396
Oil	201 779	Coal	34 620	Other	9 656
Gas	85 326	Oil	171 527		
Other	96 265	Gas	29 990		
		Electricity and others	92 434		

Source: EDMC (2012).

### FINAL ENERGY CONSUMPTION

In 2010, Japan's total final energy consumption was 328.6 Mtoe, or 6.1% more than in the previous year. The industrial sector consumed 44% of the total, followed by the transportation sector at 25%. By energy source, petroleum products accounted for 52% of total final energy consumption, followed by electricity and other (28%), coal (11%) and gas (9%).

In 2010, energy consumption in the industrial sector increased by almost 9.3%. The residential/commercial sector's energy consumption also decreased by 0.3% and the transport sector's consumption increased by 3.2%.

## 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 responsible for 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, 2008a): 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, 2008a). 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, 2008a). The strategy contains a programme of action to 2030 that 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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).

## ENERGY MARKETS

### OIL

Japan aims to decrease its oil dependency, partly because of its experiences during oil crises in 1973 and in 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 National Oil Corporation (JNOC) is responsible for the economy's stockpile business until 2003. The Japan Oil, Gas and Metals National Corporation (JOGMEC) 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 January 2012 Japan held the equivalent of 204 days of net imports, including state-owned and private sector stocks (PAJ, 2012a).

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 Non-fossil 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 37 743 in 2011 as a result of market liberalization (Sekiyu Tsushinsha 2012). 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 27 in 2012. Refining capacity decreased from 5.27 million barrels/day (mbd) in 1996 to 4.48 mbd in 2012 (Sekiyu Tsushinsha 1996; PAJ, 2012b).

## NATURAL GAS

Demand for natural gas has been increasing rapidly over the past two decades. Between 1990 and 2010, natural gas demand grew at an annual rate of 3.4%. 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 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 ocean areas surrounding Japan and is viewed as a future energy resource.

## COAL

In 2010, 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, paper and pulp production. Japan is the biggest coal importer in the world, accounting for about 18% of total global coal imports in 2010.

## ELECTRICITY MARKET

Electricity was the second largest contributor (after the petroleum industry) to total final energy consumption in 2009. 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 four cycles of amendments to the Electricity Utilities Industry Law, in 1995, 1999, 2004 and 2008.

### 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 energy efficiency the industrial, consumer (commercial and household) and transport sectors. Japan has improved energy efficiency by about 40% after the oil crises of 1973.

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 is implementing 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 (the Japanese parliament). This Act took effect on 1 July 2012. This Act 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.

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.

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. 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 three years from the enforcement of the Act (METI, 2011a).

## NUCLEAR ENERGY

Japan's Nuclear Energy Policy is under review following the Fukushima Daiichi Nuclear Power Plant Accident. Nuclear power plants in Japan stopped operation for periodic inspections (once in 13 months in succession, regardless of the Fukushima Daiichi Nuclear Power Plant Accident; eventually, as of May 2012, Japan had no operating nuclear power plants. The four units of the Fukushima Daiichi Nuclear Power Plant were decommissioned in April 2012.) The Japanese Government is carefully evaluating the safety of all existing nuclear power plants including those under periodic inspection. An IAEA review team concluded that this procedure was generally consistent with IAEA Safety Standards.

As of February 2013, only two nuclear power plants (Ohi units 3 and 4) are operating. The Nuclear Regulation Authority aims to establish new safety regulations for nuclear power plants by July 2013.

## 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 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 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 1307.00 million tonnes of CO<sub>2</sub> equivalent in 2011 (an increase of 3.4% compared to the previous year and an increase of 3.6% compared to the base year 1990) (ME, 2012a).

The Tax for Promotion of Global Warming Countermeasures took effect in 1 October 2012 (ME, 2012b). This tax is levied on crude oil and oil products, gas and coal. The tax value is JPY 289/tonne-CO<sub>2</sub> for each kind of product. Revenue from this tax is used for implementing various measures to promote energy efficiency and renewable energy, and use of clean fossil fuels.

At the COP 18 Meeting in December 2012, the Japanese Government (via the Ministry of the Environment) again announced its long-term goal of an 80% reduction in GHG emissions by 2050 (ME, 2012c) s

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## NOTABLE ENERGY DEVELOPMENTS

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### ELECTRICITY

In 2012, the Japanese Government asked the people of Japan to save electricity during summer (on week days from 2 July to 28 September 2012) and winter (on week days from 3 December 2012 to 29 March 2013), in anticipation of a possible shortage of electricity supplies due to stoppage of almost all of the economy's nuclear power plants (METI, 2012a; METI, 2012b).

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- Ministry of the Environment—[www.env.go.jp/en/index.html](http://www.env.go.jp/en/index.html)
- Ministry of Land, Infrastructure, Transport and Tourism—[www.mlit.go.jp/index\\_e.html](http://www.mlit.go.jp/index_e.html)

# KOREA

## INTRODUCTION

The Republic of Korea is located in North-East Asia between China and Japan. It has an area of 99 538 square kilometres and a population of around 48.88 million people as of 2010. Korea's population density is very high, with an average of more than 491 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 6.3% per year from 1980 to 2010, reaching USD 1 214.6 billion (USD (2000) at PPP) in 2010. Per capita income in 2010 was USD 24 851, 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 2010. 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, 2010

Key data		Energy reserves	
Area (sq. km)	99 538	Oil (barrels)	—
Population (million)	48.9	Gas (billion cubic metres)— recoverable	3
GDP (USD (2000) billion at PPP)	1214.6	Coal (million tonnes)— recoverable	326
GDP (USD (2000) per capita at PPP)	24 851		

Sources: EDMC (2012); EIA (2009); MKE and KEEI (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased more than six fold between 1980 and 2010, from 38.32 million tonnes of oil equivalent (Mtoe) in 1980 to 250.1 Mtoe in 2010. In particular, from 1990 to 2000, energy supply increased at an annual average rate of 7.3%, far exceeding the economic growth rate of 6.1% for the same period. Likewise, per capita primary energy supply grew from 1.0 tonne of oil equivalent in 1980 to 5.1 tonnes of oil equivalent in 2010. The increase was similar to that of Japan and most European economies.

In 2010, Korea's total primary energy supply was 250.1 Mtoe, a 9.0% increase from the previous year. By energy source, oil represented the largest share (38%), followed by coal (29%), and gas (15%). The remaining 17% of primary energy supply came from nuclear and hydro energy sources. Korea imported around 88% of its total energy needs in 2010, including all of its

oil, 99% of gas requirements and 98% of its coal supply. The cost of Korea's energy imports was USD 121.7 billion in 2010 (it was USD 141.5 billion in 2008 and USD 91.2 billion in 2009). Energy imports accounted for almost one third of Korea's total import value in 2010.

Oil supply in 2010 was 95.1 Mtoe, a 4.99% increase from the previous year. In 2010, the economy imported about 81.8% of its crude oil from the Middle East. In the case of coal, its supply in 2010 totalled 73.0 Mtoe, a 12.7% 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 38.6 Mtoe in 2010; its share of the primary energy supply was 15.5% 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 2010 was 499.5 Terawatt-hours, a 9.9% increase from 2009. Generation by thermal sources, including coal, oil and natural gas, accounted for 68.3% of the total electricity generated, followed by nuclear at 29.7%, and hydro at 1.3%.

Table 2 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	44 963	Industry sector	44 899	Total	499 508
Net imports and other	221 057	Transport sector	29 950	Thermal	341 395
Total PES	250 106	Other sectors	82 364	Hydro	6 472
Coal	73 029	Total FEC	157 213	Nuclear	148 596
Oil	95 113	Coal	9 293	Other	3 045
Gas	38 685	Oil	82 201		
Other	43 279	Gas	20 367		
		Electricity and other	45 352		

Source: EDMC (2012).

### FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2010 was 157.2 Mtoe, a 6.6% increase from the previous year. The industry sector accounted for the largest share at 28.5%, while the transport sector accounted for 19.1%. The remainder (52.4%) 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 52.3% of total energy consumption, followed by electricity and other (28.8%), natural gas (13.0%), and coal (5.9%). Because of the economy's policy measures, natural gas consumption has increased significantly.

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## POLICY OVERVIEW

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### 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 that will support sustainable development that fully considers the 3Es (energy, economy, and environment).

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, and to discuss 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 and 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 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 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 over 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 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, to promote the development of the gas industry, and to 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 existing import and transportation contracts, the privatisation of import and wholesale businesses, stabilized prices and balanced 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 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, including in 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, for example in 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%. Between 1990 and 2009, installed capacity increased 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. Taking decommissioning 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. It is part of Korea's long-term energy plan, announced in August 2008, 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 to 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 will introduce a renewable portfolio standard in 2012, support the construction of 1 million ‘green homes’ between 2009 and 2020, and provide incentives for the wider use of renewable energy sources in new and newly-renovated buildings. It will also strengthen 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 aims 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 provides 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 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, the 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 specialized 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

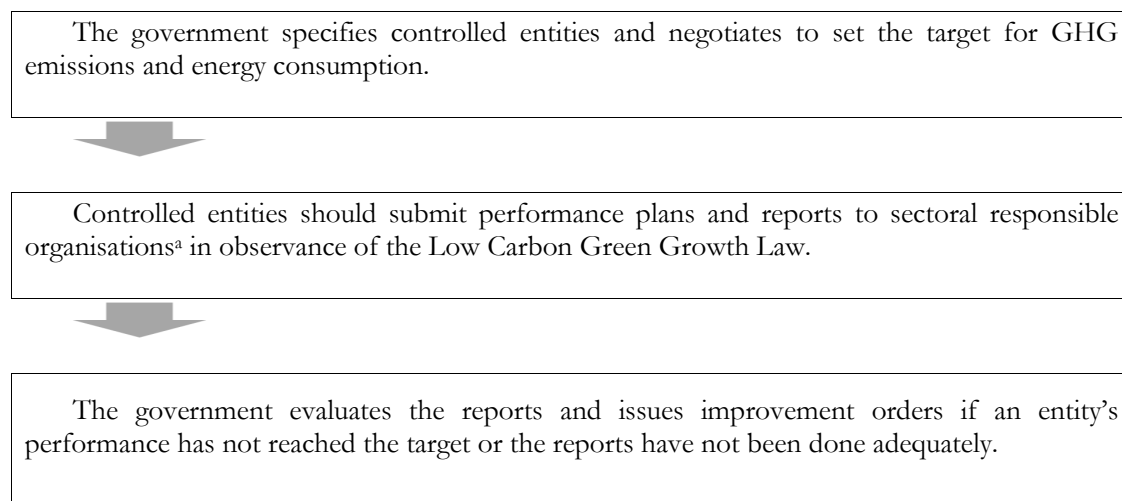
#### R&D PLAN TO NURTURE THE GREEN INDUSTRY

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 for 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 <sub>2</sub> )	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 tCO<sub>2</sub>

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 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 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 CO<sub>2</sub>)

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.

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## USEFUL LINKS

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Korea Electric Power Generation Corporation—[www.kepco.co.kr/eng/](http://www.kepco.co.kr/eng/)  
 Korea Energy Economics Institute—[www.keei.re.kr](http://www.keei.re.kr)  
 Korea Energy Management Corporation—[www.kemco.or.kr](http://www.kemco.or.kr)  
 Korea Gas Corporation—[www.kogas.or.kr](http://www.kogas.or.kr)  
 Korea National Oil Corporation—[www.knoc.co.kr](http://www.knoc.co.kr)



Ministry of Knowledge Economy—[www.mke.go.kr](http://www.mke.go.kr)

Ministry of Strategy and Finance—[www.mosf.go.kr](http://www.mosf.go.kr)

Statistics Korea—[www.kostat.go.kr](http://www.kostat.go.kr)

# 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 2010, Malaysia's population was around 28.3 million.

In 2010, Malaysia's GDP was USD 332.9 billion (USD (2000) at PPP). GDP per capita was USD 11 723 (USD (2000) at PPP), an increase of 5.5% from 2009. Malaysia's economy is strongly driven by the services and manufacturing sectors, contributing 57.3% and 27.6% of GDP respectively in 2010 (MOF, 2011, Table 3.1). The economy's main exports are electrical and electronic products, palm oil products, timber and timber-based products, liquefied natural gas (LNG) and crude petroleum. Its top three export destinations are Singapore, China and Japan (DOS, 2013).

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 2010, Malaysia's crude oil reserve, including condensate, was 5.8 billion barrels. Malaysia also has an abundant natural gas reserve, estimated to be 2.51 trillion cubic metres (88.587 trillion standard cubic feet) (EC, 2012). Malaysia's hydropower potential is assessed at 29 000 megawatts (MW); 85% of the potential sites are located in East Malaysia. Biomass sources are mainly palm oil, wood and agro-industry.

Table 1 Key data and economic profile, 2010

Key data		Energy reserves	
Area (sq. km) <sup>a</sup>	330 803	Oil (billion barrels)—proven <sup>c</sup>	5.8
Population (million) <sup>b</sup>	28.3	Gas (trillion cubic metres)—proven <sup>c</sup>	2.51
GDP (USD (2000) billion at PPP) <sup>b</sup>	332.93	Coal (million tonnes) <sup>c</sup>	1938
GDP (USD (2000) per capita at PPP) <sup>b</sup>	11 723	Uranium (million tonnes)	N/A

Sources: a. EPU (2010a), b. EDMC (2012), c. EC (2012, pp. 31, 37 & 43)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 69 587 kilotonnes of oil equivalent (ktoe) in 2010. Of this, natural gas and oil accounted for the largest shares with about 40% each of the total primary energy supply, at 28 060 ktoe and 28 504 ktoe respectively. This is followed by coal with 12 496 ktoe (18%), and other sources with 527 ktoe less than 1%.

Malaysia is a net energy exporter. Its total energy exports in 2010 were 15 636 ktoe, a decrease of 16% compared to 2009. Petroleum and petroleum products made up the bulk of energy exports with Australia, Thailand, India and China as the major export destinations for crude petroleum (DOS, 2011, p. 14) and China, India, Japan and Korea as the major importers for petroleum products (MOF, 2011, p. 72).

### OIL

Malaysia's oil production averaged 638.3 thousand barrels per day (Mbbbl/d) in 2010, of which 82% is crude oil. The majority of the production comes from the offshore fields in the Malay

basin in the west (44%) as well as the Sabah (26%) and Sarawak (30%) basins in the east. The economy has five oil refineries with a combined capacity of 492 Mbbl/d. Domestic consumption of petroleum products was 203 902 thousand barrels in 2010, mostly in the form of motor petrol and diesel. In 2010, exports of crude oil amounted to 17,125 ktoe while exports of petroleum products totalled 8429 ktoe. To meet domestic requirements, Malaysia imported 10 359 ktoe of petroleum products the same year (EC, 2012, pp. 31-33).

#### NATURAL GAS

Like its oil reserves, Malaysia's natural gas reserves lie offshore of Peninsular Malaysia's east coast, Sabah and Sarawak. In 2010, Malaysia's average daily natural gas production stood at 211.7 million cubic metres per day (mcmd). Most of the production came from Sarawak (121.2 mcmd or 57%), followed by Peninsular Malaysia (77.8 mcmd or 37%) and Sarawak (12.7 mcmd or 6%) (EC, 2012, p.37).

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 (2060 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 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 under construction and expected to be completed by 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 13% of world LNG exports. As of 2010, Japan remained the largest importer of Malaysia's LNG, followed by Korea and Chinese Taipei (MLNG, 2011).

#### COAL

Bituminous and sub-bituminous coals make up the bulk of coal reserves in Malaysia. Although the coal resource in Malaysia is substantial (estimated coal reserves as of 31 December 2010 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 only conducted in Sarawak— 2010 production comes from the areas of Sri Aman (126 919 metric tonnes) Kapit (466 840 metric tonnes) and Mukah-Balingan (1 792 237 metric tonnes) (EC, 2012, p.43).

Malaysia's domestic coal consumption in 2010 was 23 million tonnes, of which 86.9% was consumed by the power generations sector. The remainder was consumed by the iron and steel industry, and by cement manufacturers (EC, 2012, p.43). To meet this demand, coal is imported from Australia, Indonesia, South Africa and Viet Nam (Tse, 2011).

#### ELECTRICITY

Malaysia's total installed electricity generation capacity as of 2010 was 24 361 MW –of which 67.2% was owned by independent power producers (IPPs) and the rest by government-linked utilities (EC, 2012, p.47). Total electricity generation in the same year was 113 048 gigawatt-hours (GWh), an increase of 7% from the previous year. Thermal generation, mostly from natural gas and coal, accounted for 94.5% of total power generation; hydropower accounted for the remainder.

Table 2 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	85 110	Industry sector	12 041	Total	113 048
Net imports and other	- 15636	Transport sector	16,780	Thermal	106 776
Total PES	69 587	Other sectors	11,469	Hydro	6 272
Coal	12 496	Total FEC	40 290	Nuclear	–
Oil	28 060	Coal	1563	Geothermal	–
Gas	28 504	Oil	24 383	Other	–
Other	527	Gas	5355		
		Electricity and other	8989		

Source: EDMC (2012).

For full details of the energy balance table see [www.ieej.or.jp/egeda/database/database-top.html](http://www.ieej.or.jp/egeda/database/database-top.html).

### FINAL ENERGY CONSUMPTION

In 2010, total final energy consumption in Malaysia was 40 290 ktoe, an increase of 5.4% from 38 244 ktoe in 2009. The transport sector was the biggest final energy user at 16 780 ktoe, or 41.7% of total final energy consumption, followed by the industry sector at 12 041 ktoe, or 29.9%, and other sectors (agriculture, residential/commercial and non-energy) at 28.5%. By energy type, oil contributed the largest share, with 60.5% of consumption, followed by electricity (22.3%), gas (13.3%) and coal (3.9%).

## 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 principle 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 prolong 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 electricity 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%); it 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 established: 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 supply; 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). In terms of electricity production, the 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 sets the general direction of, and strategies for, energy policy and determines the level of its implementation. The role of the Ministry of Energy, Green Technology and Water is to facilitate and regulate the electricity sector and to ensure that affordable energy is available to consumers throughout the economy. This includes the formulation of energy policy in coordination with the Economic Planning Unit.

The Energy Commission has been the regulatory agency for the electricity and piped gas supply industries in Malaysia since 2002, replacing the Department of Electricity and Gas Supply. 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 electricity and piped gas supply, 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 completed its first LNG Regasification Terminal (RGT) in Malacca in mid-2012. Once fully operational, the terminal will have the capacity to process and store 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 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 in 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 2010, two new gas fields came on stream, increasing the total number of producing fields in Malaysia to 106, of which 68 are oil fields and 38 are gas fields. Four new production-sharing contracts (PSC) were awarded during 2010, bringing the total number of PSCs in operation to 72.

Malaysia's total reserves increased marginally in 2010 by 1.9%, to 20.56 billion barrels of oil equivalent (boe). This was accomplished through Enhanced Oil Recovery (EOR) projects at the Dulang and Samarang fields, as well as additions from new discoveries from the Siakap North, Kawang and Tukau Timur fields. 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, 2010).

### 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 electricity supply as well as creating a sustainable electricity 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 sector.*
  - 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 5 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 5 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 on energy efficiency improvements. Malaysia and other South East Asia economies under ASEAN are 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 United Nations Development Program (UNDP) and Global Environment Facility (GEF). The MIEEIP was aimed to address barriers to energy efficiency and energy conservation in 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.

### CLIMATE CHANGE

Malaysia signed the United Nations Framework Convention on Climate Change (UNFCCC) on 9 Jun 1993 and ratified it on 17 July 1994. At the 2009 Climate Change Summit in Copenhagen, Malaysia's Prime Minister pledged to "voluntarily reduce CO<sub>2</sub> 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 to achieve 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 on climate change 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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) to be launched in 2013. 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 be tabled in 2013, and includes provisions for banning incandescent light bulbs and 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 June 2012, 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 that is expected to be completed by 2020. 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).

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#### USEFUL LINKS

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- Economic Planning Unit, Prime Minister's Department—[www.epu.gov.my](http://www.epu.gov.my)
- Energy Commission—[www.st.gov.my](http://www.st.gov.my)
- Ministry of Energy, Green Technology and Water—[www.kettha.gov.my](http://www.kettha.gov.my)
- Ministry of Finance—[www.treasury.gov.my](http://www.treasury.gov.my)
- Ministry of National Resources and Environment—[www.nre.gov.my](http://www.nre.gov.my)
- Petronas—[www.petronas.com.my](http://www.petronas.com.my)
- Tenaga Nasional Berhad—[www.tnb.com.my](http://www.tnb.com.my)



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# MEXICO

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## INTRODUCTION

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The United Mexican States (in Spanish, *Estados Unidos Mexicanos*) more commonly known as Mexico, is a federal constitutional republic located in North America and divided into 31 states and one federal district. In Latin America, Mexico is the second-largest economy, and one of the three APEC member economies. In 2010, it had a total population of 112.3 million, which is projected to grow to 121.9 million by 2050 (Conapo, 2005). According to Mexican Government statistics, in the same year 46.2% of the population was considered poor, and 10.4% live under extreme poverty conditions (Coneval, 2011). The largest urban metropolitan areas are Mexico City, Guadalajara and Monterrey. Mexico City, formed by the Capital City (Distrito Federal) and its metropolitan area known as Zona Metropolitana del Valle de México (ZMVM), is one of the largest urban centres in the world, with a population of around 20 million.

Bordered by the United States (US) to the north and Belize and Guatemala to the south, Mexico has a land area of around 1.96 million square kilometres. This area is rich in biodiversity and has a wide range of climatic conditions, ranging from very dry with high temperatures in the north, to very humid with high temperatures in the south, mild in the centre and warm on the coasts. The currency is the Mexican Peso (MXN) and the economy's growth depends heavily on crude oil exports, remittances (mostly from the US) and tourism.

In 2010, Mexico's real gross domestic product was USD 1 074 billion (USD 2000 at PPP). From 2000, economic expectations were high due to political changes and reforms, however the economy was unable to become more dynamic and during the 2000-2010 period, its growth was moderate, rising at an annual average rate of 1.8% (EDMC, 2012). Due to its strong dependence on exports and its strong ties to the US economy, Mexico was affected by a prevalent slower global growth, although during the first half of 2012 the value of its exports was able to grow 5.8% and its domestic demand also grew 3.6%. In addition, during 2012, Mexico's economic sectors expanded, having a positive impact on job generation (SHCP, 2012). According to international forecasts, the Mexican economy was projected to grow in 2012 and 2013 by 2.2% and 3.7%, respectively (World Bank, 2011), with the Mexican government's projections reporting preliminary growth of 3.9% in 2012 and estimating an expansion of 3.5% in 2013 (SHCP, 2012).

The energy sector is critical to the Mexican economy. The oil sector in particular is a central component of the Mexican economy and while oil exports only amounted to 16% of the economy's total exports value in 2011, they provided more than a third of the total government revenue, from which Mexico's social development is primarily funded (Inegi, 2012; SHCP, 2013).

Mexico has made important changes to its energy policy aimed at its competitiveness. Following the energy reform of 2008, the state-owned company *Petróleos Mexicanos* (*Pemex*) was given greater flexibility through passage of a new Pemex Organic Law (in Spanish, *Ley Orgánica de Petróleos Mexicanos*). In the electricity sector, the most significant change was the liquidation of the Luz y Fuerza del Centro utility in 2009, which in spite of being responsible for supplying electricity to Mexico's Central area including Mexico City, had become very inefficient financially and operationally. These measures, however, remain insufficient to provide the energy sector with adequate investments to develop its full potential. Moreover, namely in the oil sector, the reforms proved to have little effect in transforming Pemex's operational efficiency and modernisation towards maintaining in the long-term its role as Mexico's largest taxpayer.

In 2011, Mexico's proved 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, 2010

Key data		Energy reserves	
Area (million sq. km)	1.96	Oil (billion barrels) – proved <sup>a</sup>	10.2
Population (million)	112.3	Gas (trillion cubic meter) – proved <sup>a</sup>	0.35
GDP (USD (2000) billion at PPP)	1 074	Coal (billion tonnes) – proved <sup>b</sup>	1.21
GDP (USD (2000) per capita at PPP)	9 465	Uranium (thousand tonnes of uranium metal) <sup>c</sup>	2.8

a. As of 1 January 2012. Oil reserves do not include condensates and natural gas liquids. Gas reserves refer to dry gas. Pemex (2012a).

b. At the end of 2011. BP (2012)

c. As of 1 January 2011. Reserves refer to reasonably assured resources. NEA (2012)

Source: EDMC (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Mexico's total primary net energy supply in 2010 was 178 411 kilotonnes of oil equivalent (ktoe), a 2.1% increase from the 174 680 ktoe reached in 2009, which can be mainly attributed to higher production of coal and gas. Fossil fuels dominated Mexico's primary energy supply at nearly 90% of the total, with the rest composed of non-fossil sources such as nuclear power and renewable energy (EDMC, 2012).

By the end of 2011, Mexico's proved oil reserves reached 10.2 billion barrels. According to official estimates, Mexico was ranked 17th in the world for its oil reserves and 33rd for its gas reserves (Pemex, 2012a).

In 2011, Mexico produced 2.55 million barrels per day (Mbd) of crude oil; with 55.6% being heavy, 31.3% light and the remaining 13.1% being extra-light crude. In recent years, Pemex has focused on discovering and exploiting new fields to offset the natural decline of its once largest asset of Cantarell; which peaked in 2004 with 3.38 million barrels per day and has dropped since then at an annual average rate of 4% up to 2011. Mexico is a net crude oil exporter, with around 52.5% of its total indigenous crude oil production, equivalent to 1.34 million barrels per day, sent overseas in 2011 (Pemex, 2012), 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, lack of sufficient domestic refining capacity forces the economy to be an oil product importer, especially of gasoline. In 2011, nearly 50.9% of the total gasoline demand was supplied by imported stock (Pemex, 2012a).

Mexico's proved natural gas reserves at the end of 2011 totalled 0.35 trillion cubic metres with production in the same year reaching 0.19 billion cubic metres per day, of which roughly 67% was associated with crude oil and the remainder was non-associated gas. In spite of its production levels, Mexico is a net natural gas importer. Imports grew by a considerable 20% from 2010 to 2011 to reach nearly 50 million cubic metres per day, as a result of sustained domestic demand in the industrial and electricity generation sectors. Around 78% of these imports came by pipeline from the US, while the rest was received as liquefied natural gas (LNG) from shipping tankers from Qatar, Nigeria and Peru, among other economies (Sener, 2012e).

Table 2 Energy supply and consumption, 2011

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	226 377	Industry sector	27 415	Total	270 968
Net imports and other	-43 697	Transport sector	51 846	Thermal	217 391
Total PES	178 411	Other sectors	34 192	Hydro	37 121
Coal	8 439	Total FEC	113 453	Nuclear	5 879
Oil	97 570	Coal	1 626	Others	10 577
Gas	53 285	Oil	73 858		
Others	19 118	Gas	12 746		
		Electricity and others	25 223		

Source: EDMC (2012)

### COAL

In Mexico, coal represents only a small proportion of the total primary energy supply, equivalent to roughly 4.7% in 2010. With production and imports considered, coal primary energy supply in 2010 amounted to 8 439 ktoe (EDMC, 2012). Most of Mexico's recoverable coal reserves of 1.21 billion tonnes are located in the state of Coahuila in the north-east, while some significant additional resources are in Sonora (in the north-west) 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, 2012).

During 2011, coal production reached 14.5 million tonnes, representing an increase of 21% from the previous year. Coal production in 2011 was comprised 94% of thermal coal and 6% of coking coal. Thermal coal is used as a fuel for thermal power plants while coking coal's main use is for 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 generated in Mexico was around 271 000 gigawatt hours (GWh) in 2010, with most energy produced by 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 electricity 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. Thermal power plants (including combined cycle technologies and IPP generation) accounted for 67.1%; hydropower 22.8%; coal-fired thermal plants 4.8%; nuclear 3%; geothermal 1.5%; and wind farms 0.7% (Sener, 2012f).

### FINAL ENERGY CONSUMPTION

In 2010, Mexico's total final energy consumption was 113 453 ktoe, an increase of 3% from 2009. By fuel source, petroleum products accounted for 65.1%; electricity and others, 22.2%; natural gas, 11.2% and coal barely 1.4% (EDMC, 2012).

Energy consumption in 2010 was concentrated in the transport sector (48%) followed by the industrial sector (29%), residential and commercial (20%) and agricultural (3%). The fuels most in demand in Mexico in 2010 in each sector were: natural gas – 37% of industry sector demand; gasoline – 66% of transport sector demand; liquefied petroleum gas – 38% of the residential, commercial and public sector demand; and diesel – 74% of agricultural sector demand (Sener, 2010a).

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## ENERGY POLICY OVERVIEW

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### ENERGY POLICY FRAMEWORK

In order to provide an overview of Mexico's energy sector, it is worth noting that since its legal framework grants the State absolute ownership of natural resources and the duty to exploit them, oil and gas production is restricted for private participants. 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 are exclusively reserved to the government, although in recent years efforts have been made to increase the inflow of private investments, especially to develop infrastructure.

With the aim of liberalising the economy, implementing market mechanisms and opening it to foreign trade and investment, Mexico has carried out and promoted reforms since the 1980s. In the energy sector, there have been significant structural changes to the legal and institutional frameworks with the objective of ensuring a reliable energy supply, improving competitiveness in line with international trends and at the same time reducing carbon intensity.

The single most significant development in energy policy in Mexico was the approval of its energy reforms in October 2008, which created a set of laws and initiatives to strengthen the energy sector and grant greater autonomy to Pemex. Additionally, as a result of these reforms, Mexico's National Energy Strategy was formalised to issue a yearly planning document containing long-term policies covering a 15-year span, and to become the reference point from which all other energy policies must be derived. The strategy focuses on three critical areas: energy security, economic efficiency and environmental sustainability.

Mexico's Ministry of Energy (*Secretaría de Energía*, or Sener) is responsible for the economy's energy policy within the existing legal framework. At the beginning of each six-year Presidential term, the law mandates the development of the Energy Sector Program, a planning document to outline the main objectives and strategies of the energy policy to be enforced. The last Energy Sector Program issued for the 2007–2012 period aimed to secure the energy supply required for development at competitive prices, while minimising environmental impact, operating at high standards, and promoting energy efficiency and diversification. The program also set out the major indicators, strategies and action targets for the energy sector based on the following major objectives (Sener, 2007).

- Ensure the economy's energy security for hydrocarbons
- Foster the operation of the hydrocarbons sector under international quality, transparency and accountability standards
- Increase exploration, production and transformation of hydrocarbons in a sustainable way
- Promote electricity tariff levels that can cover the costs of efficient operation of electric power utilities
- Balance the primary energy source mix
- Strengthen the electric power utilities with regards to operational, reliability and quality standards for the services they provide
- Promote efficient production and use of energy
- Foster renewable energies and biofuels which are technically, economically, environmentally and socially feasible
- Mitigate growth of greenhouse gas (GHG) emissions.

In spite of the reforms adopted to date, the administration of President Peña Nieto, which took office in December 2012, is faced with the ambitious challenge of exploiting the potential of domestic energy resources while improving economic growth, a goal in which his predecessors fell short due to the lack of significant structural modifications. While no formal plans have been announced at the time of this writing, the current federal government has announced its

intention to achieve substantial reforms in the energy sector, to turn it into an effective lever for Mexico's transformation (Presidencia de la República, 2012).

### OIL SECTOR

Pemex, one of the largest oil companies in the world, is by law the sole upstream and downstream agent in Mexico, being also responsible for the final distribution of most oil products in the economy. To carry out its activities across the entire oil industry's value chain, Pemex has four subsidiaries: Pemex Exploration and Production, Pemex Refining, Pemex Gas and Basic Petrochemicals, and Pemex Petrochemicals. In spite of its being responsible for Mexico's production and transformation of hydrocarbons since 1938, during the last decade contract mechanisms for exploration and production have been fostered to promote private investments in areas such as dry gas and mature oil basins (Pemex, 2012b).

With the reforms passed 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. In this regard, born with these reforms, the autonomous technical authority known as the National Hydrocarbon Commission (*Comisión Nacional de Hidrocarburos*, or CNH) commenced 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 line with these efforts, 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. Financed through Pemex fee payments stipulated in Mexico's Income Law, this trust fund aims to support scientific and applied research in the oil sector's upstream and downstream areas.

### POWER SECTOR

As in the case of Pemex in the oil sector, transmission, transformation, distribution and sale of electricity for public service purposes in Mexico is carried out exclusively by the government-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 (*Sistema Interconectado Nacional*, or SIN), with the electricity being dispatched and controlled by CFE through its National Centre of Energy Control (*Centro Nacional de Control de Energía*, or CENACE). While most of the economy's territory is covered by SIN, two systems in the Baja California peninsula are still isolated; altogether, these systems form the National Electricity System (*Sistema Eléctrico Nacional*, or SEN). 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 across the economy by CFE through CENACE.

On 11 October 2009, the Luz y Fuerza del Centro utility, responsible for servicing Mexico's central area, including Mexico City, was liquidated by presidential decree due to its poor efficiency and considerable financial losses (DOF 2009). As a result, technical operation of this area was taken over by CFE, which stands as the only power utility in Mexico.

### 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 (*Normas Oficiales Mexicanas*, or NOMs), which contain the specific requirements, in terms of features, usage and maintenance, for electric products and appliances to be sold in Mexico. From 1995 when Mexico first adopted energy standards, 24 mandatory energy efficiency standards for electrical appliances, energy building codes, and lighting have been established (Sener, 2012d).

In addition, 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 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's 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 areas.

### NUCLEAR

Mexico is experienced in the exploitation of nuclear energy, and in spite of having only one nuclear power plant (Laguna Verde) which began operations in 1990, the government has opened the possibility of increasing its nuclear power capacity.

On one hand, 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 is 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. On the other hand, the diversification of energy sources through the use of clean technologies included in Mexico's National Energy Strategy considers the development of additional nuclear capacity to meet electricity demand in the long term under two scenarios different from business-as-usual. While the first of these scenarios considers the installation of up to eight nuclear power plants with a capacity of 1 400 megawatts each, the second scenario includes only two nuclear power plants with the remaining additional capacity being covered by wind power (Sener, 2012c).

It is worth noting, though, that apart from these planning exercises, the Mexican government has not implemented any other action that might provide a stronger signal of its intent to increase nuclear-based electricity generation.

### 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. The laws passed are:

- the Law for the Use of Renewable Energy and Finance of the Energy Transition and regulations
- the Law for the Promotion and Development of Biofuels and Regulations
- the National Strategy for Energy Transition and Sustainable Energy Use
- the Special Program for Efficient Use of Renewable Energy
- the Introduction Program for Biofuels
- the Advisory Council for Renewable Energies.

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). The program's three specific objectives are:



- Foster development of a renewable energy industry in Mexico
- Expand the energy portfolio and increase the economy's energy security so as not to rely on one energy source
- Expand electric power service in rural communities where grid connection is not technically and/or economically feasible by using renewable energy.

### 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*, by its Spanish acronym) on 25 May 2007 which led to the publication of the Special Climate Change Programme 2009–2012 (*PECC*, by 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 (Semarnat, 2009).

In the short-term, PECC established an emissions mitigation goal of 50.7 million tonnes of carbon dioxide equivalent by 2012. From 2009 to the first half of 2011, Mexico was able to mitigate 33.4 million tonnes of carbon dioxide equivalent, with the energy sector alone accounting for 45% of those emissions, while 38% came from agriculture and forestry, 13% from reduced energy demand, and 4% from waste management (Semarnat, 2011).

Committed to contributing to climate change issues, Mexico has actively participated in several multilateral climate change forums. In late 2010, Mexico hosted the 16th Conference of Parties of the United Nations Framework Convention on Climate Change in Cancun City. As incoming President, Mexico acted as a facilitator of the negotiations during 2010 to create an adequate technical and political framework to achieve successful results, and to provide a multilateral forum in which effective agreements and solutions could be achieved. More recently, in April 2012, Mexico, through Sener, participated in the Third Clean Energy Ministerial held in London, to which Ministers from more than 20 economies gathered to enhance collaboration and support clean energy development.

### 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 Technology National 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 the industrial and domestic activities, some of them are also research projects.



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## NOTABLE ENERGY DEVELOPMENTS

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### OIL SECTOR

To successfully meet its challenges in the Mexican oil sector, Pemex performance is aimed at sustaining hydrocarbon production and increasing its downstream activities. In July 2011, Pemex's Administrative Board approved the 2012-2016 Business Plan, which defines the company's future priorities and comprises several major projects to be carried out by its subsidiaries on the basis of four pillars: growth, operational efficiency, governance responsibility and management modernisation.

On 8 November 2011, the Programme for the Structural Change of Mexico's natural gas was announced with the intention of strengthening the current pipeline transport system through the addition of 56 568 kilometres and development of a new network of roughly 4 300 kilometres, representing an increase of 37% from the current pipeline system's length and involving investments equivalent to USD 10.9 billion.

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, 2012f). Another relevant achievement was the allocation of MXN 3 billion (around USD 229 million at an 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. During 2012, the new refinery project was still in its pre-investment stage and it was expected that by the end of that year, the specific requirements for equipment and processes could be made public for international bidding (Pemex, 2012c).

### 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. Up to 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 State, 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, 2012e).

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, 2012e).

## POWER SECTOR

Several major projects were underway in the power sector in 2012. In this case, eight new power plants, which will add 2 291 megawatts to the SEN 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 477 MW capacity). Most of the fossil fuel-based plants employ improved combined cycle technologies to attain a more efficient generation at lower environmental cost.

On November 2012, Mexico was officially admitted as the 47<sup>th</sup> 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 savings and households. In particular, some of the most successfully implemented were the following (Sener, 2012f):

- Programme for Energy-Saving Household Appliances Replacement “*Cambia tu Viejo por uno Nuevo*”. This program strives to replace household freezer and air conditioning equipment 10 years or older with energy-efficient new appliances through a preferential-rate loan from the Mexican Government paid through the power utility bill. From its implementation in 2009 until December 2012, 1.66 million freezers and 199 thousand air conditioning equipment had been replaced within the programme.
- Programme for Sustainable Light “Luz Sustentable”. The objective of this programme is to provide free replacement of up to four traditional incandescent bulbs per household with up to four energy-efficient lamps. With nearly 45.8 million lamps replaced by December 2012, the success of the Programme has been so high that on 26 July 2012 it was awarded *Guinness Record* recognition for the largest number of energy-efficient lamps ever given away to promote energy savings.

## 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 objective 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

Up to the first half of 2012, wind power capacity amounted to nearly 393 MW which represented a growth of 3.5 times from 2011, as a result of the beginning of operations of the wind power plants of Oaxaca II, III and IV (Sener 2012f). 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).

## SOLAR ENERGY

As with wind energy, solar power generation has a promising outlook in Mexico. 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 (*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, in the state of Sonora, with 477 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, 2012f).

## GEOHERMAL ENERGY

Mexico was a pioneer in geothermal power utilisation in the Americas, with the first geothermal well being drilled in the 1950s. Currently, Mexico's geothermal electricity capacity is 886.6 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 720 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 2011, total geothermal generation was 6 506.6 GWh, a slightly decrease (1.7%) from 2010.

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

By December of 2012, the Mexican Energy Ministry had awarded 28 permits, two for production and storage, 1 for transportation and 25 for commercialization of biofuels. It also had received nine permits exemption notifications for biofuel production plants, each with capacity equal to or less than 500 litres per day and storage of up to 1000 liters (SENER, 2012f). 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 to which Pemex must comply when purchasing this feedstock to blend with its gasoline production.

## INTERNATIONAL COOPERATION

Mexico has a significant role in international energy cooperation. 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.

During 2011 and 2012, Mexico fostered bilateral energy cooperation with the United States, Canada, Poland, United Kingdom, Djibouti, Russia, Saudi Arabia, Korea, Indonesia, New Zealand, El Salvador, Guatemala, Cuba, Jamaica, Colombia, Uruguay and Bolivia. During the same period, Mexico also participated in multilateral bodies such as the G20, the European

Union, North America's Energy Working Group, the Clean Energy Ministerial, the Energy and Climate Partnership of the Americas, the International Energy Forum and the Organization for Economic Co-operation and Development (OECD), among many others. In the oil sector in particular, in 2011 and 2012 Pemex signed several co-operation and technical agreements with international oil companies and institutions in areas such as deep water, technological research and human resources development to strengthen its technical capacity and expertise.

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#### USEFUL LINKS

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- Biodiesel Chiapas—[www.biodieselchiapas.mx](http://www.biodieselchiapas.mx)
- Bioenergéticos México—[www.bioenergeticos.gob.mx](http://www.bioenergeticos.gob.mx)
- Comisión Federal de Electricidad (CFE)—[www.cfe.gob.mx](http://www.cfe.gob.mx)
- Comisión Nacional para el Uso Eficiente de la Energía (Conuee)—[www.conuee.gob.mx](http://www.conuee.gob.mx)
- Comisión Nacional de Hidrocarburos (CNH)—[www.cnh.gob.mx/](http://www.cnh.gob.mx/)
- Comisión Regulatoria de Energía (CRE)—[www.cre.gob.mx](http://www.cre.gob.mx)
- Instituto Nacional de Estadística y Geografía (Inegi)—[www.inegi.org.mx](http://www.inegi.org.mx)
- Petróleos Mexicanos (Pemex)—[www.pemex.gob.mx](http://www.pemex.gob.mx)
- Presidencia de la República—[www.presidencia.gob.mx](http://www.presidencia.gob.mx)
- Secretaría de Economía (SE)—[www.economia.gob.mx](http://www.economia.gob.mx)
- Secretaría de Energía (Sener)—[www.energia.gob.mx](http://www.energia.gob.mx)
- Secretaría del Medio Ambiente y Recursos Naturales (Semarnat)—[www.semarnat.gob.mx](http://www.semarnat.gob.mx)



# NEW ZEALAND

## INTRODUCTION

New Zealand is an island economy in the South Pacific, mainly consisting of the North Island and the South Island as well as a number of 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 23 000 (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 81.1 million barrels of oil, 29.4 billion cubic metres of natural gas and 571 million tonnes of coal. In 2011, hydro, geothermal, wind and bioenergy resources met around 77% of electricity demand (MED, 2012, Table G2a).

Table 14 Key data and economic profile, 2010

Key data		Energy reserves	
Area (sq. km) <sup>a</sup>	268 680	Oil (million barrels) <sup>b</sup>	81.4
Population (million)	4.4	Gas (billion cubic metres) <sup>c</sup>	29.4
GDP (USD (2000) billion at PPP)	102.5	Coal (million tonnes) <sup>d</sup>	571
GDP (USD (2000) per capita at PPP)	23 462	Uranium (million tonnes of uranium metal)	–

a. Statistics New Zealand (2012), Summary.

b. MED (2012a), Table H.2, figure shown is 'Remaining Reserve P90 as at 1 January 2012' and includes LPG.

c. MED (2012a), Table H.3, figure shown is 'Remaining Reserve P90 as at 1 January 2012'.

d. Proven reserves at the end of 2010 from BP (2012).

Other data: EDMC (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

In 2010, New Zealand's total primary energy supply was 19 765 kilotonnes of oil equivalent (ktoe). A number of energy sources contributed to this total, including oil (31%), geothermal (27%), gas (19%), hydro (11%), and coal (7%), with wind, biomass, biogas, waste heat, and solar providing the remainder (5%). Due to an assumed conversion efficiency of only 15% in geothermal electricity generation, the geothermal share of final energy supply is much smaller than its primary energy supply share of 27%. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2010 was 93%, up from 88% in 2009 as growth in indigenous production outpaced growth in total primary energy supply. Since 2000, growth in New Zealand's primary energy supply has been modest, increasing at an average annual rate of 1.1% (EDMC, 2012).

Coal, predominantly lignite, is New Zealand's most abundant fossil energy resource. However, almost all coal production is of sub-bituminous and bituminous coals. In 2010, coal production increased by 19% on an energy-equivalent basis compared with 2009, reaching the highest production level since 2006 (EDMC, 2012).



Oil is sourced from 17 fields in the Taranaki region (MED, 2012, p. 43). The production of crude oil, natural gas liquids and condensate was down 0.9% on an energy-equivalent basis in 2010 compared with 2009, but up 153% compared to 2005 (EDMC, 2012). Oil production was underpinned by the growth in production from the newest offshore fields, Pohokura, Tui, and Maari and from onshore fields such as Cheal and Sidewinder (MED 2012, Table D2a). Despite this growth, domestic oil production met only 48% of demand in 2010 (MED, 2012, Table D3). Therefore, New Zealand imports a large volume of crude oil and petroleum products.

Natural gas is sourced from 14 fields (MED 2012, p. 71). In 2010, natural gas production increased by 7% compared with 2009 (EDMC 2012). 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 2010, New Zealand generated 44 822 GWh of electricity, about 3% more than in 2009 (EDMC 2012). New Zealand has plentiful hydro and renewable energy resources. Reflecting this, about 74% of electricity generation was from hydro and renewable sources. Hydro is the major source of electricity generation, accounting for 56% of total generation. Hydro production fluctuates from year to year depending on rainfall; 2010 was a fairly normal hydro year. Geothermal generation accounted for another 13% of total generation (MED, 2012, Table G2a). 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 (MED 2012, Table G3c).

Table 15 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	18 423	Industry sector	3 895	Total	44 822
Net imports and other	2 853	Transport sector	4 610	Thermal	10 804
Total PES	19 765	Other sectors	4 270	Hydro	24 714
Coal	1 307	Total FEC	12 775	Nuclear	–
Oil	5 482	Coal	599	Other	9 304
Gas	3 728	Oil	5 887		
Other	9 248	Gas	1 658		
		Electricity and other	4 631		

Source: EDMC (2012).

### FINAL ENERGY CONSUMPTION

In 2010, New Zealand's final energy consumption was 12 775 ktoe or 3% higher than in 2009. The transport sector consumed 36% of final energy, the industry sector consumed 30%, and other sectors 34%. Final energy consumption was dominated by oil, accounting for 5 887 ktoe (46%), followed by electricity and other (mainly heat) at 3 380 ktoe (36%), gas at 1 658 ktoe (13%), and coal at 599 ktoe (5%) (EDMC, 2012).

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 78% of domestic oil consumption in 2010, the same percentage as in 2009. Consumption of oil

products in the other sectors was shared between residential, commercial and agricultural (3%), industry (6%), and non-energy or other (13%) (EDMC, 2012).

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## POLICY OVERVIEW

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### 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 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; the efficient use of energy; and secure and affordable energy. The Energy Strategy includes the New Zealand Energy Efficiency and Conservation Strategy 2011–2016 (NZECS) to replace 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 about 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 an 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 an Electricity Authority that has more independence from the government. This change was effective from 1 November 2010 (EA 2012). Some of the responsibilities of the Electricity Commission which overlapped with those of other agencies have been transferred to those other 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

The ownership of all petroleum resources (including natural gas) in New Zealand 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 on them (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 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.

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 90% of electricity to be generated 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 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 CO<sub>2</sub>-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 CO<sub>2</sub>-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 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 emission trading scheme is detailed in Table 16. Furthermore, a raft of other changes were included extending the transitional period and to introduce offsetting of emission 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 will 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 16 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 (2011).

## NOTABLE ENERGY DEVELOPMENTS

### 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). Transpower has three major grid 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).

### PIKE RIVER COAL MINE EXPLOSION

On 19 November 2010, a major explosion at the Pike River coal mine near Greymouth, operated by Pike River Coal Limited, killed 29 employees and contractors. A Royal Commission of Inquiry into the incident highlighted 16 recommendations to improve regulatory oversight and improve mining safety. The government is hoping to implement all the recommendations before 2014. The most urgent recommendation is to implement a new regulatory framework to cover all mining in New Zealand (RCPRCMT, 2012; MBIE, 2012b).

### CHRISTCHURCH EARTHQUAKES

On 4 September 2010 at 4.35 a.m., a magnitude 7.1 earthquake occurred about 40 kilometres west of Christchurch at a depth of 10 kilometres. The earthquake caused significant damage but there was no loss of life and no serious injuries (Geonet, 2010). On 22 February 2011, at 12.51 p.m., a magnitude 6.3 aftershock occurred within 10 kilometres of Christchurch at a depth of only 5 kilometres. Although the second earthquake was smaller than the first, it was closer to the city, closer to the surface, and occurred during a working day. Consequently, 181 people were killed and 164 people were seriously injured (Geonet, 2011). The International Monetary Fund assumes the cost of earthquake reconstruction will be NZD 15 billion, or about 7.5% of New Zealand's 2011 GDP (IMF, 2011), although reconstruction cost estimates have risen recently.

While the earthquake had little direct impact on New Zealand's energy situation outside the affected area, it has necessarily diverted some of the government's attention away from energy policy initiatives.

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#### USEFUL LINKS

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- Climate Change Information, Ministry for the Environment—[www.climatechange.govt.nz](http://www.climatechange.govt.nz)
- Electricity Authority—[www.ea.govt.nz/](http://www.ea.govt.nz/)
- Energy Efficiency and Conservation Authority (EECA)—[www.eeca.govt.nz](http://www.eeca.govt.nz)
- Environmental Protection Authority—[www.epa.govt.nz/Pages/default.aspx](http://www.epa.govt.nz/Pages/default.aspx)
- Ministry of Economic Development (MED)—[www.med.govt.nz](http://www.med.govt.nz)
- New Zealand Government (portal for access to New Zealand government agencies and government-funded websites)—[www.newzealand.govt.nz](http://www.newzealand.govt.nz)
- New Zealand Government (news and speeches from government ministers)—  
[www.beehive.govt.nz](http://www.beehive.govt.nz)
- New Zealand Parliament—[www.parliament.govt.nz](http://www.parliament.govt.nz)
- New Zealand Petroleum & Minerals (formerly Crown Minerals)—[www.nzpam.govt.nz/cms](http://www.nzpam.govt.nz/cms)
- Transpower—[www.transpower.co.nz](http://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 six million, spread across its total area of 462 840 square kilometres.

In 2010, its real GDP was estimated at USD 13.5 billion (USD (2000) at PPP), an increase of 8.0% from 2009.

Table 17 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (sq. km)	462 840	Oil (million barrels)	88
Population (million)	6.9	Gas (billion cubic metres)	442
GDP (USD (2000) billion at PPP)	13.5	Coal (million tonnes)	—
GDP (USD (2000) per capita at PPP)	1 967	Uranium (million tonnes U)	—

a. Proved reserves as of 1 January 2010 from Oil & Gas Journal (2010).

Source: EDMC (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

In 2010, PNG's net primary energy supply was 2333 kilotonnes of oil equivalent (ktoe), an increase of 2.8% from 2009. Light crude oil and petroleum products accounted for 77%, gas for 15% and hydro and other fuels for the remaining 8%.

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 resulting in the development of some 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 2004 commissioning of the first refinery plant (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.

ExxonMobil and its partners—Oil Search, Santos, AGL, Nippon Oil and local landowners—are targeting the Hides field plus a string of other gas and associated fields to develop PNG's first liquid natural gas (LNG) project.

In 2010, PNG generated 3500 gigawatt-hours (GWh) of electricity, a 1.6% increase from 2009. Sources of generation included thermal at 62% (oil 47%, gas 16%), hydro at 28%, and geothermal at 10%. 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 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).

Table 18 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 407	Industry sector	883	Total	3 500
Net imports and other	—	Transport sector	421	Thermal	2 176
Total PES	2 333	Other sectors	128	Hydro	987
Coal	—	Total FEC	1 431	Nuclear	—
Oil	1 815	Coal	—	Geothermal	337
Gas	123	Oil	1 155	Other	—
Other	394	Gas	—		
		Electricity and other	277		

Source: EDMC (2012).

### FINAL ENERGY CONSUMPTION

In 2010, total final energy consumption in PNG was 1431 ktoe (an increase of 23% from 2009). The industrial sector's consumption increased 40% from 2009, and the sector was the largest end user, accounting for 62% of energy used, followed by transport (29.4%) and other sectors, including agriculture and residential/commercial (8.9%). By energy source, petroleum products accounted for 80.7% of total consumption, while 'electricity and other' accounted for 19.4%.

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 is continuously extending its rural distribution network throughout the economy, especially within the outskirts of urban areas.

### POLICY OVERVIEW

#### ENERGY POLICY FRAMEWORK

Jurisdiction over energy matters is responsibility of the Papua New Guinea government. The PNG National Energy Policy and the Rural Electrification Policy are under review by the PNG Government Task Force on Policy. The exploration and development of petroleum resources are authorised and administered by the Department of Petroleum and Energy.

The Papua New Guinea Government has 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 to have access to a reliable and affordable energy supply, and sufficient power is 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. Comprehensive analysis is required regarding the cost effectiveness of various alternative sources of power.

### ENERGY MARKETS

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 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 PNG Power Limited and selected corporatised government statutory entities. This made it responsible for setting prices or tariffs for electricity and petroleum products.

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 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 take is about 50%.

### ENERGY EFFICIENCY

Energy efficiency is not currently a major priority for the government of PNG, but in order to sustain DSP 2010–2030 goals, it might be considered as an important factor. 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

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 provides approximately 40% of PNG's its operation's current power needs, and provides free electricity to residents who live near the Lihir mine site.

## 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 CO<sub>2</sub> emissions (Newcrest Mining, 2012).

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## NOTABLE ENERGY DEVELOPMENTS

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### 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 introduction of internationally competitive fiscal incentives in September 2003 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).

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**USEFUL LINKS**

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- Department of Petroleum and Energy—[www.petroleum.gov.pg](http://www.petroleum.gov.pg)
- Papua New Guinea, Development Strategic Plan 2010-2030—  
[www.treasury.gov.pg/html/publications/files/pub\\_files/2011/png-development-strategic-plan.2010-2030.pdf](http://www.treasury.gov.pg/html/publications/files/pub_files/2011/png-development-strategic-plan.2010-2030.pdf)
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[www.unescap.org/pdd/calendar/CSN-Cambodia-Dec10/Papers-Presentations/PapuaNewGuinea\\_PPT.pdf](http://www.unescap.org/pdd/calendar/CSN-Cambodia-Dec10/Papers-Presentations/PapuaNewGuinea_PPT.pdf)

# 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 2010 had a total population of about 29.1 million people, which represents a growth of 1.1% from the previous year (EDMC, 2012). Around 34.8% of Peru's population is considered poor and 11.5% extremely poor; its major population centre is the Lima department, 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 2010 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 been 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; in 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 8.8% growth from 2009 to 2010 with GDP reaching USD 220.8 billion (USD (2000) at PPP) in 2010, and GDP per capita growing 7.7% to reach USD 7 593 (EDMC, 2012). Inflation decreased to an annual rate of 2.2% in 2010, mostly due to the decline of food prices (BCRP, 2010). In addition, Peru's foreign reserves reached a record USD 33.1 billion while fiscal deficit represented 3.2% of 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 of the crude oil produced is of extra-heavy quality, a substantial share of domestic production is exported since several domestic refineries are unable to process it. 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 19 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (million sq. km)	1.3	Oil (million barrels)	1 206
Population (million)	29.2	Gas (trillion cubic metres)	0.3
GDP (USD (2000) billion at PPP)	220.8	Coal (million tonnes)	8.7
GDP (USD (2000) per capita at PPP)	7 593	Uranium (tonnes)	1 800

a. Proved reserves at the end of 2011 (MINEM, 2011c)

Source: EDMC (2012)

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).

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**ENERGY SUPPLY AND DEMAND**

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**PRIMARY ENERGY SUPPLY**

Peru's total primary energy supply (TPES) in 2010 was 17 030 kilotonnes of oil equivalent (ktoe), which represented a considerable increase of 24.2% from 2009, due to the extraordinary growth observed in the production of natural gas and its liquids. By energy source, in 2010 a little more than half (8 614 ktoe) of TPES came from oil, 32% from natural gas (5 496 ktoe), and 4% from coal (688 ktoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others contributed to the remainder at 13% (2 231 ktoe) (EDMC, 2012). In 2010, Peru's energy exports represented 20% of its primary energy (2 824 ktoe) and mainly consisted of crude oil (EDMC, 2012).

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, 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. 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 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 2010, Peru's electricity generation totalled 35 907 gigawatt-hours (GWh), an 8.7% increase from the 33 029 GWh generated in 2009. Hydropower's share of this total was the largest, at 56% (20 052 GWh), with electricity generated from thermal plants accounting for 42% (15 122 GWh) and the remainder being met by other sources such as biomass and wind (EDMC, 2012).

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 recent 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 final energy sectors other types of biomass (such as firewood, vegetable coal, dung and yareta –a moss-type plant dried to be burned) are used for heating and cooking. In 2011, energy supply from renewable sources was made up by firewood with 44.2%, hydropower with 44% and other biomass sources with the rest (MINEM, 2011b).

Table 20 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	16 945	Industry sector	3 688	Total	35 907
Net imports and other	-2 824	Transport sector	6 048	Thermal	15 122
Total PES	17 030	Other sectors	2 783	Hydro	20 052
Coal	688	Total FEC	12 518	Nuclear	-
Oil	8 614	Coal	599	Others	733
Gas	5 496	Oil	8 067		
Others	2 231	Gas	1 135		
		Electricity and others	2 717		

Source: EDMC (2012).

#### FINAL ENERGY CONSUMPTION

Final energy consumption in Peru grew steadily in 2010, reaching 12 518 ktoe, a 3.7% increase from 2009. Transportation was the most dynamic sector, with a 10.7% jump from the previous year, and representing nearly 48% of total final energy consumption in 2010. The industrial sector's share was 29%, while the combined 'other' residential, commercial and agriculture sectors consumed 22%. Accordingly, oil products dominated total final energy consumption in 2010 with 64%, the majority of which was consumed as diesel, gasoline and liquefied petroleum gas. Electricity made up 22% of total end-use energy demand, while gas and coal accounted for the remaining 9% and 5%, respectively (EDMC, 2012).



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## POLICY OVERVIEW

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### 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, following.

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 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 include 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 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 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 of renewable energies according to the geography and climatic conditions of several regions.
- Mining and energy sectors to commit 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: i) 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); ii) a firm price guaranteed for bidders who are awarded energy supply contracts for up to 20 years; and iii) 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 to obtain 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, to provide in advance tax reimbursement on the electricity sales of renewable energy-based utilities; in 2008 Law No. 1058 was passed to allow tax benefits to investment participants in electricity generation based on renewable energy (including hydro), by means of 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 on 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 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 Peru's several 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).

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## NOTABLE ENERGY DEVELOPMENTS

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### 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—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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#### USEFUL LINKS

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Agencia de Promoción de la Inversión Privada— <http://proinversion.gob.pe>

Banco Central de Reserva del Perú— [www.bcrp.gob.pe](http://www.bcrp.gob.pe)

Comité de Operación Económica del Sistema Interconectado Nacional— [www.coes.org.pe](http://www.coes.org.pe)

Instituto Nacional de Estadística e Informática— [www.inei.gob.pe](http://www.inei.gob.pe)

Instituto Peruano de Energía Nuclear— [www.ipen.gob.pe](http://www.ipen.gob.pe)

Ministerio del Ambiente— [www.minam.gob.pe](http://www.minam.gob.pe)

Ministerio de Economía y Finanzas— [www.mef.gob.pe](http://www.mef.gob.pe)

Ministerio de Energía y Minas— [www.minem.gob.pe](http://www.minem.gob.pe)

Organismo Supervisor de la Inversión de la Energía y Minería— [www2.osinerg.gob.pe](http://www2.osinerg.gob.pe)

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Presidencia de la República del Perú— [www.peru.gob.pe](http://www.peru.gob.pe)

Programa de Adaptación de Cambio Climático— [www.paccperu.org.pe](http://www.paccperu.org.pe)

Proyecto Camisea—[www.pluspetrol.net/camisea.html](http://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 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 2010 reached 93 million. 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 remarkable 7.6% growth in 2010, the highest growth recorded since the Marcos Era in the early 1980s. As a result of the economy's strong performance, per capita GDP increased to USD 3 159 (USD 2000 at PPP) in 2010. The industry sector propelled the notable increase in the economy, backed by a strong revival in manufacturing output and renewed construction projects in the private sector (Navarro & Yap, 2011).

The country's proved fossil fuel reserves are around 100 million barrels of oil including condensate, 70.4 billion cubic metres of natural gas (equivalent to 2 487 billion cubic feet) and 449 thousand tonnes of coal, mainly lignite. However, in view of the volatility of oil prices in the world market, 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 (26%) to its power generation. Of the total electricity generation, the output from geothermal energy reached 9 929 gigawatt-hours (GWh), about 14.7% of the economy's electricity requirement. Hydropower and other renewable energy sources provide total combined power generation of 7 894 GWh.

Table 21 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (thousand sq. km)	300	Oil (million barrels)—proved	100
Population (million)	93.3	Gas (billion cubic metres)—proved	70.4
GDP (USD (2000) billion at PPP)	294.6	Coal (thousand tonnes)—proved	449
GDP (USD (2000) per capita at PPP)	3159	Uranium	—

Sources: a. DOE (2011), EDMC (2012)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Total primary energy supply in 2010 reached 40 730 kilotonnes of oil equivalent (ktoe), a 3.2% increase from the 2009 supply level of 39 457 ktoe. Of this total, 57.5% was contributed by indigenous sources; the remainder was imported. Geothermal and other renewable energy resources accounted for 39.5% of the total primary energy supply, while oil and coal, which are largely imported, contributed 36% and 17.4%, respectively.

### FOSSIL ENERGY

While the economy's total primary energy supply increased in 2010, its total domestic oil production slightly decreased by 4.2% from the 962.2 ktoe in 2009. This might be explained by the failure of the Tindalo Extended West Test (EWT) to produce oil at economic rates, resulting in the abandonment of the field at year end. Moreover, condensate production in 2010 decreased 10.3% due to the declining reservoir condensate-to-gas ratio (CGR) of the Malampaya well. Similarly, domestic production of natural gas reflected a 5.8% decline from the previous year's volume of 3 214.7 ktoe.

Meanwhile, local coal increased by 41.9% in 2010 from the 2009 level of 2 474 ktoe, and contributed most of the increase in the economy's total primary energy supply. The significant increase in local coal production may be attributed to an upsurge in production by the economy's major coal producer, the Semirara Mining Corporation.

To help meet the economy's fuel requirements, the Philippines imports 42.5% of its total energy supply. Net imported fuels were mainly comprised of oil and oil products (79.1%), coal (20.3%) and biofuels (0.6%). Levels of net imported energy were 8.5% higher than the 2009 level of 15 970 ktoe.

### RENEWABLE ENERGY

Renewable energy sources have a significant share of the economy's total primary energy sources, accounting for 39% of the total in 2010. Geothermal continues to be the major indigenous renewable energy source of the economy, representing 36% of its total indigenous primary energy supply in 2010 and being used solely for power generation. With a total installed capacity of 1 966 megawatts (MW), the Philippines is the second-largest producer of geothermal energy in the world. As the economy aims to reach the first position, 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 32% of the economy's total indigenous energy supply in 2010.

### ELECTRICITY GENERATION

The economy's total electricity generation in 2010 was 67 742 GWh, a 9.4% increase from 61 922 GWh in 2009. Its power requirements for 2010 were sourced primarily from coal-fired and natural gas-fired power plants, with shares of 34% 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 15% during the same year. On the other hand, hydropower plants, ranked fourth out of the economy's total power generation, experienced a decline of 7% from the 8 387 GWh of electricity generated in 2009. Oil-based thermal plants, which provided 10.5% of the economy's total power requirements, increased by 16% in 2010.

Table 22 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	23 404	Industry sector	6 364	Total	67 742
Net imports and other	17 326	Transport sector	9 023	Thermal	49 920
Total PES	40 730	Other sectors	9 136	Hydro	7 803
Coal	7 030	Total FEC	24 523	Nuclear	–
Oil	14 621	Coal	1 830	Other	10 019
Gas	3 028	Oil	12 320		
Other	16 051	Gas	70		
		Electricity and other	10 302		

Sources: Primary energy supply and consumption (DOE, (2011c); power generation (EDMC, 2012)

### FINAL ENERGY CONSUMPTION

The total final energy consumption of the Philippines in 2010 reached 24 523 ktoe, a 4.2% increase from the 2009 level of 23 525 ktoe. The transport and ‘other’ sectors accounted for the largest energy consumption, each with a 37% share of the total energy demand in 2010. In terms of fuel, oil and oil products continued to be the major fuel consumed, accounting for half of the total energy demand. Energy demand sourced from electricity and others followed next with 42% of the total. Natural gas use declined slightly by 0.6% compared to the previous year’s demand level of 70.1 ktoe.

## 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, 2012). 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; and,
- 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*). As of 2011, 27 service contracts (*SCs*) have been supervised and monitored by the Department of Energy, and 20 bid proposals have 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 (mmb) 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 ktoe (450 million cubic feet (mmcf)). Meanwhile, 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 which could be tapped for exploration, development and utilisation. It has 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 stipulated in the Electric Power Industry Reform Act of 2001 (*EPIRA*) (DOE, 2005). It strives to address power issues by continuing implementation of the remaining phase of the reforms, particularly the implementation of Retail Competition and Open Access (*RCOA*). The Philippine electricity market is now in the process of improving the mechanisms that are envisioned to stimulate competition. Preparations for *RCOA* are on-going simultaneous with improvements being introduced in the governance and operation of the Wholesale Electricity Spot Market (*WESM*).

After several months of trial operations, in June 2006 the *WESM* started commercial operations in the Luzon grid. Four years into its commercial operations in Luzon, the Visayas grid was integrated into the *WESM* and commercial operations commenced in that grid in December 2010. The establishment of the *WESM* creates a level playing field for the trading of electricity among *WESM* participants, thereby granting third party access to the power system. Although prices are still governed by commercial and market forces, customers may have the option to buy energy at a price lower than the regulated rate (*WESM*, 2012). As of October 2011,



the integrated WESM has a total of 112 participants comprised of 47 generating companies and 65 customer trading participants, which are in turn comprised of six private distribution utilities, 46 electric cooperatives, six bulk end-users and seven wholesale aggregators

Meanwhile, privatisation of remaining assets is still underway, with the bidding process for the 96 MW and 1014 MW-rated capacity assets of the Visayas and Mindanao grids to start respectively in July 2011. The remaining 650 MW rated capacity asset in the Luzon grid is expected to be turned over in January 2013. One of the primary objectives of the EPIRA was to appoint independent power producers (IPPs) to administer, conserve and manage the contracted energy output of the National Power Corporation (NPC).

Along this line, the government is expected to appoint an Independent Administrator for its remaining NPC-IPP contracts covering the Luzon, Visayas and Mindanao grids with a total of 1 273 MW of contracted capacity in 2012. (DOE, 2011a). Other privatisation accomplishments were:

- *Privatisation Proceeds.* As of October 2011, the total amount collected for privatisation of assets amounted to USD 5.272 billion. Of the total amount collected, about 98% 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 October 2011, the Transmission Corporation (TransCo) has signed 84 sale contracts amounting to about PHP 4.09 billion with 66 distribution utilities, electric cooperatives (ECs) and consortia. The sales cover an aggregate length of about 3 323 circuit kilometres (ckt kms) of sub-transmission lines and 30 200 sub-transmission structures. TransCo is looking forward to the sale of about 800 ckt kms of sub-transmission lines and 560 megavolt amperes of substation equipment to parties among the 33 interested distribution utilities and consortia over the next four years

The economy's barangay (a village, district or ward, i.e. the basic political unit) electrification level rose from 99.85% in June 2010 to 99.89% as of end of December 2010. Among the major islands, in 2010 Visayas had already reached the 100% electrification level, while Luzon's was recorded at 99.87% and Mindanao's at 99.82% for the same period.

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.

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) assisted and funded project 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 mmboe or PHP 220 billion worth of energy savings in 2011.

As for the government energy management program, as of 2011 there are 590 government offices which have 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 mmboe 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. *DEAEEA* generated an estimated aggregate energy savings of around 92 million litres of oil equivalent amounting to PHP 3.6 billion and CO<sub>2</sub> 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 involves the retrofitting of 35 government office buildings; replacement of incandescent bulbs with energy-efficient compact fluorescent lamps (CFLs) in the residential sector, from the five million CFLs procured in 2010; installation of 223 LED solar home systems and a lamp waste management facility; replacement of incandescent traffic lamps with light-emitting diode (LED) units at 159 intersections; retrofitting of more than 3 000 inefficient lamps with an energy-efficient lighting system in Burnham Park and Wright Park in Baguio City, and public street lighting on major roads in Cagayan De Oro City.

With these programmes, the government is expected to save 313 GWh in electricity, equivalent to PHP 1.2 billion annually, a 10%-20% reduction in overall energy consumption in

retrofitted government office buildings, and annual emissions avoidance of 169 000 tons of CO<sub>2</sub>. For 2012, the government is expected to achieve major milestones in its energy efficiency programmes, specifically the following:

- To be able to meet the revised target of 313 GWh of electricity savings under the Philippine Energy Efficiency Project (PEEP) by 2013;
- To post a savings of more than PHP 1.6 billion (USD 32 million), based on the FY 2011 results of the recognition award program (the Don Emilio Abello Energy Efficiency Award); and
- To increase promotion of the EE&C awareness campaign in major energy demand sectors such as the commercial, industrial, household, transport and power sectors.

### 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 2010, the total installed electricity generating capacity from renewable energy sources stood at 5 438 MW. Of the total capacity, hydropower contributed the biggest share with 3 400 MW, of which 3 324 MW is grid-connected while the remaining (76 MW) is off-grid. Geothermal is the second biggest contributor with 1 966 MW, followed by biomass with 73 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.

In relation to formulation of renewable portfolio standards (RPS), the DOE has conducted eight public consultations nationwide (including the February 2013 consultation conducted in Taguig City) prior to finalisation of the standards. Meanwhile, the following feed-in-tariff (FIT) rates were recommended by the NREB for the ERC's approval:

- Run-of-the-river hydropower: PHP 5.9/kWh
- Biomass: PHP 6.63/kWh
- Wind: PHP 8.53/kWh
- Solar: PHP 9.68/kWh
- Ocean: Undecided (the tariff for ocean energy was not determined). Likewise, the hydropower reservoir and geothermal supplies were not subjected to the FIT due to their market competitiveness.

In conjunction with this, the FIT-ALL payment and collection guidelines as well as the net metering programme for renewable energy were submitted by the NREB to the ERC.

### 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### ENERGY REFORM AGENDA

In 2010 under the new administration, the Department of Energy's guiding vision is 'energy access for more'. This will give the greater majority access to reliable energy services and fuel, most importantly for local productivity and rural development. The government has outlined the following three major pillars as its overall guideposts and direction:

- Ensure energy security
- Achieve optimal energy pricing
- Develop a sustainable energy plan.

To attain its vision, the government has phased the three major pillars into short-term (2010–2011), medium-term (2011–2013) and long-term (2013–2016) timelines.

An over-arching strategy to achieve these three major pillars is the principle of good governance. As the government liberalises access to energy, it will encourage transparency and accountability in all phases of energy policy, programmes and project development. It will also promote open competition and due diligence in all energy contracting rounds, to level the playing field. Doing business in the energy sector will become significantly easier and more convenient with the creation of a one-stop shop to streamline government procedures and processes. Enhancing current fiscal and non-fiscal incentives will pave the way for a more investment-friendly environment.

To promote development, integrated information and communication technology infrastructure was established to enable various stakeholders to obtain access to energy-related information and services in real-time. Updated and online energy data and information will help

policy makers to make decisions, appropriately guide the business sector on the best investment options, and empower consumers among the general public.

### 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 shall 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.

The 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

### 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 which 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 Therefore;



- Downstream Natural Gas Industry Development Act; and
- 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 (referring to the subsidized rate given to low-income captive market end-users who cannot afford to pay at full cost) (DOE, 2011b) 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) which must be overcome for replication and up-scaling.

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#### USEFUL LINKS

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Asian Development Bank—[www.adb.org](http://www.adb.org)

Department of Energy, Republic of the Philippines (DOE)—[www.doe.gov.ph](http://www.doe.gov.ph)

Department of Science and Technology (DOST)—[www.dost.gov.ph/](http://www.dost.gov.ph/)

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

National Power Corporation (NPC)—[www.napocor.gov.ph/](http://www.napocor.gov.ph/)

National Transmission Corporation (TransCO)—[www.transco.ph/](http://www.transco.ph/)

Philippine National Oil Company (PNOC)—[www.pnoc.com.ph/](http://www.pnoc.com.ph/)

Wholesale Electricity Spot Market (WESM)—[www.wesm.ph/](http://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 (2012), from 1990 to 2010, Russian population declined from 148.3 million people to 141.8 million people. Shares of urban and rural population remain unchanged, at 74% and 26% respectively. Russia's average population density of only 8.33 people per square kilometre is very low, with the majority of the population living in the European part of the economy (GKS, 2012).

The Russian Federation's economy continued to develop strongly, achieving 4.3% growth in 2010 and an average growth rate of 4.81% after 2000. In 2009 the global economic and financial crisis affected the Russian economy, with GDP declining by 7.81% in 2009 from the 2008 level. The recovery was driven by soaring world prices for oil and natural gas.

Table 23 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (million sq. km)	17.1	Oil (billion barrels)	88.2
Population (million)	141.75	Gas (billion cubic metres)	44.6
GDP (USD (2000) billion at PPP)	1 598.68	Coal (billion tonnes)	157.0
GDP (USD (2000) per capita at PPP)	11 278	Uranium (kilotonnes of uranium metal) <sup>b</sup>	181.4

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

b. Reasonably assured resources. NEA (2010).

Source: EDMC (2012)

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, more than 40% of tax and custom duty payments, and 30% of 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 2011 the Russian Federation holds 21.4% of the world's gas, 5.3% of its oil reserves, 18.2% of its coal reserves, and about 14% of its uranium ore reserves (BP, 2012). 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 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 44.6 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 primary processing of about 254 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 2010, 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.

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## ENERGY SUPPLY AND DEMAND

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### PRIMARY ENERGY SUPPLY

The Russian Federation's total primary energy supply in 2010 was 701.7 million tonnes of oil equivalent (Mtoe), comprising natural gas (54.6%), crude oil and petroleum products (19.8%), coal (16.6%) and others, including nuclear and hydro (9.0%).

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 505,3 million tonnes of crude oil and gas condensate in 2010. The oil heartland province of West Siberia accounted for about two-thirds of total production. Refiners consumed 250,0 million tonnes of crude oil as feedstock, producing 244.0 Mtoe of petroleum products, including 37.7 million tonnes of gasoline, 70,0 million tonnes of diesel oil, and 71.6 million tonnes of fuel oil.

Oil exports reached 247,0 million tonnes of crude oil and 132,4 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 474.5 Mtoe in 2009 to 540.2 Mtoe in 2010. Net exports of natural gas in 2010 accounted for 154.1 Mtoe (113% of the 2009 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 180 Mtoe of coal in 2010 (117% of the 2009 level). Coal exports reached 84.3 Mtoe. From 2000 to 2010 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 Kansko–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 24 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 293 080	Industry sector	132 036	Total	1 038 030
Net imports and other	–579 023	Transport sector	96 490	Thermal	695 935
Total PES	701 668	Other sectors	217 293	Hydro	168 397
Coal	116 427	Total FEC	445 819	Nuclear	170 415
Oil	139 166	Coal	19 345	Geothermal and others	3 283
Gas	382 803	Oil	103 767		
Others	63 272	Gas	143 229		
		Electricity and others	179 478		

Source: EDMC (2012).

The Russian Federation produced 1 038 TWh of electricity in 2010, of which 67.0% was from thermal power plants, 16.2% from hydropower and 16.4% from nuclear energy. Geothermal and others represent only 0.4% of 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 renewable energy would have to be delivered to consumers.

#### FINAL ENERGY CONSUMPTION

In 2010, total final energy consumption in the Russian Federation was 445 Mtoe, an increase of 6.6% compared with the previous year. By sector, industry accounted for 29.6%, transport for 21.6% and other sectors for 48.8%. By energy source, coal accounted for 4.3%, petroleum products 23.3%, natural gas 32.1% and electricity and others (including heat) 40.3%. Because of Russia's extremely cold climate, the most important energy use is for space heating (about one-quarter of 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, to increase the share of less energy-intensive services, and to improve the efficiency of the heat supply to the residential and commercial sectors, are important issues in 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.

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## POLICY OVERVIEW

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### ENERGY POLICY FRAMEWORK

The adoption of the Energy Strategy of Russia for the period up to 2020 in August 2003 (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, to strengthen Russia's position in those markets, and to 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 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 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 take a larger share in 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 reduction in the energy intensity of the economy by 40% 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 a main objective 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 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 out 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 energy efficiency of the economy, the general scheme for 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 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 positioning of petrochemical capacities into six clusters, including pipeline transportation projects, projects to upgrade existing and build new facilities for 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 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 (the *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, the 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. The 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, considering its international influence and its growing domestic economic and social challenges, the draft of the Oil law is still being developed. This law will be important for facilitating investments in the industry, both domestically and abroad.

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 are already 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 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 is 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 which 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, including a schedule for contracted industrial gas prices to 2011, to create a net-back pricing mechanism for international gas markets. 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 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 controls 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 (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 Shtokman and Yamal, 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 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, 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* are 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, to increase the efficiency of power generation and consumption, and to 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 (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, to minimise energy losses (and subsidies), and to provide business incentives. A transparent market for 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 983 000 kilometres (km), 80% of which were paved. The country had only 29 000 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 83 000 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 233 000 km in 2010, 167 000 km of which was gas pipeline, 49 000 km was oil pipeline, and 16 000 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 are 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. 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, and encourage companies to increase 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 are being 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 (the 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. A major impediment for businesses to improve their energy efficiency though, 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 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 in 20 years (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 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 for federal subsidies for connecting renewable energy generators to the power grid, to 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 (equivalent to two 1 000 MW reactor loads) will be created at the IUEC as a fuel bank available under the IAEA's control. The first phase of the capacity enhancement is scheduled for 2011, when 1 million separation work units are 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 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 Use of Nuclear Energy were amended in June 2010. Since 2007, expired contracts for depleted uranium hexafluoride enrichment/conversion are not being extended, and no such new contracts were signed as of the beginning of 2010.

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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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, provision of high quality energy services at affordable prices, lowering 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 the subjects 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

There was a wide range of significant developments in the oil and gas sector in 2012. 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 continued dialogue on natural gas supplies to China. Both economies addressed the current status of the bilateral cooperation in the energy sector, placing an emphasis on issues surrounding the set-up of 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 Gazprom Group and relevant Japanese companies and progress with construction of an LNG plant near Vladivostok, and emphasised the successful cooperation between Gazprom and Japanese energy companies within the Sakhalin II project.

The Russian Federation and the Republic of Korea continues discussing 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 highlighted 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 can compare with 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 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 for haulage of coal production supply will fall 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, in conformity with accepted rates for forming new centres of coal production, coal production sites will shift to the East. 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 to strengthen their collaboration 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

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#### 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/](http://www.minenergo.gov.ru/)
- Ministry of Natural Resources—[www.mnr.gov.ru/](http://www.mnr.gov.ru/)
- Federal Service on Ecological, Technological and Nuclear Supervision—[www.gosnadzor.ru/](http://www.gosnadzor.ru/)
- Ministry of Economic Development—[www.economy.gov.ru/minec/main/](http://www.economy.gov.ru/minec/main/)

Federal State Statistics Service—[www.gks.ru/](http://www.gks.ru/)  
Ministry of Industry and Trade—[www.minprom.gov.ru/](http://www.minprom.gov.ru/)  
Federal Agency on Technical Regulating and Metrology—  
[www.gost.ru/wps/portal/pages.en.Main](http://www.gost.ru/wps/portal/pages.en.Main)  
Federal Antimonopoly Service—[www.fas.gov.ru/](http://www.fas.gov.ru/)  
Federal Customs Service—[www.customs.ru/en/](http://www.customs.ru/en/)  
Federal Tariff Service—[www.fstrf.ru/](http://www.fstrf.ru/)

#### ENERGY-RELATED NON-PROFIT AND STATE-OWNED BUSINESS INSTITUTIONS

AtomEnergoProm—[www.atomenergoprom.ru/en/](http://www.atomenergoprom.ru/en/)  
Federal Power Grids—[www.fsk-ees.ru/](http://www.fsk-ees.ru/)  
Non-commercial Partnership of the Wholesale Power Market—[www.np-ats.ru/](http://www.np-ats.ru/)  
Gazprom—[www.gazprom.ru/](http://www.gazprom.ru/)  
Rosneft—[www.rosneft.ru/](http://www.rosneft.ru/)  
RusHydro—[www.rushydro.ru/](http://www.rushydro.ru/)  
Transneft—[www.transneft.ru/](http://www.transneft.ru/)  
Transnefteprodukt—[www.transnefteprodukt.ru](http://www.transnefteprodukt.ru)

#### STATE ENERGY-POLICY-RELATED RESEARCH CENTRES

Institute of Energy Strategy—[www.energystrategy.ru/](http://www.energystrategy.ru/)  
Centre for Energy Policy—[www.cenef.ru/](http://www.cenef.ru/)  
Energy Research Institute of the RAS—[www.eriras.ru/](http://www.eriras.ru/)  
Energy Systems Institute of the SB of RAS—[www.sei.irk.ru/eng/index.htm](http://www.sei.irk.ru/eng/index.htm)

#### MAJOR ENERGY-RELATED MEDIA IN THE RUSSIAN FEDERATION

Official newspaper, *Rossijskaya Gazeta*—[www.rg.ru/](http://www.rg.ru/)  
Central Dispatching Unit of the Fuel and Energy Complex—[www.riatec.ru/](http://www.riatec.ru/)

# SINGAPORE

## INTRODUCTION

Singapore is an economy situated in South-East Asia, south of the Malaysia Peninsula between the Strait of Malacca and the South China Sea. In 2010, Singapore had a total land area of 712.4 square kilometres and a population of 5.1 million, of which 1.305 million were non-residents. Despite its small land area and population, Singapore is one of the most highly industrialised and urbanised economies in South-East Asia.

Singapore is a highly developed and vibrant free-market economy. In 2010, its gross domestic product (GDP) increased by 14.8% from 2009 to USD 234.96 billion; per capita GDP was USD 46 279 (both in USD 2000 at PPP).

The services sector accounted for 68.1% of the overall value added to Singapore's GDP in 2010, with production of goods accounting for 27.9%, and ownership of dwellings accounting for the remaining 4.0%. In 2010, the largest subsectors of the service industry were wholesale and retail trade, which accounted for 26.3% of the value added, business services (20.0%), and financial services (16.8%). Manufacturing in the goods production industry is Singapore's single largest economic subsector, accounting for 20.8% of GDP (SingStat, 2012).

In 2010, Singapore's exports were worth USD 478.84 billion; of this, 51.9% were domestic exports and the remainder were re-exports. The biggest category of exports was electronics (36.7%), followed by mineral fuels (21.6%), other machinery and equipment (14.3%), chemicals and chemical products (11.8%), 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 make it one of the most thriving economies in the world.

Table 25 Key data and economic profile, 2010

Key data		Energy reserves	
Area (sq. km)	712.4	Oil	–
Population (million)	5.1	Gas	–
GDP (USD (2000) billion at PPP)	234.96	Coal	–
GDP (USD (2000) per capita at PPP)	46 279		

Source: EDMC (2012).

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Singapore's total primary energy supply (TPES) in 2010 was 30 769 kilotonnes of oil equivalent (ktoe). Singapore relies almost entirely on energy imports to meet its domestic energy needs. In 2010, the economy imported 44 300 ktoe of crude oil and 101 100 ktoe of petroleum products. Crude oil refined in Singapore's oil refineries produced 53 283.2 ktoe of petroleum products.

Some 87.1% of 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 88 100 ktoe. Natural gas supply grew by 5.45% between 2009 and 2010, to 6 573 ktoe (a higher rate of increase than the 1.1% between 2008 and 2009). Petroleum product supply increased by 18.1% from 2009 figures, to 24 110 ktoe, a higher rate of increase than between 2008 and 2009, when oil supply increased by 10.5%.

In 2010, 45 368 gigawatt-hours (GWh) of electricity were generated, an 8.5% increase over the 41 800 GWh generated in 2009. Peak demand for electricity was 6 494 megawatts (MW) in 2010 compared with 6 041 MW in 2009. Singapore's power generation is based entirely on thermal power plants, with the exception of small photovoltaic installations connected to the grid. In 2010, the licensed power generation capacity of thermal power plants was 10 262.5 MW, which includes four large incinerators with a total electricity generating capacity of 275 MW (and a total incinerating capacity of 2.5 million tonnes of solid waste per year). In 2010, Singapore had residential and non-residential grid-connected solar photovoltaic systems installations with total capacity of 3 686.2 kilowatt peak kWp—the power from a solar module with full solar radiation present—consisting of 111.6 kWp of residential and 3 574.6 kWp of non-residential capacity.

The fuel mix for power generation in 2010 was dominated by natural gas (78.7%), with some petroleum products (18.7%) and other fuels (biogas, waste & solar) (2.6%). The power generation reserve margin is about 36.7%, well in excess of Singapore's 30% minimum reserve margin for power system security.

Table 26 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	86	Industry sector	10 986	Total	45 368
Net imports and other	67 070	Transport sector	6 586	Thermal	44 919
Total PES	30 769	Other sectors	2 370	Hydro	–
Coal	–	Total FEC	19 942	Nuclear	–
Oil	24 110	Coal	–	Geothermal	–
Gas	6 573	Oil	16 316	Other	449
Other	86	Gas	119		
		Electricity and other	3 507		

Source: EDMC (2012).

#### FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (FEC) was 19 942 ktoe in 2010, an increase of 23.8% from 2009 (16 114 ktoe). Petroleum products accounted for 81.8% of the energy used, electricity 17.6% and natural gas 0.6%. The energy consumption share by sector was: industry 55.1%, transport 33.0%, and other sectors 11.9%.

#### POLICY OVERVIEW

##### ENERGY POLICY FRAMEWORK

In 2007, the interagency Energy Policy Group, chaired by the Permanent Secretary of the Ministry of Trade and Industry (*MTI*), announced the economy's energy policy framework. The framework strives to maintain a balance between the policy objectives of economic competitiveness, energy security and environmental sustainability (*MTI*, 2007). Subsequently, the Economic Strategies Committee (*ESC*) Subcommittee on Ensuring Energy Resilience and Sustainable Growth released a report in 2010 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 is building a Liquefied Natural Gas terminal, which will be ready in 2013. This will reduce its dependence on piped natural gas, as it will allow Singapore to import LNG globally. Singapore is also studying other medium- to long-term energy options such as electricity import and renewables to further diversify its energy mix.
- *Strategy 2: Enhance Infrastructure and Systems.* Singapore has been pursuing the liberalisation of its electricity and gas markets to achieve competitive energy prices and improve efficiency. Investing in critical energy infrastructure ahead of demand and enhancing existing infrastructure will also help 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 to trial smart grid technologies and related applications to 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 capital 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). The Government's aim is 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. Subsidising energy could lead to inefficient use of a scarce and precious resource. To encourage consumption and investment decisions that take into account global market trends and externalities, suitable energy pricing schemes need to be in place. 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 use in its own 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; large customers use about 98% of the gas. Sembcorp Gas was the importer, transporter and retailer of gas from the West Natuna field until the new gas industry framework required it to transfer its onshore natural gas pipeline assets to PowerGas Ltd and to exit the gas transportation business.

The third pipeline, from South Sumatra, Indonesia, started supplying gas to Singapore in September 2003. It supplies 9.9 million cubic metres per day (350 MMcf/D) of natural gas for power generation and industry use. Gas Supply Pte Ltd is the importer of the gas from South Sumatra, which is retailed by Gas Supply and City Gas. Both Gas Supply and City Gas engage the services of PowerGas Ltd for gas transportation. The fourth pipeline, from Malaysia, started

operations in 2007 and supplies 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.

With gas representing a large share of electricity production, the diversification of supply has become an important issue. This has been highlighted by a number of power outages since 2003. In 2006, following a feasibility study done in 2005, the Singapore Government decided to import liquefied natural gas (LNG). Singapore's initial plan was to have an LNG receiving terminal, with a capacity of 3 million tonnes per annum (Mtpa). The LNG terminal would be located in the south-west of Jurong Island, Singapore. Singapore has introduced controls on new natural gas imports by pipeline, to allow for the build-up of LNG demand until the capacity of 3 Mtpa is fully utilised.

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. It was decided to increase the design capacity of the LNG terminal to 3.5 Mtpa, with provisions to expand it to 6 Mtpa by the end of 2013 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 Mtpa of LNG. Initial deliveries are expected to begin in 2013 when the LNG import terminal is completed.

#### ENERGY TECHNOLOGY/R&D

Singapore's energy research, development (R&D) and demonstration strategies are motivated by two considerations: (i) to develop capabilities to support the clean energy sector as a key growth area, and grow a viable industry that will create jobs; and (ii) 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 efficiency of 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 test-beds 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 (that is, gas retail and gas import) from the monopolistic part (that is, 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 comprising 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 (TTIDES-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.

There are four EV models currently available under the EV testbed: Daimler smart electric drive (ed), Mitsubishi i-MiEV, Nissan Leaf and Renault Fluence Z.E. Robert Bosch (SEA) Pte Ltd was appointed by EMA as the Charging Service Provider (CSP) to provide nationwide charging infrastructure for this testbed. Other CSPs can set up 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 (EMA, 2012).

As of 15 December 2012, there are 58 EVs on the roads as part of this testbed. To cater to the charging needs of the EVs, 42 normal charging stations and 1 quick charging station have been installed. EMA also plans to have up to two more quick-charging stations in the near future.

#### 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 38% to 44% over the 2000–11 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 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 would 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 3 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 as well 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 Housing Development Board (HDB) towns (Tampines, Yishun, Sembawang, Pasir Ris, Taman Jurong, Bedok, and Changi-Simei), first instance 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 5 years. For developments attaining Green Mark Platinum or Gold<sup>PLUS</sup>, 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 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 target to achieve beyond Green Mark Platinum, 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 2 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<sup>PLUS</sup>) for projects developed on government sales sites, the higher Green Mark standards will be set as 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 air-conditioned area of greater than 5 000 square metres must attain the Green Mark Platinum rating, while existing public sector buildings with air-conditioned area of greater than 10 000 square metres must attain the Green Mark Gold<sup>Plus</sup> 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 to make better energy choices, the mandatory energy labelling scheme (MELS) was introduced for the two most energy intensive appliances, namely air conditioners and refrigerators, in Jan 2008. The scheme was extended to clothes dryers in 2009.
- In addition, minimum energy performance standards (MEPS) were introduced in Sep 2011 for household air-conditioners and refrigerators. 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 encourages 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, the Singapore Government 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, annually consuming 2.7 million tonnes of waste disposed (biomass and wastes), which could generate about 200 MW of green energy in 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).

The government's main focus on renewable energy is solar power. Singapore has established 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 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 at Serangoon and Wellington, generating 220kWh of electricity per day for each precinct in the process. As of end 2011, there are 120 grid-connected commercial solar PV installations with a total capacity of 5.26 MWp. And there are also 36 households with solar PV installations connected to the grid, making up 0.29 MWp of capacity (EMA, 2012).
- 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 (EMA, 2012)

### NUCLEAR

Singapore currently does not have a nuclear energy industry. In 2010, the Singapore Government 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.

### 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 or nuclear power, marking it as an alternative-energy disadvantaged city-state. However, as a responsible global citizen Singapore must still play a 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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 enhancing 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 in, 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 2005 levels by 2030, with an intermediate goal of 20% from 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. The terminal will now have the capacity to handle up to 6 Mtpa of throughput. The terminal’s throughput capacity will further rise to 9 Mtpa when a fourth tank and its related regasification facilities are constructed (EMA 2012). 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 (EMA, 2012).

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 BG's proposed Queensland Curtis LNG facility in Australia will serve as one of the sources of supply for Singapore.

The power generation sector has contracted for an increase in 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 November 2010, the Finnish oil refining and marketing company Neste Oil announced the start-up of 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 clear and colourless paraffin, with a high cetane number (85–99).

### BIOMASS CLEAN COAL COGENERATION PLANT

At present, Singapore has a Biomass Clean Coal (BMCC) cogeneration plant which is managed by Tuas Power. 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. To ensure that environmental sustainability is not compromised with the development of the BMCC cogeneration plant, low-sulphur and low-ash coal is used 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 430 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 are scheduled to enter 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 and procurement and construction contract, and associated long-term service agreement, were signed in 2010. The power plant is expected to be operational 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 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 to go to the national grid. It is the first incineration plant to be built and operated by the private sector in Singapore. 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). Considering that electricity import can further diversify Singapore's energy mix by tapping new energy options that may be unavailable or economically unfeasible in Singapore, while also reducing demand for scarce available land for power plants in the economy, EMA plans to import up to 600 MW of electricity from other economies (EMA, 2012).

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## USEFUL LINKS

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- APEC Biofuels—[www.biofuels.apec.org](http://www.biofuels.apec.org)
- BG Group—[www.bg-group.com](http://www.bg-group.com)
- Department of Statistics Singapore —[www.singstat.gov.sg](http://www.singstat.gov.sg)
- Economic Development Board— [www.edb.gov.sg/](http://www.edb.gov.sg/)

- Energy Market Authority—[www.ema.gov.sg](http://www.ema.gov.sg)
- Economic Strategies Committee (ESC) Recommendations —[app.mof.gov.sg/esc.aspx](http://app.mof.gov.sg/esc.aspx)
- Land Transport Authority—[www.lta.gov.sg](http://www.lta.gov.sg)
- Ministry of the Environment and Water Resources—[www.mewr.gov.sg](http://www.mewr.gov.sg)
- Ministry of National Development—[www.mnd.gov.sg](http://www.mnd.gov.sg)
- Singapore LNG Corporation—[www.slngcorp.com](http://www.slngcorp.com)
- Solar Energy Research Institute of Singapore (SERIS)—[www.seris.nus.edu.sg](http://www.seris.nus.edu.sg)
- Temasek Holdings—[www.temasekholdings.com.sg](http://www.temasekholdings.com.sg)

# 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 2010, Chinese Taipei's gross domestic product (GDP) was USD 689.7 billion, and its per capita income was USD 29 778 (USD 2000 at PPP), an increase of 10.5% from 2009, representing a rebound from the previous year's global economic recession. 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 2010, the services sector contributed 67.2% of GDP, followed by the industrial sector (31.1%) and the agriculture sector (1.6%) (DGB, 2012). 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 23.16 million grew at a rate of 0.17% in 2010 compared with 2009. This was slower than the average annual population growth rate of 0.39% between 2000 and 2010 (EDMC, 2012).

Chinese Taipei has very limited domestic energy resources and relies on imports for most of its energy requirements. There are no oil or coal reserves in Chinese Taipei, but the economy has gas reserves of around 15.18 billion cubic metres (EIA, 2012). In 2010, installed electricity generation capacity totalled 48 882 megawatts (MW) (EDMC, 2012).

Table 1 Key data and economic profile, 2010

Key data		Energy reserves <sup>b</sup>	
Area (sq. km) <sup>a</sup>	36 189	Oil (million barrels)	–
Population (million)	23.2	Gas (billion cubic metres)	15.18
GDP (USD (2000) billion at PPP)	689.7	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	29778		

a. DGB (2012)

b. EIA (2012)

Source: EDMC (2012)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Traditionally, lack of domestic energy and mineral resources forces Chinese Taipei to import nearly all of its energy requirements, with imports accounting for 98% of its primary energy supply in 2010 (BOE, 2012a). 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 has grown at an average rate of 4.1% between 1995 and 2010.

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 91.3% in 2010 (BOE, 2012b). In 2010, Chinese Taipei's total primary energy supply was 104 568 kilotonnes of oil equivalent (ktoe), a decline of 2.47% from the previous year. By fuel, oil contributed the largest share (49%), followed by coal (32.1%), natural gas (10.2%) and other fuels (8.7%) (EDMC, 2012).

In 2010, Chinese Taipei imported almost its entire crude oil requirements. The Middle East represents its major supplier, accounting for 79.7% of total oil imports of 54.9 million tonnes of crude oil in 2010. 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 82.8% of total coal imports in 2010. In 2010, Chinese Taipei imported 63.16 million tonnes of coal. Most coal (73.3%) was used for power generation (BOE, 2012a; BOE, 2012c).

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 67.3% of total natural gas imports in 2010. LNG imports in 2010 amounted to 10.95 million tonnes, a 24.6% increase from 2009 (BOE, 2012c).

Table 2 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	13 625	Industry sector	22 476	Total	247 033
Net imports and other	101 759	Transport sector	11 854	Thermal	191 762
Total PES	111 523	Other sectors	33 760	Hydro	7 255
Coal	39 186	Total FEC	68 090	Nuclear	41 629
Oil	45 915	Coal	6 915	Other	6 387
Gas	14 082	Oil	40 170		
Other	12 340	Gas	2 124		
		Electricity and other	18 881		

Sources: EDMC (2012), BOE (2012b).

Chinese Taipei generated 247 033 gigawatt-hours (GWh) of electricity in 2010. Taiwan Power Company's (TPC) thermal power generation contributed 46.8% (26.3% from coal, 3.3% from oil and 17.2% from LNG) and nuclear energy generation 16.9%; privately owned cogeneration contributed 17.3%; independent power producers (IPPs) 16.8%; hydropower 2.9%; and wind power 0.21%. TPC dominates Chinese Taipei's electric power sector; IPPs account for 16.35% 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 light water reactors in the fourth nuclear energy project are under construction to boost electricity generation (EDMC, 2012; BOE, 2012a).

#### FINAL ENERGY CONSUMPTION

Final energy consumption in Chinese Taipei was 68 090 ktoe in 2010, 6.4% higher than in 2009. The industry sector consumed 33% of the total energy used, followed by the transport sector (17.4%) and the other sectors (including residential and services) (17.2%). By energy source, petroleum products accounted for 59% of total final energy consumption, followed by electricity (27.6%), coal (10.2%) and gas (3.1%).



In 2010, energy used in the industry sector increased by 12.5% due to the global economic recovery, while energy consumption in other sectors also showed minor increases (EDMC, 2012).

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## POLICY OVERVIEW

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### 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 2008). 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—for a cleaner energy supply and rationalised energy demand.
- Follow-up work—for government agencies to formulate concrete action plans which clearly set carbon-reduction targets, to build monitoring and follow-up mechanisms to regularly review the effectiveness and performance of the action plans, and to establish quantitative objectives for each task to measure its performance and to facilitate implementation.
- Target for energy conservation: reduce energy intensity 20% by 2015 (based on 2005), with a further reduction of 50% by 2025 through technology breakthroughs (based on 2005).
- Reduce CO<sub>2</sub> emissions to the level of 2005 by 2020, and to 2000 levels by 2025. Increase the share of low carbon fuel to 55% by 2025.
- Secure a stable energy supply to satisfy economic development and the demands of daily life.

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 Dependency, Create a Low-carbon Green Energy Environment & Gradually Move towards a Nuclear-free Homeland”. The major strategies concerning nuclear power are (BOE, 2011):

- 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 of the life spans of the three existing nuclear power plants (six units); it is expected that the first unit will be decommissioned in 2018, with all six existing units to be decommissioned by 2025;
- The safety of the 4th Nuclear Power Plant must be ensured prior the start of commercial operation;
- If the two reactor units of the 4th Nuclear Power Plant achieve consistent operation before 2016, suspension of operations at the 1st Nuclear Power Plant will also be moved forward.

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 2012d, 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 2012e). 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, 2012a).

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 2011, CPC had engaged with international oil companies in cooperative exploration in 21 fields in seven economies. Within Chinese Taipei, CPC continued to rejuvenate old oilfields, which delivered positive results by the end of 2011. CPC's drilling at several areas around the midsection and south part of Taiwan Island uncovered large amounts of natural gas, with 424 million cubic metres produced in 2011.

CPC also received permission to resume operations at the F Structure gas field offshore of Kaohsiung, which is estimated to contain gas reserves of 5.979 billion cubic metres (CPC, 2012a, CPC 2012b). 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, 2012a).

## 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 2010 included the following (BOE, 2012a):

- Two companies were granted petroleum refining business licenses, two companies were granted LNG import licenses, and 203 companies were granted gasoline and diesel wholesale licenses. A total of 1 589 oil import and export agreements were also approved in 2011.
- The number of gasoline refilling stations increased slightly from 2 696 to 2 698 in 2011; the number of natural gas refilling stations increased from 44 to 52, reflecting the growth of LNG and hybrid vehicles.
- Twenty-five natural gas companies economy-wide provided natural gas to about three million users (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 16% (BOE 2012a), based on peak demand. During the 1990s, some of the Taiwan Power Company's (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 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 independent power producers (IPPs) when the reserve capacity fell below 16%. Electricity produced by IPPs is sold to TPC through TPC's transmission lines. TPC provided 67.2% of power generation capacity in 2011, with 16.5 % from IPPs and 16.3% from cogeneration plants. However, TPC contributed 69.2% of the net electricity supply with IPPs at 16.8% and cogeneration at 14.0%. (BOE, 2012b)

In order to enhance the stability of the electricity supply, TPC continues to improve its transmission and distribution system. In 2011, seven substations, 349 km of transmission lines, and main transformers with a capacity of 4 224 MVA were completed. In terms of the distribution system, 1 574 automated feeders were completed. The total number of automated feeders has reached 6 351, accounting for more than 68% of all feeders of the company. These improvements are expected to greatly reduce the duration of forced power outages. The SAIDI (System Average Interruption Duration Index) was 18.224 minutes/customer-year and the SAIFI (System Average Interruption Frequency Index) was 0.204 freq./customer-year in 2011. Despite the increase in power supply from the south to the north, the line loss was controlled at a high standard of 4.76%. (TPC, 2012a, 2012b)

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, and the legislative process to amend the Electricity Act is expected to be completed by 2013.

This will enable the electricity generation sector to set up and invest in integrated utilities, transmission utilities and distribution utilities. In addition, generators will be able to sell power to consumers directly, which means the market structure will no longer be a monopoly. A competitive mechanism will also be established to improve the performance of utilities.

### 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 overall energy consumption, the industry sector is Chinese Taipei's major energy user, accounting for 53.5% of total energy consumed, with residential and commercial consumption following at 22.2% in 2011. The transport sector accounted for 13.3%. 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 2012a, 2012b).

In 2011, Chinese Taipei's energy intensity was 7.99 litres of oil equivalent per TWD 1000, a 20.1% 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, 2012a):

- Carried out energy audits of the major energy users and helped them to set up internal energy auditing systems and report the results to the government. A total of 4 490 high-energy users (3 069 manufacturers and 1 421 non-manufacturers) were audited by the government in 2011. The audits showed energy savings of 65.59 million litres of oil equivalent (MLOE) for the 3 069 manufacturers and 32.4 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 1 001 companies were visited in 2011 and shown potential energy savings of 13.9 MLOE, with 7.4 MLOE being achieved.
- Since 2001, promoted the voluntary accreditation of high energy-efficient products and an energy labelling system. A total of 36 product categories were included in the energy labelling system, with 370 manufacturers and 6 261 brands gaining accreditation by October 16, 2012. More than 130 million labels were issued by the end of June 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 extended to gas stoves and instantaneous gas water heaters in December 2012. There are 6 317 air conditioner models, 964 refrigerator models, 4 513 automobile models, 968 motorcycle models, 193 dehumidifier models and 1 548 CFL models for which mandatory energy label applications have been completed as of November 2012.
- Chinese Taipei began to employ LED signalled 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 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 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. 67 projects were conducted under the Energy Saving Performance Contract (ESPC) mechanism by the end of 2011, with an average energy savings up to 55% compared with 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 2012a):
  - *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 2011, this system was already employed in 967 convenience stores in Chinese Taipei and is ready for export or technology transfer to other economies. There are a total of 77 manufacturers involved in this area, with revenue at TWD 12.5 billion in 2011.
  - *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, and manufacturing capabilities, through to 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 2011 were:
    - Completion of the prototype testing of an inverter centrifugal chiller with a capacity of 500-600RT (refrigeration ton) using environmental refrigerant R-134a, achieving an efficiency target of COP (coefficient of performance) larger than 6.1 and IPLV (COP) (integrated part load value) larger than 9.5. Completion of the prototype testing of a centrifugal compressor water chiller with a capacity 30-100RT using magnetic bearings, achieving an efficiency target of COP equal to 5.3 and IPLV (COP) equal to 8.3.
    - Development of the first prototype of a CO<sub>2</sub> heat pump (employing its own CO<sub>2</sub> 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 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 domestic industry to increase its global market competitiveness. The major achievements in 2011 were:
  - Development of oxygen-rich combustion technology and its use in heavy-oil combustion systems. This can reduce NO<sub>x</sub> 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 emphasize 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 is to develop 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 2011 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.
  - Established 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 power generation capacity from renewable resources will account for 16.1% of total power generation capacity by 2030 (BOE, 2011; BOE, 2012a).

#### 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 2011 included the following (BOE, 2012a , 2102f):

- 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 73.7 MW with electricity generated reaching 67.5 GWh in 2011.

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 2011, there were about 160 companies with total revenue of about TWD 197.9 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 2011, Chinese Taipei had installed 268 sets of wind turbines economy-wide, with a total installed capacity of 522.7 MW, and an annual output of 1.493 billion kWh of electricity. This is sufficient to supply electricity for one year to 373 000 households. The first off-shore wind turbine is expected to be installed by 2014. There were about 64 companies with total revenue of about TWD 6.6 billion in 2011. Most of them are small wind turbine manufacturers.

- The promotion of a bioenergy

The bioenergy industry includes bio-diesel, bio-methane, and bio-heat and 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 2011, 11 companies were approved as qualified biodiesel manufacturers with a production of about 5.8 MLOE in 2011. The biodiesel industry mainly uses waste cooking oil as its raw material (BOE, 2012). 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 2011.

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 total electricity generation of 3.59 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 2011 were (BOE, 2012a):

- 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 2011 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 2011. The major achievements in 2011 were:

- Development of new high-efficiency hetero-junction solar cells 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 18.3% and modules to 16.9%.
- A new generation of thin-film solar modules with initial efficiency of 9.4% and stable efficiency of 8.2%.
- A prototype of dye-sensitized solar modules with glass substrate was developed with an efficiency of 8.21%, and with a flexible substrate, efficiency of 5.4%.
- Development of a copper indium gallium selenide (CIGS) using vacuum technology and slurry print production technology. Conversion efficiency can reach 16%, while module efficiency with flexible stainless steel sheets can reach 9.9%.
- 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 2011 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 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 2011 were:

  - Continue the life testing for a 3 kW fuel cell cogeneration system. The overall system efficiency is 76.4% with power generation at 32.5% and heat recovery at 43.9%. Cumulative testing time reached 8,087 hours as of the end of 2011.
  - Continue to put efforts into system integration for the application of fuel cells and enhancing capabilities for development of key components, including the membrane electrode assembly, a gas diffusion layer/electrode, recombinant, etc. There were a total of 48 manufacturers with total revenue of about TWD 330 million in 2011.

## 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 first unit of the fourth nuclear energy plant (1 350 MW) will be completed in 2015, and the second (1 350 MW) will be completed in 2016 (AEC 2012). By 2016, there will be 7 844 MW of installed nuclear energy generation capacity. 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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.
- A voluntary carbon emissions reduction programme attracted a total of 42 participating companies, with 25 proposals approved and 22 projects further verified for their achievements. The potential for carbon emissions reductions was estimated to be 36.9 million tonnes/CO<sub>2</sub>e with 12 million tonnes/CO<sub>2</sub>e verified by the end of 2011.

Emissions from fossil fuel combustion are the major source of greenhouse gas (GHG) emissions in Chinese Taipei. The economy emitted 250 million tonnes of CO<sub>2</sub> in 2010, down 5.4% over 2009. 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 CO<sub>2</sub> emissions has slowed significantly in the past decade. CO<sub>2</sub> emissions grew 1.2% annually after the year 2000, slower than the economic growth rate (3.1% annually), and the economy's CO<sub>2</sub> intensity has steadily declined since 2003. It appears the rates of CO<sub>2</sub> 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, 2012a).

### PROMOTION OF LOW-CARBON ENERGY TECHNOLOGY AND INDUSTRY

Chinese Taipei has a developing green energy industry. However, to be able to respond to future developments and competition, it is necessary for Chinese Taipei 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. The wind power, biomass, hydrogen and fuel cell, Energy Information Communication Technology (EICT), and electric vehicle industries are considered to have promising potential. Total revenue from these green energy industries was TWD 415 billion in 2011, with growth of 159% compared with 2008. Cumulative new investment from 2009 to 2011 was TWD 195 billion, with the creation of new employment opportunities for 46 200 people from 2008 to the end of 2011.

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## NOTABLE ENERGY DEVELOPMENTS

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### PEER REVIEW ON ENERGY EFFICIENCY

Chinese Taipei hosted an APEC Peer Review on Energy Efficiency between 23–27 August 2010. The Peer Review was well organised; the government arranged a comprehensive consultation program with government officials and industry representatives, and provided the review team with detailed background information to help with their analysis.

The review team noted a strong history of government engagement with businesses and the public on energy efficiency and conservation issues. This leadership element is critical to ensuring further progress is made on energy efficiency in Chinese Taipei. The commitment to energy efficiency and conservation extends from the highest level of government (the Executive Yuan) to the general public, and is reflected in the implementation of international best practice energy efficiency policies and measures. The review team made 35 recommendations in its draft final report to support the Chinese Taipei Government's energy efficiency strategy. The recommendations cover the institutional context; energy efficiency goals, targets and strategy; energy data collection and monitoring; the industry, electricity, residential and commercial and transport sectors; appliances and equipment; and education and energy efficiency related R&D.

### APEC EWG42 AND ASSOCIATED MEETINGS

Chinese Taipei organized and hosted the APEC EWG42 and associated meetings in Kaohsiung from October 17 to 21 2011. Over those five days, several meetings were organized, including: (1) the 6th Meeting of the Energy Trade and Investment Task Force (ETITF), (2) the APERC Workshop, (3) a Knowledge Sharing Platform (KSP) Workshop for the Energy Smart Communities Initiative, (4) a Low Carbon Model Town (LCMT) Workshop, (5) a Workshop on Phasing out Inefficient Fossil Fuels Subsidies, (6) the 42nd Meeting of the APEC Energy Working Group, and (7) site visits to the Chinese Steel Company for energy conservation and to the National Stadium for its PV system.

### 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 to reduce energy intensity by 20% by 2015, and by 50% by 2025 (based on 2005 levels).
- To reduce CO<sub>2</sub> 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 into a low-carbon society and to 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 to seek solutions for overcoming current problems. One of the meetings was focused on energy policy, and the major conclusions from that meeting were:

- 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.
- Development of new energy technologies for alternative power generation should be enforced. 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.

## 2011 INTERNATIONAL ENERGY OUTLOOK FORUM

On August 5 2011, Chinese Taipei hosted the “2011 International Energy Outlook Forum” with the Lawrence Berkeley National Laboratory (LBNL) of the US, and invited Dr. Paul Alivisatos, President of LBNL and other experts to discuss new and renewable technology with local experts. This forum has fostered cooperation between Chinese Taipei and the LBNL in the following areas:

- Under the Memorandum of Understanding (MOU) between the Industrial Technology Research Institute (ITRI) and the LBNL, closer cooperation is being conducted in the fields of PV, wind power, smart grids, CCS and smart green buildings.
- Focus on the application of large-scale power storage systems and applications with the renewable energy. The expectation for expansion of smart green buildings into everyday life will also be emphasized.
- More than 30 researchers have joined the LBNL for cooperative research in the past seven years (2005 to 2011). Closer cooperation is also expected in the future in order to transfer all technology to industry for both economic growth and carbon reduction.

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#### USEFUL LINKS

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Bureau of Energy, Ministry of Economic Affairs—[www.moeaboe.gov.tw](http://www.moeaboe.gov.tw)  
 Chinese Petroleum Corporation—[www.cpc.com.tw](http://www.cpc.com.tw)  
 Directorate General of Budget, Accounting and Statistics, Executive Yuan—[www.dgbas.gov.tw](http://www.dgbas.gov.tw)  
 Industrial Development Bureau, Ministry of Economic Affairs—[www.moeaidb.gov.tw](http://www.moeaidb.gov.tw)  
 Ministry of Economic Affairs—[www.moea.gov.tw](http://www.moea.gov.tw)  
 Ministry of Transportation and Communications—[www.motc.gov.tw](http://www.motc.gov.tw)  
 Taiwan Power Company—[www.taipower.com.tw](http://www.taipower.com.tw)



# THAILAND

## G INTRODUCTION

Thailand is a South-East Asian economy with an area of 513 115 square kilometres and a population at the end of 2010 of about 69.1 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 2010, Thailand's GDP reached USD 470.5 billion (USD 2000 at PPP), an 8% increase from USD 436.4 billion in 2009. In the same period, GDP per capita also increased 7.2%, from USD 6 352 (USD 2000 at PPP) to USD 6 807 (USD 2000 at PPP).

At the end of 2010 Thailand had proved reserves of 442 million barrels of oil, nearly 300 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 73% of its oil supply coming from imported stock in 2010 (EDMC, 2012)

Table 1 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (sq. km)	513 115	Oil (million barrels)	442
Population (million)	69.1	Natural gas (billion cubic metres)	299.8
GDP (USD 2000 billion at PPP)	470.5	Coal (million tonnes)	1 239
GDP (USD 2000 per capita at PPP)	6 807		

a. Proved reserves. Source: BP (2012)

Source: EDMC (2012)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

Total primary energy supply in 2010 was 99 243 kilotonnes of oil equivalent (ktoe), which represented an increase of 7.3% from 2009. Oil accounted for 45% of total primary supply, while gas, coal and others accounted for roughly 37%, 9% and 9%, 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 2010, coal supply was 9 062 ktoe, down 9% from the previous year.

Natural gas supply in 2010 was 36 307 ktoe, a 15% increase from 31 631 ktoe in 2009. 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 revisited Power Development Plan (PDP) launched in 2010, nuclear power and coal (with clean coal technology) will be the main sources of energy diversification.

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 2010, total electricity generation was 144 362 GWh, a 2.6% decrease from 2009. Thermal generation, mostly from natural gas and coal, accounted for nearly all of the power generation (96%), with hydropower 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, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	48 872	Industry sector	18 381	Total	144,362
Net imports and other	53 458	Transport sector	21 194	Thermal	138,817
Total PES	99 243	Other sectors	22 074	Hydro	5,537
Coal	9 062	Total FEC	61 648	Nuclear	–
Oil	44 950	Coal	7 929	Other	8
Gas	36 307	Oil	35 853		
Other	8 925	Gas	5 053		
		Electricity and other	12 813		

Source: EDMC (2012)

### FINAL ENERGY CONSUMPTION

Thailand's total final energy consumption in 2010 was 61 648 ktoe, an increase of 3.6% from the previous year. The transport sector was the largest energy-consuming sector, accounting for 21 194 ktoe, or 34% of total final energy consumption. The second largest consumer of energy was the industry sector, which consumed 18 381 ktoe in 2010, an increase of 2.8% from 2009. By fuel type, oil accounted for a 58% share (35 853 ktoe) of total energy consumption in 2009, followed by electricity and other (21%), coal (13%) and gas (8%).

Oil demand decreased very slightly from 35 866 ktoe in 2009 to 35 853 ktoe in 2010. Natural gas consumption increased by 5%, mainly due to the economy's promotion of natural gas for vehicles. Coal consumption increased significantly by 10.3% to 7 929 ktoe in 2009, compared with the previous year. Domestic electricity demand increased significantly by 10.2% from year 2009. 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 for sustainable energy management to ensure the economy has sufficient energy to meet its needs. It 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.

Organisations also responsible for energy include the:

- 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—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—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 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 and biomass such as gasohol—a mix of ethanol into gasoline in different percentages: E10, E20 and E85—biodiesel, 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; encouraging the greater use of natural gas in the transport sector by expanding the natural gas transportation system nationwide; and promoting the research and development in all forms of alternative energy.

The strategies with targets and actions to achieve the policy under the current 15-year Renewable Energy Development Plan (REDP) 2008–22 are:

1. *Promote the production and use of biofuels, e.g. ethanol and biodiesel, to replace oil consumption.* The targets are to replace oil consumption with the use of ethanol; promote the use of gasohol E85 and flexible fuel vehicles (FFV) in Thailand; and promote the domestic production capacity of B100. The actions to achieve this include:
  - Establishing the production and utilisation of ethanol and biodiesel as an economy-wide agenda and providing clear directions for its implementation
  - Supporting the establishment of ethanol production plants to enhance Thailand as the 'ethanol hub' for ethanol production and distribution in Asia

- Promoting the wider use of E85 fuel, by supporting an E85 automobile manufacturing line in Thailand, with an initial target of 1 000 000 E85 cars by 2018
  - Revising the regulations for ethanol export
  - Promoting community-scale biodiesel projects, emphasising technology transfer and suitable technical management so as not to cause an environmental impact on the communities
  - Making the use of B5 biodiesel mandatory economy-wide
  - Phasing out of regular unleaded gasoline by October 2012 for gasoline and gasohol.
2. *Promote the use of natural gas in the transportation, industrial, commercial and household sectors.* The target is to increase the number of Natural Gas Vehicle (NGV) mother stations. There were 18 stations as of November 2011. The actions to achieve this include:
- Applying NGVs to public fleets, focusing on taxis, tuk-tuks (motored tricycles), public and private buses, and trucks
  - Reviewing NGV prices, taking into consideration the actual costs and Thailand's overall economic situation
  - Planning the expansion of the natural gas transmission pipeline system to be the backbone of NGV growth.
3. *Promote all forms of renewable energy.* The target is to increase the use of wind, solar, hydropower, biomass, biogas, and energy from waste, with adjustable targets (flexible to current situations). The actions to achieve this include:
- Promoting power generation from renewable energy in all forms, by providing incentives, e.g. the current adder provision ('adder' is an additional energy purchasing price on top of the normal price power producers receive when selling electricity to power utilities)
  - Promoting the conversion of plastic waste into crude oil and providing incentives similar to the adder provision, but using the capital resources of oil reserve to hedge against oil price volatility (Oil Fund) and support the costs incurred by the adder provision to oil refineries that purchase oil derived from plastic waste for further processing.
  - Monitoring the incentive programme and developing a feed-in-tariff instead of the adder to support alternative energy for power generation.
4. *Carry out research and development in alternative energy, renewable energy and other innovative energy technologies.* The target is to develop and integrate the alternative energy research and development (R&D) plans of the concerned agencies, to enhance the capability to respond to the renewable energy development already approved in the 15-year Renewable Energy Development Plan (REDP). The actions to achieve this include:
- Supporting the R&D necessary for the development of alternative energy, especially R&D in energy from plants, in terms of both second generation biofuels and equipment for generating energy from biomass and biogas
  - Supporting R&D in modifying old-model cars to use gasohol E20 and E85
  - Supporting R&D in car engines to use biodiesel B10
  - Supporting research in advanced technologies, e.g. hydrogen and solar cells
  - Increasing the share of domestic technology utilisation (local content).
5. *Set alternative energy as an economy-wide agenda and determine incentive measures.* The target is to have the National Alternative Energy Master Plan implemented. The actions to achieve this include:

- Using the 15-year REDP, approved by the National Energy Policy Council (NEPC) and Cabinet as the master plan, to promote and support alternative energy in all forms
  - Developing an integrated plan of action for alternative energy development under the targets set out in the 15-year REDP.
6. *Establish and strengthen renewable energy networks.* The target is to encourage participation at the community, district and provincial levels, to create energy security from the foundations. The actions to achieve this include:
- Establishing one prototype village-based or community-based energy source in each province, using local cultures to foster the economical and wise use of energy in a community and to increase the economic value of the community
  - Speeding up the expansion and development of prototype community-based energy sources to popularise the concept, by integrating them into community energy planning projects with a target of ‘one district, one community energy source’ by 2011
  - Setting up ‘community energy volunteers’ by selecting community leaders or mentors
  - Devising an alternative energy development plan at the provincial level and at the provincial cluster level, using the ‘cluster concept’ in the 15-year REDP framework
  - Implementing community-scale energy projects in an additional 300 tambon (sub-district) administrative units economy-wide, aiming to reduce the energy cost of each community by 15%–20%
  - Promoting technology appropriate for people’s way of living, particularly in rural communities, e.g. community-scale biodiesel projects and training courses on the manual production of biodiesel, 200-litre charcoal-making stoves, high-efficiency stoves, charcoal briquette-making machines and household biogas digesters
  - Promoting the ‘green home’ concept for urban communities, by developing technologies appropriate for urban communities, housing estates and condominiums.

#### 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 (PEOs) for the protection of energy consumers; establishing NGV quality standards to ensure safety, including supervising the installation costs of 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 for 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 which supports the development of energy crops and which 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 EPPO is soliciting the Ethanol Producer Association and Biodiesel Producer Association for a more suitable pricing formula for monitoring 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

The government's energy efficiency and conservation policy is to encourage energy conservation and efficiency in the household, industry, service and transport sectors through different policies of which their strategies are:

1. Promote energy development and energy conservation. The target is to increase the energy conservation target set out in the Energy Conservation Program to 20%, focusing on the industry and transport sectors.
  - To do so, the actions proposed refer to the drafting of the Energy Conservation Program, Phase 4 (2012–2016) to address future crises caused by oil price volatility, climate change and a world food crisis, with the participation of the public and stakeholders at all levels.
2. Organise campaigns to create an energy-saving awareness and provide knowledge about energy conservation. The objectives are:
  - To accelerate implementation of 11 Energy-Saving Measures for the People to quickly attain practical achievements and set an energy-saving target at THB 100 billion per year (approx. USD 3 300 million per year)
  - To enhance local administration organisations (LAOs) as focal agencies in creating and disseminating an energy-saving culture among target groups such as children and young people, housewives and senior citizens through Community Energy Volunteers



- To attain the participation of 100 000 households in the Household Energy Credit project, which will contribute to energy savings at no less than THB 1 000 million per year (approx. USD 33 million per year)
  - To set the energy credit provision target at THB 60 billion per year (approx. USD 2 billion per year), contributing to energy savings at no less than THB 40 000 million per year.
3. Devise incentives and provide prerequisites to induce investment in energy saving. The objective is to reduce energy intensity, or energy consumption per production unit, in the industry sector by 20% compared with the base year (2006). This target has been superseded by the target in the 20-year Energy Efficiency Development Plan (EEDP) 2011–30 adopted in 2011. The new target is to reduce energy intensity by 25% in 2030 compared with that in the 2005 base year.
  4. Promote R&D in energy-saving systems and technologies. The aim of this measure is to put in place integrated resources planning for energy conservation R&D.
  5. Set standards, rules and regulations for energy-saving equipment, materials and energy management. In order to promote these new instruments, it will be necessary to announce the Minimum Energy Performance Standards (MEPS) for several electrical appliances by 2011 and to issue ministerial orders, particularly on the Building Energy Code and the International Organisation for Standardization (ISO)–Energy.
  6. Promote the creation of prototype networking, e.g. small and medium enterprises (SMEs) with distinguishing features or with interests in energy-saving. The objective is to make the Thailand Energy Awards recognised by the groups targeted for energy savings.

In 2011, the Thailand Government adopted the 20-year Energy Efficiency Development Plan (EEDP) 2011–30. This plan has a target to reduce energy intensity by 25% in 2030, compared with that in the base year 2005. This is the equivalent of a reduction in final energy consumption of 20% in 2030, or of about 30 000 kilotonnes of oil equivalent (ktoe), compared with that in 2005. The economic sectors with priority for undertaking energy conservation are the transport sector (13 400 ktoe in 2030) and the industry sector (11 300 ktoe in 2030). The EEDP aims to reduce energy elasticity (the percentage change in energy consumption to achieve a 1% change in national GDP) from an average of 0.98 in the past 20 years to 0.7 in the next 20 years. The implementation of the EEDP will result in cumulative energy savings at an average of 14 500 ktoe per year, and cumulative CO<sub>2</sub> emissions reductions at an average of 49 million tons per year.

Thailand has set up three categories of energy efficiency measures:

- Social campaigns for the public
- Investment promotions for industry
- Laws and regulations to introduce standards or codes.

The steps Thailand has already taken to conserve energy include:

- Setting up concrete measures in the Building Energy Code
- Creating the standards for and labelling on appliances such as light bulbs, air conditioners, and refrigerators
- Setting up supporting programmes for industries and SMEs, e.g. USD 4 billion has already been approved and allocated to finance energy efficiency projects.

### RENEWABLE ENERGY

The Renewable and Alternative Energy Development Plan (2012–2021) sets a framework for Thailand to increase the share of renewable and alternative energy 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, that act as special-purpose vehicles for renewable energy development projects, the Revolving Fund that provides low interest rates, and investment grants from the Energy Conservation Fund.

To move the REDP into action, the 15-year period was broken down into three stages of about five years each, with targets and actions for the short term, medium term, and long term of the plan. The continuous development spectrum will involve revising legislation and setting up guidelines and standards, undertaking R&D and installing the infrastructure necessary to support renewable energy development. Thailand expects to attract more than USD 15 billion in 'green investment' and to cut CO<sub>2</sub> emissions by 42 million tonnes per year by 2022.

### NUCLEAR

Thailand is still looking into the issues of regional nuclear cooperation, nuclear energy safety as well as capacity building, education and training, and information sharing. The development of a nuclear energy programme is a stepped process. It will require strong political will and public acceptance. The government is disseminating information to the public so Thai citizens will be aware of what is needed. The Nuclear Power Program Development Office's (*NPPDO*) 2010 update for the 20-year Power Development Plan (*PDP*) 2010–30 showed supply from nuclear energy generation should not be higher than approximately 10% of total power generating capacity (e.g. 2022—6%, 2030—11%); the expected total capacity of nuclear energy plants by 2030 is expected to be 5 000 MW (updated from 2 000 MW in the previous *PDP* plan). A revision to the Power Development Plan that was made in June 2012 limits the share of nuclear to less than 5% of total generating capacity.

The same revision of *PDP* 2010 stipulates that Thailand's reserve margin should not be less than 15% of peak power demand and reduces the allowable share for foreign power purchases from neighbouring countries from 25% to 15% of total generating capacity. Due to the damage done to Japan's Fukushima Daiichi nuclear plant by the earthquake and tsunami in March 2011, the Thai government has pushed forward the construction of some thermal power plants to bring them on line earlier than expected. The purchase of power from neighbouring economies is also viable.

### 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 which attach importance to the environment, 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 with targets and actions to achieve the policy are:

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, to reduce Thailand's CO<sub>2</sub> 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 CO<sub>2</sub> 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 which are environmentally friendly and easy to operate and maintain 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

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- Department of Alternative Energy Development and Efficiency (DEDE)—[www.dede.go.th](http://www.dede.go.th)
- Electricity Generating Authority of Thailand (EGAT)—[www.egat.co.th/en](http://www.egat.co.th/en)
- Energy Policy and Planning Office (EPPPO)—[www.eppo.go.th](http://www.eppo.go.th)
- Ministry of Energy (MoEN)—[www.energy.go.th/en](http://www.energy.go.th/en)
- Prime Minister's Office—[www.opm.go.th](http://www.opm.go.th)

# UNITED STATES

## INTRODUCTION

The United States (US) is the world's largest economy, with a GDP of USD 11.5 trillion (USD 2000 at PPP) in 2010 (EDMC, 2012). The US spans 9.8 million square kilometres and had a population of 309 million people in 2010 which has grown at a rate of around 1% per year since 1990, although this growth rate has steadily fallen each year since 2007 (EDMC, 2012).

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, 2012). 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 and volatile with consistently high unemployment, which reached the highest levels in over 25 years (BLS, 2010). In 2010 though, economic growth expanded again at about 3%.

The US is the largest producer, consumer and importer of energy in the world. It is also rich in energy resources. In 2010, the US had 30.9 billion barrels of proven oil reserves, 8 500 billion cubic metres of natural gas reserves and 237 billion tonnes of coal reserves (BP, 2012). 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 7.0 tonnes of oil equivalent energy per capita in 2009, close to three times the APEC average and in excess of domestic energy production (APEREC, 2013).

Table 1 Key data and economic profile, 2010

Key data 2009		Energy reserves 2010 <sup>a</sup>	
Area (sq. km)	9 826 675	Oil (billion barrels)	30.9
Population (million)	309	Gas (billion cubic metres)	8 500
GDP (USD (2000) billion at PPP)	11 547	Coal (million tonnes) – recoverable	237 000
GDP (USD (2000) per capita at PPP)	37 330	Uranium (million tonnes) – recoverable <sup>a</sup>	0.472

a. BP (2012)

b. NEA (2012), At a production cost of less than 260 USD per kg

Source: EDMC (2012)

## ENERGY SUPPLY AND DEMAND

### PRIMARY ENERGY SUPPLY

In 2010, total primary energy supply in the US was 2 187 million tonnes of oil equivalent (Mtoe). By fuel type, 40% of supply came from crude oil and petroleum products, 23% from coal, 25% from natural gas and 12% from nuclear, hydro, geothermal and other fuels. Net imports provided about 24% of the economy's primary energy requirement in 2010 (EDMC, 2012).

In 2010, oil provided 873 Mtoe of the primary energy supply. This was a decline to pre-2000 levels with import dependence reducing substantially. 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, 2013). The decline in imports is the result of several factors, including a decline in consumption resulting from the economic crisis, 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 2010 as the third-largest crude oil producer in the world, with production averaging 7.5 million barrels per day (EDMC, 2012). 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 556 Mtoe in 2010. 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, 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 2010 total primary gas supply was above the peak recorded in 2000 (EDMC, 2012). 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 unconventional gas reserves from tight geological formations has resulted in an abundant supply and low wellhead prices.

Table 2 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 731 824	Industry sector	270 601	Total	4 379 207
Net imports and other	725 792	Transport sector	576 123	Thermal	2 884 531
Total PES	2 187 199	Other sectors	155 272	Hydro	286 388
Coal	502 642	Total FEC	1 469 716	Nuclear	847 536
Oil	873 497	Coal	23 199	Other	360 751
Gas	556 493	Oil	800 389		
Other	376 544	Gas	319 163		
		Electricity and other	326 965		

Source: EDMC (2012).

The US held about 4.1% of the world's natural gas reserves in 2011 (BP, 2012). The US 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 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 23% of production in 2010 (EIA, 2012d). Further increases in shale gas production are anticipated, with total production expected to increase around threefold from 2010 to 2035, and accounting 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 and construction of an LNG exporting terminal will likely take 4–5 years from approval (EIA, 2012d).

Primary energy supply of coal in the US totalled 502 Mtoe in 2010 (EDMC, 2012). 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 2010, the US was the fourth largest coal exporter in the world, behind Australia, Indonesia and Russia (EIA, 2011a). In 2011 coal exports were 97.3 million tonnes (107.3 million short tons) or an increase of over 30% from 2010. Coal imports have steadily declined from 32.9 million tonnes (36.3 million short tons) in 2007 to 11.9 million tonnes (13.1 million short tons) in 2011. 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). Moreover, 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).

Total renewable energy production in the US in 2010 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 13.2% from the previous year, or an annual growth rate of 23.4% since 2006 (EIA, 2012a, 2012d).

By consumption of renewable energy type, biomass as a whole represented 48.9% of the total, hydroelectric power 34.3%, geothermal 2.5%, wind 12.6% and solar/photovoltaic 1.7%. There has been particularly rapid expansion of wind power, which between 2006 and 2011 recorded a 35% 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 2010, total final energy consumption in the US was 1 470 Mtoe, a decrease of 0.2% from the previous year. By sector, transport consumed 39%, industry accounted for 18%, and other sectors (including non-energy uses) consumed 43%. By fuel, petroleum accounted for 54% of final consumption, natural gas 22%, coal 2%, and electricity and other fuels 22% (EDMC, 2012).



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## POLICY OVERVIEW

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### 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, to shift towards alternative energy sources, to create a market for independent power producers, and to 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 (*EPAct 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).

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 CO<sub>2</sub> 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 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, 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). The total government spending for energy-related research and development had remained relatively stable since the 1990s at around USD 3 billion a year (in USD 2005 terms) (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 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. 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. 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. Forty-two states and the District of Columbia had enacted RPS legislation, with varying degrees of stringency, by the end of 2010.

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

The US Government has partnered with industry to support research, development and deployment of nuclear energy for civilian applications since the Atomic Energy Act of 1954 (NRC, 2011b). This partnership yielded a domestic fleet of commercial nuclear reactors that in 2010 remained the largest in the world (IAEA, 2010). 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).

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).

The US also participates in international efforts to develop 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 emitters (EPA, 2012b). The EPA endangerment finding has been challenged through the Court of Appeals. The outcome of this ruling and subsequent plan to limit GHG emissions will have major implications for US energy developments in future.

In addition to GHG emissions limits, the EPA has enforced emission standards on mercury and toxic pollutants beginning from 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. However, the FutureGen Alliance has faced some difficulty in securing a willing industry partner. The Department of Energy may contribute more than USD 1 billion, made available through the Recovery Act. At this stage only the preferred site has been selected with no further confirmation on project timing (DOE, 2009, 2010b, 2010d).

#### CLEAN ENERGY MINISTERIAL

In September 2007, the US convened the first Major Economies Meeting on Energy Security and Climate Change, hosting representatives from 17 developed and developing economies to set goals for reducing GHG emissions and establishing mid-term targets (White House, 2007). Similar meetings continued in 2009 as part of the Major Economies Forum on Energy and Climate (White House, 2009), and in 2010, the US hosted representatives of 24 economies at a Clean Energy Ministerial. To date, the participants in the Clean Energy Ministerial have 13 active initiatives designed to increase the spread of clean energy technologies (DOE, 2010e).

### 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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#### USEFUL LINKS

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- American Recovery and Reinvestment Act of 2009—[www.recovery.gov](http://www.recovery.gov)
- Database of State Incentives for Renewables and Efficiency—[www.dsireusa.org](http://www.dsireusa.org)
- Department of Energy—[www.energy.gov](http://www.energy.gov)
- Department of Interior—[www.doi.gov](http://www.doi.gov)
- Energy Information Administration—[www.eia.doe.gov](http://www.eia.doe.gov)
- Energy Star—[www.energystar.gov](http://www.energystar.gov)
- Environmental Protection Agency—[www.epa.gov/energy](http://www.epa.gov/energy)
- Federal Energy Regulatory Commission—[www.ferc.gov](http://www.ferc.gov)
- Fuel economy—[www.fueleconomy.gov](http://www.fueleconomy.gov)
- Nuclear Regulatory Commission—[www.nrc.gov](http://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. Viet Nam 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 86.9 million in 2010, Viet Nam has been transformed since 1986 when it began rapid economic development. In 2010, Viet Nam had a GDP of USD 221.7 billion and an income per capita of USD 2 551 (both in USD 2000 at PPP). GDP grew at an average annual rate of 7.0% from 2000 to 2010.

The government has set a target for average annual GDP growth of 6.5% from 2011 to 2015, based on export growth increasing by 10% per year, 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 27 Key data and economic profile, 2010

Key data		Energy reserves <sup>a</sup>	
Area (sq. km)	331 501	Oil (million tonnes) <sup>b</sup>	615
Population (million)	86.9	Gas (billion cubic metres) <sup>b</sup>	600
GDP (USD (2000) billion at PPP)	221.7	Coal (billion tonnes)	6.1
GDP (USD (2000) per capita at PPP)	2 551		

a. In the case of oil and gas, refers to proved reserves as of 2005. GSO (2011).

Source: EDMC (2012).

## 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 2011, Viet Nam had 16 producing oil and gas fields and 21 other fields will be explored in coming years (PVN, 2012). Most oil exploration and production occurs offshore in the Cuu Long and Nam Con Son.



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 latest 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 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 94 407 GWh in 2010. The structure of 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 Vietnam'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 28 Energy supply and consumption, 2010

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 277	Industry sector	14 926	Total	94 407
Net imports and other	-6 998	Transport sector	11 164	Thermal	66 875
Total PES	45 910	Other sectors	9 903	Hydro	27 532
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 (2012)

### 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, no change compared with 2009.

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## POLICY OVERVIEW

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### 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 Directorate of Energy (the new name that was applied to the former Energy Department in December 2011) 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 it the first priority for review.

#### ENERGY SECURITY

Viet Nam is diversifying its consumption of energy by developing regional indigenous resources and expanding regional cooperation. Viet Nam 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 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; the power sector is still in the process of reform; electricity shortages are improving but still occur sometimes; and 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 infrastructure
- Apply preferential policies for financing and widen 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
- Support Viet Nam's oil companies to invest in exploration and the development of oil and gas resources overseas
- Intensify regional and international energy cooperation and diversify energy import sources
- 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 electricity supply to support economic development and to provide power to meet the consumption needs of the people. EVN also has the key responsibility of ensuring investments in power generation and network expansion meet the power demand in 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) is 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 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 through 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.

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 has allowed raising the coal price for power production according to the progress of electricity price adjustments. It will be adjusted to not less than the coal production cost to ensure funding for the renovation, expansion and improvement of capacity of 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 comprises four businesses, which will hold 100% of the assets: the Petroleum Exploration and Production Corporation, the Gas Corporation, the Electricity Production and Trading Corporation (established when Viet Nam National Oil and Gas Group power plant investments came into operation), and the Oil Refining and Petrochemical Corporation (established when the group's refining and petrochemical plants came into operation). 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 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 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 around 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*

PVN has begun to expand its activities overseas, which include exploration and production contracts that have been signed in Iraq and Algeria, and a share of acquisition oil from international oil companies in Mongolia and Malaysia. 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 and 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, has just been 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 around 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 total energy consumption over the 2006–10 period and 5%–8% in the 2011–15 period.



The programme includes six components: strengthen state management of energy efficiency and conservation by developing a management system for energy saving; strengthen education, disseminate information and enhance public awareness to promote energy efficiency and conservation (EE&C) as well as environmental protection; develop and popularise highly energy-efficient equipment by phasing out low-efficiency equipment; promote EE&C in industry; promote EE&C in building; and promote EE&C in transportation. Phase one of 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 EE&C and is authorised to administer the implementation of 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 central government through to local government.

A National Steering Committee chaired by MOIT was established to monitor 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 CO<sub>2</sub> 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 were not expected to 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’ 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 include developing 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, since 2008, been developing policy to support renewable energy use. Government documents in this area include the Decision by the Minister of Industry and Trade on “Regulation on avoided cost 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 of incentives for capital investment, and 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 June 2010, the Prime Minister also approved a project on Orientation on Nuclear Power Development Planning by 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 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 that climate change due to anthropogenic greenhouse gases is a real threat, and that Viet Nam is 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 "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 impacts 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 "National Target Programme to Respond to Climate Change" (NTP-RCC) to assess climate change impact on sectors and regions over specific periods, and to develop feasible action plans to effectively respond to climate change in the short and long term 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 21<sup>st</sup> 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.

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## NOTABLE ENERGY DEVELOPMENTS

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### 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 has 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 has just commenced operating 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 Binh Dinh province (65 MW), wind power projects in Ninh Thuan province (126 MW), a wind farm in 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, Son La Hydro Power Plant with a total capacity of 2 400 MW has now been completed, with the final unit with a capacity of 240 MW commencing commercial operation in December 2012.

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#### USEFUL LINKS

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