APEC ENERGY OVERVIEW

2011

Prepared by

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APEC#211-RE-01.7

FOREWORD

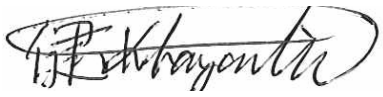
The sustainable development and use of energy resources continues to be at the forefront of energy policy in APEC. Facilitating economic growth and securing adequate energy supply, while also taking into account the global responsibility for reducing greenhouse gas emissions, has resulted in a focus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

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 2012

ACKNOWLEDGEMENTS

The *APEC Energy Overview* could not have been accomplished without the contributions of many individuals and organisations in APEC economies. We would like to thank APEC members for their efforts to improve the accuracy and timeliness of the information provided,in particular, members of the APEC Expert Group on Energy Data and Analysis (EGEDA). We would also like to thank members of the APERC Advisory Board for their helpful information and comments. Finally, we would like to thank all those whose efforts made this overview possible, in particular those named below.

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ABBREVIATIONS AND SYMBOLS

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

ACRONYMS

APEC	Asia–Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APP	Asia–Pacific Partnership on Clean Development and Climate
ASEAN	Association of Southeast Asian Nations
CBM	coal-bed methane

CCS	carbon capture and storage
CCT	clean coal technology
CDM	clean development mechanism
CFL	compact fluorescent lamp
CME	coconut methyl ester
COP 15	15th Conference of the Parties to the United Nations Framework Convention on Climate Change
CSM	coal-seam methane
DUHF	depleted uranium hexafluoride
EAS	East Asia Summit
EDMC	Energy Data and Modelling Center, Institute of Energy Economics, Japan
EEZ	exclusive economic zone
FEC	final energy consumption
GDP	gross domestic product
GHG	greenhouse gas
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
IPP	independent power producer
JOA	joint operating agreement
JOB	joint operating body
LCD	liquid crystal display
LED	light-emitting diode
LEU	low-enriched uranium
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MDKB	measured depth below kelly
MOPS	Mean of Platts Singapore
NGL	natural gas liquids
NGO	non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PES	primary energy supply
PPP	purchasing power parity
PSA	production sharing agreement
PSC	production sharing contract
PV	photovoltaic
RE	renewable energy
TFEC	total final energy consumption
TPES	total primary energy supply
TVDKB	true vertical depth below kelly
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VAT	value added tax

CURRENCY CODES

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

AUSTRALIA

INTRODUCTION

Australia is the world's largest island economy and the world's sixth largest economy (in land area). It lies in the southern hemisphere, between the Indian and Pacific oceans. Its total land area of nearly 7.7 million square kilometres is divided into six states and two territories. The population of around 21 million lives mostly in major cities or regional centres along the eastern and south-eastern seaboards. Australia has maintained robust economic growth, averaging 3.1% over the period 2000–07. In 2009, GDP reached USD 665.36 billion (USD (2000) at PPP), up from USD 590.34 billion in 2006.

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.

The coal and petroleum industries contributed AUD 47 billion to industry gross value added in 2009–10, representing 3.5% of the Australian total. The electricity and gas supply industries contributed another AUD 22 billion to industry gross value added in the 2009–10 financial year (July–June) (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, Australia 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, 2009

Key data		Energy reserves	
Area (sq. km)	7 692 024	Oil (billion barrels)	4.2
Population (million)	21.02	Gas (billion cubic metres)	3 080
GDP (USD (2000) billion at PPP)	665.36	Coal (million tonnes)	76 200
GDP (USD (2000) per capita at PPP)	30 416		

Sources: EDMC (2011); BP (2010).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009 Australia's total primary energy supply was 126 941 kilotonnes of oil equivalent (ktoe). Around 40% of supply came from coal, 32% from oil, 22% 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 2012). It is also an important component of domestic energy supplies, accounting for around 75% of fuel used in electricity generation. Australian coal production has been increasing in the last decade, underpinned by strong growth in demand and the addition of new capacity.

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 2009, Australia's production of gas was approximately 41 184toe. Around 44% of this was exported as LNG to consumers in Japan, Chinese Taipei, Republic of Korea and China.

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 is imported. 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 2012). In 2009, Australia's crude oil, LPG and condensate production was 40 356 ktoe.

In 2009, 261 012 gigawatt-hours (GWh) of electricity was generated, mostly from thermal sources (87%). Coal is the major energy source, reflecting its wide availability and relatively low cost. Coal is expected to remain the most commonly used fuel in electricity generation. However, given the large number of gas-fired, CSM-fired and wind-powered projects under development, those energy sources are expected to account for an increasing proportion of total electricity generation.

FINAL ENERGY CONSUMPTION

Australia's final energy consumption in 2009 was 77 082 ktoe. The transport sector accounted for 37% of the total, the industry sector 34% and the other sectors, which include residential and commercial, 29%. By energy source, petroleum products accounted for 49% of consumption, electricity and other 29%, natural gas 17% and coal 4%.

Table 2 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	296 282	Industry sector	25 864	Total	261 012
Net imports and other	–156 291	Transport sector	28 714	Thermal	226 354
Total PES	126 941	Other sectors	22 504	Hydro	12 292
Coal	50 930	Total FEC	77 082	Nuclear	–
Oil	40 356	Coal	3 277	Other	22 366
Gas	28 286	Oil	37 996		
Other	7 369	Gas	13 215		
		Electricity and other	22 594		

Source: EDMC (2011).

POLICY OVERVIEW

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 2004). 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. The draft Energy White Paper was released in December 2011, and is going through a consultation and submission process (RET 2011). 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. 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 2011a)

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 NESA determined that Australia's energy security had declined, compared with the assessment conducted as part of the 2004 Energy White Paper process, because of the need to address new challenges (mainly, reducing carbon emissions). The challenges governments need to address to maintain or to improve Australia's energy security include: the need for further market reforms and greater infrastructure resilience; the rising cost of investment capital globally; and the transition to a lower-carbon economy.

An update to the 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 increasingly will be shaped by the strength of new investment going forward and the price of energy, which are both being materially influenced by global trends (RET 2011b). The NESA was a key input into the development of the draft Energy White Paper released in December 2011 (RET 2011).

UPSTREAM ENERGY DEVELOPMENT

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

- Private decision-makers should be allowed to manage risk in a regulatory framework that is predictable, transparent, equitable and timely.
- Energy resource developments should be required to comply with standards of environmental performance that are commensurate with those imposed on other sectors of the economy.
- Commercial decisions should determine the nature and timing of energy resource developments; government interventions should be transparent and allow commercial interests to seek least-cost solutions to government objectives (for example, environmental, safety or good resource management objectives).
- Generally, government objectives should be driven by sector-wide policy mechanisms, rather than be the imposition of inconsistent requirements on individual projects or private investors.

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.

ELECTRICITY AND GAS MARKETS

The NEM was established in 1998 to allow the interjurisdictional flow of electricity between the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria (Tasmania joined the NEM in 2005). 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 (the 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; and 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 that investment, written down over a period of up to 25 years. Unlike other costs, this starting base will not be uplifted. (Treasury 2011)

The Australian Government encourages foreign investment that is consistent with the needs of the Australian community. This policy, together with the Foreign Acquisitions and Takeovers Act 1975, provides the framework for assessing foreign investment proposals. Foreign corporations with proposals to establish a business with an investment of more than AUD 10 million are required to inform the Foreign Investment Review Board (FIRB) to obtain approval. Such proposals are generally approved unless they are deemed to be contrary to Australia's interest. Foreign investors that wish to obtain a substantial interest (more than 15%) in an Australian corporation with assets greater than AUD 100 million, or where consideration for the shares is more than AUD 100 million, must notify the FIRB. Approval is also required for all direct investments by foreign governments or their agencies, regardless of the size of the investment (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 program of work for promoting energy efficiency in Australia. The NSEE is a coordinated approach to accelerate 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 the 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 2011c).

The Energy Efficiency Opportunities (EEO) program is designed to address organisational barriers to efficient energy use by building the energy management capacity of companies. The program requires participant firms using more than 0.5 petajoules (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 Board encourage senior managers to carefully consider energy use in a strategic business context. More than 220 businesses are currently registered with the program, 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 2011d).

RENEWABLE ENERGY

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 programs 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 AUD3.2 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 either; implemented, amended or closed their feed-in tariff schemes. Several states governments have recently completed reviews or are in the process of reviewing, their jurisdictional feed-in tariff arrangements for small-scale renewable technologies.

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 RET (Renewable Energy Target), 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 Program
- AUD 1.5 billion Solar Flagships Program
- 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 programs 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
- encouraging 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 Program continues, managed by the Department of Resources Energy and Tourism. The Flagships program 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.

NOTABLE ENERGY DEVELOPMENTS

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_2-e (or 23%) in 2020.

CARBON PRICE

The carbon pricing mechanism establishes a fixed carbon price of AUD 23 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.

The proposed emissions trading scheme is a modified cap and trade scheme; it differs from the traditional 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.

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, covering fuel tax and synthetic greenhouse gases, apply an equivalent carbon price to some business transport emissions, to the non-transport use of transport fuels, and to synthetic greenhouse gases.

Together, these approaches cover all six greenhouse gases included under the Kyoto Protocol. This broad coverage ensures the economy as a whole will start moving towards a clean energy future, the cheapest ways of reducing pollution will be implemented, and the overall cost to the Australian economy will be lower (DCCEE 2011).

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, 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. The Clean Energy Finance Corporation'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.

The Treasury has responsibility for implementation of this program. The Chair is expected to be appointed later this year, and report to the Government in early 2012. The CEFC is expected to be implemented by 2014.

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 programs 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 Program
- Renewable Energy Demonstration Program
- ACRE Solar Projects
- Geothermal Drilling Program projects
- Australian Biofuels Research Institute (ABRI) initiatives
- Emerging Renewables Program
- Renewable Energy Venture Capital Fund
- Australian Solar Institute
- Low Emissions Technology Demonstration Fund (Solar)
- Second Generation Biofuels Research and Development Program
- 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 PROGRAM

This AUD 1.5 billion program, 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 400MW split across one photo voltaic (PV) project and one solar thermal project.

CLEAN TECHNOLOGY PROGRAM

The AUD 1.2 billion Clean Technology Program will provide support for manufacturers through three components: the Clean Technology Investment Program; the Clean Technology Food and Foundries Investment Program; and the Clean Technology Innovation Program. 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 PROGRAM

The AUD 1.7 billion Carbon Capture and Storage (CCS) Flagships Program 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_2 capture, transport and storage hub that has the potential to make significant CO_2 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_2 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_2 of tens of millions of tonnes.

Complementing this program 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 out to 2016–17.

DRAFT ENERGY WHITE PAPER

In December 2011, a draft Energy White Paper was released, seven years after the previous version. The paper takes into account the need to build a resilient policy framework for the future, taking into account the growing demand for energy, the international impact on energy resources and the development of Australia's critical energy resources (RET 2011).

The main objectives of the paper are to:

- strengthen the resilience of Australia's energy policy framework
- reinvigorate the energy market reform agenda
- develop Australia's critical energy resources, particularly Australia's gas resources
- accelerate clean energy outcomes.

NEW ENERGY PROJECTS

Australia's production and infrastructure capacity will be expanded in the future (ABARES 2011, BREE 2011), following the completion of investment decisions for the following projects:

- Xstrata Coal's Mangoola (Anvill Hill opencut) black coal project in New South Wales with a capital expenditure of USD 880 million.
- Yancoal Australia's Moolarben stage 1 black coal project in New South Wales. This project had a capital cost of AUD 405 million.
- BHP Billiton's Mount Arthur opencut (MAC20) black coal project in New South Wales with a capital expenditure of USD 260 million.
- The Halyard gas project in Western Australia. This is a joint project undertaken by Apache Energy and Santos and has a capital cost of USD 115 million.
- The Young–Wagga Wagga pipeline in New South Wales, developed by the Australian Pipeline Group.
- The Micro LNG plant in Tasmania, developed by BOC at a capital cost of AUD 150 million.
- The Kitan oil and natural gas project in Northern Territory. This is a joint project undertaken by Eni, Inpex and Talisman Energy, with a capital expenditure of AUD 600 million.
- The NWS CWLH oil and natural gas project in Western Australia. This is a joint project undertaken by Woodside Energy, BHP Billiton, BP, Chevron, Shell and Japan Australia LNG, with a capital expenditure of USD 1.47 billion.
- The Integrated Isaac Plains Project. This is a black coal mining project in Queensland undertaken by Aquila Resources and Vale, with a capital expenditure of AUD 86 million.
- The Honeymoon uranium project in South Australia. The project was developed by Uranium One and Mitsui at a capital cost of AUD 146 million,
- The Abbot Point Coal Terminal X50 expansion in Queensland, undertaken by North Queensland Bulk Ports, with a capital expenditure of AUD 818 million.

- The Abbot Point Coal Terminal yard refurbishment project in Queensland, undertaken by North Queensland Bulk Ports, with a capital expenditure of AUD 68 million.
- The Wollert to Euroa gas pipeline in Victoria, undertaken by the Australian Pipeline group.
- BG Group approved the development of its Queensland Curtis Island LNG facility in October 2010. Once completed in 2014, the facility will have an annual capacity of 8.5 million tonnes of LNG and will be the first facility in the world to use coal seam gas as a feedstock in the production of LNG.
- The Gladstone LNG development was approved in early 2011, with an estimated capital cost of US$16 billion. This project will also use coal seam gas as a feedstock for LNG production, and with an annual capacity of 7.8 million tonnes is scheduled to commence production in 2015.
- Woodside Energy has almost completed construction of the Pluto train 1 LNG project which is expected to have a final capital cost of just under $15 billion. The Pluto train 1 LNG project will have an annual capacity of 4.3 million tonnes of LNG, and is scheduled for completion in early 2012.

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

Australian Energy Regulator—www.aer.gov.au

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Bureau of Resources and Energy Economics—www.bree.gov.au

Commonwealth Law—www.comlaw.gov.au

BRUNEI DARUSSALAM

INTRODUCTION

Brunei Darussalam (the Abode of Peace) is located on the north-west coast of the island of Borneo. It covers a total land area of around 5765 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 Brunei Darussalam 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. Its capital Bandar Seri Begawan is located in the Brunei-Muara District. Brunei Darussalam is a small economy with a population of around 406 200 in 2009. It is characterized by a mixture of foreign and domestic entrepreneurship, government regulation, welfare measures, and village tradition.

In 2009, Brunei Darussalam's GDP was USD 15.68 billion (USD (2000) at PPP). GDP per capita was USD 39 239 (USD (2000) at PPP). Brunei Darussalam's economic activity has been dominated by oil and gas since they were first discovered in 1929. The oil and gas sector is the economy's main source of revenue and constitutes around 96% of Brunei Darussalam's export earnings and around 67% of its GDP. To further sustain and strengthen the oil and gas industry, the government of Brunei Darussalam is actively pursuing the development of new upstream and downstream activities.

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 (EEZ). In 2009, crude oil and condensate production averaged 174 thousand barrels per day (Mbbl/D), the majority of which was exported (91.2%). Gas production was around 34 million cubic metres a day, most of which was exported as liquefied natural gas (LNG) to the major markets of Japan and Korea.

Table 1 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (sq. km)	5 765	Oil (billion barrels)	1.1
Population (million)	0.406	Gas (trillion cubic metres)	0.4
GDP (USD (2000) billion at PPP)[b]	15.68	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	39 239		

a Proven reserves at the end of 2010, from BP (2011).

b EDMC (2011)

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply of Brunei Darussalam in 2009 was 2679 kilotonnes of oil equivalent (ktoe). Natural gas represented about 70% of the total primary energy supply and oil 30%. Oil and gas production was 19 905 ktoe in 2009, a decline of 5.2% from 2008. As a major oil and gas exporter, Brunei Darussalam exported 85.3% of its oil and gas production in 2009.

Brunei Darussalam's proven oil reserve in 2009 was 1.1 billion barrels, and its natural gas reserve was 0.4 trillion cubic metres (BP 2011). Oil production in the economy started in the onshore Seria field in 1929, the Champion field is its largest oil producer, and the South-West Ampa field is its largest gas field, supplying 75% of annual gas production. At current production

rates, the 2009 proven oil and gas reserves are expected to be depleted within 20 and 30 years, respectively. In this connection, the government is developing a plan to prolong the economic life of Brunei's eight-decade-old oil and gas industry, by developing upstream and downstream businesses and by improving energy supply and use.

The main export destinations of Brunei Darussalam's oil and condensate were the ASEAN countries, Australia, Korea, India, New Zealand, China and Japan. The average natural gas production for 2009 was about 34 million cubic metres per day of which the majority (81%) was exported as liquefied natural gas (LNG) to Japan (88%) and Korea (12%).

In 2009, the economy generated 3611 gigawatt-hours (GWh) of electricity, entirely from thermal sources. Almost all of the electricity generated was supplied by natural gas fuelled power plants.

Table 2 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	19 905	Industry sector	209	Total	3 611
Net imports and other	–16 995	Transport sector	352	Thermal	3 611
Total PES	2 679	Other sectors	393	Hydro	–
Coal	–	Total FEC	955	Nuclear	–
Oil	811	Coal	–	Geothermal	–
Gas	1 868	Oil	646	Others	
Others	–	Gas	30		
		Electricity and other	279		

Source: EDMC (2011).

FINAL ENERGY CONSUMPTION

Brunei Darussalam's total final energy consumption in 2009 reached 955 ktoe, a modest increase of 1.5% from its 2008 level. The combined energy consumption of the residential, commercial and non-energy sectors topped the economy's energy demand at 41.2%. The transport sector consumed 36.9% of the total energy used; the industry sector 21.9%. In terms of energy source, oil was the fuel most consumed accounting for 67.7% of final consumption, followed by electricity and other sources (29.2%) and gas (3.1%). Natural gas accounted for 99% of the fuel used to generate electricity; the other 1% was generated by diesel fuel.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Brunei Darussalam's energy policy is handled by the Energy Division of the Prime Minister's Office, which is headed by the Minister of Energy. The Energy Division is responsible for overseeing the policy on, the planning for and the regulating of the energy matters and issues affecting Brunei Darussalam. The Petroleum Unit, the oil and gas industry regulator, and the Department of Electrical Services, the state-owned electricity utility supplier, are also under the purview of the Minister of Energy.

Brunei Darussalam implements a five-year economic development plan known as the National Development Plan. Currently, the ninth National Development Plan (2007–12) is in force. Under the plan, energy policy is directed towards strengthening and expanding the oil and gas industry. In line with this plan, the economy has launched a long-term development plan, the Brunei Vision 2035. The vision states the economy's major goals for the next three decades are economic diversification and strengthening the oil and gas sector. The latter is to be achieved by

expanding the economy's oil and gas reserves through ongoing exploration, both in existing areas and in new deep-sea locations.

Brunei Darussalam's energy policy is centred on its oil and gas industry. In 1981, the Oil Conservation Policy was introduced when oil production peaked at 239 thousand barrels per day (Mbbl/D) in 1980. The policy aimed to prolong the life of the economy's oil reserves. As a result, oil production gradually declined to around 150 Mbbl/D in 1989. In November 1990, the government reviewed the policy and removed the production ceiling, resulting in the production of 219 Mbbl/D by 2006. In 2008, oil production averaged 174 Mbbl/D.

In 2000, the Brunei Natural Gas Policy (Production and Utilization) was introduced. The policy aimed to maintain gas production at 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 generation.

In January 2002, the Brunei National Petroleum Company Order set up the Brunei National Petroleum Company Sdn Bhd (PetroleumBRUNEI) to act as Brunei Darussalam's national oil company.

ENERGY SECURITY

As an active member of the Association of Southeast 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 programs and for more focus to be put on results or outcomes through regularly measuring the progress of programs and activities using the agreed KPIs and targets.

Cognizant of its role in the success of the Action Plan, Brunei Darussalam will 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 the 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.

It is hoped the economy's venture into renewable energy along with its work to upgrade and expand existing electricity-generating facilities will help to ensure 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 EEZ. 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 the next two decades, a further block of 10 000 square kilometres has been opened up for deepwater exploration in existing production fields. Onshore areas have also been recently 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 35 years has required the industry to move from primary recovery to secondary and 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 shot of a 3D seismic survey officially launched Brunei Darussalam's first large-scale onshore exploration project in 20 years. This was a milestone for the joint venture involving, PetroleumBRUNEI and the Block L consortium.

Brunei Darussalam also has an excellent long-term prospect for natural gas and LNG development. LNG will refurbish its existing capacity to extend its operating life for 20 years, or up to 2033. Besides exporting its natural gas, Brunei Darussalam would like to use it to develop domestic petrochemicals and energy-intensive industries.

ENERGY MARKETS

The energy market in Brunei Darussalam is regulated by the government. No dedicated energy regulator exists in the economy. Regulatory functions are fulfilled by the Department of Electrical Services, established in 1921. Its mission includes the management and development of the electricity sector. Energy prices are subsidised. However, 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. The government is also concerned about the increasing cost of maintaining fuel subsidies. In 2008, it began a Subsidy Awareness Campaign to expose the public to the scale of energy subsidies in the economy.

ELECTRICITY MARKET

Brunei Darussalam's electricity generation is almost entirely natural gas fired. The electricity system's three main grids are operated by two utilities, the Department of Electrical Services and the Berakas Power Company Private Limited (BPC). BPC supplies around 40% of the total power generated in Brunei Darussalam. The National Development Plan for 2007–12 proposes to interconnect the three power grids by 2012. In the long term, the economy also expects to harness the hydroelectric potential of the Temburong River. This project has a potential capacity of around 80 megawatts (MW) and could produce an estimated 300 GWh a year.

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 25% by 2030, with 2005 as the base year. This is in line with the goal set by the Asia–Pacific Economic Cooperation (APEC) leaders in the Sydney Declaration 2007. In this connection, the economy has developed the following energy efficiency and conservation strategies:

- Promote public awareness and encourage the adoption of energy efficient technologies and best practices.
- Establish and develop energy efficiency and conservation regulations and guidelines to encourage best practice.
- Improve energy efficiency in the supply, transportation and utilisation of energy.
- Develop energy efficiency labelling and standards to encourage the purchasing of energy efficient appliances.
- Strengthen collaborations with local and international institutions, to develop and enhance human capacity-building and to sustain energy efficiency efforts.

The economy is also enhancing its human capacity-building through seminar-workshops on energy management and energy audit, and through energy education in schools. The energy management and energy audit seminar-workshops are being conducted by local higher educational institutions and international partners to train property managers and officers from government agencies and the private sector. The Energy Management Guide and the Basic Energy Audit Guide are available to give practical help to those carrying out energy efficiency and conservation measures in the government and private sectors.

To build an energy efficiency and conservation culture at the grass-root level, the Ministry of Education and the Energy Division collaborated to introduce into the school curriculum 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, where school students are encouraged to act as energy ambassadors to promote energy efficiency and conservation measures in their schools and at home.

To further promote energy efficiency and conservation initiatives and measures economy-wide, the government has declared 24 May as Energy Day in Brunei Darussalam. National Energy Efficiency and Conservation Initiative Awards are given to recognize those who have achieved a 10% or more energy saving.

RENEWABLE ENERGY

Aware of the volatility and uncertainty oil and gas brings to its economy, Brunei Darussalam is working to harness its renewable energy potential. In July 2010, the economy commissioned a 1.2 (MW) solar power plant, the largest-scale photovoltaic installation project in the ASEAN region. The power plant will provide energy to 200 homes in Seria. It will also provide a saving of 340 kilolitres of crude oil and a reduction of about 940 tonnes of carbon dioxide emissions annually.

The economy's venture into renewable energy is expected to ensure its energy security outlook. Solar energy is by far the most promising among the known renewable energies, given the economy's exposure to equatorial sunshine. Hydropower and wind power have also been identified as potentially suitable renewable energy sources for power generation in Brunei Darussalam.

In 2010, the government, through the Centre for Strategic and Policy Studies, commissioned an international consultant to do a feasibility study to identify the potential of alternative energy sources in Brunei Darussalam. The project was due to be completed in 2011.

NUCLEAR

Brunei Darussalam does not have a nuclear energy industry.

CLIMATE CHANGE

Brunei Darussalam recognises the importance to its economic growth of energy security and environmental sustainability. Environmental policy directions are embedded in the 2035 long-term development plan. 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.

In 2007, Brunei Darussalam acceded to the United Nations Framework Convention on Climate Change and subsequently to its Kyoto Protocol in 2009. Brunei Darussalam also associated itself with the Copenhagen Accord in 2009.

Brunei Darussalam's major greenhouse gas emissions come from the oil and gas production industry, power generation and transportation. As part of the economy's environmental initiatives, actions have been taken by the major oil and gas producers to reduce greenhouse gas emissions through field rationalisation projects and improvements in operational efficiencies. Efforts are also focused on energy efficiency and conservation measures in power generation facilities. In 2008, a more efficient combined cycle 116 MW power plant was commissioned.

To identify more accurately the sources of greenhouse gas emissions from the different sectors in Brunei Darussalam, the government has commissioned a consultant to conduct a study. The project was due to be completed by the end of 2010.

NOTABLE ENERGY DEVELOPMENTS

ENERGY PROJECTS

The Brunei Darussalam Government seeks to maximise the economy's oil and gas resources potential, and to take advantage of its strategic location for trading. Plans are underway to develop export-oriented petroleum industries, including oil refining, petrochemicals, and associated downstream industries. A world-class industrial site, the Sungai Liang Industrial Site in the Belait District, will be the location for the development of petrochemical industries. The first petrochemical plant to be constructed at the site, a methanol production plant, was successfully commissioned with its first methanol product in April 2010. The methanol plant, owned by the Brunei Methanol Company, has an annual production of 850 000 tonnes. Methanol will initially be produced for export. Natural gas is the primary feedstock for the methanol plant.

The government wants experienced investors to set up an export-oriented oil refinery. The new refinery will be expected to also cater for the growing domestic requirements for petroleum products, as the economy's existing refinery is not able to meet the increasing demands. The Brunei Economic Development Board plans to base the refinery on the island of Pulau Muara Besar, in the Brunei-Muara District.

Brunei Darussalam is also developing a fully-fledged Brunei National Institute for Energy Research and Innovation. The research institute will focus on developing innovative solutions for using fossil fuels, for energy efficiency and conservation, and for energy renewables.

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USEFUL LINKS

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

Brunei LNG Sdn Bhd—www.blng.com.bn

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

Energy Division, Prime Minister's Office—www.energy.gov.bn

Petroleum Unit of the Prime Minister's Office—www.petroleum-unit.gov.bn

CANADA

INTRODUCTION

Canada occupies the northern part of North America and is second only to Russia in geographic size. The population of Canada is around 33.7 million, of which approximately 39% is concentrated in the province of Ontario (EDMC 2011; Statcan 2009). Canada is known for its wealth of energy and other natural resources. In 2009, its gross domestic product (GDP) amounted to roughly USD 1022 billion, a 2.5% decrease from 2008, and its per capita income was USD 30 264 (both in USD (2000) at PPP) (EDMC 2011). Canadians are big energy consumers, due to their high standard of living, the cold climate, the long distances between major cities, and the many energy-intensive and bulk-goods industries. Canada's final energy consumption per capita in 2009 was 5.8 tonnes of oil equivalent (EDMC 2011).

Canada is the world's fifth-largest energy producer (behind the United States, Russia, China and Saudi Arabia). It is a major energy exporter, being the most important source of United States' energy imports (US EIA 2009). Canada has abundant reserves of oil, natural gas, coal and uranium in its western provinces and huge hydropower resources in Quebec, British Columbia, Newfoundland, Ontario, and Manitoba. It also has significant offshore oil and gas deposits near Nova Scotia and Newfoundland. Installed electricity generation capacity was 133 gigawatts (GW) in 2010 (NEB 2011a). Energy production is important to the Canadian economy, accounting for approximately 7% of its GDP and for 363 000 jobs, representing 2% of the Canadian labour force in 2008 (NEB 2009a).

Table 3 Key data and economic profile, 2009

Key data		Energy reserves[b]	
Area (sq. km)[a]	9 984 670	Oil (billion barrels)	33.2
Population (million)	33.74	Gas (trillion cubic metres)	1.75
GDP (USD (2000) billion at PPP)	1 022	Coal (million tonnes)	6 578
GDP (USD (2000) per capita at PPP)	30 264	Oil sands (billion barrels)	143.3

a NRCan (2009a).

b BP (2010).

Source: EDMC (2011).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

In 2009, Canada's domestic energy production reached 390 million tonnes of oil equivalent (Mtoe). Oil and natural gas accounted for most of the supply, at 40% and 35% respectively. Canada's primary energy supply totalled 255 Mtoe in 2009. Oil (38%), gas (31%) and hydropower (12%) accounted for the greatest shares (EDMC 2011).

Canada's natural gas production has been in decline since 2006. Gross production in 2007 was 216 billion cubic metres (bcm); it fell to 209 bcm in 2008 (Statcan 2009). In 2009, indigenous gas production in Canada fell by around 7% (EDMC 2011). Drilling levels began to decline in mid-2006 as increasing capital and labour costs, and declining productivity in new gas wells, combined to reduce profitability. The decline in drilling grew steeper in the fourth quarter of 2008, as the recession took hold and the price of gas plummeted. Just over 10 000 gas wells were drilled in 2008, 17% less than in 2007 (NEB 2009a). This trend continued into 2009 as the economic slowdown took hold (NEB 2009a). The success in developing the United States' shale

gas resource has led producers to take an interest in shale gas plays in British Columbia. However, additional pipeline capacity is likely to be necessary to support growing production from this region.

Net natural gas exports fell in 2008, when the United States' demand for Canadian gas was both reduced by the onset of the recession and displaced by growing gas production in the United States (NEB 2008; NEB 2009a). The recession could also be attributed to the 50 per cent decline in the number of wells drilled in 2009 compared to 2008 (NEB 2011b). In 2009, net natural gas exports totalled approximately 79 Mtoe, a decrease from 85 Mtoe in 2008 (EDMC 2011). Canada's import capacity was expanded in 2009, with the opening of the economy's first liquefied natural gas (LNG) terminal in New Brunswick. The Canaport LNG import facility has a maximum send-out capacity of 1.2 billion cubic feet per day (Canaport LNG 2009).

In 2009, crude oil production decreased to 98 Mtoe from 102 Mtoe in 2008 (EDMC 2011). With the economic down-turn at the end of 2008 and into 2009, many projects to expand production from oil sands were slowed down or postponed. Production is expected to rise with an economic recovery.

Table 4 Energy supply and consumption, 2009

Primary energy supply (ktoe)[a]		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	390 442	Industry sector	51 922	Total	603 597
Net imports and other	–141 487	Transport sector	55 749	Thermal	124 615
Total PES	254 730	Other sectors	86 662	Hydro	364 030
Coal	23 824	Total FEC	194 334	Nuclear	91 342
Oil	97 772	Coal	2 292	Other	23 365
Gas	78 683	Oil	86 630		
Other	54 451	Gas	54 711		
		Electricity and other	50 701		

a Excludes stock changes and international marine bunkers.

Source: EDMC (2011).

In 2009, 97.8 Mtoe of crude oil was exported, total crude oil exports in 2009 consisted of 32% light crude oil (including synthetic crude) and 68% heavy crude oil (EDMC 2011; NEB 2009b). Canada is also a net exporter of petroleum products, mainly to the United States. The construction of two export pipelines began in 2008 to allow for further oil sands production to meet the continuing demand in the United States (NEB 2009a).

Canada generated about 603 terawatt-hours (TWh) of electricity in 2009, 5.9% less than in 2008. The decrease can be explained by the economic down-turn experienced globally and in North America during 2009. Canada is the world's second-largest producer of hydro-electricity, and hydropower dominates the generation mix with a 60% share. Thermal plants contribute 21% to the generation mix and nuclear energy contributes 15%. Canada and the United States have an active electricity trade, and the electricity networks of the two economies are heavily integrated. In 2009, Canada exported 51.7 TWh of electricity and imported 18.2 TWh (EDMC 2011).

Canada's coal production in 2009 was 31.5 Mtoe, an 8.5% decrease from 2008 (EDMC 2011). The global economic crisis affected Canada's coal production and exports, with exports declining by around 15%, in 2009. In the second half of 2009, the global demand for coking coal began to recover, boosting the confidence of coking coal consumers and suppliers. Canada's coal industry has made significant improvements in reducing greenhouse gas emissions and Canada has become the world's leading expert on carbon capture and storage (CCS). Three large-scale CCS demonstration projects, funded by both the private and public sectors, are currently under way in Canada (NRCan 2009b).

In 2009, Canada was the world's second-largest producer of uranium behind Kazkhstan. The economy's output totalled 10 274 tonnes of uranium metal (tU), and accounted for 20.1% of global production. All Canada's production was from three production centres in northern Saskatchewan operated by two of the world's largest uranium-producing companies (NRCan 2009b). Canada's one commercial uranium refinery is the world's largest, with a capacity of 18 000 tonnes per year (NRCan 2009b; Cameco Corp. 2010).

In 2009, renewable energy production decreased by 3% compared to that in 2008 and accounted for 15% of Canada's primary energy supply (EDMC 2011). However the wind industry has grown rapidly in recent years. The contribution of wind energy to electricity generation is expected to grow steadily, as at the end of 2011 Canada ranks sixth globally in terms of new installed wind energy capacity. The Canadian wind industry installed a record level of just over 41,000 MW of new clean, reliable wind power in 2011, bringing the total installed capacity globally to more than 238,000 MW at the end of last year (CanWEA 2011).

FINAL ENERGY CONSUMPTION

In 2009, total end-use energy consumption in Canada reached approximately 194 Mtoe, down 3% compared to 2008. Industry accounted for 27% of energy use, transport for 29%, and other sectors for 44%. By energy source, petroleum products accounted for 45% of final energy consumption, natural gas 28%, electricity 21%, and coal 9% (EDMC 2011).

Final energy consumption within each sector decreased in 2009 compared to that in 2008, reflecting the economic slowdown that started at the end of 2008. Energy consumption in the industry sector decreased by 2.1%, and energy consumption in the transport sector decreased by 2.6% (EDMC 2011).

In 2009, final energy consumption in the residential and commercial sector decreased by 2% compared to that in 2008 (EDMC 2011). Of the total residential and commercial energy consumption, the largest end uses were for space and water heating, residential appliances, and commercial lighting (NRCan 2009c).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In Canada, jurisdiction over energy matters is shared between the provincial and federal governments. Under the Canadian Constitution, the provinces are the owners and managers of energy resources (except for uranium); the federal government is responsible for the control of international and interprovincial trade. Through Natural Resources Canada (NRCan), the National Energy Board (NEB), and other government departments—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 strategies and to honour international agreements.

Energy policy in Canada is primarily market-based. Physical energy security in Canada is not an issue due to its abundant and diverse resource base. However, the sustainable development of existing resources to ensure adequate supplies for the future is a key priority. Policies are aimed at promoting economic growth while encouraging the sustainable development of resources and limiting environmental impacts. NRCan intervenes in areas where the market does not adequately support these policy objectives: regulation to protect the public interest and promote health and safety; and policies and programs to encourage scientific and technological research, promote energy efficiency, and help 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 2009d; NEB 1996).

The NEB, a federal regulatory body reporting to Parliament through the Minister of Natural Resources, has the main 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

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. Although some of these utilities are privately owned, many are Crown corporations owned by the provincial governments. Independent power producers also exist, but 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 level and the mechanism by which they are set. In 2007, residential prices per kilowatt-hour ranged from USD 0.06 to USD 0.14. Provinces with an abundant supply of hydro-electricity have the lowest prices. In most provinces, prices are set by the regulator according to a cost of generation plus reasonable rate of return formula. 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 2009a).

Institutional arrangements have been made to improve the reliability of the electricity power system. The Untied 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 (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 (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. In 2009, Canada's nuclear plants generated 15% of Canada's electricity (EDMC 2011). 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 2009e).

Atomic Energy of Canada Limited (AECL), which is wholly owned by the Canadian Government, is the designer and builder of the CANDU (Canada Deuterium Uranium) power reactors. AECL also delivers research and development support and services, such as consulting and maintenance, to nuclear utilities. 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 2009, the Canadian Government provided CAD 733 million (for 2009–10) to AECL for its operations, including the development of the Advanced CANDU Reactor, the completion of CANDU reactor refurbishment projects, the repair and return to service of the National Research Universal (NRU) reactor, and the maintenance of safe and reliable operations at the Chalk River Laboratories. In December 2009, the federal government issued an invitation to potential investors to make proposals that would allow the CANDU reactor business to take advantage of commercial opportunities in Canada and in other economies, while reducing the risks carried by taxpayers. The federal government will assess how well the proposals received meet its aims of preserving Canada's nuclear industry and the employment it provides, and of controlling costs and achieving maximum value for taxpayers (NRCan 2010).

ENERGY EFFICIENCY

Energy Efficiency Act

The Energy Efficiency Act of 1992 provides for the making and enforcement of regulations on performance and labelling requirements for energy-using products such as dishwashers, water heaters, refrigerators, space heating and cooling equipment, and industrial motors (Minister of Justice 2009c). The goal of the Act is to transform the market by eliminating the least efficient products and by promoting the development and deployment of new, high-efficiency products.

To increase its scope and effectiveness, the Energy Efficiency Act was amended in 2009. One of the important provisions was to provide the authority to regulate standby power consumption in an effective manner. Standby power consumption is estimated to account for as much as 10% of household electricity use in Canada. By implementing the amendments, Canada became one of the first economies in the world to be able to introduce comprehensive standards to regulate the amount of standby power consumed by many products—such as computers, battery chargers, CD players and televisions—when they are not in use. The amendments will also make it possible to prescribe standards not only for products that use energy but also for products, such as thermostats, that affect energy use. Other provisions will ensure a level playing field for dealers of affected products and will improve the well-known EnerGuide label to make it easier for Canadians to make informed choices when shopping for energy-using products (NRCan 2009f).

The Tenth Amendment to the Energy Efficiency Regulations includes minimum energy performance standards for many appliances, including general service lighting and furnace standards, that are among the most stringent in the world. The lighting requirements will come into effect throughout 2012 and will eliminate trade in the standard incandescent light bulbs that are in common use (Gazette 2009a).

End-use efficiency

To promote energy efficiency and conservation in end-use markets, the federal government relies on a variety of policy instruments. These include voluntary measures, equipment and product energy efficiency standards and labelling, financial incentives for certain types of investments, research and development, and education programs. The federal, provincial and territorial governments, municipalities, utilities and some non-governmental organisations sponsor and collaborate on programs aimed at improving energy efficiency.

For the transport sector, the government provides consumers with information about the fuel efficiency of light-duty vehicles, and encourages manufacturers and importers to meet voluntary company average fuel consumption goals. Under the Motor Vehicle Fuel Consumption Standards Act of 1985, the federal government is authorised to set fuel consumption standards, require the testing and labelling of vehicle fuel economy, and impose fines for noncompliance (Minister of Justice 2009d). In 2009, the government proposed to introduce mandatory vehicle greenhouse gas emission standards under the Canadian Environmental Protection Act, effectively

controlling fuel economy. These standards, which will begin in model year 2011, will be equivalent to those announced by the United States in 2009 (Gazette 2009b).

CLIMATE CHANGE

Energy production and use is responsible for the majority of Canada's greenhouse gas and air pollutant emissions. In early 2010, Canada announced the submission of its 2020 emissions reduction target under the Copenhagen Accord. Canada's 2020 target, an economy-wide 17% emissions reduction below 2005 levels, is aligned with the United States' target, and will be subject to adjustment to remain consistent with the United States' target (Government of Canada 2010). Canada will continue to support the G8 partners' goal of reducing global emissions by at least 50% by 2050, as well as the goal of developed economies reducing emissions of greenhouse gases in aggregate by 80% or more by 2050 (NRCan 2010).

The federal government is pursuing a number of actions to reduce emissions including funding programs to help Canadians use energy more efficiently, to boost renewable energy supplies, and to develop cleaner technologies (Treasury Board 2008):

- *Energy efficiency*. The government is delivering a series of ecoENERGY Efficiency Initiative measures, with up to CAD 675 million in funding, to promote smarter energy use and to provide financial incentives in support of energy-efficiency improvements in homes, small buildings, industry and transportation (Environment Canada 2007; Department of Finance 2009).
- *Renewable energy*. Through ecoENERGY for Renewable Power, the government is investing close to CAD 1.5 billion to boost Canada's renewable energy supplies and to create up to 14.3 terawatt-hours of additional renewable electricity generation (Environment Canada 2007).
- *Science and technology*. The government is investing CAD 230 million through the ecoENERGY Technology Initiative to fund research and development on eight technology priorities relating to clean energy supply, reducing energy waste, and reducing pollution from energy use (Environment Canada 2007; NRCan 2009g).
- *Transportation*. A series of ecoTRANSPORT initiatives (worth more than CAD 463 million) are being implemented to reduce the environmental impacts of transportation and to secure Canada's future prosperity and competitiveness by making the transportation system more economically and environmentally sustainable. One example of this is the ecoENERGY for Personal Vehicles Program (CAD 21 million over four years) which provides help with buying, driving and maintaining cars to reduce fuel consumption and greenhouse gas emissions (Environment Canada 2007).
- *Biofuels*. The government is also supporting the expansion of the Canadian production of renewable fuels through the provision of up to CAD 1.5 billion in operating incentives to producers of renewable alternatives to gasoline and diesel (Environment Canada 2007). This complements a regulatory requirement to include 5% of renewable fuel in gasoline by 2010 and 2% of renewable fuel in diesel and heating oil by 2011. Further, in 2007, the government committed itself to accelerating the commercialisation of next-generation biofuel technologies by providing CAD 500 million over eight years to Sustainable Development Technology Canada (SDTC). SDTC will invest with private sector partners to establish large-scale demonstration facilities for the production of next-generation renewable fuels (NRCan 2009h). The federal government has also announced funding of CAD 345 million to bolster the development of biofuels and other bio-products (NRCan 2010).

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

Canada introduced a new amendment to its Energy Efficiency Act during 2009. Details of the amendment are in the 'Energy efficiency' section.

NEW CLEAN ENERGY TECHNOLOGY INVESTMENT

The federal government is providing direct support for the research, development, demonstration and adoption of new technologies through a number of mechanisms, including:

- *Green Infrastructure Fund*. The 2009 Budget provided CAD 1 billion over five years for a fund to improve the quality of the environment. This will include funds for sustainable energy generation and transmission that will contribute to improved air quality and will reduce carbon emissions (APEC EWG 2009).
- *Clean Energy Fund*. In the 2009 Budget, the government provided nearly CAD 1 billion for a Clean Energy Fund to support the research, development and demonstration of clean energy technologies. Over five years, this funding will be available for the demonstration of technologies, including large-scale carbon capture and storage (CCS) projects (APEC EWG 2009).
- *Carbon capture and storage*. In 2009, the federal government and the Alberta Government allocated almost CAD 2.5 billion towards large-scale CCS demonstration projects. These investments include the following projects that are being co-funded by the two governments: CAD 865 million for Shell's Quest CCS Project, which will integrate CCS technology at Shell's Scotford oil sands upgrader; CAD 778.8 million for TransAlta's Project Pioneer for the construction of a new coal-fired power plant equipped with post-combustion capture technology; and CAD 558.3 million for Enhance Energy's Carbon Trunk Line Project to build a CO_2 pipeline in Alberta and capture CO_2 from an existing fertiliser plant and later, an upgrader. The Alberta Government will invest CAD 285 million in a fourth large-scale CCS project in Alberta, the Swan Hills Synfuels Plant, which will capture CO_2 from an in-situ coal gasification project. The federal contribution to these CCS projects is sourced from the ecoENERGY Technology Initiative and the Clean Energy Fund (NRCan 2010).
- *Sustainable Communities*. The EQuilibrium™ Communities Initiative will seek to improve community planning and to develop healthy sustainable communities that are energy-efficient and economically viable. It will do this by providing financial, technical and promotional help to community projects chosen through a national competition (NRCan 2010).

ECOENERGY RETROFIT INCENTIVE

The ecoENERGY Retrofit Incentive program was expanded to include businesses and public institutions that own, manage or lease buildings with up to 20 000 square metres of floor space, as opposed to the original 10 000 square metres. These groups can now join homeowners and industry in applying for federal funding to invest in energy-saving upgrades, such as installing efficient lighting, building automation control systems or upgrading heating, ventilation and cooling systems. The increase in floor area eligibility opens the program to many additional building types, including hotels, motels, churches, hospitals, recreational complexes and schools. Multiple buildings, such as those on a university campus, can be included in a single project (NRCan 2008).

In the 2009 Budget, the government provided an additional CAD 300 million over two years to the ecoENERGY Retrofit Incentive program (bringing the total to CAD 675 million) to fund an estimated 200 000 additional home retrofits. The program has proved successful in achieving

energy savings and the ecoENERGY Retrofit—Homes program has been extended to March 2012 (Department of Finance 2009; NRCan 2009g; NRCan 2011).

OIL SANDS

Canada is endowed with large oil sands reserves. As of 2011, the remaining ultimate potential of oil was 343 billion barrels; oil sands bitumen accounts for 90% of this. There is much potential to add to Canada's oil reserves. Alberta has all the proven oil sands resources; assessments are still underway for oil sands bitumen resources in Saskatchewan. The Grosmont carbonate formation is estimated to account for 21% of oil sands reserves in Alberta but has thus far not been assigned any reserves. After Saudi Arabia and Venezuela, Canada has the world's third-largest proven oil reserves. Seventy two per cent of Canada's conventional crude oil can be found in the East coast offshore, northern Canada and other frontier basins that are relatively unexplored. More developed conventional light and conventional heavy oil deposits in the Western Canada Sedimentary Basin (WCSB), account for the remaining 28%.

In recent years, the run up on oil prices and technological improvements had 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 of several oil sands projects, the NEB forecasts oil sands crude production will rise to 2.8 million barrels per day by 2020. This production would contribute to Canada's overall crude oil production, which is forecast to rise to 3.8 million barrels per day by 2020, despite declining production from other sources (NEB 2009c).

Depending on the geology, generally two different production methods are used. For oil sands near the surface, the extraction of bitumen from the sand, clays and water that make up the oil sands involves surface mining operations. However, most oil sands resources must be recovered in situ or in place by drilling into the oil sands, and heating the bitumen to allow it to flow. The application of horizontal drilling and multi stage hydraulic fracturing has developed a potential for previously low-producing or unproductive oil reservoirs in the WCSB. This technology has the potential to be applied to many regions of Canada, thus increasing the overall potential of resources and production. As the technology is still in its early development stages, its ultimate impact is unclear (ERCB 2008; ERCB 2009; NEB 2011a).

While there are new technologies and extraction methods being developed to improve recovery and to reduce costs, including vapour recovery extraction, toe-to-heel air injection, and froth treatment, there are a number of environmental impacts associated with oil sands development (Government of Alberta 2009). Heavier forms of crude oil, such as the oil sands, require more energy and resources to produce and refine compared to lighter crude oil, resulting in higher air pollutant and greenhouse gas emissions. In addition, the unique nature of oil sands extraction technologies has other environmental challenges associated with production, such as water and land use. The federal and provincial governments are making investments (e.g. in CCS technology) to bring on this strategic resource in an environmentally responsible way. Prospects for enhanced oil recovery by means of carbon dioxide flooding have increased through the federal and provincial governments' financial support of several projects in Western Canada designed to capture carbon dioxide from large emitters and to distribute it to candidate oil pools. Since this initiative is quite new, its full impact is unknown (NEB 2011a).

LNG TERMINAL PROJECTS

The Canaport LNG terminal in Saint John, New Brunswick, began operating in June 2009 and is currently Canada's only operating LNG import facility (Canaport LNG 2009). Several other LNG import and export proposals are under consideration (NRCan 2009i). However, most of the import proposals are on hold due to: difficulties in securing a long-term supply; concerns over existing excess regassification capacity in North America; and the prospects for domestic shale gas as a new long-term source of natural gas (NRCan 2010).

One of the proposed LNG terminals gaining traction in Canada is Kitimat LNG Inc.'s proposed export terminal near the Port of Kitimat, British Columbia. Originally slotted to be an

LNG import facility, in 2008 Kitimat reversed its proposal to become an LNG export facility. This move reflected an increased optimism over new shale gas developments in North Eastern British Columbia, and North America broadly; and the expectation natural gas prices in Asia would continue to exceed those in British Columbia. If realised, the project could further connect the North American gas market with the Asia–Pacific market (NRCan 2010).

OTHER PROJECTS

In December 2011, the NEB approved the Bakken Pipeline project. The pipeline will connect to the Enbridge Pipelines Inc. Mainline and will serve as a continuous, long-term source of oil supply to the Eastern Canadian and United States Midwest markets. This will maintain the long-term competitiveness of refineries in those regions (NEB 2011c).

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CHILE

INTRODUCTION

Chile is one of three APEC economies in Latin America. Chile became an APEC member in November 1994. It borders Peru to the north, Bolivia to the north-east and Argentina to the east, and has a coastline of 6435 kilometres along the Pacific Ocean to the west. With a land area of nearly 756 102 square kilometres, the economy is 4300 kilometres long and averages 175 kilometres wide. Administratively, Chile is divided into 15 regions, which are subdivided into 53 provinces and 346 communes. The economy's own statistics show the population was 16.9 million in 2009, about 86.8% of whom live in urban areas (INE 2010a). The three largest urban regions are the Santiago metropolitan region (44.8% of the total population), the Bío Bío region with 11.5%, and the Valparaíso region with 10.8%. From 1980 to 2009, Chile's population increased at an average annual rate of 1.5%, and it is expected to reach 20.2 million by 2050 (INE 2010b). The population density is 22 people per square kilometre, but is much higher in metropolitan areas (around 433 people per square kilometre).

Chile's economic growth has been impressive. Since 1990, the Chilean economy has almost doubled its per capita income and it has been one of the fastest growing economies in Latin America. In 2009, Chile's gross domestic product (GDP) reached USD 195.56 billion and its GDP per capita was USD 11 523 (USD (2000) at PPP). In 2009, major contributions to GDP came from financial services (17.3%) and the manufacturing industry (16.0%). Other economic sectors that made important contributions to GDP included personal services (12.1%), construction (7.6%), transport (7.6%), and mining (7.1%) (INE 2011). Chile's economy is dependent on commodity prices, particularly copper prices. Chile continues to attract foreign direct investment, mostly focused on developing gas resources, water, electricity and mining.

The Chilean Government has focused on increasing the openness of its economy through trade liberalisation and the pursuit of bilateral free trade agreements. Chile claims to have more bilateral or regional trade agreements than any other economy. By 2008, it had signed trade agreements (not all of them full free trade agreements) with 58 partners, 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 (IEA 2009).

Table 5 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	756 102	Oil (million barrels)[a]	150
Population (million)	16.97	Gas (trillion cubic metres)	0.097
GDP (USD (2000) billion at PPP)	195.56	Coal (million tonnes)	700
GDP (USD (2000) per capita at PPP)	11 523		

a Proven reserves at the end of 2009 (O&GJ 2009).

Source: EDMC (2011).

Chile's energy security is challenged by its limited energy resources, in particular its oil and natural gas resources. The government has introduced new policy in this area, following the reduction in the natural gas supply from Argentina in 2004. Chile is a net energy importer and the economy is dependent on crude oil imports. In 2009, energy imports met 59.3% of Chile's internal energy demand, and crude oil made up 69.1% of its energy imports.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Chile's total primary energy supply (total PES) decreased by 6.44% between 2008 and 2009. In 2009, total PES reached 29 178 kilotonnes of oil equivalent (ktoe), of which 54.7% came from crude oil and oil products, 7.7% from natural gas, 12.5% from coal and 25.2% from other sources, mainly biomass and hydropower. Chile is a net importer of primary energy. In 2009, it imported around 71.8% of its total PES, an increase of 0.63% compared with 2008. Most primary energy imports are of crude oil. Domestic energy production is limited, although there was a slight growth in production of 2.55% between 2008 (9011 ktoe) and 2009 (9241 ktoe). Chile's domestic energy production is mainly from renewable sources, which account for 75%; the remainder comes from hydrocarbons (crude oil, natural gas and coal). Among the renewable sources, biomass (principally wood) is the largest contributor, with a share of 53% of total domestic production (EDMC 2011).

Chile has limited crude oil reserves of around 150 million barrels (about 20.7 million tonnes of oil equivalent) (O&GJ 2009). All of Chile's crude oil reserves are in the southern Magallanes region in onshore and offshore fields. To meet its crude oil demand in 2009, 98.1% of the economy's total crude oil supply was imported (of the total crude oil supply of 10 648 ktoe). In the case of petroleum products, Chile's indigenous production in 2009 totalled 10 549 ktoe, made up mainly of diesel (35%) and gasoline (26%). That was supplemented by 6862 ktoe of imports, which accounted for 39% of the total 2009 petroleum products supply. In the case of natural gas, Chile produced 2523 million cubic metres (mcm) and imported 885 mcm in 2009 (MINERGIA 2010a).

There are three important coal production regions in Chile: the Bío Bío region, the La Araucanía region, and the Magallanes y Antártica region. Coal reserves (proven and probable) are estimated at around 700 million tonnes (CNE 2008). In 2009, domestic coal production increased by around 33.8%, reaching 352 ktoe and accounting for around 3.8% of total domestic primary energy supply.

In 2009, Chile's installed electricity capacity was 16 153 MW, including public service suppliers (92.1%) and self-suppliers (7.9%). Thermal power plants have traditionally accounted for the bulk of installed electricity capacity. At the end of 2009, thermal power represented 66% of the total capacity (self-suppliers included). The share of hydropower declined from 47.7% in 1998 to 33.5% in 2009, with a total installed capacity of 5406 MW at the end of 2009. Chile's electricity generation in 2009 rose 2.7% from 2008, to a total of 61 328 gigawatt-hours (GWh); 58.6% came from thermal power generation and 41.4% from hydropower (EDMC 2011).

Renewable energy (hydro, wind, biomass and biogas) contributed 79.4% of Chile's domestic energy production in 2009 (7339 ktoe). Chile is dependent on wood for domestic energy production (49.8% of total indigenous production and 69.6% of energy from renewable sources). The production of wood in 2009 totalled 14.65 million tonnes (5128 ktoe). Around 88.5% (12.97 million tonnes) of the total wood supply was for final consumption. The second largest renewable energy contributor is hydro. In 2009 Chile produced 2228 ktoe (25 990 GWh) of hydropower, which was 21.6% of total indigenous energy production. A small volume of electricity was generated from wind power in 2009 (79 GWh). Chile began some production of biogas in 2009, producing a total of 6.9 ktoe (12 million cubic metres) (MINERGIA 2010a).

Table 6 Energy supply & consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	9 241	Industry sector	8 356	Total	61 328
Net imports and other	–20 947	Transport sector	6 834	Thermal	31 704
Total PES	29 178	Other sectors	6 745	Hydro	25 174
Coal	3 639	Total FEC	21 935	Nuclear	–
Oil	15 964	Coal	230	Geothermal	–
Gas	2 236	Oil	12 080	Others	4 450
Others	7 339	Gas	679 784		
		Electricity and other	8 945		

Source: EDMC (2011).

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

FINAL ENERGY CONSUMPTION

Chile's total final energy consumption decreased by 8.53% from 2008 levels, reaching 21 935 ktoe in 2009. The two main energy consuming sectors were industry (38.1%) and transport (31.2%). Petroleum products made up 55.1% of final consumption, electricity 40.8%, natural gas 3.1% and coal 1.0%. Oil consumption grew consistently from 2000 to 2008, with an average annual growth rate of 4.1%. Between 2008 and 2009, however, oil consumption sharply decreased by 8.07% (EDMC 2011).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Chile's energy policy is oriented towards reducing the economy's vulnerability to supply shocks and its dependence on energy imports, which have grown on the back of increased energy consumption. Especially, the government developed a new long-term energy policy after the 2004 Argentine gas crisis and the 2007–08 electricity shortage. More recently, in early 2012, the Chilean government through its Ministry of Energy issued the National Energy Strategy 2012-2030 (ENE in Spanish) to guide the energy sector and set its policy and objectives in the long term. The document, focused on electricity issues and looks to supply clean, competitively-priced and reliable energy to Chile in the following decades in order to support its development and sustain economic growth. To accomplish this goal, ENE established 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 on electricity transmission
- Modifications to the electricity market to make it more competitive.
- Development of electricity interconnections 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.

All energy sector public services are now overseen by the Ministry of Energy. These include the National Energy Commission (CNE), the Superintendence of Electricity and Fuel (SEC), and the Chilean Commission on Nuclear Energy (CCHEN). 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 Ministry has created two important institutions: the Renewable Energy Centre (CER) and the Chilean Energy Efficiency Agency (AChEE). The activities of these agencies are integrated with other government agencies, and involve public and private sector cooperation.

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. According to some of the most recent rankings, Chile is first among Latin American economies in terms of business and private investment attractiveness, market access, and transportation and communication infrastructure. For example, Chile ranked 15th among the most attractive economies to do business and invest in over the next five years, according to the Best Place to do Business 2009–2013 index published by The Economist Intelligence Unit (CORFO 2009).

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 economy's government's role is restricted to being a regulator policy maker and technical consultant. —such 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 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 the entry conditions for non-conventional renewable energy (NCRE) into the electricity system.

From ENE's goals issued in 2012, the electricity market in Chile will experience some changes in the near future to improve competition and transmission infrastructure and foster interconnection with its neighbouring economies, especially with Argentina, To succeed in its goals, ENE defined several strategies that include the creation of autonomous electricity dispatch centres, improvement in the supply and transmission bidding schemes, regulatory modifications in the transmission and subtransmission issues, introduction of smart grid technologies and inclusion of net metering into the residential sector's electricity fares (MINERGIA 2012).

In the oil and gas sector, even though most of Chile's energy sector has been liberalised and is privately owned; Empresa Nacional del Petroleo (ENAP), is a government-owned hydrocarbon company which controls the bulk of oil production and oil refining in the economy. Despite its limited hydrocarbon resources, as ENAP carries out its exploration and production activities overseas, in places such as Ecuador, Argentina and Egypt, Chile hopes to develop its oil industry to a level that will enable it to become self-sufficient and, eventually, an oil exporter.

ENAP began implementing a new Oil Market Policy in December 2009. This policy has two fundamental objectives: to ensure a highly efficient and competitive market for the distribution of petroleum products; and to ensure supply for the whole economy. The new policy sets the basis for parity pricing of petroleum product imports, and sets up incentives for distribution

companies. 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).

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, and municipalities (IMF 2009).

There are three kinds of fuel tax in Chile: an import tax paid on imported fuel products; specific taxes for fuels used in transport vehicles; and a value-added tax paid on all fuels. In 2010, the import tax rate was around 6%, depending on the country of origin. Specific taxes for transportation fuels are applied to gasoline, diesel oil, LPG and CNG. The value-added tax is a direct tax on consumption and the 2010 rate was 19% (IEA 2009).

In general, prices for oil-based fuels are set by market conditions by the refiner and throughout the distribution chain, including retail sales at service stations. However, specific excise tax (IEC) are charged on transport fuels (i.e. gasoline, diesel, LPG and CNG). Gasoline is taxed at a fixed rate. Nonetheless, the government set a policy to reduce price volatility for those final consumers subject to the IEC. The Consumers' Protection System for IEC taxpayers (SIPCO) was established in February 2011 to cover the prices for the fuels mentioned above only in the transport sector. Within SIPCO, a price band is established around each one of those fuels past and future prices average over a five-month window and every week, CNE estimates an import parity price based on prices in the two previous weeks. If this estimated price exceeds the price-band ceiling, a reduction in the rate of IEC tax is applied to benefit final fuel consumers. Conversely, if the import parity price of the week is below the price-band floor, an increase in the rate of IEC tax is applied to make up the difference, paid for by final consumers. SIPCO thus aims to be revenue-neutral in the medium-term.

Before SIPCO was implemented, two other price-stabilisation mechanisms existed which had similar objectives but were designed differently. The Petroleum Price Stabilisation Fund (FEPP) was the first of these mechanisms. It was established in 1991 and initially covered a wide range of petroleum products. Its scope is now restricted to domestic kerosene. The second of these mechanisms was the Fuel Price Stabilisation Fund (FEPC), which was run from 2005 to 2010. Both FEPP and FEPC shared SIPCO's objective, which is to mitigate price volatility to the consumers (OECD 2011).

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 (IEA 2009).

Chile's natural resources offer opportunities for investors in non-conventional renewable energy (NCRE). There is a growing demand for energy from this sector and the economy offers competitive prices that generate opportunities. InvestChile, through its cross-sector investment program in NCRE, promotes and facilitates investment in the business niches that help strengthen the sector. It seeks to include new players, to promote technological upgrades, and to promote local capacities. InvestChile offers information services, support in different stages of a project, access to business networks and financing sources, and support selecting locations and searching for investment partners. InvestChile's portfolio contains 150 projects, totalling 2386 MW in production and about USD 4691 million in investment. Of these projects, 21 are operating with the total capacity of 162 MW (CORFO 2009).

ENERGY EFFICIENCY

One of Chile's most important initiatives in energy efficiency is the government's creation of the Ministry of Energy to centralize the functions of developing, proposing and evaluating public policies in this area. The new ministry includes the Chilean Energy Efficiency Agency (Agencia Chilena de Eficiencia Energética, or AChEE), a public–private organisation (a foundation) in charge of implementing energy efficiency programs according to the policies developed by the ministry.

AChEE's mission is to consolidate energy efficiency in a way that contributes to Chile's sustainable energy development. The strategic objectives of AChEE 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
- position and introduce energy efficiency in all levels of training, both formal and informal
- take advantage of international experiences and instruments to accelerate the development of energy efficiency and to measure the emissions reduction
- strengthen institutional management through quality control processes (ISO).

Chile has a comparative product-labelling program that breaks down all similar models of a product into one of seven efficiency categories: 'A' (most efficient) through to 'G' (least efficient). By the end of 2011, this labelling was currently applied to 12 product lines in Chile (incandescent and compact fluorescent light bulbs, refrigerators, and microwave ovens); and by December 2011 the television and decoders group was added. The products covered are mostly for residential applications. Future coverage is aimed at residential to small commercial applications. Chile is in the process of developing the law to allow the Ministry of Energy to establish mandatory 'minimum energy performance standards' (MEPS). The first MEPS under development are for light bulbs. Chile is also promoting energy efficiency programs for buildings: since 2009 the Chilean Government has published building energy efficiency guidelines as recommendations for new house designs and the thermal insulation of existing homes (MINVU 2009, 2010).

As part of its work to implement Chile's ENE, CNE is working on the National Action Plan on Energy Efficiency 2020 (known by its Spanish acronym, PAEE 2020), expected to be available during 2012. In addition to PAEE 2020, ENE's main goal of promoting energy efficiency in the economy, is supported by the following objectives stated on the document, that are to be developed (MINERGIA 2012):

- Develop energy efficiency marks, to recognize and award the energy-efficiency leading companies.
- Set minimum energy performance standards for energy equipment and appliances and strengthen the current labelling program.
- Develop efficient lightning programs in the residential and public sectors,
- Due to energy efficiency's cross-institutional nature, create a government commission integrated with public bodies and ministries, in order to develop energy efficiency policies, where reports are to be submitted directly to Chile's President.

RENEWABLE ENERGY

In 2006, the CNE, in conjunction with Congress, examined the law for renewable energy projects with the aim of removing all commercial barriers to development. This initiative was a priority in the government's energy policy as a complementary measure for addressing energy security. In April 2008, Law 20.257 (the Law of Non-Conventional Renewable Energy) was

enacted. It aims to provide an incentive for the inclusion of non-conventional renewable energy in the economy's electricity systems.

Law 20.257 took effect in 2010. It requires 5% of the total production in new energy contracts to come from non-conventional sources. The required level of non-conventional sources gradually rises to 10% of total energy production by 2024 (around 3410 MW). This provision is expected to result in nearly 1600 MW of additional power from NCRE sources by 2035. In addition to that, the Chilean Parliament is currently discussing an increase of NCRE participation in total energy production of between 15% and 20% by 2020. The only mechanism used to promote solar energy is the CORFO's financing of feasibility studies for NCRE projects—in most cases this amounts to 3% of the project's total cost. See the 'Fiscal regime and investment' section for more information on CORFO's NCRE program.

Due to ENE's goal of promoting non-conventional renewable energy (which includes all but large hydro), it is expected that in the near future this energy will increase its share in the Chilean electricity matrix. To achieve this goal, ENE has appliedseveral strategies, including improvement of 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 economical issues that each technology presents (MINERGIA 2012).

In addition to the above, ENE's goal of expanding hydropower generation to reduce dependence on energy imports will also contribute to the reduction of fossil fuels in Chilean power generation in favour of carbon-free, renewable technologies.

NUCLEAR

In 1964, Chile created the Chilean Commission of Nuclear Energy (CCHEN 2010). This agency is in charge of the operation and regulation of the economy's two nuclear reactors, which are located in the Santiago metropolitan region. CCHEN operates these reactors for research purposes only.

The President of the Republic created, in 2007, the Nucleo-electricity Working Group (or Zanelli Commission) to contribute to the analysis of the opportunities, advantages, challenges and risks of using nuclear energy. Nowadays, Chile is developing the technical capacity and legal framework required for it to make a decision on the use of nuclear energy in the future (MINERGIA 2010b). In early 2012, with the publication of ENE, Chile confirmed its decision of not developing any nuclear project in its long-term energy policy (MINERGIA 2012).

CLIMATE CHANGE

In 1995, Chile signed the United Nations Framework Convention on Climate Change. It also ratified the Kyoto Protocol in 2002. In 2006, the Chilean Government published a National Strategy on Climate Change to promote action plans in that area. In December 2008, to complement the strategy, Chile published the National Action Plan on Climate Change 2008–12. The action plan assigns institutional responsibilities for adapting to climate change, mitigating the effects of climate change, and strengthening Chile's capacities to address climate change (CONAMA 2008). 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 eventually establish 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 ENE publication in early 2012, the Chilean government stresses its commitment to the economy's sustainable development in the long-term by developing and using energy in a way that preserves the environment.

While Chile's contribution to global carbon emissions is low (0.2% at the worldwide level), the economy is highly vulnerable to 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.

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 was 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 is directly connected to the education of the population on environmental issues and climate change, and its plan incorporates a climate change educational campaign.

NOTABLE ENERGY DEVELOPMENTS

Some of the Chilean energy sector's most significant keystones by the end of 2010 and in 2011 (Cuenta Anual 2011) were:

- The creation of CADE (Electric Development Advisory Commission) comprising high governmental representatives.
- CADE submitted, to the government, its proposals on energy development; power generation, transmission and distribution; energy efficiency and new and conventional renewable energy (NCRE).
- An energy ration decree was issued to avoid, reduce and manage the economy's power generation shortfall.
- Communication and information protocols for energy supply emergencies were improved to better tackle such situations.
- Two technical mandatory compliance standards, for thermal power plants and for environmental quality specifications for breathable particles, were issued.
- A net metering Law is underway for its approval. This will allow small-sized power producers to input their power surpluses to the main power grid.
- In October 2010, in the Antofagasta region, a concession for the construction of the first wind farm in fiscal territories was awarded. Operations are expected to begin in 2013.
- There were bidding processes for 20 geothermal areas, and five new areas will be added by the first half of 2012.
- The National Energy Efficiency Plan is on its way to being issued. It will set the guidelines and actions to be taken for the next 10 years to promote energy efficiency in all the economy's productive sectors.
- About 1500 rural communities were provided with an electric power supply in 2011.

PETROLEUM SECTOR

In November 2010, the Latin America focused oil and gas company GeoPark (a company active in Chile) announced the successful drilling and testing of a new oil well. The well is on the Guanaco prospect on the company's wholly-owned Fell Block in Chile. The company reported that the Guanaco-3 production test represented the third successful well and the first exploration discovery drilled by GeoPark in 2010. Preliminary interpretations indicate the Guanaco structure is approximately 3.5 square kilometres in area (GeoPark 2010).

GeoPark supplies one-third of the hydrocarbons produced in Chile. It channels its oil output to ENAP and its natural gas production to Methanex, a major producer of methanol at Cabo Negro, near Punta Arenas. From there, the methanol is shipped to its markets in Asia, South and North America, Europe and South Africa.

RENEWABLE ENERGY

In September 2010, the government opened a tender process for 20 new geothermal concessions in Chile. Thirteen companies have made a bid for the concessions, including the Chilean unit of the Italian power utility Enel SpA, the power generator, Colbun, and the mining company, Minera Escondida. As of the end of February 2011 concessions have been awarded by the Ministry of Energy.

Chile's main areas of geothermal activity are in the Andes of the far north, and in south-central areas of the economy. A project located in the concession area called San Gregorio, which is being explored by Geoglobal Energy Chile, is close to becoming the first operational geothermal project in Chile (with a potential capacity of 75 MW) (Geoglobal 2010). In addition, USD 31 million was awarded to promote research on biofuels production; and, in the isolated Coquimbo area, 34 schools were given a power supply through photovoltaic solar panels (Cuenta Anual 2011).

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Nuclear Energy Chilean Commission (CCHEN)—www.cchen.cl
National Energy Commission (CNE)—www.cne.cl
National Energy Efficiency Program (PPEE)—www.ppee.cl
Ministry of Environment—www.mma.gob.cl
National Institute of Statistics (INE)—www.ine.cl
Superintendence of Electricity and Fuel (SEC)—www.sec.cl
Economic Load Dispatch Centre of (SIC)—www.cdec-sic.cl
Economic Load Dispatch Centre (SING)—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 in 1978, China entered a new period of high-speed economic 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 5878.3 billion, with the primary, secondary and tertiary industries accounting for 10.1%, 46.8% and 43.1%, respectively (NBS 2011).

Due to its huge population and booming economy, China plays an increasingly important role in the world's energy markets. Some statistics reported China was the world's largest energy consumer in 2010 (BP 2011). However, its per capita primary energy consumption, at 1.61 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 (NEA 2010).

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 14 784 million barrels and proven natural gas reserves of 2808 billion cubic metres (bcm) at the end of 2010. In addition, China is endowed with 400 gigawatts (GW) of 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 limitation of its energy reserves per capita forces 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 basically achieved its goal of a quadrupling of GDP supported by a doubling of energy consumption.

Table 7 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (sq. km)	9 600 000	Oil (million barrels)	14 784
Population (million)	1 331.46	Gas (billion cubic metres)	2 808
GDP (USD (2000) billion at PPP)	7 324.02	Coal (billion tonnes)	114.5
GDP (USD (2000) per capita at PPP)	5 501		

a Proven reserves at the end of 2010 (BP 2011).

Source: EDMC (2011).

Energy supply and demand

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001, driven mainly by rapid growth, especially in the energy consumption of heavy industry. In 2009, the total primary energy supply increased 8.5% compared with 2008, reaching 2118 million tonnes of oil equivalent (Mtoe)—including net imports and other. Of this, coal was the dominant source, accounting for 74.1%, followed by oil (18.7%), gas (3.9%) and other (3.3%) (EDMC 2011).

Table 8 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 897 388	Industry sector	841 452	Total	3 714 650
Net imports and other	220 456	Transport sector	149 602	Thermal	2 982 780
Total PES	2 117 844	Other sectors	288 580	Hydro	615 640
Coal	1 568 767	Total FEC	1 279 634	Nuclear	70 134
Oil	395 328	Coal	476 500	Other	46 096
Gas	83 505	Oil	350 417		
Other	70 243	Gas	136 593		
		Electricity and other	316 123		

Source: EDMC (2011).

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

China has provided a lot of 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 2969 million tonnes of coal equivalent (Mtce) (2078 Mtoe), of which coal accounted for 76.5%, followed by oil (9.8%), gas (4.3%) and other (9.4%) (NBS 2011). 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 the total domestic energy production is still at a comparatively high level. In 2010, coal production reached 3235 million tonnes (Mt), a historic high. China has been a net coal importer since 2008. The economy imported 164.78 million tonnes of coal in 2010, 31% higher than the previous year; it exported 19.03 million tonnes of coal, 15% lower than the previous year (NBS 2011).

In 2010, China's domestic crude oil output exceeded 200 Mt, rising 6.9% compared to 2009. At the same time, crude oil imports reached 239 Mt, a growth of 17.5 % (NEA 2011). Since 1993, China has been a net oil importer, and oil imports increased to 53.8% of oil supply in 2010.

China's proven gas reserves and gas production have expanded rapidly. Gas reserves have grown by an average of 144 bcm per year, from 1366.9 bcm in 2000 to 2807.7 bcm in 2010 (BP 2011). Since 2000, gas production in China has grown 13.4% a year, on average, to reach 94.8 bcm in 2010. The expansion of natural gas pipelines has also been rapid (NBS 2011). At the same time, China imported 9.34 Mt of LNG in 2010, up 75% compared to 2009, and imported 4.4 bcm of pipeline gas for the first time (NEA 2011).

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 reduced demand after the closure of inefficient state-owned industrial

units, which were major consumers of electricity. However, a shortage of electricity supply developed as a result of rapid economic expansion after 2001. Between 2001 and 2004, installed generation capacity increased steadily at an annual average rate of 10%; since 2004, installed generation capacity has increased by 100 GW a year. In 2010, installed generation capacity reached 966 GW, an increase of 10.56% compared with 2009 (CEC 2011).

The power structure is becoming more diversified with wind power and nuclear energy generation increasing rapidly. In 2010, total power generation in China was 4227.77 TWh. Thermal power accounted for 80.81% (3416.63 TWh) of total generation, hydropower 16.88% (686.74 TWh), nuclear energy 1.77% (74.74 TWh), wind power 1.17%(49.4 TWh) and other 0.01% (0.27 TWh) (CEC 2011).

FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1279.63 Mtoe in 2009, 5.0% higher than in the previous year. The industry sector was the largest consumer, accounting for 65.8% of total final energy consumption, followed by the transport sector (11.7%) and other sectors, including residential, commercial, and agriculture (22.5%) (EDMC 2011).

Final electricity consumption, excluding losses and own-use, increased 7.3% to 3477 TWh in 2009, compared to the previous year (NBS 2010). The demand rate growth was, as in previous years, based mainly on increased consumption in the commercial and residential, transport and industry sectors. In 2009, the industry sector accounted for the majority of electricity consumption (67.8% or 117.39 Mtoe), followed by the residential and commercial sector (26.9% or 70.51 Mtoe, including non-specified), agriculture (3.3% or 8.08 Mtoe) and transport (2.0% or 5.31 Mtoe). In terms of growth, electricity consumption in the residential and commercial sector in 2009 increased by 11.9% compared with the previous year, the transport sector by 7.9%, the agriculture sector by 6.2%, and the industry sector by 5.7% (EDMC 2011).

Coal consumption, excluding coal consumption to generate electricity, was 476.50 Mtoe in 2009 (EDMC 2011). 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 2009, total final oil consumption was 350.42 Mtoe. Diesel accounted for 38.7%, while gasoline accounted for 19.3%, LPG 7.3%, fuel oil 7.2% and others 43.6%. The industry sector was the largest oil-consuming sector, accounting for 40.3% of total final oil consumption, or 141.05 Mtoe. The transport sector was the second largest in terms of consumption; it accounted for 37.8% of total oil consumption or 132.49 Mtoe, an increase of 1.8% over the previous year (EDMC 2011).

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 21.23 Mtoe in 2009; commercial consumption grew from 0.38 Mtoe in 2000 to 2.73 Mtoe in 2009. However, the industry sector was still the largest sector in total final gas consumption, accounting for 75.3% or 102.84 Mtoe (EDMC 2011).

Based on the change of the 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 68.0% (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).

Policy overview

ENERGY POLICY FRAMEWORK

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

In March 2011, the National People's Congress approved the Twelfth Five-year National Economic and Social Development Plan (the Twelfth Five-year Plan), which clarifies the national strategic intent, government's focus and people's common program of action during the period 2011–15. The plan emphasis 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 optimize the energy structure, construct a modern energy industry with the merits of safety, stability, economy, and cleanliness. Some targets related to energy also are published in the plan, including: increasing the proportion of non-fossil fuel usage in total primary energy consumption to 11.4% in 2015, and reducing the energy consumption per unit of GDP by 16% compared to 2010.

ORGANISATION

To strengthen coordination and decision-making, China has established a high-level coordinating body—the National Energy Committee. The committee, chaired by Premier Wen Jiabao, 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, industrial policies and standards, and for administering the energy sector including coal, oil, natural gas, power including nuclear energy, and new and renewable sources of energy. It has also assumed the responsibilities of 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 in the NDRC, to provide technical support to the government to implement 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 still being drafted. During 2010, some progress in energy-related law was made.

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 the completely-secure purchase of power from renewable energy sources, and the establishment of a development fund for renewable energy. The amendment provides that power grid companies will receive all of the revenue generated from the surcharge on retail power tariffs, and it sets a minimum target for the amount of electricity the grid companies must buy from renewable energy projects.

The 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 made clear the responsibility and duty 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 around 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 tax, royalties, mineral resources compensation, consumption tax and others. Since 1 October 1984, China has collected resource tax on oil, natural gas and coal. The levying scope was expanded in 1994, after which the tax was levied according to the amount of production as well as the situation of the resources. In September 2011, the Provisional Regulations on Resource Tax was amended by the State Council. From 1 November 2011, the assessment base of resource tax for 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 ore are singled out from coal and nonferrous metal ore resources respectively. Correspondingly their tax rates are raised to CNY 8–20 per tonne and CNY 0.4–60 per tonne.

The collection of royalties is limited to offshore and onshore oil and gas exploitation. In offshore exploitation, since 1989, production of up to 1 million tonnes of crude oil has royalties levied at a rate of 2.5%–4%. Similarly, production of up to 2 billion cubic metres 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 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 from 20%–40%.

ENERGY SECURITY

'More coal, less oil and gas' characterises China's energy resource. 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 globalization of its oil and gas assets. The trend to 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 need, high rates of supply decline and faltering domestic production have resulted in China turning to secure oil internationally and 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, in the way of cooperation with international 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 million tonnes of crude oil per year from 2011–30. On 10 September 2010, the domestic

engineering of the China–Myanmar oil and gas pipeline was settling in Yunnan province. In 2009, the first phase of China's SPR projects were completed and in operation. In 2010, a second batch of SPR projects went under construction, and a third batch 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 batches, China's SPR capacity will reach 350 million barrels by the end of 2015 (CPCIF 2011).

ENERGY MARKET

Reforms of the energy sector have been steady. The reforms focus on the establishment of an energy industrial system that adjusts to the socialist market economic system. The main reforms have included the reorganisation of the energy industry sector and the establishment of economy-wide energy sector companies; the establishment of coal market price mechanisms, such as removing controls on coal prices; perfecting the oil price mechanism and adjusting the oil price; establishing the modern enterprise system (including the participation of many electricity companies and oil companies in overseas markets); the implementation of electric power system reform, including the establishment of the electricity regulatory commission, two grid companies, five power generation groups and four auxiliary companies; and moving renewable energy commercialization forward (IONEA 2009).

Another area of market reform is in energy capitalisation. Chinese energy companies have expanded their resource base through international capital markets, with the three top oil companies in China now listed in various locations around the world. The Chinese coal industry includes between 40 and 50 listed companies, with a total market value of more than CNY 1000 billion; the electricity industry has between 50 and 60 listed companies with a total value of more than CNY 600 billion in early 2009 (Cui 2010).

COAL MARKET

A revised draft of the Coal Law was submitted to the State Council in September 2008. The aim of this is to establish a complete legal system for coal that will fully protect the development of the Chinese coal industry and help it make progress in a healthy and sustainable direction. Compared with the current Coal Law, the revised version focuses on increasing the qualification requirements for coal development and raising the ratio of industrial concentration, as well as proposing to establish a coal strategic resources reserve system. Other highlights include the rationalisation of the coal industry management system, and an emphasis on the coal industry development plan.

The Coal Industry Policy, which is the first industrial policy for China's coal industry, was issued by the NDRC on 23 November 2007. The policy includes 10 chapters that cover development targets, industrial distribution, industrial access, industrial organisation, industrial technology, safety, trade and transportation, economical use and environmental protection, labour protection, and supporting measures. The policy aims to build a new coal industry system, to change the industry's mode of economic development, and to promote its healthy development in China.

On 21 October 2010, the State Council announced the Instructions for Accelerating Coal Mine Enterprise Merger and Restructuring, prepared by the NDRC. According to this document, there were more than 11 000 coal mine enterprises, and a number of them had outdated technology, and safety and environmental protection practices. The document urged the merger and acquisition of coal mine enterprises and indicated that all the qualified state-owned and private coal mines could be part of the process. It also encouraged the integration of management between coal and electricity enterprises, and the mutual infiltration between a coal mine enterprise and its upstream or downstream industries. With this effort, China hopes to create a group of large coal mine enterprises with annual outputs of more than 50 million tonnes. The output of these large enterprises should account for over 50% of total coal production.

The government has traditionally participated in negotiating the price of coal. After more than a decade of gradual reform, on 15 December 2009, the NDRC issued Instructions for

Improving the Work of Dovetailing the Supply, Transport and Demand of Coal, which declared the government would exit the negotiations between coal buyers and sellers.

To have the ability to respond to supply disruptions or a serious shortage of coal due to natural disasters or other emergencies, since 2011 the central government has started to entrust the large coal and power enterprises to establish coal reserves in the important collection and distribution centres, consumption areas and key transport hubs. The central government grants a subsidy to the trustees for their costs in relation to the reserves, and instructs them to use the reserves when it is necessary. The capacity of the first batch was 5 million tonnes and it was expected to be achieved by the end of May 2011.

OIL MARKET

In December 2008, China started the 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 program. The program 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 increases similarly. For gasoline and diesel oil, the consumption tax aims to implement a fixed amount tax rather than an ad valorem tax.

The oil product price continues to be the government mandated price or guided price according to the variety of products. When the moving average oil price for 22 consecutive working days in the related international market changes more than 4%, the government adjusts 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 Standardization Technical Committee for the Oil and Natural Gas Industry was set up on 9 May 2008, China's oil and natural gas industry standardization 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 high quality and relatively clean energy, with its high conversion efficiency, lower environment cost, low investment cost, and short construction periods. There is an increasing global trend in actively developing natural gas resources, and China's energy industry is now rapidly expanding in this area. The industrial chain to end users of natural gas is extending, while diversification in natural gas consumption is increasing. On 30 August 2007, China released its National Gas Utilization Policy, which was intended to ease natural gas supply and demand, and to optimise the structure of natural gas utilization.

In September 2011, the NDRC, the Ministry of Finance, the Ministry of House and Urban–Rural Development and the NEA jointly issued an Instruction for Developing the Distributed Energy of Natural Gas. From 2011–15, China will construct about 1000 distributed energy of natural gas projects, and about 10 demonstration areas with typical distributed energy features. Distributed energy will be promoted in the up-scale cities and the total installed capacity will reach 50 000 MW by 2020 (NDRC 2011).

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 increasing 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).

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

During the second round of the strategic and economic dialogue in May 2010, China and the United States signed the work plan of action on shale gas resources. They agreed that, based on the United States' experience of unconventional natural gas developments and in accordance with relevant Chinese laws and regulations, both sides will strengthen cooperation in shale gas resources evaluation, exploration and the development of technology and related policy.

ELECTRICITY MARKET

As well as 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 Electricity Regulation, 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, besides the NDRC and the NEA. 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 standardization
- 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.

China's power shortage problems experienced early this century have been largely resolved. From 2002–06, installed electricity generation capacity increased rapidly; that growth rate has slowed since 2007, giving the economy the opportunity to optimize its electricity structure.

Since 2007, China has accelerated the closing of inefficient small thermal power plants. Between 2006 and 2010, a total 72.1 million kW of capacity was lost with the closure of such plants. By the end of 2010, more than 70% of the thermal power plants were large-sized plants with a capacity of 300 MW or more. The number of installed ultra-supercritical power units reached 33, while 11 more units were under construction (NEA 2011).

In November 2009, the NDRC, the SERC and the NEA jointly issued a tariff adjustment program, which came into effect on 20 November 2009. Under the program, the economy-wide average sales price of electricity would increase by CNY 0.028 per kilowatt-hour (kWh). At the same time, opinions were being widely sought on a proposal to accelerate tariff reform. On 9 October 2010, the NDRC released a draft guidance document on the implementation of a residential electricity step tariff. Public feedback is sought on the proposal to change the existing single form of residential electricity pricing to segment pricing according to the levels of electricity consumed (that is, if the user used more electricity, the incremental electricity use would be paid for at a higher price).

According to the SERC, the average power tariff in 2010 was CNY 384.56 per thousand kWh, a 0.67% increase from 2009. By plant type, the average gas turbine power tariff was CNY 610.82 per thousand kWh, nuclear energy CNY 432.20 per thousand kWh, thermal power CNY 394.77 per thousand kWh, and hydropower CNY 291.20 per thousand kWh was the lowest (SERC 2011).

NUCLEAR

The development of nuclear energy has become an option to optimise China's energy structure, to ensure energy security and to improve environmental protection. The Medium- and Long-Term Nuclear Energy Development Plan (2005–20), issued in 2007, planned for the total nuclear energy installed capacity to reach 40 million kW by 2020, and for the annual generation capacity of 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 celebrated its step of developing 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 Twelfth Five-year Plan, the construction of nuclear-energy power plants with a total capacity of 40 000 MW will start during 2011–15, and the location of plants will be expanded from China's maritime provinces to its central provinces.

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 works, will be suspended. By the end of 2011, the nuclear safety plan is still being developed.

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 reaching a 15% share for non-fossil fuels in its primary energy consumption 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 its 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 an area of 300 million square metres of solar water heaters, and promotes household biogas and livestock farm biogas so it can achieve an annual use of 44 billion cubic metres by 2020.

In the Twelfth Five-year Plan, China confirms its ambitious targets on renewable energy. From 2011–15, 120 million kW of hydropower plants and more than 70 million kW of wind power plants will start construction. By the end of 2015, the capacity of installed solar power plants is expected to be more than 50 million kW, which greatly exceeds the original target.

Around the Renewable Energy Law, China has developed a series of rules to ensure the smooth implementation of the law. These are:

- Related Regulation on Power Generation from Renewable Energy, issued in January 2006 by NDRC.
- Trial Procedures for Power Pricing and the Cost-sharing Management of Renewable Energy, issued in January 2006 by NDRC.
- Interim Measures for Allocation of Additional Revenue from Power Tariffs for Renewable Energy, issued in January 2007 by NDRC.
- Catalogue for the Development of the Renewable Energy Industry, issued in October 2005 by NDRC.
- Regulation Approach for Grid Enterprises for Full Purchase of Electricity from Renewable Energy, issued in May 2007 by the State Electricity Regulatory Commission.
- Technical Specifications for Civil Solar Heating Systems, issued in December 2005 by the Ministry of Construction.

According to the Trial Procedures for Power Generation from Renewable Energy, the renewable power generation benchmark price will be set by the government as a mandated price or guiding price, the later coming from the winner price in the bid organised by government. The price gap between renewable power generation and local coal-fired generation with desulfuration will be pooled in the provincial and national grid.

From 2003, China piloted land wind power franchise bidding. After accomplishing six batches of the pilot, the cost of land wind power was reduced greatly and became stable. Based on this, the NDRC published the guiding price for land wind power generation in July 2009. The benchmark prices for wind-generated power, at CNY 0.51, CNY 0.54, CNY 0.58 and CNY 0.61 per kW in four types of resource areas, further standardizes the administration of wind power prices, and promotes the healthy development of the wind power industry. In October 2010, the first batch of offshore wind power franchise bidding was accomplished and the preparation of the second batch is underway.

The generation price of 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.

As well as price promotion, since 2006 China has introduced a series of financial and tax policies to boost the development of renewable energy power projects, including the following:

- The Measures for the Administration of the Subsidy Funds for the Utilization of Straw for Energy (November 2008) stipulates that the types and quantities of crop straw consumed (excluding the stew generation) by a qualified enterprise will be calculated according to the types and quantities of straw-energy products it actually sells each year. It also states that a comprehensive subsidy, with funds from the central government, will be granted to the enterprise at a certain rate.
- The Interim Measures for the Administration of the Subsidy Funds from Public Finance for the Application of Photovoltaic Solar Energy in Buildings (March 2009) stipulates that the standard for the subsidy will be, in principle, CNY 20/Wp in 2009 and the rate should be adjusted in line with the development of the industry in the future.
- The Interim Measures for the Administration of the Financial Subsidy Funds to the 'Gold Sun' Exemplary Projects (July 2009) stated that a photovoltaic solar power project that is connected to the power grid and falls within a specified scope should receive a subsidy equivalent to 50% of the total investment in its generation units and the accessory systems for power transmission and distribution. For independent power units in remote areas with no access to other power, the percentage should be 70%.
- The Interim Measures for Management of Special Funds for Architectural Applications of Renewable Energy (September 2006) stipulates that buildings which use renewable energy for cooling, heating, lighting and cooking, may be eligible for government funding, following an evaluation and selection process. The amount of unit subsidies for different types of demonstration buildings are determined according to the incremental cost, advanced technology level, and the market price surge, among other things, each year.

In August 2011, the NEA published the 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 it takes on wind power.

ENERGY EFFICIENCY

China has a comprehensive energy efficiency program focusing on promoting energy conservation and reducing emissions. In recent years, China has issued several important laws and regulations on energy conservation, including the revised Energy Conservation Law (issued on 28 October 2007, effective from 1 April 2008), the Public Sector Energy Saving Regulation (issued on 1 August 2008, effective from 1 October 2008), the civil building Energy Saving Regulation (issued on 1 August 2008, effective from 1 October 2008), as well as other documents including the notice of In-depth Development of Energy Saving Action, and the notification about Further Strengthening Fuel-efficiency and Power-saving.

In the Eleventh Five-year Plan, the government set a target of decreasing energy intensity (energy consumption per unit of GDP) by 20% from the 2005 level by 2010. A series of initiatives were employed for achieving the ambitious goal. These included enhancing target responsibility assessment, implementing key energy conservation projects, promoting energy-saving technology, improving related standards, and implementing incentive policies (IOSC 2011).

China has resolved and assigned responsibilities to fulfil set targets in energy conservation. It has also established a statistical monitoring and evaluation system to regularly evaluate the completion of energy conservation targets and the implementation of energy conservation measures by 31 provincial governments and 1000 key enterprises. In 2010, China launched a special program of supervision over energy conservation and emissions reduction in 18 key regions. Strict target responsibility, evaluation and accountability contributed to achieving the national energy conservation targets.

Since 2006, the NDRC and other ministries have issued opinions on implementing 10 Key Projects of Energy Conservation, including the upgrading of industrial boilers and kilns,

combined heat and power generation, electromechanical system energy conservation, and residual heat and pressure utilization. China has conducted energy conservation in 1000 enterprises, enhanced the energy conservation management of key energy-consuming enterprises, and promoted energy audit and energy efficiency benchmarking activities. It has launched low-carbon transportation action for automobiles, ships, roads and harbours in 1000 enterprises, and vigorously developed urban public transport. It has also improved the take-up rate of mandatory energy conservation standards in new buildings, quickened the energy conservation transformation of existing buildings, promoted the use of renewable energy resources in buildings, and conducted the energy conservation transformation of government office buildings. By the end of 2010, the implementation rate of mandatory energy efficiency standards for new urban buildings reached 99.5% in the design stage and 95.4% in the construction stage. During the Eleventh Five-year Plan period, the accumulated total energy-efficient floor space constructed was 4.857 billion square metres, with an energy-saving capacity of 46 million tons of standard coal.

China has released a total of 115 key economy-wide energy-efficient technology promotion catalogues in three batches, and promoted seven energy-efficient technologies in the iron and steel, building material and chemical industries. During the Eleventh 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 the energy-efficient design standards for residential buildings in three climate zones (freezing cold and cold, hot in summer and cold in winter, and hot in summer and warm in winter), the energy-efficient design standards for public buildings, and the code of acceptance inspection of 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 of 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 reach a higher level in energy-efficiency.

The government has launched a project to promote energy-efficient products for the benefit of the people, and has promoted high-efficiency illumination products and air conditioners, energy-efficient motors and other energy-efficient products by way of government subsidies. The central treasury has appropriated subsidies to support the production of and to promote the use of some 360 million high-efficiency illumination 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 illumination products. By the end of 2010, the market share of high-efficiency illumination products had reached 67%, and that of high-efficiency air conditioners, 70%.

In August 2010, the government issued a new government procurement list as a part of the System of Government Procurement of Energy-efficient Products. On the list were 28 product categories covering about 30 000 models produced by 605 manufacturers. For nine categories it is compulsory to purchase from the energy-efficient list; this includes air conditioners, four lighting products, televisions, water heaters, computers, printers, monitors, toilets and water nozzles.

To support energy performance contracting projects and to promote the development of the energy service industry in China, on 3 June 2010 the Ministry of Finance and the NDRC jointly issued a notification about the Interim Measures for Funding Financial Incentives for Energy

Performance Contracting Projects. The government increased its financial support, adopted a policy of taxation support and improved related accounting systems and financial services to strengthen support for the energy conservation service industry. From 2005–10, the number of energy conservation service companies increased from 80 to over 800, the number of employees in this sector increased from 16 000 to 180 000, the size of the energy conservation service industry grew from CNY 4.7 billion to CNY 84 billion, and the annual energy-saving capacity rose from some 600 000 tonnes to more than 13 million tonnes of standard coal.

CLIMATE CHANGE

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 in its mid-term and long-term planning for economic and social development as a major issue concerning its overall 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 that of 2005. To accomplish the above goals, China adopted a range of major policy measures to mitigate and adapt to climate change during the Eleventh Five-year Plan (2006–10) period. The Outline of the Twelfth Five-year Plan established the policy orientation of promoting green and low-carbon development, and expressly set out the objectives and tasks of addressing climate change for the next five years. These include: by 2015, carbon dioxide emissions per-unit GDP would be reduced by 17% and energy consumption per-unit GDP by 16%, compared with those of 2010; the proportion of the consumption of non-fossil energy in the consumption of primary energy would be increased to 11.4%; and the acreage of new forests would increase by 12.5 million ha, with the forest coverage rate raised to 21.66% and the forest growing stock increased by 600 million cubic metres (IOSC 2011).

In 2008, the Chinese Government published a White Paper on China's Policies and Actions for Addressing Climate Change. In that, 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 programs to address climate change, most of which are under implementation.

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 localities. At the same time, China strengthened scientific research in and the impact evaluation 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.

To build up its basic capability in this regard, during the Eleventh Five-year Plan period China continued to improve relevant legislation, management systems and working mechanisms for addressing climate change. It strengthened statistical and calculation research and institutional structures, raised the level of scientific research and policy study, and strengthened relevant education and training programs. China also proactively publicizes relevant scientific knowledge in addressing climate change, enhances public awareness of low-carbon development, gives full play to the initiatives of non-governmental organizations, the media and other outlets, and uses various channels and measures to guide the whole society to participate in actions addressing climate change. Energy-saving publicity week, Cool China–National Low-carbon Action, the Earth Hour program and other similar activities are accepted and advocated by more and more people.

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. The 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'. The developed countries should take the lead in reducing emissions substantially, and provide financial support and transfer technologies to developing countries. The developing countries, while developing their economies and fighting poverty, should actively adopt measures to adapt to and to 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.

Notable energy developments

COAL INDUSTRY

On 8 August 2010, the world's first coal-based polyolefin production line, with coal as the raw material, passed through the whole technical process and succeeded in its trial run, in Baotou. The project has an annual output ability of 1.8 million tonnes of coal-based methanol and 0.6 million tonnes of methanol-based polyolefin. The core device adopts China's independent intellectual property rights of the methanol to olefins technology—DMTO technology (CEN 2010).

On 13 October 2010, China's first government-backed and enterprise-operated coal price index, the Bohai rim power coal price index, started its trial operation and released its first data. The index is based on the CIF (cost, insurance and freight) price in relevant ports of the areas, and is published every Wednesday (CEN 2010).

On 21 October 2010, the State Council announced the Instructions for Accelerating Coal Mine Enterprise Merger and Restructuring, prepared by the NDRC. Some commentators consider mutual infiltration between a coal enterprise and its upstream and downstream relevant industries will be the trend, and the industry chain-integration mode including coal businesses will be an important characteristic of future large energy companies (CEN 2010).

In 2010, driven by the decreasing international coal price, the thermal plants in south–east coastal areas increased their overseas coal purchasing. China's coal imports reached 146 million tonnes in 2010, up 40.9% from the previous year (NEA 2011).

OIL INDUSTRY

On 5 June 2010, construction started on the China–Myanmar oil and gas pipelines. The preliminary design capacity of the crude oil pipeline is 22 million tonnes a year, equivalent to more than 40 daily transportation barrels; and the preliminary design capacity of the natural gas pipeline is 12 billion cubic metres a year (CEN 2010).

On 25 June 2010, the National People's Congress Standing Committee adopted the Protection of Oil and Pipelines Law, which was officially implemented on 1 October 2010 (CEN 2010).

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 million tonnes of crude oil a year. According to

the agreement, the pipeline will carry 15 million tons of crude oil a year from 1 January 2011, lasting 20 years, up to a maximum of 30 million tons a year (CEN 2010).

In 2010, the first batch of economy-wide strategic petroleum reserve projects successfully completed collections. The second batch of strategic petroleum reserve projects is being implemented. A number of commercial petroleum reserve bases were set up and put into operation, with the capacity of up to 26.5 million cubic metres by the end of 2010. Three gas storage units were established with a total working capacity of 1.39 billion cubic metres (bcm); the construction of another 10 gas storage units has started, with a total capacity of 24.4 bcm (NEA 2011).

NATURAL GAS INDUSTRY

On 29 March 2010, the Sichuan–East China gas transmission engineering 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, and a plan 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 region 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 the domestic natural gas price and to publicise related policies about natural gas pricing and supporting measures (CEN 2010).

On 26 October 2010, the B line of the China–Central Asia gas pipeline realized production. It came on line two months earlier than the original target for the central Asia pipeline double ventilation project. The A line was completed in December 2009. According to the plan, total capacity will reach 30 bcm of natural gas by the end of 2011 (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 that announced the further expansion of international cooperation on coal bed methane (CBM) exploration. Three companies were selected as the first batch of pilot units. So far, four domestic companies have the franchise for CBM international cooperation (CEN 2010).

ELECTRICITY

On 21 July 2011, China's first fast neutron reactor—China's experimental fast reactor (CEFR)—had its first critical success, 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 2010).

On 25 August 2010, unit 4 of the Xiaowan hydropower plant in Yunnan was put into production. The capacity of China's installed hydropower has now reached 200 million kilowatts (kW) (CEN 2010).

On 31 August 2011, the offshore wind power plants passed the 240 hours' examination. This project is the first of its kind in China and its total capacity is 100 megawatts (CEN 2010).

On 20 September 2010, unit 1 of the Lingao nuclear energy second phase engineering in Guangdong province went into operation. The capacity of China's installed nuclear energy has now reached 10 million kW. On 20 October 2011, unit 3 of the Qinshan nuclear energy second phase engineering in Zhejiang province was put into commercial operation (CEN 2010).

On 3 November 2010, phase 1 of China's first kilowatt wind-power based project was completed. The project started in April 2008 and is expected be totally finished by the end of 2015. The actual capacity of phase 1 is 5.36 million kW; phase 2 of the project is planned to be built with a capacity of 8 million kW (CEN 2010). In 2010, the added capacity of installed wind

power economy-wide was 14.57 million kW, and the total installed capacity of wind power in the grid reached 29.58 million kW (CEC 2011).

In 2010, there were great achievements in power transmission technology. The Xiangjiaba–Shanghai ±800 000 volts HVDC transmission demonstration project started production in July. This project has the world's largest HVDC transmission capacity at 7 million kW, the longest transmission distance and the highest voltage level of dc engineering. In October, the Ningdong–Shandong ±600 000 volts HVDC transmission demonstration project went into commercial operation. On 29 July 2010, the power grid network engineering started. The total line of this engineering project is 1774 km, east from Xining, in Qinghai, and west to Lhasa, in Tibet. It will be accomplished by the end of 2012, when the power grids of Tibet and Qinghai will realize connection, and it will solve the shortage problem of Tibet electricity (CEN 2010).

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 in the world. The length of 220 kilovolt (kV) and above transmission lines was 445 600 km, the capacity of 220 kV and above substation equipment was 1.99 billion kilovolt–ampere (kVA), by the end of 2010. This is an increase of 10.87% and 16.37% from the previous year, respectively (CEC 2011).

China has made progress on energy savings and emissions reduction. In 2010, the unit coal consumption of 6000 MW and above thermal power plants for supplying electricity was 333 gce/kWh, lower than the previous year's 7 g/kWh; the economy-wide line loss rate was 6.53%, down 0.19% from the previous year; the economy-wide power plants electricity use rate was 5.43%, down 0.33% from the previous year. In 2010, sulfur dioxide from power generation was 9.26 million tonnes, down 2.3% from the previous year. By the end of 2010, the capacity of coal-fired power plants with operating flue gas desulfurization was more than 560 million kW, accounting for about 86% of the total. The capacity of coal-fired power plants with operating f flue gas denitration was about 90 million kW, accounting for about 14% of the total (CEC 2011). The two units of million MW ultra-supercriticals in Shanghai Waigaoqiao's third generating company set the record of unit coal consumption for supplying electricity at 279.4 gce/kWh, making it the leading level in the world (PD 2011).

ENERGY CONSERVATION AND ENVIRONMENTAL PROTECTION

China has accomplished its energy conservation goals listed in the Eleventh Five-year Plan. China's energy consumption per unit of GDP dropped 19.1% from that of 2005 accumulatively, a reduction of 1.46 billion tons of carbon dioxide emissions. During the same period, China's economy expanded at an average annual rate of 11.2%, while its energy consumption grew only 6.6% annually on average. The energy consumption elasticity coefficient dropped from 1.04 in the Tenth Five-year Plan period (2001–05) to 0.59, 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 batch 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 the 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 the 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 Twelfth Five-year Plan period (2011–15) and the Work Plan for Greenhouse Gas Emission Control for the same period, making an overall arrangement for energy conservation, emissions reduction and greenhouse gas emissions control during that period.

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USEFUL LINKS

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

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

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

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

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

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

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

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

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

Standardization Administration—www.sac.gov.cn

HONG KONG, CHINA

Introduction

Hong Kong, China—a special administrative region of the People's Republic of China—is a world-class financial, trading and business centre of some 7.004 million people situated at the south-eastern tip of China. It has no natural resources; all of the energy consumed in Hong Kong, China, is imported. The energy sector consists of investor-owned electricity and gas utility services.

In 2009, the per capita GDP of Hong Kong, China, was USD 34 882 (USD (2000) at PPP), among the highest of the Asia–Pacific Economic Cooperation (APEC) economies. GDP decreased 2.66% in real terms in 2009, to USD 244.30 billion. The services sector remained the dominant driving force of overall economic growth, accounting for 92.6% of GDP in 2009 (EDMC 2011; CSD 2011a).

The economy of Hong Kong, China, is driven by its vibrant financial services sector. The shift towards higher value-added services and a knowledge-based economy will continue. To stay competitive and attain sustainable growth, Hong Kong, China, needs to restructure and reposition itself to face the challenges posed by globalization and 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 liberalization of trade in goods under CEPA, all products originating in Hong Kong, China, enjoy tariff-free access to mainland China on application by local manufacturers, provided all CEPA rules of origin are agreed to and met.

With the support of mainland China under CEPA and the Framework Agreement on Hong Kong/Guangdong Co-operation, Hong Kong, China will reinforce and enhance its status as an international centre for financial services, trade and shipping, and as an advanced global manufacturing and modern services base. Mainland China's Twelfth Five-year National Economic and Social Development Plan also supports the opening up of service industries to Hong Kong, China'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 9 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	1 104	Oil (million barrels)	–
Population (million)	7.004	Gas (billion cubic metres)	–
GDP (USD (2000) billion at PPP)	244.30	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	34 882		

Source: EDMC (2011), CSD (2011b)

Energy supply and demand

PRIMARY ENERGY SUPPLY

Hong Kong, China, has no domestic energy reserves or petroleum refineries; it imports all of its primary energy needs. It generates some electricity. Total primary energy supply in Hong Kong, China, was 13.4 million tonnes of oil equivalent (Mtoe) in 2009, about the same amount as in 2008. Coal maintained the highest share of the total primary energy supply (53.4%), followed by oil (22.3%), gas (18.7%) and other sources (5.6%) (EDMC 2011).

In 2009, the total installed electricity generating capacity in Hong Kong, China, was 25 288 megawatts (MW) (EDMC 2011), including imported power from Guangdong, mainland China (12 624 MW in Hong Kong, China). 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 (2500 MW), Castle Peak (4108 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. The Environmental Impact Assessment (EIA) study was presented for public consultation in June 2009 (CLP 2011a, 2011b). PAH's electricity is supplied by the Lamma Power Station, which has a total installed capacity of 3736 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 2009, and is expected to install a photovoltaic (PV) system (550 kW) in 2010 (PAH 2011a, 2011b).

Table 10 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	65	Industry sector	636	Total[a] (gross)	38 872
Net imports and other	29 280	Transport sector	2 155	Thermal	38 728
Total PES	13 400	Other sectors	4 096	Hydro	–
Coal	7 154	Total FEC	6 887	Nuclear	–
Oil	2 988	Coal	–	Other	144
Gas	2 512	Oil	2 623		
Other	745	Gas	651		
		Electricity and other	3 613		

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

Sources: EDMC (2011); CSD (2011b)

Town gas and liquefied petroleum gas (LPG) are the two main types of fuel gas used in Hong Kong, China. Town gas is distributed by the Hong Kong and China Gas Company Limited. It is manufactured at plants in Tai Po and Ma Tau Kok, using naphtha and natural gas as feedstock. LPG is supplied by oil companies, imported into Hong Kong, China, by sea and stored at the five terminals on Tsing Yi Island (Towngas 2011).

FINAL ENERGY CONSUMPTION

In 2009, the total final energy consumption in Hong Kong, China, was 6887 ktoe, almost the same as in the previous year. The other sectors (residential and commercial) accounted for the largest share of energy used at 59.5%, followed by the transport sector (31.3%) and the industry sector (9.2%). By energy source, electricity and other made up 52.5% of end-use consumption, followed by petroleum products (38.1%), and gas (9.5%) (EDMC 2011).

Gas is supplied for domestic, commercial and industrial uses in two main forms—town gas and LPG. In addition, LPG is used as a fuel for LPG taxis and light buses, and natural gas is used for electricity generation and city gas production.

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. There is worldwide consensus on the need to combat climate change, reduce greenhouse gas emissions and develop 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. Specifically, Hong Kong, China, proposes to optimize the fuel mix for power generation. This will mean significantly reducing its reliance on fossil fuels, phasing out existing coal-fired 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 to 3.6–4.5 tonnes (Policy Addresses 2010–11 and 2011–12).

The 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 (wind and PV).
- Seek input from the community to improve energy efficiency.
- Enhance the management of electricity demand.

ENERGY MARKETS

A memorandum of understanding (MOU) signed by the Hong Kong, China, Government and the National Energy Bureau of the People's Republic of China on 28 August 2008 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 a LNG terminal to be built as a joint venture on a neighbouring mainland China site. Gas-fired power plants generated 23% of the economy's electricity in 2009. 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 to be developed in the South China Sea
- The 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 2011b).

ENERGY EFFICIENCY

Buildings consume about 89% of the electricity used in Hong Kong, China. The economy is putting its efforts into the energy conservation of buildings as its first priority. Following that, its efforts will go into improving the energy efficiency and air quality of the transport sector.

Buildings

To strengthen its efforts and results in building energy conservation, Hong Kong, China, has enhanced the regulations and mandatory management system for the Building Energy Codes (BEC). The Buildings Energy Efficiency Bill was passed in November 2010 and the Buildings Energy Efficiency Ordinance was gazetted in December 2010. With an 18-month grace period, the Ordinance is expected to be fully implemented by mid-2012. It is estimated mandatory compliance will result in energy savings of 2.8 billion kilowatt-hours (kWh) for new buildings in the first 10 years of the Ordinance's implementation. This will contribute to a reduction in carbon dioxide emissions of 1.96 million tonnes. Further energy savings will be realised in existing buildings constructed before the new legislation came into effect, by requiring compliance with the BEC when prescribed major retrofitting works are carried out in these buildings (EMSD 2011a).

Government buildings will demonstrate state-of-the-art energy efficient designs and technologies for building energy conservation. These are based on the environmental performance framework that covers energy efficiency, greenhouse gas reduction, renewable energy application, waste reduction, water management, and indoor air quality. During this action, all newly-built government buildings over 10 000 square metres will be assessed by 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 also aims to achieve a 5% saving on the total electricity used in government buildings from 2009–10 to 2013–14 after discounting activity changes, using the electricity consumption in 2007–08 as the baseline.

Also in April 2009, the government introduced buildings energy efficiency funding schemes with a total of HKD 450 million to be used to subsidize environmental performance reviews and upgrades for communal areas of residential, commercial and industrial buildings. The funding schemes also cover energy/carbon audits and additions, alterations and improvement works to upgrade the energy efficiency performance of building services installations. The subsidy can cover up to 50% of expenditure.

energy consumption indicators

In 2010, Hong Kong, China reviewed and updated the 68 groups of energy consumption indicators covering the residential (six 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 performances with respect to corresponding peers. It helps to foster the concept of efficient energy consumption and to promote the general public's awareness of it. The general public can assess their energy consumption performances in accordance with their energy end-use systems and equipment, compared with other subjects in the same energy-consuming group (EMSD 2011b).

Energy efficiency labelling

Hong Kong, China has a voluntary Energy Efficiency Labelling Scheme that covers 18 types of household and office appliances, including refrigerators, room coolers, washing machines, electric clothes dryers, compact fluorescent lamps, electric storage water heaters, electric rice-cookers, dehumidifiers, televisions, multifunction office devices, photocopiers, laser printers, LCD monitors, electronic ballasts, computers, domestic gas instantaneous water heaters, fax machines and bottled cold/hot water dispensers (EMSD 2011c).

A new Mandatory Energy Efficiency Labelling Scheme—Energy Efficiency (Labelling of Products) Ordinance—has been in effect since December 2009. The first phase of the scheme

covered room air conditioners, refrigerating appliances, and compact fluorescent lamps. It is estimated the electricity savings will be around 150 million kWh per year (or a CO_2 emissions reduction of around 105 000 tonnes per year). The second phase added dehumidifiers and washing machines from March 2010, with an 18-month grace period. It is estimated there will be additional electricity savings of around 25 million kWh per year (or a CO_2 emissions reduction of around 17 500 tonnes per year).

Transport

In Hong Kong, China, franchised buses 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 in the franchises. The bus companies will be required to switch to zero-emission buses or the most environmental-friendly buses when replacing existing ones, taking into account the feasibility and affordability for bus operators and passengers.

In terms of fuel consumption and other environmental performances, hybrid buses are superior to ordinary diesel buses. In view of the market availability and technical developments, hybrid buses have the potential to replace diesel buses on a large scale within a short period. 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 Hong Kong, China'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. There are too many to phase them all out in the coming few years. In view of this, the Hong Kong, China, 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 the retrofit of the devices on all Euro II and Euro III buses. Bus companies will bear the subsequent operational and maintenance costs.

The Hong Kong, China, Government also plans to designate pilot low-emission zones in busy districts such as Causeway Bay, Central and Mong Kok. It will increase, as far as 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.

Behind 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 application by the transport trade.

RENEWABLE ENERGY

Despite the geographical and natural constraints for Hong Kong, China, 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 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 demand for electricity by 2020 (EPD 2011; EMSD 2011d).

The two local power companies have carried out detailed studies on the construction of offshore wind farms. The selected site for the wind farm of CLP Power Hong Kong Limited (CLP Power) is located approximately 9 kilometres east of the Clearwater Bay peninsula within the south-eastern waters of Hong Kong, China. Its plan is 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 for producing electricity of up to 390 million kWh per year. CLP Power has completed the EIA process and obtained an environmental permit for the proposal. A feasibility study, including the

collection of field data, is being carried out at the selected site. Power Assets Holdings Ltd's (PAH's) selected site is located approximately 4 kilometres south-west of Lamma Island. PAH plans to install about 30 wind turbines at a capital cost of about HKD 3 billion, with an estimated total generation capacity of around 100 MW for producing 170 million kWh of electricity every year. PAH's detailed EIA report has been approved and the required environmental permit issued.

The government has also taken the lead in installing a 350 kW PV system on the roof of the Electrical and Mechanical Services Department headquarters in Kowloon Bay. To save power in water heating, it has also installed large-scale solar water heating installations on government buildings, including swimming pools.

The two local power companies have also set up photovoltaic panels to generate electricity for connection to their power grids. For instance, PAH has installed a 550 kW PV system at its Lamma power station to generate electricity of around 620 000 kWh for use by about 150 domestic households every year.

In its effort to convert waste to energy and to reduce greenhouse gas emissions, Hong Kong, China, is planning to construct and operate an integrated waste management facility, two organic waste treatment facilities and a sludge treatment facility by 2020. If these projects are taken forward as planned, the government expects them to meet about 2% of the economy's total demand for electricity by 2020.

NUCLEAR

Hong Kong, China, has set a target for nuclear energy to be 50% of the fuel mix by 2020. In view of this vision, CLP Power is contracted to purchase around 70% of the electricity generated by the two 984 MW pressurised water reactors at the Guangdong Daya Bay Nuclear Power Station at Daya Bay in mainland China, to help meet the long-term demand for electricity in its supply area (CLP 2011b). It meets almost 25% of its 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 to alleviate air pollution and greenhouse gas emissions locally.

To increase the public's confidence in nuclear safety, CLP Power announced an enhanced notification mechanism for 'non-emergency licensing operational events' in January 2011. The enhanced mechanism of 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

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 in the economy by 50%–60% by 2020, compared with 2005. The government also suggested a number of emissions reduction measures and is now seeking input from the community to improve energy efficiency and to enhance the management of electricity demand (EPD 2011).

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 the 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 buildings in 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:
   - Stepping up access to public transportation, and setting up 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, 15% of buses and goods vehicles are hybrid and EVs (electric vehicles) 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 utilizing recovered landfill gas and gas generated from waste water treatment.
5. *Revamping the fuel mix for electricity generation.* Measures to increase the use of non-fossil, clean and low-carbon fuels for electricity generation, having balanced the various objectives of Hong Kong, China's energy policy. It is proposed that, by 2020, coal will account for no more than 10% of the fuel mix, natural gas around 40%, renewable energy about 3%–4% and imported nuclear-generated power will meet the balance of about 50%.

Notable energy developments

Following the successful implementation of the first phase of the Mandatory Energy Efficiency Labelling Scheme, the second phase of the scheme included dehumidifiers and washing machines and was fully implemented from 19 September 2011 after an 18-month grace period (EMSD 2011e).

Lighting, on average, accounted for around 15% of total electricity consumption in Hong Kong, China, in the past decade. Incandescent light bulbs work by heating a tungsten filament with 90% of the consumed electricity lost as heat, and only 10% used for lighting. Replacing incandescent light bulbs with more energy-efficient products will achieve substantial savings in electricity consumption. The government expects the replacement scheme to achieve electricity savings of up to 390 gigawatt-hours per year. Assuming an average tariff of HKD 1 per kWh, the

scheme can achieve annual savings of HKD 390 million in electricity bills and reduce carbon emissions by 273 000 tonnes. In view of this, Hong Kong, China, launched a three-month public consultation on the restriction of the sale of energy-inefficient incandescent light bulbs on 12 August 2011 (EMSD 2011f).

In June 2007, Hong Kong, China's Environmental Protection Department commissioned a comprehensive study to review the economy's Air Quality Objectives (AQOs) and to develop a long-term air quality management strategy. The study was completed in mid-2009 and suggested the following strategies for the economy's new AQOs (EPD 2011):

- Protect public health as the primary objective.
- Adopt a progressive, forward-looking approach to setting the AQOs with reference to the World Health Organization's guidelines and interim targets to achieve continued, progressive long-term air quality improvement.
- Have a regular review system to update the AQOs for the protection of public health.
- Pursue the World Health Organization's air quality guidelines as the long-term goal.

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useful links

Census and Statistics Department—www.censtatd.gov.hk

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

Environment Bureau—www.enb.gov.hk

Environmental Protection Department—www.epd.gov.hk

Transport Department—www.td.gov.hk

INDONESIA

INTRODUCTION

Indonesia is a large archipelago located south-east of mainland South-East Asia, between the Pacific Ocean and the Indian Ocean. Indonesia's territory encompasses 17 508 large and small islands and large bodies of water at the equator over an area of 7.89 million square kilometres (including Indonesia's Exclusive Economic Zone). Indonesia's total land area (24.4% of its territory) is about 1.82 million square kilometres. The population was 229.96 million in 2009.

Indonesia had a gross domestic product (GDP) of USD 777.45 billion and a per capita GDP of USD 3381 in 2009 (USD (2000) at PPP). Excluding the oil and gas sector, manufacturing accounted for the largest component of GDP in 2009 (26.8%), followed by retail, hotel and restaurant (16.9%); agriculture, livestock, forestry and fisheries (13.6%); finance, leasing and corporate services (9.6%); other services (9.4%); mining and quarrying (8.3%); transport and communications (8.8%); construction (6.4%); and electricity, gas and water supply (0.8%). In 2009, Indonesia attained economic growth of 4.58%, a decline of 6.01% from 2008.

Indigenous 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 2009, oil and gas exports contributed 16.0% of Indonesia's total exports of about USD 112.54 billion; coal exports contributed 12.0%. Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 47.7% of the Indonesian Government's budget in 2009.

Indonesia's proven fossil energy reserves at the end of 2009 comprised 4.3 billion barrels of oil (2008: 3.7 billion barrels); 3.1 trillion cubic metres of natural gas (2008: 3.18 trillion cubic metres); and 5529 million tonnes (Mt) of coal (2008: 5529 Mt).

Table 11 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (million sq. km)	7.89	Oil (billion barrels)	4.3
Population (million)	229.96	Gas (trillion cubic metres)	3.1
GDP (USD (2000) billion at PPP)	777.45	Coal (million tonnes)	4 328
GDP (USD (2000) per capita at PPP)	3 381		

a Proven reserves at the end of 2009 (BP 2010).

Source: EDMC (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009, Indonesia's total primary energy supply (TPES) was 158 016 ktoe of commercial energy – made up of oil (45.7%), coal (20.8%), natural gas (28.4%) and other energy (mainly hydropower and geothermal) (5.2%) – and 44 988 ktoe of biomass. Indonesia is a net exporter of energy: the overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal totalled 131 799 ktoe in 2009. Total energy exports in 2009 increased by 14.6% from 2008 (115 722 ktoe), an increase driven primarily by coal exports.

Oil

In 2009, Indonesia produced 53 314 ktoe of crude oil and condensates; of this 20 376 ktoe (38.2%) was exported. Crude oil and condensate exports declined by 1.2% from 20 619 ktoe in 2008. To meet domestic oil requirements, Indonesia imported 18 284 ktoe of crude oil and 18 856 ktoe of petroleum products in 2009, up 11.0% from a total of 33 457 ktoe in 2008. Notably, oil production has declined significantly over the past decade (in 1997, Indonesia produced 72 474 ktoe of crude oil and condensates).

Most of Indonesia's 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. The two fields are mature, notably the Duri oil field, which is the site of one of the world's largest enhanced oil recovery efforts.

Natural gas

Indonesia produced 77 022 ktoe of natural gas in 2009, an increase of 6.1% from 72 604 ktoe in 2008. Of the total natural gas production, 39.9% was processed into LNG for export. The economy produced 24 779 ktoe of LNG in 2009, a decline of 3.1% from 25 583 ktoe in 2008. In 2008, Indonesia also exported 7401 ktoe of natural gas (9.6% of total natural gas production) by pipeline to Singapore and Malaysia. Overall, 49.5% of Indonesia's natural gas production is exported; the balance is made available for domestic requirements.

Indonesia's large natural gas reserves are located near Arun in Aceh, around Badak in East Kalimantan, South Sumatra, the Natuna Sea, the Makassar Strait, and Papua; smaller gas fields are offshore from West and East Java. The LNG exports from Tangguh, Papua began in 2009; gas is supplied from the onshore and offshore Wiriagar and Berau gas blocks, which are estimated to have reserves of 0.396 billion cubic metres (14 trillion cubic feet (Tcf)).

Coal

In 2009, Indonesia produced 150 835 ktoe of coal, an increase of 12.0% from 134 652 ktoe in 2008. Most of Indonesia's coal production in 2009 (116 424 ktoe or 77.2%) was exported. Domestic consumption of coal was 32 805 ktoe in 2009, of which 65.7% was consumed in power generation, while 34.3% was used to meet final energy demand in industry.

About 57% of Indonesia's total recoverable coal reserve is lignite, while 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. Indonesian coal has a heating value range of 5000 to 7000 kilocalories per kilogram and is distinctive for its low ash and sulphur content (sulphur content is typically less than 1%).

Electricity

Indonesia had 31 453 MW of grid electricity generation capacity in 2009 – this capacity was provided by the state-owned electricity company (PLN) and independent power producers (IPPs). In 2009, 152 018 GWh of electricity was generated, of which 23.1% was supplied by IPPs. In 2009, electricity generation was based on coal (41.8%), natural gas (23.6%), oil (21.3%) and renewable energy (13.3%).

FINAL ENERGY CONSUMPTION

Total final energy consumption of commercial energy was 92 182 ktoe in 2009, a decline of 10.0% from 100 345 ktoe in 2008. The share of the final energy consumption by sector in 2009 was 40.3% for industry, 33.3% for transport and 26.4% for other sectors. Indonesia's economy is highly dependent on oil; final energy consumption of oil in 2009 was 50 616 ktoe (54.4% of the total final energy consumption).

Table 12 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production[a]	290 486	Industry sector	37 124	Total	152 018
Net imports & other	–131 799	Transport sector	30 729	Thermal	132 453
Total PES	158 016	Other sectors	24 329	Hydro	11 095
Coal	32 805	Total FEC	92 182	Nuclear	–
Oil	72 172	Coal	11 294	Others	8 470
Gas	44 842	Oil	50 616		
Others	8 198	Gas	18 688		
		Electricity	11 584		

a Excludes biomass.
Source: EDMC (2011).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Energy Law

On 10 August 2007, Indonesia enacted Law No. 30/2007 regarding Energy. This Energy Law elucidates principles regarding the utilization 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, utilization of indigenous energy resources, and energy reserves.

The Energy Law mandates the creation of a National Energy Council (*Dewan Energi Nasional*, DEN). Its tasks are to:

- draft the National Energy Policy (KEN)
- endorse the National Energy Master Plan (*Rencana Umum Energi Nasional*, RUEN)
- declare measures to resolve 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 in a process that involves the regional governments and has due regard to input and recommendations 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: 7 ministers and high-ranking government officials responsible for the supply, transportation, distribution and use of energy; and 8 stakeholder members from industry, academia, expert groups, environmental groups, and consumer groups. The selection and appointment of members of DEN was finalized in late 2008.

DEN finalized the draft of the National Energy Policy in March 2011 for endorsement by parliament (the DPR) and enactment by the government. The 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.

Advanced reform of the electricity sector, which would have established the possibility of direct competition in power generation through (the now annulled) Law No. 20/2002, was rejected by the Constitutional Court in 2004.

The Oil and Gas Law

The Oil and Gas Law (Law No. 21/2001) created the upstream oil and gas implementing agency, *Badan Pelaksana Hulu Minyak dan Gas Bumi* (BP MIGAS), and the downstream oil and gas regulatory agency, *Badan Pengatur Hilir Minyak dan Gas Bumi* (BPH MIGAS). BP MIGAS and BPH MIGAS are independent government entities which report to parliament and are not part of government departments.

BP MIGAS manages, operates and has stewardship over upstream activities on behalf of the government as the holder of exclusive mining authority. Its duties include advising the minister with respect to policy on preparing and offering areas for work by investors and cooperation contracts; executing cooperation contracts; reviewing field development plans for the minister's approval; approving work plans and budgets; authorizations for expenditure; monitoring and reporting to the minister on the implementation of cooperation contracts; and appointing a selling agent for the state's share of oil and gas. 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 to promote gas utilization 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 and BPH MIGAS, and the termination of Pertamina's monopoly in upstream oil and gas activities.

Indonesia's oil and gas sector has a fiscal contractual system or regime, which relies mainly on production sharing contracts (PSCs) in oil and gas exploration and production; other types of joint contracts may also apply. PSCs are cooperative contracts for oil and gas exploration and production between the government and private investors (which include foreign and domestic companies, as well as Pertamina).

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 by both

the government and the investor. By instituting permits, the government expects to be better placed 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
- 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.

The 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 privately owned sector power systems, each operating within their respective business area (*wilayah usaha*). 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. As yet, there is no ruling whether PLN will implement tariff differentiation over its extensive power systems across Indonesia.

Law No. 30/2009 requires the formulation of three Government Regulations on electricity supply businesses, electricity support businesses, setting of selling prices of electricity, charges for the use of power lines, and electricity tariffs. Other regulations for the electricity industry will be formulated by the government and the provincial governments; this will include regulations on the buying and selling of electricity across Indonesia's borders.

The 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. The Ministry of Energy and Mineral Resources 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 awarding 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 utilization 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% in 2009 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).

Table 13 Main features of Indonesia's production sharing contracts

Elements	Third generation PSC (1988–recent)
First tranche petroleum (FTP)	15%–20%
Cost recovery limit	80%–85% (limited by FTP)
Investment credit	17%–20%
Domestic market obligation	25% of equity of oil; full price for the first 5 years and 10% at export price thereafter
Depreciation:	
Oil	7 years DDB (switching to SLD in five years)
Gas	14 years (switching to SLD)
Interest recovery	Available
Abandonment liability	None. Since 1995, PSCs have required the contractor to provide for abandonment.
Equity split, government/contractor: [a]	

Oil	85%–15%
Gas	70%–30% and 65%–35%
Corporate tax (as of 1995)	44%
Life span of contract/work area or block	30 years, 10-year limit for exploration
Effective date (ED) of work	Upon signing by the Minister of Energy and Mineral Resources, on behalf of the Government of Indonesia
Relinquishment of work area	During exploration, 25% of work area is relinquished in the 3rd year from ED, 25% of the remaining work area is relinquished in the 6th year from ED, and 25% of the remaining work area is relinquished in the 10th year from ED.

DDB = double declining balance; SLD = straight-line decline.

a The government take is under a production sharing agreement (PSA).

Source: Miriawati (2006).

Indonesia has other types of joint contracts in oil and gas: the technical assistance contracts (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, the participants in PSCs, TACs and EOR contracts may also enter into separate agreements known as joint operating agreements (JOA) and joint operating bodies (JOB).

Indonesia revised the terms of the domestic market obligation (DMO) 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.

Coal Bed Methane

Business in coal bed 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 coal bed methane gas development. The Minister of Energy and Mineral Resources issues regulations and establishes and offers coal methane gas work areas. The Directorate General of Oil and Gas technically establishes and offers coal bed methane work areas, with due consideration to the opinion of BP MIGAS.

Coal bed 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 offer of coal gas methane work area; use of data and information, equipment and facilities; research, assessment and development of coal gas methane; dispute resolution; ruling on coal methane gas as associated natural resource; and utilization of coal bed 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. PUP is a contract between the government and a private mining company; the government is 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 of 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 stated that existing contracts will be upheld, but the specific transition of existing concessions is yet to be formulated.

Geothermal

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

ENERGY EFFICIENCY

Government regulation on energy conservation

As called for by the Energy Law (Law No. 30/2007), the government issued Government Regulation No. 70/2009 regarding Energy Conservation, on 16 November 2009.

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 audit and energy conservation program for final energy users of 6000 toe or greater
- implementation of energy-efficiency standards and energy labelling
- government incentives of tax exemptions, fiscal incentives on import of energy-saving equipment, and low interest lending rates to encourage investments in energy conservation
- government disincentives of written notices to comply, public announcements of non-compliance, monetary fines, and reduced energy supply for non-compliance.

At the time of writing, the government is finalizing the regulatory framework to implement Government Regulation No. 70/2009 regarding Energy Conservation throughout Indonesia.

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 programs 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 applies. The aim of this policy is to:

- Achieve energy elasticity to GDP of less than one by year 2025
- Realize an optimum primary energy consumption mix in 2025, with shares as follows:
  - oil—to become less than 20%
  - natural gas—to become more than 30%
  - coal—to become more than 33%
  - biofuels—to become more than 5%

- renewable energy and other energy including nuclear—to become more than 10%
- liquefied coal—to become more 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* (DIM 2005).

Indonesia's 2006 Energy Policy expects the combined share of renewable energy and nuclear in the overall energy mix in 2025 to have exceeded 17%. The policy has 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% geothermal share and a combined share of biomass, hydropower, solar, wind and nuclear power to make up the remainder to 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 utilization priority of biofuels; categories of biofuels; standards and specification 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 the total fuel consumption (biofuel blend), as shown in the following table.

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 5695 million litres in 2025.

Table 4 Minimum obligations for biofuel use (% blend)

Sector	2009	2010	2015	2020	2025
Biodiesel					
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
Ethanol					
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
Straight vegetable oil fuel					
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).

Geothermal

The 2006 Energy Policy implicitly calls for Indonesia to increase total geothermal capacity to 9500 MW by 2025. In 2009 Indonesia's total geothermal capacity was 1189 MW, which is 4.3% of the total geothermal potential of 27 670 MW. Indonesia has identified 9076 MW of geothermal power potential, to come from existing geothermal plants, capacity expansion of productive geothermal resources, and from new geothermal projects, in 43 sites—specifically

4520 MW in Sumatra at 17 sites, 3635 MW in Java at 13 sites, 735 MW in Sulawesi at 4 sites, 146 MW in the Nusa Tenggara at 7 sites, and 40 MW in the Maluku Islands at 2 sites.

Under the 10 000 MW Accelerated Development of Electricity Generation – Phase II program, geothermal development projects will add a total of 3528 MW of new geothermal capacity over 2011–15; of this total capacity, 2551 MW will be developed by IPPs and 977 MW by PLN. Under PLN's 2009 Electricity Power Supply Business Plan 2009–2018 (*Rencana Usaha Penyediaan Tenaga Listrik,* RUPTL), further addition of geothermal capacity by 1902 MW is expected between 2016 and 2018.

Hydropower

PLN's 2009 Electricity Power Supply Business Plan (RUPTL) also expects the addition of 4740 MW to Indonesia's hydropower capacity during 2010–18; of this capacity, 3835 MW would be developed by PLN and 905 MW by IPPs. The hydropower capacity addition includes three pump-storage power plants in Java – specifically Upper Cisokan (1000 MW) in West Java, Matenggeng (885 MW) at the border of West and Central Java, and Grindulu (1000 MW) in East Java. These pump-storage plants are considered important for stabilising system frequency, to provide spinning reserves and system stability.

Under the 10 000 MW Accelerated Development of Electricity Generation – Phase II program for 2011–15, Indonesia is committed to building two hydropower plants – specifically Asahan III (174 MW) in north Sumatra, and Bakaru II (126 MW) in west Sulawesi. These hydropower plants would increase Indonesia's total large hydropower capacity to 3804 MW, or 5% of Indonesia's total hydropower potential of about 75 000 MW. It is worth noting that Indonesia's large hydropower potential is located in the eastern part of Indonesia, far from large demand centres.

NUCLEAR

Under current policy, Indonesia expects to have in operation its first series of four nuclear power plants, with a total capacity of 4000 MW, by 2025. A strong candidate site for these plants is the Muria peninsula on the north coast of Central Java. Nuclear plant site studies have been conducted in Indonesia since the early 1980s.

In 2007, the government established the Nuclear Power Development Preparatory Team, whose task it is to take the necessary preparatory measures and make the plans to build Indonesia's initial nuclear power plants. The legal basis of Indonesia's nuclear power development includes Law 17/2007 on Long Term Development Year 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 10 000 kW 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 uranium between 5000–10 000 tonnes, of grade range 0.10–0.30; and the Riang Tanah Merah Ore Body, a uranium vein that may contain uranium less than 5000 tonnes, grade range 0.30–1.00. The uranium mines are located in West Kalimantan.

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 formalized 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, United States. In addition, the government of Indonesia has pledged to reduce GHG emissions from forestry and the energy sector by 26% through domestic effort, and by up to 41% through cooperation with other economies.

In response to the government's 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, programs, projects, funding schemes and capacity building in all development sectors. Two initial phases of the roadmap are the integration of climate change into the Mid-Term Development Plan 2010–2014 (*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 utilize 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 actors. The Transformation Fund is not a grants fund but a revolving fund, so projects are expected to generate returns on the fund's investments.

NOTABLE ENERGY DEVELOPMENTS

OIL AND GAS

Upstream oil and gas

In 2011, the upstream oil and gas implementing agency, BP MIGAS, approved 41 oil and gas plans of development (POD) and accelerated production (put on production, or POP). The number of POD and POP approvals in 2011 was exceptionally high compared to 2003–2010. The approvals are expected to increase oil reserves by 301.72 million barrels and gas reserves by 0.113 billion cubic metres (4 Tcf), which will bring Indonesia's proven oil reserve to 3.9 billion barrels and natural gas to 2.946 billion cubic metres (104 Tcf), as at 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.

PUBLIC PRIVATE PARTNERSHIP – ELECTRICITY

Following 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 realized under the Public Private Partnership (PPP) program, which was established under Presidential Regulation No. 67 of the Year 2005 regarding Government Partnership with Private Entity to Provide Infrastructure. The terms of the PPP program include that government will invest in the project, and guarantees PLN power purchases. This will be carried out through a private guarantor established by Presidential Regulation No. 78 of Year 2010 regarding Infrastructure Guarantees in Government Partnership Projects with Business Entities which is Executed Through Private Infrastructure Guarantor.

Government guarantee for the PPP Central Java power plant project is a significant step in infrastructure development in Indonesia, as it is considered more transparent and accountable. The PPP scheme for the Central Java power plant project is Build-Own-Operate-Transfer (BOOT), and has a concession period of 25 years. The project is expected to begin commercial operation at the end of 2016.

ACCELERATED ELECTRICITY GENERATION PHASE I

The accelerated power development program 10 000 MW Phase I had constructed 4592 MW of new generation capacity at the end of 2011. The completion date for this phase has been extended by the Ministry of Energy and Mineral Resources, to 2014.

KEROSENE TO LPG CONVERSION PROGRAM

In December 2009, Phase I of the government's kerosene-to-LPG conversion program was completed. The program distributed 24.4 million three-kilogram LPG canisters to the densely populated provinces of Jakarta, Banten, West Java, Yogyakarta, and South Sumatra. The program averted the need for Pertamina to supply 5.38 billion litres of heavily subsidized kerosene for use in households in those provinces.

The programme was extended in 2010, with a further 4.715 million three-kilogram LPG canisters to be distributed (as at May 2011 some 2.379 million canisters had already been distributed). In 2012, the program expects to distribute another 800 000 three-kilogram LPG canisters.

RENEWABLE ENERGY

Hydroelectric Power

The Upper Cisokan Pumped Storage Hydroelectric power plant (4 x 260 MW) project in West Java received a government loan from the World Bank/IBRD in late 2011. The project is expected to be completed in 2016. This plant will be the first of its kind in Indonesia.

PLN has also secured financing for construction of the Jati Gede hydroelectric power plant (2 x 55 MW) in West Java, and the Merangin hydroelectric power plant (2 x 90 MW) in the province of Bengkulu, 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 leaders within the economy to act in innovative ways to save energy and water within their institutional domain and/or in the domain of state owned enterprises and regional government owned enterprises within their jurisdiction. The Presidential Instruction is to Ministers of the Unity Indonesia II Cabinet, 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 to Regents/Mayors,.

The Presidential Instruction sets targets of electricity reductions of 20% from average electricity use over the six months before the Presidential Instruction; fuel reductions of 10% (to be achieved through regulations to limit use of subsidized fuels); and water use reductions of 10% from average water use over the previous six months.

The Presidential Instruction also established a National Team on Saving Energy and Water. The Coordinating Minister of Economic Affairs chairs the team, while the Minister of Energy and Mineral Resources is the Chief Executive and also a member of the team; in total 11 Cabinet Ministers are on the team. A Team Secretary and Executive support their work.

Ministerial Regulation NO. 02 of the Year 2011: Assignment to PLN to make power purchase from Geothermal power plants

Ministerial Regulation No. 02 of the Year 2011 regarding Assignment to PLN to Make Power Purchases from Geothermal Power Plants; sets the terms under which PLN is to purchase geothermal power. The regulation applies to the winners of bids for geothermal mining work areas; and holders of valid geothermal mining work areas; or licence holders of geothermal business that is based on regulations prior to Law No. 27 of the Year 2003 regarding Geothermal.

The price established by Government is a ceiling price –USD 0.097. However, PLN geothermal power purchases (from private geothermal companies) is through a competitive bidding process. The Regulation requires PLN to purchase geothermal power from the lowest bidder. The ceiling price is a way to promote investments in geothermal power.

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USEFUL LINKS

BP MIGAS—www.bpmigas.com/ENGLISH/

BPH MIGAS—www.bphmigas.go.id

Directorate General of Taxes (Pajak)—www.pajak.go.id/eng/

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

PT PLN (Persero)—www.pln.co.id

Statistics Indonesia (Badan Pusat Statistik, BPS)—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 2009 was about USD 3354.66 billion (USD (2000) at PPP). Japan's population of 127.6 million people in 2009 had a per capita income of USD 26 299. Japan's GDP decreased by 6.3% in 2009 compared to the previous year.

Japan possesses only modest indigenous energy resources and imports almost all of its crude oil, coal and natural gas requirements to sustain economic activity. In 2009, proven energy reserves included around 44 million barrels of oil, 21 billion cubic metres of natural gas and 350 million tonnes of coal.

Table 14 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	377 800	Oil (million barrels)—proven	44
Population (million)	127.6	Gas (billion cubic metres)	20.9
GDP (USD (2000) billion at PPP)	3 354.66	Coal (million tonnes)—proven	350
GDP (USD (2000) per capita at PPP)	26 299		

a Proven Reserves at the end of 2009 (BP 2010)

Sources: EDMC (2011), Oil & Gas Journal (2010).

Energy supply and demand

PRIMARY ENERGY SUPPLY

In 2009, Japan's total primary energy supply was 465.288 million tonnes of oil equivalent (Mtoe), 8.4% less than in 2008. Of fuel types, oil contributed the largest share (43%), followed by coal (21%) and natural gas (17%). In 2008, net imports of energy sources accounted for 79% of the total primary energy supply. With limited indigenous energy sources, Japan imported almost 99% of its oil, 98% of its coal and 96% of its gas.

In 2009, Japan was the world's third largest oil consumer after the United States and China (BP 2010) and almost all of the oil was imported. The bulk of the imports (84.5% in 2009) came from economies in the Middle East such as the United Arab Emirates, Saudi Arabia, Iran, Qatar and Kuwait (BP 2010). In 2009, the primary oil supply was 198.267 Mtoe, a decline of 10.9% 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, etc. Coking coal is imported from Australia, Indonesia, Canada, the United States, Russia, and China etc.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 20.9 billion cubic metres, and are located in Niigata, Chiba and Fukushima prefectures. Domestic demand is met

almost entirely by imports of liquefied natural gas (LNG) (BP 2010), which come from Indonesia (20.1% of imports in 2009), Malaysia (19.5%), Australia (18.5%), Qatar (12.0%), Brunei Darussalam (9.4%), the United Arab Emirates (7.9%), Oman (4.0%) and others. In 2009, LNG imports to Japan comprised 35.4% 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 2009, primary natural gas supply was 79 Mtoe, a decrease of 6.7% from the previous year.

Japan has 277.511 GW of installed generating capacity and generated 1 093 787 GWh of electricity in 2009. Electricity is generated from thermal fuels (coal, natural gas and oil—64.2%), nuclear (25.1%) and hydro (7.5%); geothermal, solar and wind technologies produce the remainder (3.1%).

Table 15 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	94 020	Industry sector	132 590	Total	1 093 787
Net imports and other	371 268	Transport sector	78 464	Thermal	702 787
Total PES	465 288	Other sectors	98 725	Hydro	82 432
Coal	98 659	Total FEC	309 778	Nuclear	274 651
Oil	198 267	Coal	31 063	Other	33 917
Gas	79 120	Oil	165 711		
Other	89 242	Gas	27 389		
		Electricity and other	85 615		

Source: EDMC (2011).

FINAL ENERGY CONSUMPTION

In 2009, Japan's total final energy consumption was 309.778 Mtoe, or 7.5% less than in the previous year. The industrial sector consumed 43% of the total, followed by the transportation sector at 25%. By energy source, petroleum products accounted for 54% of total final energy consumption, followed by electricity and other (28%), coal (10%) and city gas (9%).

In 2009, energy consumption in the industrial sector declined by almost 12.5%. The residential/commercial sector's energy consumption also decreased by 3.5% and the transport sector's consumption declined by 2.6%.

Policy overview

ENERGY POLICY FRAMEWORK

The Ministry of Economy, Trade and Industry (METI) is responsible for formulating 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 is responsible for the safety of energy facilities and industrial activities. The Ministry of Foreign Affairs formulates international policies, while the Ministry of Environment is responsible for the environment 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 the nuclear fuel cycle at an early stage; the promotion of new energy sources for electric power suppliers; assurance of the 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 program 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 Japanese 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 zero-emission power sources ratio to about 70% (34% at present)
- Halving CO_2 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_2 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 Disaster, the Japanese Government decided to review its Strategic Energy Plan. A new energy plan is now under intensive development and is expected to be announced in the summer of 2012.

In August 2011 a Cabinet Decision announced the creation of a (tentatively named) "Nuclear Safety and Security Agency (NSSA)" as an Affiliated Organization of the Ministry of Environment. Its aim would be to achieve "the separation of nuclear regulation and promotion". The new agency would be created by separating the nuclear safety regulation section of the Nuclear and Industry Safety Agency (NISA) from the Ministry of Economy, Trade and Industry (METI) and combining it with the function of the Nuclear Safety Commission (NSC). The Cabinet Secretariat has begun preparation including drafting necessary Bills, with the aim of establishing the NSSA in April 2012 (Cabinet Secretariat of the Japanese Government, 2011).

ENERGY MARKETS

Oil

Japan aims to decrease its oil dependency, partly because of its experiences during oil crises. 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) managed the economy's stockpile business until 2003. JNOC provided financial and technical assistance to the Japanese oil industries for their oil and natural gas exploration and development, both domestically and abroad. In 2004, the functions of the stockpile business were transferred to Japan Oil, Gas and Metals National Corporation (JOGMEC), which was established in February 2004. Following the Specially Designated Public Corporation Rationalisation Plan, JOGMEC was established through merging JNOC and the Metal Mining Agency of Japan. Japan's oil stocks are well in excess of the International Energy Agency's 90-day net import requirements. As of January 2009, Japan held the equivalent of 152 days of net imports, including state-owned and private sector stocks.

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 petroleum companies achieve a 13% share of heavy oil cracking unit capacity in their total distillation capacity.

The number of service stations has been declining over the last 15 years because of market liberalization. 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.

Natural gas

Demand for natural gas has been increasing rapidly over the past two decades. Between 1980 and 2009, natural gas demand grew at an annual rate of 3.8%—the fastest growth in all primary energy sources. This robust growth is expected to continue, partly for environmental reasons and partly due to its ease of use. Japan has undergone natural gas market reform since 1995 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 from Indonesia, Malaysia, Brunei Darussalam, Australia and Russia (from April 2009). Since Japan has placed priority on the 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 the technological development of production/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

. From the standpoint of Japan, it is therefore essential to promote the development of overseas coal for energy security in Asia and to address growing domestic coal demand.

Electricity market

Electricity was the second largest contributor (next to petroleum) 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 price has been among the highest of the developed economies. To lower the electricity price and increase industrial competitiveness, Japan has undergone a program to reform the electricity sector, through three cycles of amendments to the Electricity Utilities Industry Law, in 1995, 1999 and 2004.

FISCAL REGIME AND INVESTMENT

The Japanese government recognizes the necessity of encouraging domestic petroleum companies to obtain oil and gas upstream 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 guarantee and building JOGMEC's flexible and effective finance system, 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. It requires improving energy efficiency in the sectors of industry, consumer (commercial and household) and transport. Japan has been improved energy efficiency by about 40% after the oil crises.

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

- Enhancing Japan's energy efficiency (already the highest level in the world) through introducing the most advanced technologies for replacing equipment in the industrial sector
- Making net-zero-energy houses available by 2020 and realizing net-zero-energy houses 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 highly-efficient 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 in two years

- Enhancing support and regulatory measures (including top-runner standards) to increase the take-up 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 due to periodical inspection of nuclear power plants the Japanese Government began a significant review of its Strategic Energy Plan.

RENEWABLE ENERGY

Japan aims to raise the share of renewable energy in its energy mix to 10% by 2020, to alleviate global warming, diversify energy sources, and promote environment-related industries. The government is developing sustainable standards for biofuels to reduce greenhouse gases. The target is to increase the share of biofuels to 3% of gasoline-equivalent sold in Japan by 2020. This is expected to reduce greenhouse gases and encourage the introduction of the next-generation of biofuel technologies (such as celluloid and algae).

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 to consumers, and implement measures for stabilizing 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 will take effect on 1 July 2012. This Act obliges electric utilities to purchase electricity generated from renewable energy sources (solar photovoltaic, wind power, hydraulic power, geothermal and biomass) based on a fixed-period contract with fixed price. Costs incurred by the utility in purchasing renewable energy sourced electricity shall be transferred to all electricity customers, who will pay the "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 the purpose. The feed-in tariff (FIT) rate and contract period are to be determined according to factors such as the type, form of installation and scale of renewable energy sources. The contract rate and period shall be notified by the Minister of Economy, Trade and Industry and will be based on the recommendation of a newly established independent committee. To promote the generation of renewable energy sourced electricity, special consideration shall be made of the profit of the 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 Disaster. As of the end of May 2012, all (50 units excluding 4 units at Fukushima Daiichi Nuclear Power Plant to be decommissioned) nuclear power plants in Japan have stopped operation for the periodical inspection (once in 13 months, regardless of the Fukushima Daiichi Nuclear Power Plant Disaster). The Japanese Government is carefully evaluating the safety of all the existing nuclear power plants including those under periodical inspections. IAEA review team concluded that this procedure was generally consistent with IAEA Safety Standards.

The same crisis has prompted an overall review of Japan's energy strategy, and in late 2011, the government also began the separation of the functions of regulation and promotion of nuclear power—as outlined in the Energy Policy Framework section.

CLIMATE CHANGE

In 2007, the Japanese Government announced Cool Earth 50, a cooperative initiative with major greenhouse gas 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 Program, 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, Prime Minister Yukio Hatoyama pledged that Japan would cut its greenhouse gas 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 greenhouse gas emissions stood at 1235.08 million tonnes of CO_2 equivalent in 2007 (an increase of 1.7% compared to the previous year) (Prime Minister of Japan and His Cabinet 2009).

In December 2011 at the COP 17 Meeting, the Japanese Government expressed clearly its opposition to 'the extension of Kyoto Protocol beyond 2013", since the existing protocol covers only a quarter of GHGs emission in the world.

Notable energy developments

ELECTRICITY

Following the East Japan Great Earthquake in March 2011 and the subsequent Fukushima Daiichi Nuclear Power Plant Disaster, Tokyo Electric Power Company (TEPCO) staged rolling outages of power supply in March 2011. As more and more nuclear power plants ceased operation for the periodical inspection, the Japanese Government called for a 15% reduction of power consumption within the supply areas of Tokyo Electirc Power Company and Tohoku Electric Power in mid 2011(This target for reduction of power consumption was achieved)

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USEFUL LINKS

Agency for Natural Resources and Energy—www.enecho.meti.go.jp/english/index.htm
Institute of Energy Economics, Japan—http://eneken.ieej.or.jp
Ministry of Economy, Trade and Industry—www.meti.go.jp/english/index.html
Ministry of the Environment—www.env.go.jp/en/index.html
Ministry of Land, Infrastructure, Transport and Tourism—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 48.75 million people. Korea's population density is very high, with an average of more than 480 people per square kilometre. More than 20% of the population lives in Seoul, Korea's capital and its largest city.

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 3.92% per year from 1980 to 2009, reaching USD 1142.4 billion (USD (2000) at PPP) in 2009. Per capita income in 2009 was USD 23 435, 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 96.4% of its primary energy supply in 2009. 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, 2009

Key data		Energy reserves	
Area (sq. km)	99 538	Oil (barrels)	–
Population (million)	48.75	Gas (billion cubic metres)—recoverable	3
GDP (USD (2000) billion at PPP)	1142.40	Coal (million tonnes)—recoverable	326
GDP (USD (2000) per capita at PPP)	23 435		

Sources: EDMC (2011); EIA (2009); MKE and KEEI (2011).

Energy supply and demand

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased more than sixfold between 1980 and 2009, from 38.32 million tonnes of oil equivalent (Mtoe) in 1980 to 232 Mtoe in 2009. In particular, from 1990 to 2000, energy supply increased at an annual average rate of 7.33%, far exceeding the economic growth rate of 6.2% for the same period. Likewise, per capita primary energy supply grew from 1.0 tonne of oil equivalent in 1980 to 4.76 tonnes of oil equivalent in 2009. The level of increase was similar to that of Japan and of most European economies.

In 2009, Korea's total primary energy supply was 232 Mtoe, a 1.02% increase from the previous year. By energy source, oil represented the largest share (40.1%), followed by coal (27.9%), and gas (13.7%). The remaining 18.3% of primary energy supply came from nuclear and hydro energy sources. Korea imported around 87% of its total energy needs in 2009, including all of its oil and gas requirements and 98% of its coal supply. The cost of Korea's energy imports was USD 91.2 billion in 2009 (it was USD 141 575 billion in 2008). Energy imports accounted for 28.2% of Korea's total import value in 2009.

Oil supply in 2009 was 93.3 Mtoe, a 1.21% increase from the previous year. In 2009, the economy imported about 85% of its crude oil from the Middle East.

Coal supply in 2009 totalled 64.7 Mtoe, a 3.83% 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. 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 31.7 Mtoe in 2009; its share in the primary energy supply accounted for 13.7% 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 2009 was 454.5 terawatt-hours, a 1.81% increase from 2008. Generation by thermal sources, including coal, oil and natural gas, accounted for 65.7% of the total electricity generated, followed by nuclear at 32.5%, and hydro at 1.2%.

Table 2 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	47 139	Industry sector	39 930	Total	454 504
Net imports and other	198 103	Transport sector	29 302	Thermal	298 953
Total PES	232 007	Other sectors	78 205	Hydro	5 641
Coal	64 665	Total FEC	147 438	Nuclear	147 771
Oil	93 315	Coal	7 772	Other	2 139
Gas	31 713	Oil	79 941		
Other	42 314	Gas	18 122		
		Electricity and other	41 603		

Source: EDMC (2011).

FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2009 was 147.4 Mtoe, a 0.74% increase from the previous year. The industry sector accounted for the largest share at 27.1%, the transport sector accounted for 19.8%. The remainder (53.1%) 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 54.2% of total energy consumption, followed by electricity and other (28.2%), natural gas (12.3%), and coal (5.3%). Because of the economy's policy measures, natural gas consumption has increased significantly.

Policy overview

ENERGY POLICY FRAMEWORK

In the past, Korea's energy policy focused on ensuring a stable energy supply to sustain economic growth. The government is now seeking a new direction in energy policy 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 liberalization efforts in the energy sector, in 2001 the government established the Korea Electricity Commission (KOREC) to take charge of the regulations in the electric power sector and to manage the 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.

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 (KEPCO).

Part of the plan has been implemented, including the establishment of the Korea Power Exchange and the Korea Power Commission in April 2001. The power generation part of KEPCO was split into six wholly-owned companies (five thermal generation companies and 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 Korea Gas Corporation (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 privatization of import and wholesale businesses, stabilized price 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 liberalization of the gas market has 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 2.25 million barrels, or 94% of this 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. Nuclear energy is a strategic priority for the Korean Government, and its share of the 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 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, the corporate tax rate was scheduled to be lowered further from 22% in 2009 to 20% in 2010, and from 11% to 10% for

the same period, respectively. However, the implementation of the tax rate reduction is 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 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 program modelled on Japan's Top Runner Program to complement the current Energy Efficiency Label and Standard Program.

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 programs to promote renewable energy.

New and renewable energy resources are significant not only because they are sustainable energy sources, 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, or 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 will 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 2050 jobs to augment its existing workforce of about 2900 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 programs 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 realize 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 is to build 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 programs 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. As the economy recovers, the priority given to R&D will become more significant.

Table 3 Policy indicators, five-year plan, 2009–13

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

Roughly 2% of the economy's annual GDP is 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 program and the carbon fund, and fosters companies specialized in the emissions trading scheme; 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

NOTABLE ENERGY DEVELOPMENTS

CLEAN ENERGY/ENERGY EFFICIENCY

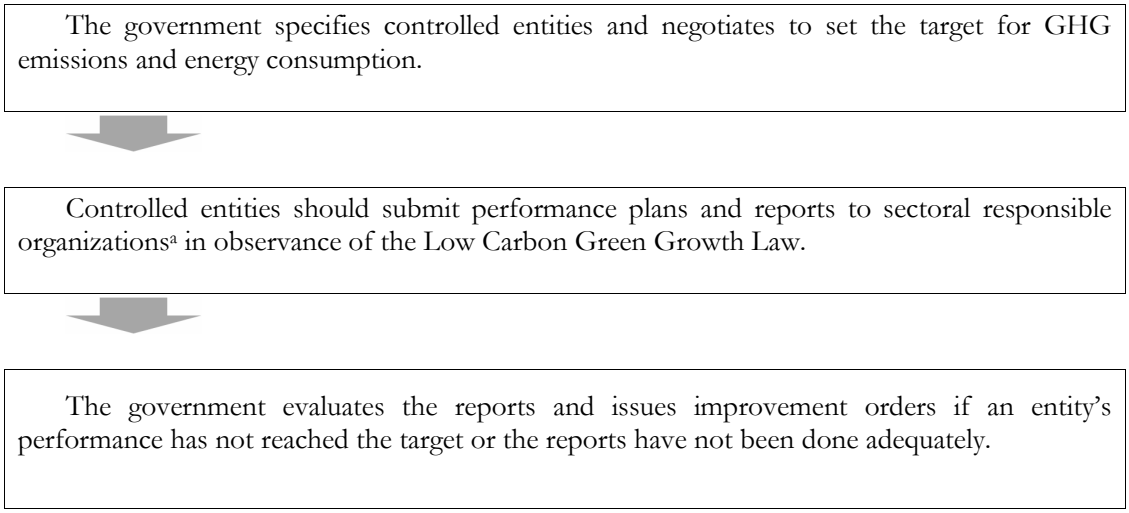
R&D Plan to Nurture the Green Industry

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 reduction for public/private large emitters.

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



a Sectoral responsible organizations:
– 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 The GHG emissions and energy standards in Korea of specified controlled entities, valid from 2011–14

	until 12 December 2011		from 1 January 2012		from 1 January 2014	
	Company	Business unit within company	Company	Business unit within company	Company	Business unit within company
GHG emission (tCO_2)	125 000	25 000	87 500	20 000	50 000	15 000
Energy consumption (TJ)	500	100	350	90	200	80

Note: 1 TJ = 23.8846 toe; 1 toe = 3.2 tCO_2

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_2)

The sectoral responsible organizations 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 should 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.

In October 2011, the government confirmed and notified the controlled entities of the targets for GHG emissions and energy consumption for 2012. The total target amount for GHG emissions for all controlled entities in 2012 is 598 million tonnes of CO_2, a 1.4% reduction compared to the business-as-usual level (900 million tonnes of CO_2). The government considers this target will not be a heavy burden on the controlled entities, since next year will be the first year of the GHG Emissions and Energy Target Management scheme's implementation. Also, the government will help the controlled entities achieve the target by providing consulting and technical auditing services.

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USEFUL LINKS

Korea Electric Power Generation Corporation—www.kepco.co.kr/eng/
Korea Energy Economics Institute—www.keei.re.kr
Korea Energy Management Corporation—www.kemco.or.kr
Korea Gas Corporation—www.kogas.or.kr
Korea National Oil Corporation—www.knoc.co.kr
Ministry of Knowledge Economy—www.mke.go.kr
Ministry of Strategy and Finance—www.mosf.go.kr
Statistics Korea—www.kostat.go.kr

MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia. Its territory covers 330 252 square kilometres, spread across the southern part of the Malay Peninsula and the Sabah and Sarawak states on the island of Borneo. In 2009, Malaysia's population was around 27.5 million. Since 2000, Malaysia's GDP has grown steadily, at an average rate of 5.1% a year. Between 2008 and 2009, however, GDP growth decreased by 1.7%, to USD 309.8 billion (USD (2000) at PPP). The GDP per capita decreased by 3.33%, to USD 11 278 (USD (2000) at PPP) in 2009.

Malaysia's economy depends heavily on manufacturing and resource extraction, although there are ongoing initiatives to expand services and higher-value-added activities. In 2009, the manufacturing sector's share accounted for 40.9% of GDP. The major energy-intensive segments of the industry sector are the iron and steel, cement, wood, food, glass, pulp and paper, ceramics and rubber industries. In the same period, the mining sector, including oil and gas extraction, accounted for 13.0% of GDP.

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. At the end of 2009, Malaysia's crude oil reserve, including condensate, was 5.8 billion barrels. Malaysia also has an abundant natural gas reserve. At the end of 2009, Malaysia's proven natural gas reserve was 2.4 trillion cubic metres. 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, 2009

Key data		Energy reserves	
Area (sq. km)	330 252	Oil (billion barrels)—proven	5.8
Population (million)	27.5	Gas (trillion cubic metres)—proven	2.4
GDP (USD (2000) billion at PPP)	309.8	Coal (million tonnes)	1 483
GDP (USD (2000) per capita at PPP)	11 278	Uranium (million tonnes)	N/A

Sources: EDMC (2011); BP Statistical Review (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 65 996 kilotonnes of oil equivalent (ktoe) in 2009. The largest energy source was gas, which accounted for 29 603 ktoe, or 44.9% of the total primary supply. Oil was ranked second, with 26 577 ktoe, followed by coal, with 9030 ktoe, and other sources, with 786 ktoe. In 2009, Malaysia produced an average of 739 thousand barrels of crude oil per day. Domestic consumption was around 539 thousand barrels of crude oil per day. Malaysia exports its oil to Singapore, Thailand, Japan and Korea. Malaysia's oil production is expected to fall in the future, mainly due to the natural depletion of its reserves.

In 2009, Malaysia's natural gas production was 64.1 billion cubic metres per day and its domestic consumption was 33.7 billion cubic metres per day. Domestic gas was mainly for power generation and industrial use. Malaysia is one of the world's leading exporters of liquefied natural

gas (LNG). In 2009, it exported a total of 22.3 million tonnes of LNG to Japan, Korea and Chinese Taipei (PETRONAS 2010).

Coal is one of the primary fuels in Malaysia's energy sector. Coal is used mainly for power generation, and by the iron and steel industry and cement manufacturers. Malaysia's coal consumption in 2009 was 9030 ktoe. Malaysia imports coal from China, Australia, Indonesia and South Africa.

In 2009, total electricity generation was 105 658 gigawatt-hours (GWh). Thermal generation, mostly from natural gas and coal, accounted for 93.7% of total power generation; hydropower accounted for the remainder. Natural gas accounted for 63.0% and coal accounted for 30.4% of the total fuels input for electricity generation (EPU 2009).

Table 2 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	84 469	Industry sector	13 419	Total	105 658
Net imports and other	–18 678	Transport sector	16 066	Thermal	98 987
Total PES	65 996	Other sectors	8 758	Hydro	6 671
Coal	9 030	Total FEC	38 244	Nuclear	–
Oil	26 577	Coal	1 378	Geothermal	–
Gas	29 603	Oil	22 757	Other	–
Other	786	Gas	5 826		
		Electricity and other	8 283		

Source: EDMC (2010).

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

FINAL ENERGY CONSUMPTION

In 2009, total final energy consumption in Malaysia was 38 244 ktoe. The transport sector was the biggest final energy user at 16 066 ktoe, or 42.0% of total final energy consumption, followed by the industry sector at 13 419 ktoe, or 35.1%, and other sectors (agriculture, residential/commercial and non-energy) at 22.9%. By energy type, petroleum products contributed the largest share, with 59.5% of consumption, followed by electricity (21.7%), gas (15.2%) and coal (3.6%).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The key ministries and agencies for Malaysia's energy sector are the Energy Unit of the Economic Planning Unit of the Prime Minister's Department; the Ministry of Energy, Green Technology and Water; and the Energy Commission. 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 (MEGTW 2008). 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.

In general, Malaysia's energy sector is guided by the National Energy Policy, which has the following objectives: ensuring the provision of adequate, secure and cost-effective energy supplies by developing indigenous energy resources, both non-renewable and renewable, using least-cost options, and diversifying supply sources both within and outside the economy; promoting the efficient use of energy and the elimination of wasteful and non-productive patterns of energy consumption; and ensuring that factors pertaining to environmental protection are taken into consideration in the production and use of energy, by minimising the negative impacts of energy production, transportation, conversion and use on the environment.

The National Depletion Policy was formulated to prolong and preserve the economy's energy resources, particularly its oil and gas resources. Under this policy, the total annual production of crude oil should not exceed 3% of oil originally in place, which currently limits oil production to around 680 000 barrels per day. To diversify the fuel mix used in electricity generation, the economy introduced the Four-Fuel Policy. The initial focus of this policy was to reduce the economy's overdependence on oil as the principal energy source, and it aimed for an optimal fuel mix of oil, gas, hydro and coal for use in electricity generation. As a result, oil's domination of the power generation fuel mix has been significantly reduced and replaced with gas and coal. In 2002, the policy was expanded to incorporate renewable energy into the fuel mix after oil, gas, coal and hydro. It is now the Five-Fuel Policy for electricity generation. Nuclear energy is not used in Malaysia. However, the economy is exploring the nuclear potential as one of its options for future power generation.

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 will emphasise 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 2010).

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 such as renewable energy. The importation of liquefied natural gas (LNG) was also identified as a way to improve energy security, and work has started on the economy's first LNG receiving terminal in Sungei Udang Port in Malacca. This facility is due for completion in mid-2012.

Malaysia also addresses energy security by cooperating closely with its neighbours under the Association of Southeast 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. The project 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 the National Green Technology Policy. One objective of the policy is to provide a path towards sustainable development. The policy is built on four pillars: energy—seek to attain energy independence and promote efficient use; environment—conserve and minimise the impact on the environment; economy—enhance economic development through the use of technology; and society—improve the quality of life for all.

The policy covers four key areas:

- *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.

To promote the development of green technology activities, the Malaysian Government has established a MYR 1.5 billion fund. The fund will provide soft loans to companies that supply and use green technology.

To expand the use of green, including energy-efficient, technology in buildings, the government launched the Green Building Index (GBI) on 21 May 2009. In line with this, the government is providing the following incentives:

- Building owners obtaining GBI certificates from 24 October 2009 to 31 December 2014 are given income tax exemption equivalent to the additional capital expenditure in obtaining such certificates.
- Buyers purchasing buildings with GBI certificates from developers are given stamp duty exemption 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 by withdrawing energy subsidies gradually. In 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 power's natural gas prices has been put 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 subsidy 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 2010).

UPSTREAM ENERGY DEVELOPMENT

Malaysia's upstream energy development is governed by the Petroleum Development Act 1974. The Act vests Petroliam Nasional Berhad (PETRONAS) with the entire ownership and

control of petroleum resources in Malaysia. PETRONAS is wholly-owned by the Malaysian Government.

PETRONAS is intensifying its exploration of deepwater and extra-deep water areas. In 2009, 16 new fields came on stream, increasing the total number of producing fields in Malaysia to 104, of which 68 are oil fields and 36 are gas fields. Six new production-sharing contracts were awarded during 2009, bringing the total to 71, with 25 in Peninsular Malaysia, 22 in Sarawak and 24 in Sabah.

During 2010, the discovery of gas reserves by PETRONAS Carigali, a subsidiary of PETRONAS, from the economy's first High Pressure High Temperature (HPHT) well in the Kinabalu field off the coast of Sabah, was a key milestone for the domestic exploration and production sector. It potentially opens up new exploration prospects for deeper reservoirs.

ELECTRICITY AND GAS MARKETS

Malaysia has a reliable and stable electricity supply system, which is regulated by the government. In the 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 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 liquefied natural gas (LNG) by 2015. To improve the efficiency of coal use and to reduce carbon dioxide emissions, the government will explore super-critical coal technology for new investments. Specific initiatives to increase generation capacity include:

- *Peninsular Malaysia*. Two hydroelectric plants will be commissioned during the plan period in Ulu Jelai and Hulu Terengganu with a combined capacity of 622 MW.
- *Sabah*. Three new power plants will be commissioned with a combined capacity of 700 MW. These include two gas-based power plants on the west coast, and one coal-based power plant on the east coast using clean coal technology.
- *Sarawak*. The 2400 MW Bakun Hydroelectric Project will be commissioned in stages.

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.

The economy is exploring the use of nuclear energy. Currently, nuclear energy has no share in the power generation fuel mix. Recent developments in the world energy market—such as the volatility of oil and gas and coal prices, the depletion of indigenous oil and gas resources, and environmental concerns about coal-fired power plants—have made the government consider

nuclear energy as an option for its future power needs. The government has initiated a study on the potential of nuclear energy for power generation in Malaysia. The economy is considering nuclear energy in its power generation sector after 2020.

In 2009, the Peninsular Gas Utilisation system supplied 60.8 million standard cubic metres per day (MMscm/D) of gas, a decrease of 1.1% from 2008, for domestic consumption and export to Singapore. The power sector remains the largest domestic gas user, consuming 59.7% of gas transmitted through the system. Industrial, petrochemical and other users accounted for 34.1%, increasing from 19.9 MMscm/D in the previous year to 20.7 MMscm/D in 2009. About 6.2% was exported to Singapore. The Peninsular Gas Utilisation gas input came from the offshore Terengganu gas field and through imports from the Malaysia–Thailand Joint Development Area, Indonesia and Viet Nam. In 2009, the gas input from the offshore Terengganu field decreased by 3.5% from the previous year,and almost 24% of the total supply was imported.

ENERGY EFFICIENCY

Energy efficiency improvement is one of the important elements 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. Under this framework, the National Energy Efficiency Master Plan 2010 is intended to be a holistic roadmap for implementing improvements in energy efficiency in the industrial, commercial and residential sectors. The plan's target is to reduce electricity consumption by 10% (7.3 million tonnes of oil equivalent) in the year 2020 compared to a 'business-as-usual' scenario. The plan sets out 18 programs in those sectors that will result in significant energy savings over the plan period and beyond.

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.

In December 2011, the government adopted the feed-in-tariff (FiT) for power generated from renewable energy resources. The FiT is funded through a levy imposed on electricity users in the economy. The government also established a special agency, the Sustainable Energy Development Authority (SEDA), under the Ministry of Energy, Green Technology and Water, to manage the FiT fund and to support the development of renewable energy in the economy. 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's National Climate Change Policy was formulated in 2009. The main objectives of this policy are to streamline and coordinate government action across existing legislation and policies, to establish an inter-ministerial and cross-sectoral committee to drive and facilitate the implementation of adaptation and mitigation measures, and to identify options and strategies to achieve a low-carbon economy. Under the Tenth Malaysia Plan, Malaysia will adopt a dual strategy to address the impacts of climate change: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce the emission of greenhouse gases (GHGs).

NOTABLE ENERGY DEVELOPMENTS

THE TENTH MALAYSIA PLAN (2011–15)

The Malaysian Prime Minister unveiled the Tenth Malaysia Plan on 10 June 2010. This plan introduces a revised energy policy that emphasises energy security and economic efficiency as well as environmental and social considerations. Details of the plan are in the Policy Overview section.

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USEFUL LINKS

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Ministry of Energy, Green Technology and Water—www.kettha.gov.my

Ministry of Finance—www.treasury.gov.my

PETRONAS—www.petronas.com.my

MEXICO

Introduction

Mexico, whose official name is the United Mexican States (Estados Unidos Mexicanos), 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 (Inegi 2010), which is projected to grow to 121.9 million by 2050 (Conapo 2005). According to Mexican Government statistics, 46.2% of the population is considered poor, and 10.4% is 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 2009, Mexico's real gross domestic product (GDP) was USD 1022 billion (USD 2000 at PPP). From 2000, economic expectations were high due to political changes and reforms, however in the 2000-2009 period economy has grown little, rising at an annual average rate of 1.4% (EDMC 2011). Due to its strong bond to the US economy, during 2010 and 2011 Mexico was still struggling with the effects of the global economic crisis and the collapse of international trade during the last quarter of 2008 and the first quarter of 2009. In spite of this, the first half of 2010 was more favourable than previous years; this helped the US economy to improve, with positive effects for Mexican exports, especially from the automotive, electric/electronic and mining sectors. As a result, job generation and companies' income grew, bank credit capacity expanded, and economic outlooks were more positive than previous years. Ultimately the impact on the Mexican economy was positive and led to an upturn in the Mexican demand for goods and services (SHCP 2011). According to international forecasts, the Mexican economy was projected to grow at about 4.4% in 2011 and 4.1% in 2012 (World Bank 2011).

The energy sector is critical to the Mexican economy. The oil sector in particular is a central component of the Mexican economy. While oil exports only contributed to 11% of the total exports in 2010, their value was USD 35.9 billion, provided nearly one third of the total government revenue, from which Mexico's social development is mainly funded (Inegi 2011, SHCP 2011).

Mexico has made significant changes to policies in the energy sector to attract investments and strengthen the economy's competitiveness. Following the Energy Reform of 2008, structural changes in the oil and power sectors have been carried out. In the oil sector, the goal of providing the state-owned company Petróleos Mexicanos (Pemex) with greater executive capacity and flexibility was accomplished through the passing of its new law (Ley Orgánica de Petróleos Mexicanos). In the electricity sector, the most significant change was the liquidation of the Luz y Fuerza del Centro electricity utility in 2009 which was responsible for supplying electricity to Mexico's Central area, including Mexico City.

In 2010, 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 1.3 thousand tonnes of uranium.

Table 16 Key data and economic profile, 2009

Key data		Energy reserves	
Area (million sq. km)[a]	1.96	Oil (billion barrels) – proved[a]	10.2
Population (million)[a]	112.3	Gas (trillion cubic meter) – proved[a]	0.35
GDP (USD (2000) billion at PPP)	1 022	Coal (billion tonnes) – proved[b]	1.21
GDP (USD (2000) per capita at PPP)	9 516	Uranium (thousand tonnes of uranium metal)[c]	1.3

a At 1 January 2011. Oil reserves do not include condensates and natural gas liquids. Gas reserves refer to dry gas. Pemex (2010).
b At the end of 2010. BP (2011)
c At 1 January 2009. Reserves refer to reasonably assured resources. NEA (2010)
Source: EDMC (2011).

Energy supply and demand

PRIMARY ENERGY SUPPLY

Mexico's total primary energy supply in 2009 was 171 885 kilotonnes of oil equivalent (ktoe), a 3.9% decline from the 178 785 ktoe reached in 2008, this can be mainly attributed to a lower production of crude oil and condensates. Hydrocarbons (oil and gas) dominated the primary energy supply with shares of 56% and 28%, respectively. The remaining 16% was provided by coal and non-fossil sources such as nuclear power and renewable energy (EDMC 2011, Sener 2010a).

Pemex, one of the largest oil companies in the world, is by law the sole upstream and downstream agent in the economy and is also responsible for final distribution of most oil products (liquefied petroleum gas being an exception). Pemex carries out its activities across the oil industry's entire value chain through its four integrated subsidiaries: Pemex Exploration and Production, Pemex Refining, Pemex Gas and Basic Petrochemicals, and Pemex Petrochemicals. After 74 years, Pemex has not only been responsible for Mexico's production and transformation of hydrocarbons but at a broader level, for the economy's development and prosperity as well, as Mexico's most significant taxpayer.

By the end of 2010, Mexico's proved oil reserves reached 10.2 billion barrels. The proved reserves–replacement ratio was 85.8%, the highest in Mexico's history. According to official estimates, Mexico was ranked 17th in the world for its oil reserves and 33rd for its gas reserves (Pemex 2011).

In 2010, Mexico produced 2.58 million barrels per day (Mbd) of crude oil; with 55% being heavy, 32% light and the remainder being 12% extra-light type. In recent years, Pemex's efforts have been aimed at discovering and exploiting new fields to offset the natural decline of its largest field (Cantarell); since 2004 when a peak of 3.38 million barrels per day was achieved, production has dropped to an annual average rate of 4.4% up to 2010. Mexico is a net crude oil exporter, with around 53% of its total indigenous crude oil production sent overseas in 2010 exports were1.36 million barrels per day (Pemex 2010). In the same year the economy was the second largest oil supplier to the US (EIA 2011). Nonetheless, lack of sufficient domestic refining capacity forces the economy to be an oil product importer, especially of gasoline. In 2010, nearly half of the total gasoline demand was supplied by imported stock (Pemex 2011).

Located across its territories, Mexico has six oil refineries (Cadereyta, Madero, Minatitlán, Salamanca, Salina Cruz and Tula), with a total capacity of 1.54 Mbd of crude oil. The six refineries form the National Refining System (in Spanish Sistema Nacional de Refinación, or SNR), which is managed by Pemex Refining.

Table 17 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	214 691	Industry sector	25 840	Total	261 018
Net imports and other	–39 767	Transport sector	50 474	Thermal	213 738
Total PES	171 885	Other sectors	33 788	Hydro	26 713
Coal	7 823	Total FEC	110 102	Nuclear	10 501
Oil	96 258	Coal	1 087	Others	10 666
Gas	48 530	Oil	72 502		
Others	19 274	Gas	11 805		
		Electricity and others	24 708		

Source: EDMC (2011)

Mexico's proved natural gas reserves at the end of 2010 totalled 0.35 trillion cubic metres. In the same year, natural gas production was 0.20 billion cubic metres per day, of which roughly 65% was associated to crude oil and the remaining 35% was non-associated gas. The Burgos natural gas field has been the main producer of non-associated natural gas over the past 10 years while the offshore oil fields have been the most significant associated gas source, despite Cantarell's declining production (Pemex 2010).

As a result of an increase in natural gas production in the US, dry natural gas exports decreased sharply, from 1.9 million cubic metres per day in 2009 to 0.5 million cubic metres per day in 2010 (a 71% decrease). On the other hand, natural gas imports grew by 27% over the same period, from 11.9 million cubic metres per day to 15.2 million cubic metres per day, such an increase is a result of a drop in natural gas prices in the North American region, along with increased production from shale gas resources in the US. Both factors, prices and availability, promote wider use of this fuel, especially in the electricity sector. Imports came primarily from the US, while smaller proportions came as liquefied natural gas (LNG) in tankers from Nigeria, Egypt and Norway, among other economies (Pemex 2010, Sener 2010c).

COAL

In Mexico, coal represents only a small proportion of the total primary energy supply (4.6% in 2009). 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 70% of the recoverable reserves are of anthracite and bituminous type, while 30% are sub-bituminous and lignite (BP 2011). During 2009, coal production was 5.5 million tonnes of oil equivalent (7.9 million tonnes of coal equivalent), which represented a 7.5% fall from the previous year. Coal production in 2009 was composed of 80% thermal coal and 20% 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 2009 were 3.3 million tonnes of oil equivalent (4.7 million tonnes of coal equivalent), and represented 42% of the total coal demand. These imports came principally from Australia, the US and South Africa. Overall, total coal supply was 7.8 million tonnes of oil equivalent (11.1 million tonnes of coal equivalent) during 2009 (Sener 2010a).

ELECTRICITY

The Mexican Government manages all transmission, transformation, distribution and sale of electricity for public service purposes through the Power Federal Commission (CFE for its acronym in Spanish). CFE also administers all Independent Power Producers (IPPs), in the areas where private sector participation is permitted. The Mexican electricity grid is well developed and

is interconnected through the National Electricity System (Sistema Eléctrico Nacional, or SEN); electricity is then dispatched and controlled by CFE through its National Centre of Energy Control (Centro Nacional de Control de Energía, or CENACE).

In 2011, the total installed power capacity for public service was 52 511 megawatts (MW), a decrease of 434 MW from 2010. The drop was a result of capacity withdrawals, mainly thermal and geothermal due to the end of its lifetime. Around 77.3% of this installed capacity was run by CFE, with the remaining 22.7% coming from IPPs that supply CFE. Thermal power plants (including combined cycle technologies and IPPs generation) accounted for 63.4%; hydropower 21.9%; thermal coal-fired plants 6.2%; geothermal 1.7%; nuclear 2.6% and wind farms 0.2% (Sener 2011a).

FINAL ENERGY CONSUMPTION

In 2009, Mexico's total final energy consumption was 110 102 ktoe, a drop of 4.2% from 2008. Total energy consumption was concentrated in the transport sector (46%) followed by the industrial sector (23%), while the remaining 31% was spread across other sectors (residential, commercial and agricultural). By fuel source, petroleum products accounted for 65.9% of consumption, natural gas 10.7% and coal barely 1%; electricity and others made up the remaining 22.4% (EDMC 2011). The fuels most demanded in Mexico in 2009 in each sector were: natural gas – 37% of industry sector demand; gasoline – 67% of transport sector demand; liquefied petroleum gas – 38% of the residential, commercial and public sectors demand; and diesel – 74% of agricultural sector demand (Sener 2010a).

Energy policy overview

ENERGY POLICY FRAMEWORK

Mexico has carried out and promoted several waves of economic reform since the 1980s, with the aim of liberalising the economy, implementing market mechanisms and opening it to foreign trade and investment. Since 2000 Mexico has made significant structural changes to the legal and institutional frameworks in the energy sector to improve its competitiveness and prepare for fundamental changes in international energy markets worldwide.

In 2007, the Mexican Government published a general long-term vision statement, Visión 2030. The document has five keystone principles: rule of law and safety; economic competitiveness and job generation; equal opportunities; environmental sustainability; and effective democracy and responsible foreign affairs policy. Each 'pillar' has set goals, with detailed strategies to achieve each one. Visión 2030 represents an ambitious new program based on collaboration at all levels of government. The main goal is to provide all Mexicans with access to a better standard of living. 'Living better' stands as the government's motto; the aim is to promote a stronger economy that is in constant development, and which attracts increased investment to create more and better qualified jobs for Mexicans (Presidencia de la República 2007).

In Mexico, ownership of natural resources and the legal right to own and operate strategic industries, including oil and its control over the oil and electricity industries is established by the Mexican Constitution's Articles 27 and 28, and their respective regulatory laws. This identifies strategic areas as the exclusive responsibility of the government, such as the ownership and production of radioactive minerals, oil and all other hydrocarbons, basic petrochemical feedstock, electricity and nuclear electricity generation.

Mexico's Ministry of Energy (Secretaría de Energía – Sener, by its Spanish acronym) is responsible for the economy's energy policy within the existing legal framework. In 2007, at the beginning of the current President's six-year term, the Energy Sector Program 2007–2012 was issued. This was based on the Visión 2030 project and the National Development Plan 2007–2012. The Energy Sector Program outlines the main goal of Mexico's energy policy as the secure

supply of the energy required for development; this is to be achieved at competitive prices, while minimising environmental impacts, operating at high standard and promoting energy efficiency and diversification. The program also sets out the major indicators, strategies and action targets for the energy sector in the 2007–2012 period, based on nine main 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 in regards of operational, reliability and quality standards of the services they provide
- Promote energy's efficient production and use
- Foster renewable energies and biofuels which are technically, economically, environmentally and socially feasible
- Mitigate growth of greenhouse gas emissions.

The single most significant development in energy policy in Mexico was the approval of the Energy Reform in 2008. In October 2008, the Mexican Congress approved a set of laws and reform initiatives to strengthen the energy sector and grant greater autonomy to Pemex. Three laws were amended and four new laws were created: the Regulation Law of Article 21 of the Mexican Constitution; the Organic Law of the Federal Public Administration; the Law of the Energy Regulatory Commission; the Law of Petróleos Mexicanos; the Law of the National Hydrocarbon Commission; the Law for the Efficient Use of Renewable Energies and the Financing of the Energy Transition; and the Law for the Sustainable Use of Energy.

As a result of these reforms, a new document to guide the energy sector was presented. Mexico's National Energy Strategy sets out the long-term vision for a 15-year span and represents the reference point to which all energy policies must be oriented. The strategy focuses on three critical areas: energy security, economic efficiency and environmental sustainability. It also provides insight into issues and areas that could shape the energy industry in the future. Although published by Sener, the National Energy Strategy was created through a collaboration of governmental institutions, universities, research institutions, independent experts and representatives of Mexico's political states and legislative powers, to ensure all relevant perspectives were within the strategy's scope (Sener 2010c).

OIL SECTOR

The Law of Petróleos Mexicanos regulates construction projects, acquisitions, budget and debt, in addition to its wider role in governing the organization's function and administration. The reform aimed to strengthen Pemex so it could face present and future challenges more effectively. The Mexican Government's intention is for Pemex to have greater flexibility in how it organizes itself to best comply with its responsibilities.

In addition, the government created the National Hydrocarbon Commission (CNH by its Spanish acronym) in November 2008, as an autonomous technical authority, overseeing the regulation and evaluation of the hydrocarbon industry's exploration and production activities. This body began operation on 20 May 2009.

On 16 May 2008, as part of a new effort to strengthen the oil sector, the Mexican Government, through Sener and the Science and the 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, as required by the National

Income Law, this trust fund aims to support scientific and applied research in upstream and downstream areas, including basic petrochemicals (Sener 2011a). See 'Research and Development'.

POWER SECTOR

On 11 October 2009, as part of the Mexican Government's action plan to improve energy efficiency in the power sector, the decentralized Luz y Fuerza del Centro electric power utility, which was responsible for servicing Mexico's central area, including Mexico City and its metropolitan area, was liquidated by presidential decree (DOF 2009). As a result, technical operation of this area was taken over by CFE, which now stands as the only public power utility in the economy. Luz y Fuerza del Centro was viewed as a financial and operative burden to the Mexican energy sector given its poor efficiency and the considerable public financing required to support its operations (DOF 2009).

ENERGY EFFICIENCY

Mexico has had energy efficiency programs since 1989. It has strong public institutions that encourage efforts in energy efficiency and conservation. The institution in charge of promoting the programs and providing technical advice in energy efficiency is the National Commission for the Efficient Use of Energy (CONUEE), formerly CONAE. Other institutions, such as the Trust Fund for Electricity Savings (FIDE), provide financing for energy audits and assessments, and facilitate the acquisition and installation of energy-efficient equipment. Several programs have been implemented to promote the efficient use of energy; one program is the Electric Sector Energy Savings Program (PAESE). This program includes accelerating the construction and start-up of new electrical power stations, the changing of some concepts in the Law of the Public Service of Electricity Energy to allow private sector participation in electricity generation, and the establishment of energy efficiency as an objective for the industry.

Through CONUEE, the government has launched several programs in the area of sustainable use of energy, its promotion and assessment. One of the most effective programs has been the Official Mexican Standards (Normas Oficiales Mexicanas, NOMs), which contain the specific requirements, in terms of features, usage and maintenance, for an electric product and appliances to be sold on the Mexican market (SE 2010). Mexico's mandate for Energy Efficiency Standards comes from a generic law, the Federal Law on Standardisation and Metrology (Ley Federal sobre Metrología y Normalización, 16 July 1992), which defines the NOMs. Mexico first adopted energy standards in 1995. Since then it has established 18 energy efficiency mandatory standards for electrical appliances, energy building codes, and lighting. Within this framework, 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.

In addition, the Law for Renewable Energy Utilization and Energy Transition Funding required the creation of a National Strategy for Energy Transition and Sustainable Use (ENTE for its acronym in Spanish). Through this strategy the Mexican Government promotes policies, programs, actions and projects focused on increased utilization of clean technologies and renewable energy, promotion of energy sustainability and efficiency, and reduction of Mexico's dependence on hydrocarbons. The Law also mandates the creation of the Trust Fund for Energy's Transition and Sustainable Use, which is managed by Sener. This trust fund's main focus is funding scientific and applied research projects in clean technologies, diversification of energy sources, renewable energy sources and energy efficiency areas. Up to mid 2011, several remarkable energy efficiency projects had been financed, including:

- Program for Energy-Saving Household Appliances Replacement (replacement of 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)

- Project for Integral Energy Services (which aims to bring electric power from solar panels to isolated rural areas where connection to the main power grid is not technically or economically feasible)
- Program for Sustainable Light (free replacement of up to four traditional incandescent bulbs per household with up to four energy-efficient lamps).

Overall, through the programs and policies carried out, in 2010 Mexico was able to save 24.8 gigawatt-hour (GWh) and this figure is expected to grow in the years to come (Sener 2011b).

NUCLEAR

One of the objectives of Mexico's National Energy Strategy is the diversification of energy sources through the use of clean technologies. To achieve this goal, the Mexican Government is examining the possibilities of increasing its nuclear power generation capacity. Mexico is experienced in the exploitation of nuclear energy, and presently runs Laguna Verde nuclear power plant (1365 MW). : The Law for the Use of Renewable Energy and Finance of the Energy Transition (LAERFTE, 2008) calls to limit electricity generation from fossil fuel based technologies to 65% of the total in 2024. This means external factors like carbon emissions and clean technology innovation will have a significant impact on Mexico's power industry (Sener 2010c).

According to the 2010-2025 Building and Investment Program for the Power Sector, in order to meet the economy's electric demand over the next 15 years, 14 848 MW of additional capacity will be required. Although it is partially undecided what power generation technologies will be employed, one of the available options, nuclear power generation, will not be considered until after 2021. This deferment of further nuclear power station development is influenced by reduced projections for future power demand and the time associated for the technical studies, bidding, construction and operation of technology (CFE 2010).

RENEWABLE ENERGY

To achieve its goal of reducing hydrocarbon fuel dependency and integrating sustainability into the energy policy framework, the current administration has focused on implementing its strategies in two ways: energy efficiency and renewable energies.

The Law for the Promotion and Development of Biofuels was approved by the Mexican Congress on 26 April 2007 and published on 1 February 2008. This law does not set any specific targets; rather, it is a first step towards developing a biofuels industry in Mexico, outlining the regulatory responsibilities of different ministries within the federal administration.

Mexico has developed new policy and regulatory mechanisms for the introduction of renewable energies as a result of the 2008 Energy Reform. The new mechanisms are:

- the Law for the Efficient Use of Renewable Energies and the Financing 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 Program for Renewable Energy Utilization 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'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 the electric power service in rural communities where grid connection is not technically and/or economically feasible by using renewable energy.

The program envisions renewable energy utilization 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).

As for biofuels, based on the institutional and legal framework, the government aims to attract investment across the entire biofuels value chain, in order to develop Mexico's bio-energy production potential, estimated between 62.1 and 90.3 million tonnes of oil equivalent (2600 and 3780 Petajoules) (Sener 2009b).

CLIMATE CHANGE

- For the first time ever, both the Mexican National Development Plan 2007–2012 and the Energy Sector Program 2007–2012 address directly the climate change issue as a central policy concern. As a result Mexico introduced a National Climate Change Strategy (ENCC, by its Spanish acronym) on 25 May 2007 (CICC–SEMARNAT 2007). ENCC was conceived as a strategy for mitigation and adaptation to climate change, and 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 (CDM) (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. The energy sector alone contributed to 45% of those emissions, 38% came from agriculture and forestry, 13% from reduced energy demand, and 4% from waste management (Semarnat 2011).

Mexico has actively participated in several multilateral climate change forums. In 1993, the economy ratified the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I economy and in 1998 signed the Kyoto Protocol which was ratified in 2000. In late 2010, Mexico hosted the 16th Conference of Parties (COP16) of the UNFCCC in Cancun City. As incoming President of the COP16/CMP6, Mexico acted as a facilitator of the negotiations during 2010 to create an adequate technical and political framework to achieve successful results. In Cancun, Mexico sought (COP 16 2010):

- To ensure the conferences mark the beginning of a new era of global action on climate change
- To ensure a transparent and inclusive preparatory process that takes into consideration the concerns of all member states
- To strengthen the trust and communication channels between developed and developing economies
- To affirm the importance of the multilateral system in addressing climate change
- To provide channels for the participation of various civil society organizations.

RESEARCH AND DEVELOPMENT

In Mexico, the Ministry of Energy, through its Vice-Ministry for Energy Planning and Technological Development, is in charge of research and development (R&D) policies. R&D for the energy sector is carried out by three research bodies: the Mexican Petroleum Institute supports the hydrocarbons sector; the Electric Research Institute supports electric power and

energy efficiency; and the National Nuclear Research Institute supports nuclear-based power generation and other peaceful applications.

Energy-related R&D in strategic areas has been boosted by the creation of the 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 Pemex exploration and production fee payments, 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 specialized 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.

Notable energy developments

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. Pemex looks forward to finding and developing new reserves, optimising hydrocarbon and petrochemical production levels and ensuring its competitive and efficient supply.

During the first half of 2011, Pemex made significant investment in oil refining activities. One project, for fuel quality improvement (gasoline and diesel), aims to produce ultra-low sulphur stocks in order to comply with the NOM-086 standard, which sets targets for reducing environmental impact of these fuels. The target reductions of sulphur content in fuels sold at service stations are: gasoline to drop from an average 500–1000 parts per million to 30 parts per million by 2012, and diesel from an average 500 parts per million to 15 parts per million by 2012. By mid 2011 technical assessments had been conducted in SNR to set up the units required at the refineries for producing ultra-low sulphur diesel and gasoline (Sener 2011a).

The reconfiguration project at Minatitlán refinery was finished in July 2011. This allows for a larger production of higher-value fuels (100 thousand barrels per day of gasoline and 74 thousand barrels per day of diesel and jet fuel) and upgrading of its processing units. The planned reconfiguration of the Salamanca refinery has concluded its feasibility stage and engineering procurement work has started and it is expected to add 56 tbd to the current production capacity of middle and light distillates.

Another key project, the construction of the new refinery in Tula has completed the pre-investment and conceptual engineering stage. This project is especially significant because the last refinery was built in 1979. The new refinery is expected to add 290 thousand barrels per day of refining capacity to the SNR and help increase fuel availability in Mexico's central area, which includes Mexico City and its surrounding metropolitan area (Pemex 2010).

Pemex's downstream strategic projects aim to meet the economy's growing demand for refined oil products and to reduce its current deficit. Petroleum product imports, particularly of gasoline, are expected to decrease by 2015 as a result of the introduction of additional refining capacity. However, Mexico will remain a net gasoline importer.

In 2010 natural gas production was 0.2 billion cubic metres per day, just slightly lower than 2009 levels (Pemex 2011). In November 2011, the Energy Ministry announced a strategy for the development of natural gas pipelines that will increase the length of the current gas pipeline infrastructure by nearly 38% (Sener 2011b).

In the petrochemicals area, project Etileno XXI, in which Pemex will supply ethane to produce ethylene through a cracker plant and polymerization units, was scheduled to begin construction in late 2011, and may begin operation in 2014 (Sener 2011a).This is the most important project in the last 30 years in the country related to petrochemicals. Also, it is worth to note that the new situation in the North American region along with the production of domestic shale gas can further foster the growth of the national petrochemical industry.

Liquefied natural gas

Mexico's energy policy, which has the goal of improving the security of the economy's natural gas supply, is directed towards supply diversification. Recent policy has promoted (LNG) storage and regasification facilities both in 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 2011, Mexico awarded three permits for LNG regasification facilities in its territory.

On September 2006, Altamira LNG Terminal, located in northern Mexico in 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 in 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. Ensenada LNG Terminal's owner is Sempra Energy, and half of the plant capacity is claimed by Shell.

Mexico's third LNG terminal in Manzanillo, Colima (Terminal KMS), is under construction, with a maximum regasification capacity of 14.2 Mcmd, is expected to start operation in early 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 Mcm/d by 2018. Once the three terminals are in operation, Mexico's LNG storage capacity will amount to 0.92 million cubic metres (Sener 2010b).

POWER SECTOR

Several major projects were underway in the power sector in 2011. As at mid 2011, 14 new power plants, which will add 4005 MW to the SEN were in construction, with associated investments of USD 3840 million. These plants are expected to help meet the economy's growing power demand and offset the capacity lost through plant retirement. Some of the new plants exploit renewable energy, including La Yesca hydro power plant (750 MW capacity); Los Humeros II geothermal power plant (50 MW); La Venta III wind power plant (101.4 MW); Oaxaca I, II, III, IV wind power plants (joint capacity of 405.6 MW); and the Agua Prieta II combined cycle power plant (12 MW solar generated capacity out of its total 406 MW). Most of the other plants employ improved combined cycle technologies, with the aim of more efficient generation at lower environmental cost.

CFE also runs a major maintenance and upgrading program (USD 892 million) designed to extend the life-cycle of older plants by upgrading them to improve their efficiency. By the end of 2010, this program included the upgrading of several thermal and combined cycle power plants, as well as the Laguna Verde nuclear power plant, where units I and II are running at 100% of capacity.

In 2011, CFE's Board Council approved a modification in the power reserve methodology in order to reflect in a better way the capacity reserve conditions. Under this new methodology the power reserve margin was about 26%, while the electric grid infrastructure of transmission, subtransmission and distribution lines covered 0.82 million square kilometres, with a 6.7% growth from 2009 figures (Sener 2011a).

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. One of them is the National Energy Strategy's objective for the diversification of energy resources, which aims for clean technologies utilization (renewable, hydro and nuclear technologies) as a key element in attaining energy security and environment sustainability. To this end, the economy has promoted renewable technologies for power generation, profitable cogeneration potential and bio-energy markets.

WIND ENERGY

In December 2010, the Mexican Government documented Mexico's wind and solar energy potential in the Atlas for Wind and Solar Renewable Resources – Atlas del Potencial Eólico y Solar en México. This is a series of digitized maps with supporting data to assist in identifying the economy's best areas for power generation based on wind and solar resources (Sener 2010d).

By the end of 2010, wind power generation, amounted to 85 MW, and capacity from private self-consumers permittees amounted to 475.5 MW (Sener 2011a). Moreover, at the end of 2011, the wind capacity grew, amounting to 568 MW and the Energy Regulatory Comission (CRE by its Spanish acronym) gave away 2,069 MW additional permits for wind projects. 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 and the Tamaulipas coast, bordering the Gulf of Mexico (Sener 2010d).

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 kilowatt-hour per square metre per day (Sener 2010d). 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 program 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). The goal is to install 1.8 million square metres of solar water heaters by 2012 (Sener 2007b). In 2010, the total installed area of solar water heaters was 0.8 million square metres, about 44% of the target. Most of the solar heaters installed have been for heating water pools (46.2%) and households (32.1%); the remainder are in industry, hotels and other parts of the economy. 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 construction stage. The plant, in the state of Sonora, with 406 MW of thermal capacity will have 12 MW (peak) of thermo-solar capacity, and is expected to begin operation in 2013 (Sener 2011a).

GEOTHERMAL ENERGY

Mexico was a pioneer in geothermal power utilization in the Americas, with the first geothermal well being drilled in the 1950s. Currently, Mexico's geothermal electricity capacity is 964.5 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 biggest 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 SEN In 2010, geothermal generation was 6618 GWh, a slightly decrease (1.8%) from 2009.

As part of CFE's utility retirement program, several units totalling 170 MW of installed capacity have been or will be retired from the SEN as a result of their operational lifetime

expiring. In January 2011 some units from the Cerro Prieto I and Los Azufres plants were shut down (CFE 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 capacity of 50 MW, was in 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

Up to the first half of 2011 the Mexican Energy Ministry had awarded 20 permits for biofuels production, storage, transportation and commercialization, and three biodiesel plants each with capacity equal to or less than 500 litres per day had begun operation (Sener 2011a). Although Mexico's current biofuels projects are small-scale and targeted to meet local consumption, there are ambitious plans for more significant projects. The Law of Biofuels Promotion and Development set the terms for the establishment of the Interministerial Commission for Biofuels Development, which was created in 2008. It is coordinated by the Ministries of Energy, Economy, Finance, Environment and Natural Resources, and its main objective is guiding economy-wide biofuels planning while setting priorities, establishing guidelines and monitoring status of the actions taken.

Two types of biofuels are currently produced in Mexico: biodiesel and bioethanol. Biodiesel production at Cadereyta oil refinery is expected to grow by 8.7 million litres per year, to be blended with the ultra-low sulphur diesel.

In 2008 and 2009, a pioneer project to replace methyl-tert-butil-ether (MTBE) with bioethanol made from sugarcane bagasse, as the oxygenate agent for Mexican gasoline, was carried out in at Cadereyta refinery and a storage and distribution facility. The project produced 0.15 million litres of bioethanol, which once blended were able to yield a total of 2.53 million litres of gasoline that was sold to the public through four service stations.

In order to promote biofuels and improve air quality, the Mexican Government set bioethanol introduction targets to be accomplished by 2012 in the economy's major cities and their surrounding areas (Mexico City, Guadalajara and Monterrey). The goals were based on the projected gasoline demand for each city and amount to 38.5 thousand barrels per day of bioethanol, (2.23 billion litres) (Sener 2009b).

As the only final supplier of gasoline in Mexico, Pemex was planning its procurement of bioethanol and launched a bid in 2009; several sugar milling companies (the only ones technologically capable of producing ethanol) rushed to participate. However, they were all disappointed by Pemex's price of 8.20 MXN per litre (USD 0.72) as the cost of producing ethanol in the sugar mills was over 12 MXN per litre (USD 1.04). Although a company was granted the bid, it was later cancelled by Pemex, claiming contractual issues. Up to 2011, there was no information about further bids or plans for Pemex bioethanol supply (USDA 2011).

In regards to biodiesel, in September 2010 a biodiesel production permit was granted to the Mexican State of Chiapas' Institute for Productive Reconversion and Biofuels (IRPAB), as part of its jatropha-based biodiesel production project. Chiapas had two biodiesel production plants in Tapachula and Tuxtla Gutierrez until a third plant, located in Puerto Chiapas, began operation in November 2010. The biodiesel produced the product is not commercially available, as its use is entirely as a fuel for public transportation units and for some research projects (USDA 2011). As of early 2012, IRPAB's production capacity reached 10.8 million litres per year, equivalent to 29.6 thousand litres per day (Biodiesel Chiapas 2012).

INTERNATIONAL COOPERATION

Mexico has a significant role in international energy cooperation. Mexico's membership of energy-related international organizations 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 2010 and 2011, Mexico fostered energy cooperation with the United States, Canada, Germany, Spain, Denmark, Portugal, Nigeria, China, India, El Salvador, Guatemala, Cuba, Colombia and Uruguay. During the same period Mexico participated in North America's Energy Working Group, the Clean Energy Ministerial, the Energy and Climate Partnership of the Americas, the International Energy Agency, the World Bank, the International Energy Forum, the Organization for Economic Co-operation and Development (OECD), the International Renewable Energy Agency, the International Atomic Energy Agency, and many others. Moreover, in order to strengthen its technical capacity and expertise, in 2010 and 2011 Pemex signed several co-operation and technical agreements with international oil companies in areas such as deep water and technological research applications.

In September 2010, Mexico hosted the International Energy Efficiency and Access Forum in Mexico City. This event was organized by Mexico's Energy Ministry, the Inter-American Development Bank and the World Bank, with the support of the World Economic Forum. Its objective was to foster and exchange international experiences and best practices on energy efficiency and access areas. In addition, in June 2011, Dr. Aldo Flores-Quiroga, General Director for International Affairs at Mexico's Ministry of Energy, was appointed as Secretary General to the International Energy Forum for its 2012–2016 period (Sener 2011b).

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Useful links

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

NEW ZEALAND

INTRODUCTION

New Zealand is an island economy in the South Pacific, consisting of two main islands—the North Island and the South Island—and a number of small outer islands. In land area it is a bit smaller than Japan or the Philippines, but larger than the United Kingdom. The relatively small population of about 4.3 million is comparable to a medium-sized Asian city. New Zealand's location is remote from other economies. There are no electricity or pipeline connections to other economies.

New Zealand is a mature economy. While the per capita GDP of about USD 24 000 (USD (2000) at PPP) puts it at the low end of the OECD economies, New Zealand generally rates highly in most 'quality of life' surveys. New Zealanders are generally environmentally conscious, and take pride in the 'clean and green' condition of their land, water and air.

New Zealand is self-sufficient in all energy forms apart from oil and has modest energy resources, including reserves of 96.1 million barrels of oil, 27.6 billion cubic metres of natural gas, and 571 million tonnes of coal. In 2009, hydro, geothermal, wind and bioenergy resources met around 73% of electricity demand (MED 2011a, Table G2a).

Table 18 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)[a]	268 680	Oil (million barrels)[b]	96.1
Population (million)	4.32	Gas (billion cubic metres)[c]	27.6
GDP (USD (2000) billion at PPP)	102.87	Coal (million tonnes)[d]	571
GDP (USD (2000) per capita at PPP)	23 835	Uranium (million tonnes of uranium metal)	–

a Statistics New Zealand (2011), Summary.

b MED (2011a), Table H.2, figure shown is 'Remaining Reserve P90 as at 1 January 2011' and includes LPG.

c MED (2011a), Table H.4, figure shown is 'Remaining Reserve P90 as at 1 January 2011'.

d Proven reserves at the end of 2010 from BP (2011).

Other data: EDMC (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009, New Zealand's total primary energy supply was 18 704 kilotonnes of oil equivalent (ktoe). A number of energy sources contribute to this total, including oil (33%), geothermal (24%), gas (18%), hydro (11%), and coal (8%), with wind, biomass, biogas, waste heat, and solar providing the remainder (6%). Due to an assumed conversion efficiency of only 15% in geothermal electricity generation, the geothermal share of final energy supply is much smaller. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2009 was 89%, up from 87% in 2008 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 0.7% (EDMC 2011).

Lignite is New Zealand's largest fossil energy resource. However, almost all coal production is of sub-bituminous and bituminous coals. In 2009, coal production decreased by 6% on an energy-equivalent basis compared with 2008 (EDMC 2011).

Oil is sourced from 18 fields in the Taranaki region (MED 2010, p. 44). The production of crude oil, natural gas liquids and condensate was down 7% on an energy-equivalent basis in 2009 compared with 2008, but up 149% compared to 2005 (EDMC 2011). Oil production was underpinned by the rapid growth in production from the newest offshore fields, Pohokura, Tui, and Maari (MED 2011a, Table D2a). Despite this growth, domestic oil production met only 49% of demand in 2009 (MED 2011a, p. 45). Therefore, New Zealand imports a large volume of crude oil and petroleum products.

Natural gas is sourced from 20 fields and wells (MED 2010, p. 74). In 2009, natural gas production increased by 3% compared with 2008 (EDMC 2011). 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 LNG (liquefied natural gas). New Zealand's largest gas field is the offshore Maui field, believed to be nearing depletion. This has prompted concerns New Zealand's gas supply could be inadequate to meet future demands (see the Gas Shortage Scenario in MED 2009a).

In 2009, New Zealand generated 43,472 GWh of electricity, about 1% less than in 2008 (EDMC 2011). New Zealand has plentiful hydro and renewable energy resources. Reflecting this, about 73% of electricity generation was from hydro and renewable sources. Hydro is the major source of electricity generation, accounting for 57% of total generation. Hydro production fluctuates from year to year depending on rainfall; 2009 was a fairly normal hydro year. Geothermal generation accounted for another 11% (MED 2011a, 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 (MED 2010).

Table 19 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	16 593	Industry sector	3 798	Total	43 472
Net imports and other	3 371	Transport sector	4 575	Thermal	12 276
Total PES	18 704	Other sectors	4 131	Hydro	24 220
Coal	1 485	Total FEC	12 504	Nuclear	–
Oil	6 093	Coal	539	Other	6 976
Gas	3 460	Oil	5 818		
Other	7 665	Gas	1 704		
		Electricity and other	4 443		

Source: EDMC (2011).

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

FINAL ENERGY CONSUMPTION

New Zealand's final energy consumption was 12 504 ktoe, almost unchanged in 2009 compared with the previous year. The transport sector consumed 37% of final energy, the industry sector consumed 30%, and other sectors 33%. Final energy consumption was dominated by oil, accounting for 5818 ktoe (47%), followed by electricity and other (mainly heat) 4443 ktoe (36%), gas 1704 ktoe (14%), and coal 539 ktoe (4%) (EDMC 2011).

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 2009. Consumption of oil products in the other sectors was shared between residential, commercial and agricultural (10%), industry (7%), and non-energy (5%) (EDMC 2011).

POLICY OVERVIEW

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 NZD15 billion, or about 7.5% of New Zealand's 2011 GDP (IMF 2011).

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.

ENERGY POLICY FRAMEWORK

The Ministry of Economic Development (MED) has the lead role in developing New Zealand's energy policies and strategies, although there are a number of other agencies involved. New Zealand no longer has a Ministry of Energy, although MED reports to the Minister of Energy and Resources on energy policy issues. 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) (MED 2011b) 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 2011–16 (NZEECS) to replace the 2007 NZEECS.

A new Ministry of Science and Innovation (MSI) was created in February 2011 through the merger of the existing Foundation for Research, Science and Technology and the Ministry of Research, Science and Technology. The new ministry is part of a broader government effort to boost the research, science and technology sector's contribution to economic growth. The MSI has two investment boards—a Science Board and an Innovation Board. The former deals with funding allocations for scientific research; the latter deals with funding allocations for business-facing technology schemes (MSI 2011).

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 2011). Some of the responsibilities of the Electricity Commission which overlapped 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 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 2011). The tax rate has dropped to 28%, effective from 1 April 2011 (Inland Revenue 2011). 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 (MED 2011b, NZG 2010b).

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. The discussion paper 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 practice. However, there were some areas in which New Zealand's regulatory framework could be improved (MED 2011c).

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 and NZG 2011b).

In January 2011, a Green Growth Advisory Group was appointed to advise the government on ways to help exporters make the most of a 'clean, green' New Zealand brand, make smarter use of technology and innovation, and move businesses to a lower-carbon economy. The advisory group will report to the government in December 2011 (MED 2011d).

ENERGY EFFICIENCY

New Zealand has a relatively long tradition of promoting energy efficiency. It passed the Energy Efficiency and Conservation Act 2000, which lead 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 2011a).

In August 2011, the government released the New Zealand Energy Efficiency and Conservation Strategy 2011–16 (NZEECS) to replace the 2007 strategy. The overall goal of the new strategy is for New Zealand to continue to improve its energy intensity (energy used per unit of GDP) by 1.3% per year to 2016.

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) (MED 2011b).

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 (MED 2011b).

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 the development of renewable energy (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 grant of up to 42.5 cents per litre is available to biodiesel producers (EECA 2011b) and electric vehicles are exempted from road user charges (NZG 2011d).

NUCLEAR

New Zealand does not have any commercial nuclear reactors. It currently 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 (MED 2011b).

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 2011a).

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 a tonne CO_2-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_2-equivalent emitted, effectively reducing the price of permits to NZD 12.50 a tonne (CCINZ 2011b).

All sectors of the economy will be included from 2015. They will be introduced gradually over the course of seven years (Table 20). 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 2011).

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 by 21.9 million tonnes (MFE 2011f).

Table 20 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	1 January 2015

Source: CCINZ (2011c).

NOTABLE ENERGY DEVELOPMENTS

PIKE RIVER COAL MINE TRAGEDY

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 is investigating the incident and will make recommendations regarding whether any changes or additions should be made to relevant laws and practices (RCPRCMT 2011).

NEW PROJECTS

In 2010, an additional 163 MW of geothermal electricity generation capacity came on line with the commissioning of the 140 MW Nga Awa Purua plant by Mighty River (Mighty River 2010) and the 23 MW Tauhara plant by Contact Energy (Contact Energy 2010). In March 2011, Meridian Energy completed its 64 MW Te Uku wind farm near Raglan (NZWEA 2011).

In 2010, Contact Energy also finished constructing two 100 MW gas turbine peaking units at Stratford. The plant was built in conjunction with New Zealand's first underground gas storage facility (Contact Energy 2011).

In March 2011, the Minister of Conservation approved the installation of 200 marine tidal turbines in the Kaipara harbour. This is the first project of its kind in New Zealand and it is expected to have a capacity of approximately 200 MW when completed (MED 2011a).

Transpower has four major grid upgrade projects underway or in the final stages of planning. These are the NZD 824 million North Island Grid Upgrade between Whakamaru and Auckland due for completion in 2012, 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 HVDC (high voltage direct current) Inter-island Link Project due for completion in 2014 (Transpower 2011).

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Energy Efficiency and Conservation Authority (EECA)—www.eeca.govt.nz

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Ministry of Economic Development (MED)—www.med.govt.nz

New Zealand Government (portal for access to New Zealand government agencies and government-funded websites)—www.newzealand.govt.nz

New Zealand Government (news and speeches from government ministers)—www.beehive.govt.nz

New Zealand Parliament—www.parliament.govt.nz

New Zealand Petroleum & Minerals (formerly Crown Minerals)—www.nzpam.govt.nz/cms

Transpower—www.transpower.co.nz

PAPUA NEW GUINEA

INTRODUCTION

Papua New Guinea (PNG) is located in the south-west of the Pacific Ocean, just south of the equator. It is made up of more than 600 islands, including the eastern half of New Guinea—the world's second largest island—as well as the Bismarck Archipelago, D'Entrecasteaux island group, and the three islands of the Louisiade Archipelago. The mainland and the larger islands are mountainous and rugged, with a string of active volcanoes dotting the north part of the mainland and continuing to the island of New Britain. PNG has a population of more than six million, spread across its total area of 462 840 square kilometres.

In 2009, real GDP was estimated at USD 12.48 billion (USD (2000) at PPP), an increase of 5.5% from 2008 (USD 11.83 billion).

Table 21 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (sq. km)	462 840	Oil (million barrels)	88
Population (million)	6.73	Gas (billion cubic metres)	442
GDP (USD (2000) billion at PPP)	12.48	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	1 854	Uranium (million tonnes U)	–

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

Source: EDMC (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009, PNG's net primary energy supply was 2270 kilotonnes of oil equivalent (ktoe), an increase of 3.6% from 2008. 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 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 supplies 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 co-venturers—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 LNG project (see 'Notable energy developments' section).

In 2009, PNG generated 3445 gigawatt-hours (GWh) of electricity (a 9.9% increase from 2008). The sources of generation were thermal at 64% (oil 48%, gas 16%), hydro at 25%, and geothermal at 11%. 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 22 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 749	Industry sector	629	Total	3 445
Net imports and other	–	Transport sector	404	Thermal	2 219
Total PES	2 270	Other sectors	218	Hydro	854
Coal	–	Total FEC	1 162	Nuclear	–
Oil	1 540	Coal	–	Geothermal	372
Gas	338	Oil	889	Other	–
Other	393	Gas	–		
		Electricity and other	273		

Source: EDMC (2011).

FINAL ENERGY CONSUMPTION

In 2009, total final energy consumption in PNG was 1162 ktoe (an increase of 16% from 2008). The industrial sector's consumption increased 0.2% from 2008, and the sector was the largest end user, accounting for 54.1% of energy used, followed by transport (34.7%) and other sectors, including agriculture and residential/commercial (11.2%). By energy source, petroleum products accounted for 76.5% of total consumption, while 'electricity and other' accounted for 23.5%.

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

The Papua New Guinea Government has jurisdiction over energy matters. 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 the pillars is 'natural resources and environment'. The DSP 2010–2030 also set this goal: All households have access to a reliable and affordable energy supply, and sufficient power is generated and distributed to meet future energy requirements and demands.

On 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 into 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 the 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.

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 and reducing dependency on fuel oil for electricity generation.

NUCLEAR

PNG doesn't have a nuclear energy industry as of November 2011, and there are no plans for its development.

CLIMATE CHANGE

Climate change is one of the important pillars in the National Strategic Plan 2010–2050 (see 'Energy policy framework' section).

NOTABLE ENERGY DEVELOPMENTS

UPSTREAM DEVELOPMENT

A number of international companies have shown a renewed interest in investing in PNG's upstream oil and gas sector in recent years. At the end of 2007, the total number of petroleum prospecting licences (PPLs) was 37, compared with 17 in 2003. The surge in interest has been principally attributed to the 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 venturers 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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PERU

INTRODUCTION

Peru is one of three APEC economies in Latin America – it became a member in November 1998 and hosted the APEC Leaders Meeting in 2008. Peru is located on the Pacific Ocean coast of South America, and its land area covers nearly 1.28 million square kilometres. It 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. Most of its population (55%) live in the Costa region, while 32% live in the Sierra region and 13% live in the Selva region. The economy is divided into 25 political departments and in 2009 had a total population of about 29.16 million people, of which 34.8% was considered poor and 11.5% extremely poor; the major population centre is located in the Lima department, with 8.98 million people. Peru's urbanisation rate is 76% (INEI 2011a).

Peru has a market-oriented economy, which until recently was tied to exports that provided hard currency to finance imports and external debt repayments. In 2010, Peru's GDP was composed by services (55.6%), manufacturing and construction (21.7%), agriculture and mining (13.1%) and taxes (9.7%). Recent economic growth has been supported by macroeconomic stability, improving terms of trade and increasing private investments. Economy has been driven by mining, construction, exports, and domestic consumption. Mining is especially important, since Peru is the world's top producer of silver, second of zinc, third of copper and tin, fourth of lead, and sixth of gold; mineral exports have consistently accounted for a significant portion of the economy's export revenue, in 2010 represented 61% (INEI 2011b).

In 2009 Peru struggled to fight back the international economic crisis which affected the economy in 2008 mainly by; a drop in commodities prices which reduced export value; contraction in external demand which was reflected by smaller export volumes and an international credit rating reduction as a consequence of the overall increasing risk forecast for investments in developing economies. Despite these circumstances, the Peruvian economy managed to grow almost 1% from 2008 to 2009 (MEF 2010a). In 2009 Peru's GDP was USD 202.74 billion, while GDP per capita was USD 6952 (EDMC 2011). Inflation decreased to an annual rate of 2.9% in 2009, mostly due to seasonal drops in prices of some fuels and food commodities (BCRP 2009). In addition, Peru's foreign reserves reached a record USD 33.1 billion, external debts increased to 32.7 USD billion and fiscal deficit represented 3.2% of GDP (BCRP 2011, MEF 2010b).

Peru is a net oil importer. Domestic production is not only insufficient to meet Peru's total demand, but since most crude produced is of extra-heavy type, many domestic refineries are unable to process it and a larger share is exported. As for natural gas, the economy has risen recently as a significant producer in South America.

Peru's proven energy reserves by the end of 2009 were 1190 million barrels of crude oil (including gas liquids) 0.35 trillion cubic metres of natural gas, 38 million tonnes of coal and 1800 tonnes of uranium located in the Puno region (MINEM 2009a).

Table 23 Key data and economic profile, 2009

KEY DATA		ENERGY RESERVES[A]	
Area (million sq. km)	1.28	Oil (million barrels)	1 190
Population (million)	29.16	Gas (trillion cubic metres)	0.345
GDP (USD (2000) billion at PPP)	202.74	Coal (million tonnes)	38
GDP (USD (2000) per capita at PPP)	6 952	Uranium (tonnes)	1 800

a Proven reserves at the end of 2009 (MINEM 2009a)
Sources: EDMC (2011) and MINEM (2009a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2009 was 13 708 kilotonnes of oil equivalent (ktoe), which represented a 3.38% increase from 2008 figures, mainly due to the growing production of natural gas and its liquids. By energy source, in 2009 around 53.7% (7355 ktoe) of TPES came from oil, 25.6% from natural gas (3510 ktoe), and 5.8% came from coal (799 ktoe). Non-fossil energy sources, such as hydro, wood, biomass, wind and others contributed with the remainder 14.9% (2045 ktoe) (EDMC 2011).

In 2009 Peru's primary energy imports fell by 29.3% from 2008, to reach 2424 ktoe. Imports represented 17.7% of Peru's energy requirements. Particularly, crude oil imports made up 90.4% of total primary imports, reaching 2192 ktoe at the end of 2008 while coal imports accounted for the rest. Energy exports represented 3.8% (about 521 ktoe) of total primary energy supply in 2009, superior in 5.4% than the previous year, with crude oil constituting the only primary energy source exported (EDMC 2011, MINEM 2009a).

Peru produced 157 159 barrels per day (B/D) of total oil liquids in 2010. Crude oil accounted for 46.3% of total production (72 688 B/D), and natural gas liquids (NGL) made up the remainder (84 470 B/D). From 2003 to 2010, NGL production has increased at an average rate of 54.5% per year and represents the bulk of the growing oil production, including a very significant increase of nearly 8 times between 2003 and 2005, from 4027 B/D to 35 840 B/D (MINEM 2010a). Oil refining capacity in Peru amounts to 213.3 thousand B/D spread within six refineries (Conchán, El Milagro, Iquitos, La Pampilla, Pucallpa and Talara) (Petroperu 2011, Repsol 2011). In 2010, around 55 million barrels of total crude oil were processed in Peru (including imported stock); the proportion of indigenous feedstock processed was 36.2%, and the remaining 63.8% processed was imported supply coming mainly from Ecuador and Nigeria. Production of petroleum products increased 7.1% over 2009 figures, to around 74 620 million barrels in 2010, with gasoline and diesel representing half of the total output (MINEM 2010a).

Peru is a significant gas producer. In 2010 the economy produced around 7.23 billion cubic metres (bcm) (or 255.6 billion cubic feet (bcf) of natural gas, a remarkable increase of 108.4% over the previous year, mainly due to addition of Camisea's Lote 56 output, which represented almost 40% of the total production. (MINEM 2010a)

Nearly all the natural gas produced is non-associated natural gas from the Camisea Basin, – which encompasses several natural gas fields in the Ucayali basin in south-eastern Peru, mainly in 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, and in 2004 the project started to develop. In 2010, Camisea represented one of the most important non-associated gas reserves in Latin America, with a proved potential of 0.35 trillion cubic meters. (COPRI 2000, MINEM 2010a) (MINEM 2010a).

From its beginning, output capacity at Camisea has been growing steadily as drilling activities are also occurring on Camisea's Block 56, adjacent to Block 88. Although Camisea project was initially strived to provide natural gas for domestic demand, gas production in Camisea has increased in average at an annual rate of 63.8% since 2004, which has allowed the development of an export market in the form of liquefied natural gas (LNG), which is shipped into tankers whose main destination is Mexico (MINEM 2010a, PlusPetrol 2011). In 2010, Peruvian LNG exports from its Melchorita plant amounted to 3.59 billion cubic metres, which represented approximately half of Peru's total production (Perupetro 2011).

In 2009, Peru's electricity generation totalled 33 029 gigawatt-hours (GWh), a slight 0.13% increase from the 32,986 GWh reached in 2008. Hydropower's share of this total was 60.1% (19 864 GWh), and grew 4.3% compared to the previous year. Electricity generation from thermal plants in 2009 accounted for 37.8% (12 475 GWh) and the remainder was met by other sources (biomass, mini-hydro and wind) (EDMC 2011) In the case of thermal plants, 73% of their electricity generation was fuelled by natural gas, 17% by diesel and fuel oil and 9% by coal. Gas contribution is especially high, due to the increasing gas production in the last years that has spurred Peruvian thermal plants demand towards that energy source. (MINEM 2009a) About 93% of the total electricity was generated by the National Interconnected Electrical System (SEIN), and the left 7% by isolated systems (SA) and self-use producers. Electricity losses through distribution accounted for 7.9% (roughly 2609 GWh) of total generation (2010c). By the end of 2010, the economy's electricity access reached about 80% of its total population (MINEM 2010d). Peru's proved coal reserves are around 38 million tonnes; of which 82% is anthracite and the remainder bituminous coal. Most reserves are located in the La Libertad, Ancash and Lima departments. Peru is a net importer of coal. In 2009, Peru's coal needs were met by 70% of imports (561 ktoe) and only 30% (238 ktoe) of domestic production. (MINEM 2009a).

Aside from hydroenergy, other renewable energy sources used in Peru include biomass, solar mini-hydro and wind. Mini-hydro and biomass (mostly sugarcane bagasse) are used for electricity generation, while solar energy and 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 2009, energy supply from renewable sources totalled 2045 ktoe, with hydroenergy making up 45%, firewood 40.3%, other biomass 14.6% and solar the rest (MINEM 2009a). Wind-based electricity capacity was 31 megawatts (0.01% of total electricity capacity) by 2010 and it is expected to increase in the short and medium terms (MINEM 2010d).

Table 24 Energy supply and consumption, 2009

PRIMARY ENERGY SUPPLY (KTOE)		FINAL ENERGY CONSUMPTION (KTOE)		POWER GENERATION (GWH)	
Indigenous production	12 439	Industry sector	3 941	Total	33 029
Net imports and other	–2 424	Transport sector	5 464	Thermal	12 475
Total PES	13 708	Other sectors	2 661	Hydro	19 864
Coal	799	Total FEC	12 067	Nuclear	0
Oil	7 355	Coal	580	Others	690
Gas	3 510	Oil	8 157		
Others	2 045	Gas	769		
		Electricity and others	2 561		

Sources: EDMC (2011) and MINEM (2009a).

FINAL ENERGY CONSUMPTION

Final energy consumption in Peru grew steadily in 2009, reaching 12 067 ktoe (a 9.7% increase from 2008). Transportation was the most dynamic sector, with a 24.7% jump from the previous year, and accounted for 45.3% of total final energy consumption in 2009. The industrial

sector's share was 32.7%, while 'other sectors' consumed 22.1%. Oil products dominated total final energy consumption, accounting for 67.6% of demand in 2009 with diesel and gasoline representing more than 80%. Electricity made up 21.2% of total end-use energy demand, while gas and coal accounted for the remainder, 6.4% and 4.8% respectively. In 2009 most gas and coal was consumed in the industrial sector, although around 28.5% of end-use gas was also consumed in the transport sector as compressed natural gas (CNG) (EDMC 2011 and MINEM 2009a).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In Peru, the organisation responsible for the formulation and evaluation of energy–mining policies as well as the sector 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 covers all major areas of influence in the sector, and among many other duties, oversees their activities and promotes investment to achieve sustainable national development. In addition to MINEM, the autonomous regulatory organization 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 promoting efficiency in the power and gas sectors at the lowest possible cost for the customer.

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 impacts. 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 discussions and forums the Energy Policy of Peru 2010–2040 was approved on 24 November 2010 (Supreme Decree No. 064–2010–EM – El Peruano 2010). The goal of the policy is to meet Peru's energy demand in a safe, sustainable, reliable and efficient way, supported by planning, research and technological innovation (MINEM 2010b). Its main objectives are:

- having a diversified and competitive energy matrix with emphasis on renewable energy and energy efficiency
- having a competitive energy supply
- having universal access to energy supply
- achieving the highest possible efficiency levels in the energy production and utilization systems
- achieving self-sufficiency in energy production
- developing an energy sector with minimal environmental impact and low carbon emissions, as part of sustainable development
- developing the natural gas industry and its use in household, transportation, commercial and industrial activities as well as efficient electricity generation
- strengthening institutions involved in the energy sector
- joining regional energy markets in order to achieve Peru's long-term vision.

Particular guidelines and actions are detailed in the document and will form the basis from which subsequent instruments and specific action lines may be derived. (MINEM 2010b)

ENERGY MARKETS

Peru's economy has become more market-oriented following the reforms of the 1990s. The mining, electricity, hydrocarbons and telecommunications industries have all been partially privatised. Several new laws have established a regime where 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 competitiveness of the productive sector of the economy (El Peruano 1999). See also the 'Fiscal regime and investment' section following.

In the electricity sector, reforms started in 1992 with the aim to introduce a model closer to the Chilean system implemented in 1982. An important difference 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 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 customers with a capacity higher than 1 MW could freely negotiate the conditions of their supply contract; 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 functions held by the Electric Energy Operation and Dispatch Comittee (Comité de Operación Económica del Sistema Interconectado Nacional - COES) which is now a private, independent operator and planner for the electricity system; and an adjustment of the legal framework related to the formation of transmission prices.

FISCAL REGIME AND INVESTMENT

Peruvian government strives to attract foreign investment to sustain economic growth and improve competitiveness. In the last years, Peru has expanded and streamlined the available

investment schemes, with particular interest in 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 upon 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 the 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. The 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 force in 2000 and provided a framework for private investors in telecommunications, energy, transport and sanitary services, specifying how the operations in each of these public service sectors were to be organised. Overall, Peru strives to ensure proper to attract and retain investment conditions. 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 program and it is still continuing (MINEM 2009b).

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 made significant initiatives to support energy efficiency through mechanisms; these include DS–No. 034–2008–EM of 19 June 2008 (Energy Saving Measures in Public Service), and RM No. 038–2009–MEM/DM of 21 January 2009 (Energy Consumption Indicators and its Monitoring Methodology). In 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 where 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 2009b). 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 programs that could be implemented to achieve the proposed targets.

In workshop discussions, the following actions were identified as current priorities:

- Reinforce strategic alliances with other economies to promote electricity security, efficient use of energy, and environmental protection.
- Develop tax benefits for private companies that operate with efficient technologies.
- Strengthen the Energy and Mines Regional Offices (DREMs) to be able to implement the Referential Plan.
- The 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). As well as serving as the technical regulatory body in charge of the proposal and assessment of energy efficient use and production and non-conventional renewable energy issues, DGEE is also in charge of proposing and leading the country's energy planning, and developing the National Energy Plan which must incorporate actions for electricity sector development, in line with national development policies and the 2010–2040 Energy Policy framework. (El Peruano 2010).

RENEWABLE ENERGY

Peru has set goals to increase renewable energy use, and set out a legislative and policy program 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 share of domestic power consumption to be generated from renewable energy sources excluding large hydropower generation (i.e. less than 20 megawatts 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, El Peruano 2008b)

To achieve these goals, MINEM established open auctions for renewable energy supply in order to ensure competitive conditions for the electricity generators and the customers. The first auction was finished in March 2010 and added a total renewable energy capacity to the National Interconnected Electric System (SEIN) of 411 MW, awarded in 26 projects using wind, solar, biomass and mini-hydro. A second auction, open in the second half of 2011, was aimed to obtain 1981 GWh, from which 681 GWh were restricted exclusively for hydroelectric projects (OSINERGMIN 2011).

To promote renewable energy, the government passed in 2006 the Law No. 28876, to provide in advance tax recovery to the electricity sales of renewable energy-based utilities; in 2008 the 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 up to 20% per year in order to improve the projects' feasibility (MINEM 2010e).

As for biofuels, governmental 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 areas for biofuels production.
- Ministry of Energy and Mines (MINEM): Authorizes the commercialization of biofuels and its blends with gasoline and diesel.
- Ministry of Production: Authorizes the operation of biofuels producing plants.
- OSINERGMIN: Supervises and controls the operation during the different stages of the production chain.
- PROINVERSION: Promotes investment in the biofuels sector

Under this legislation, quality standards of 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% of bioethanol and from 2011 diesel must contain 5% of biodiesel (known as B5).

Production of ethanol for fuel in Peru began in August 2009, with operations in the northern region of Piura. In 2010, Caña Brava, the only producing company, had 6000 hectares of sugar cane and a processing capacity of 350 thousand litres per day (almost 130 million litres per year). About 39% of Peruvian ethanol production is exported. A new ethanol project carried out by Maple Ethanol Peru with operations expected to begin in late 2011 was delayed to 2012. This new project will include processing capacity of 130 million litres 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.

Biodiesel production was estimated to be 32 billion tonnes by the end of 2010, this production is expected to have accounted for 24% of Peru's total biodiesel demand. Imports of biofuels have been necessary in order to meet Peru's demand, especially with the compulsory fuel blending standards in effect as mentioned above (USDA 2011).

NUCLEAR

Although Peru does not use nuclear energy for electricity generation, a government-run nuclear program has been in operation since 1975. This program involved construction of basic infrastructure, human resources training, and the establishment of the Peruvian Institute of Nuclear Energy (IPEN) as part of MINEM. Peru is 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). Moreover, the Energy Policy Proposal 2010-2040 considers consideration of nuclear energy development in the long-term, to be integrated into the Peruvian energy matrix.

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 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 environment strategy policy, the Peruvian Government, in October 2003 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 programs in production sectors. Additionally, in 2009 the NSCC was updated and in May of that year, the Climate Change Commission, integrated by 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 program, to be developed from 2009 to 2012, focuses on three main thematic lines which are water resources, food security and natural disasters. The themes are transversal implying 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 program aims to promote the implementation of climate change adaptation strategies and measures by the local population 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 (UN-FCCC 2011):

- Reduction to zero of net deforestation of natural or primary forests;
- Modification of the current energy grid, so that renewable energy (nonconventional energy, hydropower and biofuels) represents at least 33 per cent of the total energy use by 2020.
- Design and implementation of measures which allow the reduction of emissions caused by the inappropriate management of solid waste.

The Peruvian Government's international climate change commitments are MINAM's responsibility. MINAM is responsible for 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 particular factors needed to carry out projects successfully (MINAM 2011).

NOTABLE ENERGY DEVELOPMENTS

OIL AND NATURAL GAS SECTOR

During 2010, investment in oil and gas exploitation in Peru reached USD 747 million. While 55% of this total investment was made by Pluspetrol Peru Corporation S.A., mainly in Lote 88 (Camisea) a significant share (17%) was invested by the Petrotech Peruana company (MINEM 2010a).

In June 2010, Peru LNG, a consortium integrated by 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 operations of Melchorita LNG plant Peru's (and South America's) first natural gas liquefaction plant (the Melchorita Plant) and sent its first liquefied natural gas ship (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. Melchorita Plant is managed by a (Peru LNG 2011).

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THE PHILIPPINES

INTRODUCTION

The Philippines is an archipelago of 7107 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 2009 reached almost 92 million, an estimated half of which lives in Luzon, the largest of the three major island groups in the Philippines. Due to the spill-over effects of the global economic and financial crisis in 2008 and to its own natural disasters in the last quarter of the same year, the economy grew modestly by 1.2% in 2009 from the 2008 GDP of USD 259.46 billion (USD (2000) at PPP). Consequently, with the economy's continuous growing population, GDP per capita was maintained at USD 2973 (USD (2000) at PPP) in 2009.

The Philippines has modest indigenous energy resources accounting for about 63 million barrels of crude oil, 1639 billion cubic feet of natural gas 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. The economy's renewable energy sources provide a significant contribution to its power generation. Geothermal energy resources have the biggest share providing 51% of the economy's total electricity generation. Hydropower and other renewable energy sources provide a combined total power generation of 9867 gigawatt-hours (GWh).

Table 25 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (sq. km)	300 000	Oil (million barrels)—proven	63
Population (million)	91.98	Gas (billion cubic feet)—proven	1 639
GDP (USD (2000) billion at PPP)	273.45	Coal (thousand tonnes)—proven	449
GDP (USD (2000) per capita at PPP)	2 973	Uranium (million tonnes of uranium metal)	–

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

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in 2009 reached 39 456 kilotonnes of oil equivalent (ktoe), a slight decrease of 2.8% from the 2008 level. Of this total, 59.5% was contributed by indigenous sources; the remainder was imported. Geothermal and other renewable energy resources accounted for 42.7% of the total primary energy supply; oil and coal, which are largely imported, contributed 34.2% and 14.9%, respectively.

Oil, gas and coal

The economy's total domestic oil production significantly increased by 34.6% in 2009. Crude oil production alone increased more than three times its 2008 level of 130 ktoe, to 392 ktoe in 2009. This was mainly due to increased production in the Galoc oilfield which produced about 86.1% of the economy's total domestic oil production in 2009. On the other hand, condensate

from the Malampaya gas field, which is wholly exported, decreased by 2.7%. This was due to the decreasing reservoir pressure consequently causing the amount of associated condensate or heavier gas to decrease. Local coal contributed 10.5% of the total indigenous energy mix as production reached 2473 ktoe in 2009. This level is 29.9% higher than the 2008 level of 1905 ktoe due to the increase in the demand for local coal spurred by the escalation in the price of imported coal. Semirara Mining Corporation, the economy's biggest coal mine, was solely responsible for the sufficiency of the local coal production of the economy.

The economy's own natural gas resources accounted for 13.7% of the economy's total indigenous resources in 2009. The gas production level in 2009 modestly increased by 0.7% from the 2008 level of 3192 ktoe. Currently, the only commercially-producing gas field in the Philippines, the Malampaya gas project, supplies the fuel requirements of most of the gas-fired power plants in the economy.

To help meet the economy's fuel requirements, the Philippines imports 43.3% of its total energy supply. Net imported fuels mainly comprised of 32.2% oil and oil and products, 11% coal and 0.1% biofuels. Imports were 9% lower than the 2008 level of 17 557 ktoe due to the strong combined production in 2009 of domestic crude oil, gas and coal.

Renewable energy

Geothermal continues to be the major indigenous resource of the economy, with a 22.5% share of its total indigenous primary energy supply in 2009. It is used solely for power generation. With a total installed capacity of 1958 MW, the Philippines is the second largest producer of geothermal energy in the world. The economy aims to be the number one producer, and the government continues to encourage greater private sector involvement in the exploration and development of the economy's vast geothermal energy potential. Biomass and hydropower resources contributed a combined share of about 20% of the economy's total indigenous energy supply in 2009.

Electricity generation

In 2009, the economy's total electricity generation was 61 934 gigawatt-hours (GWh), a slight increase of 1.8% from 60 821 GWh in 2008. Its power requirements were sourced primarily from natural gas-fired and coal-fired power plants with 32% and 27% shares, respectively. Geothermal power plants and hydropower plants (ranked third and fourth, respectively, in terms of the economy's power generation), experienced a combined decline of 2.2% from the 20 566 GWh of electricity generated in 2008. However, electricity generated from other renewable sources (wind/solar/biomass) significantly increased by 25% during the same year. Oil-based thermal plants provided 8% of the economy's total power requirements.

Table 26 Energy supply and consumption, 2009

Primary energy supply (ktoe)[b]		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	23 486	Industry sector	5 826	Total	61 922
Net imports and other	15 971	Transport sector	7 962	Thermal	41 744
Total PES	39 457	Other sectors	9 138	Hydro	9 788
Coal	5 887	Total FEC	22 926	Nuclear	–
Oil	13 488	Coal	1 624	Other	10 390
Gas	3 215	Oil	11 373		
Other	16 867	Gas	70		
		Electricity and other	9 858		

Sources: EDMC (2011); DOE (2009b)).

FINAL ENERGY CONSUMPTION

In 2009, the total final energy consumption of the Philippines reached 22 926 ktoe, a slight increase of 2.23% from the 2008 level of 22 926 ktoe. Of this total, the transport sector continued to be the largest energy consumer, accounting for about 37.8%, followed closely by the other sector at 37.6%. In terms of fuel, oil and oil products was the major fuel consumed with a 51.3% share. Energy demand sourced from electricity and other was next, accounting for an aggregate total of about 9909 ktoe in 2009. Coal use significantly decreased by 15.9% from the 2008 level of 1746 ktoe, due to the decline in the economy's usage of coal for power generation and cement manufacturing.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Recognizing its role as the major instrument in the realization of the energy sector's vision of achieving energy independence, in 2009 the Department of Energy crafted the 2009–30 Philippine Energy Plan (PEP 2009–30) (DOE 2009c). The plan has an overall vision of 'ensuring the best energy choices for a better quality of life'. The 20-year plan incorporates the government's mission to ensure the delivery of secure, sustainable, sufficient, affordable and environment-friendly energy to all economic sectors. The mission is anchored on the following frameworks:

- The economy's Six-point National Energy Sector Strategic Directions (DOE 2009c)
  1) Promote green and clean energy
  2) Ensure responsive, comprehensive, integrated, and consistent energy policy
  3) Identify and achieve the optimal (or best) energy mix
  4) Strengthen energy research and development program
  5) Develop manpower and institutional capacities
  6) Continue the implementation of social mobilization and monitoring mechanisms at the local and economy-wide levels
- The 2008 Philippine Energy Summit
- Public consultation

- The Sustainable Development Framework (Low Carbon Strategy)
- International frameworks on energy cooperation.

These frameworks are implemented through action plans and programs by the different energy sub-sectors categorized under three broad policy thrusts:

- Ensure energy security
  - Accelerate the exploration and development of oil, gas and coal resources
  - Intensify the development and utilization of renewable and environment-friendly alternative energy resources/technologies
  - Enhance energy efficiency and conservation
  - Attain economy-wide electrification
  - Put in place a long-term reliable power supply
  - Improve transmission and distributions systems
  - Secure vital energy infrastructure and facilities
  - Maintain a competitive energy investment climate.
- Pursue effective implementation of energy sector reforms
  - Monitor the implementation of, and if necessary, recommend amendments to existing energy laws
  - Promote an efficient, competitive, transparent and reliable energy sector
  - Advocate the passage of new and necessary laws.
- Implement social mobilization and cross-sector monitoring mechanism
  - Expand reach through Information, Education and Communication (IEC)
  - Establish cross-sector monitoring mechanism in cooperation with other economy-wide government agencies, academe, local government units, non-government organizations and other local and international organizations
  - Promote good governance.

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 2009, 34 service contracts (SCs) have been supervised and monitored by the Department of Energy including the six SCs awarded in 2008 and one in 2009 which resulted from the success of PECR 2006. Currently, the economy has 16 sedimentary basins with a combined potential of 4777 million barrels of fuel oil equivalent (MMBFOE) and 689.8 million tonnes of oil equivalent (Mtoe) of oil and gas reserves.

Production from existing oilfields and gas fields yielded 965 thousand barrels of oil, 137 072 million standard cubic feet (MMscf) of gas and 5.6 million barrels (MMB) of condensate in 2008. A significant increase in oil production in 2009 was reflected, with 2.92 MMB of oil coming mostly from the Galoc Field. Commencing oil production in October 2008 with its two production wells, Galoc Field has an average daily production of 14 000 barrels. Similarly in 2009, 125 132 MMscf of gas and 13.6 MMB of condensate were realized.

An additional 150 billion cubic feet (Bcf) of gas has been recovered from the seventh well of the Malampaya gas project, which could fuel a 300 MW natural gas power plant for a period of 12 years. ExxonMobil Exploration and Production Philippines B.V. (EMEPP), which acquired a

50% ownership of SC 56 and the right to operate the oil and gas exploration project in the Sulu Sea Basin, drilled an additional well over the Sulu Sea in 2009. Blade Petroleum has shown an interest in developing the Cadlao Block, Northwest Palawan, and Shell Philippines Exploration Corporation in offshore Eastern Palawan.

Coal

The economy is endowed with domestic coal resources which could be tapped for exploration, development and utilization. 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 ; the smallest is in Quezon with 2 million metric tonnes. 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 MMMT.

Indigenous coal production in 2009 reached 4.7 MMMT at 10,000 BTU/lb, a 29.9% increase compared with the 3.6 MMMT produced in 2008. Domestic coal production in 2009 was the highest ever in the history of the economy's local coal mining and represented around 40.8% of its total coal requirement.

In 2009, coal imports reached 7.37 MMMT at 10,000 BTU/lb, of which 89.8% came from Indonesia, 7.8% from China and 2.4% from Vietnam.

MARKET REFORMS

Electricity

One of the major milestones of the Arroyo Administration was the passage of the Electric Power Industry Reform Act of 2001 (the EPIRA) (RA 9136). It was also the time of major developments in the power generation sector in which 2700 MW of natural gas-fired power plants were commissioned to meet the projected increasing electricity demand in Luzon. At the same time, there were also the challenges of the looming power shortages in the economy's two other major grids, Visayas and Mindanao, and the need to expand and improve the transmission and distribution networks to deliver to customers the power generated from existing and new power plants. The EPIRA also sought to address the economy's high electricity rates and to ensure sustainable development.

As mandated by the EPIRA, the Department of Energy supervised the restructuring of the electricity industry to meet its ultimate vision of having a power industry characterized by higher efficiency, a level playing field, lower electricity rates, and stable and secure supply of power. While the initial implementation of the EPIRA has been a daunting task, the economy has had significant accomplishments in compliance with the EPIRA provisions:

- Compliance with conditions of retail competition and open access
  - *Tariff and functional unbundling*. This was done to reflect the true cost of services provided in the power industry such as generation, transmission, distribution, and supply sectors. The National Power Corporation's (NPC's) transmission functions were transferred to the National Transmission Corporation (TransCo).
  - *Initial implementation of cross-subsidy removal*. The NPC and TransCo have completely removed the inter-grid and intra-grid cross subsidies. At the distribution level, 103 out of the 119 electric cooperatives have completed the removal of inter-class cross subsidies. The remaining 16 electric cooperatives are still implementing their cross-subsidy removal. Three out of the 18 private distribution utilities are still implementing the gradual removal of inter-class cross subsidies.
  - *Establishment of the wholesale electricity spot market (WESM)*. With the implementation of the WESM, the economy's generator trading portfolios increased to 27 with the entry of Therma Luzon (Pagbilao Independent Power Producer (IPP)

Administrator), San Miguel Energy Corp. (Sual IPP Administrator), and Sem-Calaca (new Calaca owner), and its customer-direct trading participants increased to 18.

- *Privatization of at least 70% of NPC's generating assets in Luzon and Visayas.* During the implementation of the EPIRA, the government has privatized 26 of its generating/operating plants and five decommissioned assets. Twenty of these assets comprised 91.8% of the NPC's generating capacities in Luzon and Visayas, thereby breaching the 70% condition for open access and retail competition. The latest successful bids included that of the 246 MW Angat hydropower plant and the 150 MW BacMan geothermal power plant.
- *Transfer of management and control of at least 70% of the total energy output of power plants under contract with NPC to Independent Power Producer (IPP) administrators.* One of the primary objectives of the EPIRA was to appoint IPP administrators to administer, conserve and manage the contracted energy output of the NPC. Along this line, the government successfully bid out 3479.85 MW of NPC-contracted capacities with the equivalent proceeds of USD 3228.00 million.

▪ Other privatization accomplishments

- *Privatization of the National Transmission Corporation (TransCo).* In January 2009, the Philippine Government formally turned over the 25-year concession of TransCo to the National Grid Corporation of the Philippines (NGCP). The NGCP paid USD 987.5 million upfront for the operation of the transmission system and in compliance with the provisions of the sale transaction. The amount was 25% of the USD 3.95 billion purchase price to acquire the concession contract.
- *Divestment of Transco's sub-transmission assets.* Relatedly, the divestment of TransCo's sub-transmission assets involves some 131 sale packages covering some 107 interested distribution utilities, mostly electric cooperatives. These sub-transmission assets involved a total of about 6200 circuits comprising 69 kilo volt (kV) of transmission lines and 1600 megavolt ampere (MVA) of substation capacity.

As of 30 April 2010, TransCo had divested PHP 3.42 billion (67 sale packages) worth of sub-transmission assets, including 325 MVA transformers, to 56 distribution utilities. Included in the sale packages are 40 lease purchase agreements with 32 cooperatives under concessional terms amounting to about PHP 2.46 billion. The balance of over PHP 960 million represents sales to private distribution utilities. Thirty-one sale contracts have been approved by the Energy Regulatory Commission, amounting to PHP 1.49 billion as of 30 April 2010.

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, stable and fair price of oil products of the economy.

Realizing the effectiveness of the Act in the oil market, the number of new industry players increased remarkably with 289 new entrants in the first half of 2010, with 1171 players engaged in different activities compared with 882 in 2008. This resulted in increased investment in the economy of PHP 37.97 billion in the first half of 2010, from PHP 34.67 billion in 2008.

In terms of dealership, 377 new gasoline stations were built in the first half of 2010 providing the economy with a total of 4114 gasoline stations economy-wide. Luzon has the largest number of gasoline stations among the major islands.

ALTERNATIVE FUELS

The passage of the Biofuels Act of 2006 (RA 9367), was a major policy leap in harnessing the economy's domestic alternative energy resources.

The introduction of alternative fuels in the Philippines provides a feasible solution in minimizing the effects of continuous increases in the prices of crude oil in the world market and the worsening condition of the environment. In its implementation, the Department of Energy under its Biofuels Program accredited 14 biofuel producers (12 for biodiesel and two for bioethanol) in 2009. It has also endorsed 48 projects/companies to the Securities and Exchange Commission for corporate registration and to the Board of Investments for applicable incentives under the Biofuels Act.

As monitored by the Department of Energy, the 12 biodiesel producers yielded a combined production capacity of 395.6 million litres per year. In March 2009, South-East Asia's first dedicated ethanol distillery with an integrated co-generation power plant, the San Carlos Bioenergy Inc., started operations. The plant has a production capacity of around 40 million litres of ethanol annually, representing 10% of the economy's requirements. There is also a continuing program to develop jatropha as biodiesel feedstock. The PNOC-Alternative Fuels Corporation (PNOC-AFC) is working to establish production nurseries in 13 sites all over the Philippines.

As the transport sector accounts for the biggest demand in the economy's total consumption, the promotion of the development and use of biofuels has been intensive in this sector. The initial mandatory blend of 1% coconut methyl ester (CME) for biodiesel and 5% ethanol for gasoline was increased to 2% and 10%, respectively.

The government's Natural Gas Vehicle Program for Public Transport together with the private sector have pushed for the use of CNG buses. As of June 2009, there were 26 CNG buses plying the routes of southern Luzon and Metro Manila.

In support of the Department of Energy's campaign to promote the use of cleaner and alternative fuels, the Land Transportation Franchising and Regulatory Board granted incentives to operators with LPG and CNG-fed engines by giving them preference in applying for a franchise for a public utility bus and an additional two years in the minimum age of taxis to operate. As of December 2009, there were about 17 500 converted vehicles running on LPG, up from 13 800 units in 2007, and 293 LPG-converted tricycles economy-wide.

ENERGY EFFICIENCY

As a way of hedging against the high cost of oil, the National Energy Efficiency and Conservation Program (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 (DOE 2009d). The NEECP continues to provide the framework for the economy's efforts to promote efficient and judicious use of energy, through the following programs:

- Information, education and communication campaign
- Voluntary agreement
- Energy labelling and efficiency standards for household appliances
- Government Energy Management Program
- Energy Management Program.

Total energy savings generated through the aforementioned programs increased by 24.9% in 2009, with 18.40 MMBFOE (2.66 Mtoe) savings compared with previous year's 14.70 MMBFOE (2.13 Mtoe) savings. Such energy savings were obtained through the following initiatives being implemented by the Department of Energy under the NEECP, in coordination with other relevant government agencies and the private sector:

- Social Mobilization and Information, Education and Communication (IEC) Campaign

  Aggressive implementation of an effective IEC campaign is a key component to ensure the success of the government's energy efficiency and conservation program. Currently, the IECs conducted by the government through the Department of Energy cover not

only business operations and the supply/demand chain, but they also intend to influence consumers' behaviour:

- Power Conservation and Demand Management (Power Patrol) is designed specifically for the household, industrial, commercial and academic sectors in support of the NEECP
- Fuel Conservation and Efficiency in Road Transport (Road Transport Patrol) is being implemented to improve efficiency in the transport sector.

- Energy Efficiency Standards and Labelling Program

  The Department of Energy, in partnership with the Department of Trade and Industry, has effectively implemented the mandatory Energy Efficiency Standards and Labelling Program for selected household appliances and lighting products, such as room air conditioners, refrigerators (with a storage volume of five cubic feet/142 litres to eight cubic feet/227 litres) and compact fluorescent lamps.

  Through this program alone, the economy saved 13.03 MMBFOE (1.88 Mtoe) in 2009, equivalent to USD 1.05 billion in savings. The government will widen the scope of appliances and lighting products to be covered by energy standards and labelling, to include new models of passenger cars and light duty vehicles.

- Government Energy Management Program

  Under this program, government agencies are required to monitor and reduce their annual consumption of electricity and gasoline by 10%. In support of this policy, a total of 300 departments/government agencies and attached agencies have submitted their energy consumption reports to the Department of Energy. These reports indicate the energy savings the agency was able to achieve.

To further strengthen the implementation and monitoring of new and existing energy efficiency programs with other government agencies, the following plans and programs will continue to be implemented:

- *Lamp Waste Management Facility*. The testing and recovery facility is designed to stimulate private sector interest in the lamp waste management business.
- *Philippine Efficient Lighting Market Transformation Project*. Alongside the advocacy of this project will be the implementation of:
  - Energy Conserving Design of Buildings.
  - Efficient Lighting.
  - Roadway Lighting Guidelines.

    These guidelines will be implemented by local government units with the support of the Department of Interior and Local Government and the Department of Public Works and Highway.
- *Conduct of Recognition Awards*. The regular conduct of Recognition Awards recognizes the initiatives of private companies and managers who have implemented energy efficiency and conservation programs that resulted in considerable savings in energy cost. In 2009, there were 44 companies that received the award and registered an aggregate energy savings of 89 Million Liters of Oil Equivalent (MLOE) (0.08 Mtoe) amounting to PHP 2.6 billion.
- *Philippine Energy Efficiency Project (PEEP)*. The PEEP, conceived after the 2008 Energy Summit, specifically aims at phasing-out inefficient technologies such as the shift from incandescent bulbs to energy efficient lighting systems. The project is designed to generate electricity savings of 534 GWh, as well as a deferred power-capacity saving of 400 MW per year. It will also result in an environmental pollution reduction of 300 gigagrams of CO_2 avoidance per year (ADB (2009), p. 14).

- *Promotion of Energy Service Companies.*

To improve the implementation of and compliance with the existing policies on energy efficiency and conservation, the Department of Energy will expand its role as an advocating agency. It will take the lead for the passage of an Energy Efficiency and Conservation Bill to promote the rational use of energy across all sectors of the economy. The Bill will contain specific policies, goals, directions, regulations and guidelines for the enforcement of an economy-wide energy efficiency plan. The Bill will include the implementation of the energy efficient design of buildings and the use of passive cooling in commercial establishments as prescribed by the Guidelines on Energy Conserving Design of Buildings prepared by the Philippine Efficient Lighting Market Transformation Project. It will also consider the energy efficiency initiatives of local government units to secure grassroot-level support.

RENEWABLE ENERGY

Another major accomplishment of the economy's energy sector was the passage of the Renewable Energy Act of 2008 (RA 9513) to further promote the development, utilization and commercialization of renewable energy resources. Subsequently, the Implementing Rules and Regulations were signed on 25 May 2009, and in accordance with the Act, the National Renewable Energy Board (NREB) was created. The NREB's members are representatives from other government agencies, stakeholders and non-government organisations.

The passage of the Renewable Energy Act has spurred investor interest in the development of renewable energy sources. At the end of 2009, the total installed capacity from renewable energy sources stood at 5431.4 MW. Of the total capacity, hydropower contributed the biggest share with 3367 MW, of which 3291 MW is grid connected and the remaining (76 MW) is off-grid. Geothermal is the second biggest contributor with 1958 MW, followed by biomass with 68 MW, of which 30 MW is on-grid. Biomass has its own distinct characteristics, being an area-based or site-specific generating facility due to the availability of the 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 support of the Renewable Energy Act, the Renewable Energy Policy Framework 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. Specifically, its objectives are:

- Increase renewable energy based capacity by 100% within the planning horizon
- Increase the non-power contribution of renewable energy to the energy mix by 1.44 Mtoe
- Be the number one geothermal energy producer in the world
- Be the number one wind energy producer in South-East Asia
- Double hydro capacity by 2030
- Expand the contribution of biomass by 200 MW, solar by 30 MW, and introduce ocean thermal energy conversion.

To further boost investors' interest in renewable energy development, the sector is awaiting the promulgation of other policy and regulatory mechanisms. These mechanisms include such things as a Renewable Portfolio Standard, which will set the minimum percentage of generation from eligible renewable energy resources provided by the generators, distribution utilities and electric suppliers, and a feed-in tariff (FiT) system, which will provide guaranteed payments on a fixed rate per kilowatt-hour for renewable energy generation (excluding any generation for own use).

To achieve the sectors' policy goals, it may be worth mentioning the economy has an estimated total potential capacity of 8156.70 MW of renewable energy sources. Of the total, 7137.07 MW is already indicative and already issued with pre-development contracts for

preliminary assessments and feasibility studies. The remaining 1019.63 MW is still open for private sector investments. Hydropower has the highest potential with 4933.9 MW, followed by wind and geothermal with 1491 MW and 1405 MW, respectively. The potential resource from biomass is 255 MW and from solar, 71 MW.

NUCLEAR

In the Philippines, nuclear energy is among the long-term options being considered by the government for power generation, to curb the impact of energy imports on its economy.

In 2009, based on the recommendation of the International Atomic Energy Agency's Expert Mission in February 2008, an Inter-Agency Core Group on Nuclear Energy (the Core Group) composed of officials and staff from the Department of Science and Technology and the Department of Energy was created by a Joint Department Order. The primary mandates of the Core Group are: (a) to study the prospect of introducing nuclear 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 dealing with the benefits of nuclear technology applications in the Philippines, specifically in the areas of medicine, agriculture and research, as well as how nuclear safety, security and safeguards 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 end-in-view of these IEC campaigns is the development of a Public Communication Plan for Nuclear Energy. The plan will emphasis and make it a priority to educate key policy makers in government including legislators, communities, the media, non-government organizations, religious groups, youth and academia.

While there are no legal impediments for the Philippines Government to pursue a nuclear energy program, 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 tasked with coordinating, monitoring and evaluating programs 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 to ensure 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 to showcase a low carbon strategy. This will ensure the full-scale development and commercialization of renewable energy and alternative fuels. The government will also intensify the use of natural gas, as it provides a structural change in the economy's energy mix, strengthens the economy's fuel diversification program and contributes to emissions reductions.

NOTABLE ENERGY DEVELOPMENTS

ENERGY REFORM AGENDA

In 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 (2010–11), medium-term (2011–13) and long-term (2013–16) timelines.

An over-arching strategy to achieve these three major pillars is the principle of good governance. As the government liberalizes access to energy, it will encourage transparency and accountability in all phases of energy policy, program 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 be a lot 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.

In keeping with development, putting in place an integrated information and communication technology (ICT) infrastructure will enable various stakeholders to get 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 accordance with the Renewable Energy Act of 2008 (RA 9513), the Department of Energy in consultation with its stakeholders led the formulation of the National Renewable Energy Program (NREP). The NREP outlines the policy framework embodied in the Renewable Energy Act. It sets the strategic building blocks that will help the economy achieve the goals set out in the Act. The NREP signals the economy's big leap from fragmented and halting renewable energy initiatives to a focused and sustained drive towards energy security and improved access to clean energy.

In the realization of its renewable energy goals, the NREP:

- Institutionalizes a comprehensive approach to addressing the challenges and gaps that delay the wider application of renewable energy technologies in a sustainable manner
- Outlines the action plans necessary to facilitate and encourage greater private sector investments in renewable energy development.

On a technology basis, the NREP intends to:

- Increase geothermal capacity by 75%
- Increase hydropower capacity by 160%
- Deliver an additional 277 MW of biomass power capacity
- Attain wind power grid parity with the commissioning of 2345 MW of additional capacity
- Mainstream an additional 284 MW of solar power capacity and work towards achieving the target of 1528 MW
- Develop the economy's first ocean energy facility.

The initial focus of the NREP is the addition of renewable energy based capacity for power generation. The program for non-power applications will be incorporated subsequently.

PENDING BILLS

In support of various plans and programs of the government, the Department of Energy has pushed for the passage of some relevant Bills for the energy sector. These Bills are expected to be filed in the 15th Congress.

The Natural Gas Bill was filed and remains pending in both Houses of Congress. The pending bill, which aims to provide the regulatory framework and incentives for prospective investors in natural gas, will be re-filed in the 15th Congress. As the transport sector's demand for LPG is expected to increase in the future, the Department of Energy will propose a LPG Bill to regulate the use and safety requirements of LPG for transport.

The passage of an Energy Efficiency and Conservation Bill, which will be filed in the 15th Congress, will further strengthen the National Energy Efficiency and Conservation Program and is vital to realizing the 10% efficiency improvement in the electricity sector.

MARKET REFORMS

Gearing towards a competitive power market, and in compliance with the EIPRA, the Department of Energy in consultation with its stakeholders pushed for the establishment of a wholesale electricity spot market (WESM) in the Visayas. In December 2010, following the submission by the Philippine Electricity Market Corporation (PEMC) of certification attesting all necessary systems and procedures were in place, the commercial operation of a WESM in the Visayas officially commenced, and the market integration of the Luzon and Visayas grids executed.

CLEAN TECHNOLOGY FUND PROJECT

In November 2009, the Philippine Government, in agreement with the Asian Development Bank (ADB), the International Bank for Reconstruction and Development, and the International Finance Corporation developed a business plan. The plan is called the Clean Technology Fund (CTF) Country Investment Plan (CIP). The CIP is a proposal to use the 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 programs 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

Asian Development Bank—www.adb.org

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

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

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

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

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

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

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

THE RUSSIAN FEDERATION

INTRODUCTION

With a land area of more than 17 million square kilometres, the Russian Federation is geographically the world's largest economy. It is the only APEC economy located both in Eastern Europe and Northern Asia, bordered by the Arctic and the North Pacific oceans. Its terrain 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, it lacks an optimal climate for agriculture, as most of its area has a continental climate, and is either too cold or too dry.

EDMC (2011) data shows the population from 1990 to 2009 declined from 148.29 million people to 141.85 million people. The proportions of urban and rural population are unchanged: 73% and 27% respectively. The overall population density of the Russian Federation is low (fewer than nine people per square kilometre) and the northern and eastern regions are sparsely populated.

After a decade of economic contraction (about 40% compared to the 1990 GDP level), the Russian economy began to grow again in 1999. The recovery was triggered by a devaluation of the rouble in the aftermath of the 1998 financial crisis, and its positive impact on the economy's competitiveness. In parallel, soaring world prices of oil and natural gas also drove the recovery.

The Russian Oil Stabilization Fund was established in January 2004 to reduce the vulnerability of the state budget to the volatility of world oil prices (a stabilization function), and to decrease the impact of oil-related foreign exchange inflows on the money supply and inflation (a sterilization function). Since 2008, the fund has been split into the Reserve Fund and the National Wealth Fund, with total assets of more than RUB 6.6 trillion (USD 225 billion) as of 1 January 2009. The Reserve Fund was used by the Russian Government to overcome the influence of the global economic and financial crisis in 2009, and as of 1 January 2010 the Reserve Fund and the National Wealth Fund are together valued at RUB 4.6 trillion (USD 153 billion).

Table 27 Key data and economic profile, 2009

Key data		Energy reserves[a]	
Area (sq. km)	17 075 200	Oil (billion barrels)	77.4
Population (million)	141.85	Gas (billion cubic metres)	44.8
GDP (USD (2000) billion at PPP)	1 533.06	Coal (billion tonnes)	157.0
GDP (USD (2000) per capita at PPP)	10 808	Uranium (kilotonnes of uranium metal)[b]	181.4

a Proven reserves at the end of 2010 are from BP (2011).
b Reasonably assured resources, from IAEA and NEA OECD (2010).

Source: EDMC (2011).

The Russian Federation's economy continued to develop strongly till 2008, achieving 6% growth in 2008 and an average growth rate of 6.9% 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 unemployment rate in 2009 was 7%, and inflation stayed high, at 8.2% in December 2009.

In terms of proven reserves, the Russian Federation holds almost a quarter of the world's gas, 5.6% of its oil reserves, 18.2% of its coal reserves, and about 14% of its uranium ore reserves. Even more resources remain undiscovered, but the formidable obstacles of climate, terrain and distance hinder their exploitation. The Russian Federation is the world's second-largest primary energy producer (behind the United States), the third-largest energy consumer (behind China and the United States), the largest exporter of energy (about 45% of total energy produced is exported), the largest exporter of natural gas, and in 2009 the Russian Federation overcame Saudi Arabia in oil production to become number one producer in the world.

The energy sector's output accounts for about 26% of Russia's GDP, more then 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 2009, 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, 21% of natural gas trading, 16% of reactor construction, 15% of spent nuclear fuel conversion, 13% of crude oil and petroleum products trading, and 12% of coal trading.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The Russian Federation's total primary energy supply in 2009 was 646.9 million tonnes of oil equivalent (Mtoe), comprising natural gas (54.2%), crude oil and petroleum products (21.3%), coal (14.9%) and others, including nuclear and hydro (9.6%).

By destination, more than 90% of Russia's total energy exports go to Western and Eastern Europe (including the Commonwealth of Independent States (CIS)). To secure its future energy exports, from 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 economies in North America.

The Russian Federation produced 493.7 million tonnes of crude oil and gas condensate in 2009. The oil heartland province of West Siberia accounted for about two-thirds of total production. Refiners consumed 235.7 million tonnes of crude oil as feedstock, producing 35.7 million tonnes of gasoline, 67.4 million tonnes of diesel oil and 64.1 million tonnes of fuel oil. Oil exports reached 247.4 million tonnes tonnesof crude oil and 92.9 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 declined from 664 billion cubic metres (bcm) in 2008 to 583.6 bcm in 2009, which is similar to the 2000 level. Net exports of natural gas in 2009 accounted for 168.3 bcm (86% of the 2008 level), or 28.8% 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 298.5 million tonnes of coal in 2009 (86% of the 2008 level). Coal exports reached 97.1 million tonnes. From 2000 to 2009 the proportion of the total coal production volume that is exported increased from 17.1% to 32.5%, despite the fact that the main coal-producing areas (Kuznetsky and Kansko–Achinsky basins) are landlocked in the south of Siberia, some 4000–6000 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 28 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 183 588	Industry sector	124 544	Total	991 980
Net imports and other	–528 627	Transport sector	89 617	Thermal	649 167
Total PES	646 917	Other sectors	208 722	Hydro	176 118
Coal	96 418	Total FEC	422 883	Nuclear	163 584
Oil	137 965	Coal	18 268	Geothermal	
Gas	350 395	Oil	106 240	and others	3 111
Others	62 139	Gas	128 542		
		Electricity and others	169 833		

Source: EDMC (2011).

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

The Russian Federation produced 992 TWh of electricity in 2009, of which 65.4% was from thermal power plants, 17.7% from hydropower and 16.5% from nuclear energy. 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 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 2009, total final energy consumption in the Russian Federation was 423 Mtoe, a decline of 2.9% compared with the previous year. By sector, industry accounted for 29.4%, transport for 21.2% and other sectors for 49.4%. By energy source, coal accounted for 4.3%, petroleum products 25.1%, natural gas 30.4% and electricity and others (including heat) 40.2%. 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.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In May 2008, a new Ministry of Energy was established, taking parts of government control from the former Ministry of Industry and Energy. In formulating and implementing national energy policy, the Ministry focuses on three strategic goals:

- More efficient use of energy resources and the operation of the fuel and energy complex of the Russian Federation. This goal requires an efficient and reliable supply of fuel and

energy resources and related infrastructure services to all consumer groups, at both the federal and regional levels.

- The development of a competitive fuel and energy complex in the Russian Federation. This objective is primarily to build competitive relations in the domestic and international energy markets in an open economy, and indirectly support(through the creation of jobs, increasing incomes of workers, development of 'human capital' and expansion of the available set of goods and services) the social field.
- Strengthening of Russia's position in world energy markets. This goal determines the policy of creating conditions for Russian leadership in the global economy through effective participation in the global governance process of the energy sector.

The importance of energy exports for the Russian economy is shown by the share that energy-related industries have in Russia's GDP (more than 26%), and by the volume and structure of its net energy exports that put the economy among the world's top four energy exporters.

Energy strategy to 2030

The adoption of the Energy Strategy of the Russian Federation to 2020 in August 2003 was a milestone in Russia's energy sector development. The strategy identifies the economy's long-term energy policy and the mechanisms for its realization. A revised version of the strategy – Energy Strategy of the Russian Federation to 2030, with an extended timeframe to 2030 – was adopted by the government in November 2009. The new version of the strategy was updated by taking into account the new realities and priorities in the energy sector as affected by the global recession. The strategy is a framework within which more detailed industry-oriented medium-term and short-term programs can be developed.

The strategic objective of Russia's external energy policy is to use its energy potential effectively to maximize its integration into the world's energy markets, to strengthen Russia's position in the markets, and to maximize the benefits of energy resources to the economy. To achieve this, it will implement several measures to secure domestic energy consumption, energy export obligations, and efficiency improvements along the whole energy supply chain. The measures will:

- sustain a high degree of energy security for the Russian Federation as a whole and for the energy-rich regions
- help the Russian Federation to develop a global energy security system, including the diversification of export delivery routes (at least 27% of Russia's total energy exports in 2030 should be delivered to the Asia–Pacific region, and the share of foreign direct investments to the energy-related industries should increase to 12%, from 4%)
- decrease economic dependence on the oil and gas sector (the share of energy in Russia's GDP should be reduced from 30% to 18%)
- reduce the energy intensity of the economy by 40% by 2030.

To facilitate international cooperation on energy security, the Russian Federation has adopted the following strategic initiatives:

- development of the closed nuclear fuel cycle and the expansion of nuclear power generation
- development of new hydrocarbon provinces in remote areas and offshore
- rehabilitation, modernization and development of the energy infrastructure, including the construction of trunk oil and gas pipelines, to enhance the economy's energy export capacity
- enhancement of energy exports to the Asia–Pacific region's international markets.

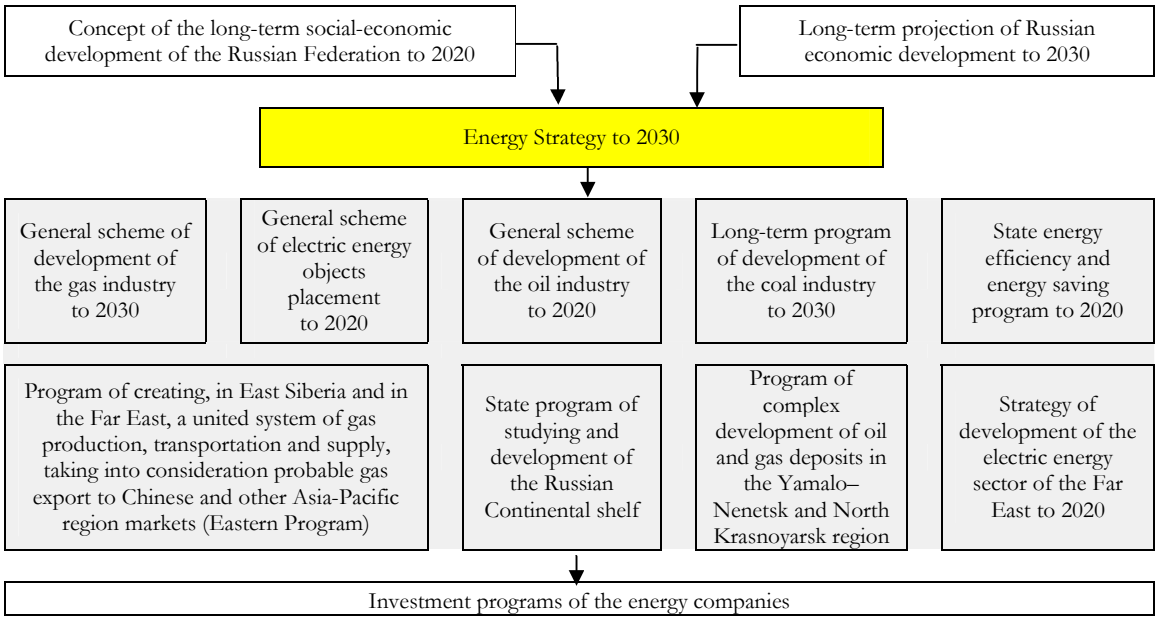
The most important tool of the Energy Strategy of the Russian Federation to 2030 (Energy Strategy to 2030) is the development of energy market institutions, such as fair pricing mechanisms, transparent trading principles, and sufficient energy transportation infrastructure. The federal government will do this through:

- legislative support for transparent and non-discriminatory access for all domestic market participants to energy infrastructure (pipelines, power and heat supply grids), tougher antimonopoly regulations to prevent cartel-type market monopolization, and the creation of an integrated monitoring system for energy markets
- stimulating private companies' participation in energy trading by means of commodity exchange, by creating a regulatory framework for the energy 'derivatives' trade (futures, options etc) in roubles through stock exchanges, and by increasing its role in pricing energy resources
- ceasing cross-subsidies and reducing the state regulation of natural monopolies' tariffs, while maintaining a socially acceptable level of residential energy expenses
- steadily liberalizing the gas, electricity, and heat domestic energy markets.

The total cost of implementing the Energy Strategy to 2030 is assessed at USD 2.4–2.8 trillion.

Under the general framework of the Energy Strategy to 2030, long-term and medium-term programs and industry-wide schemes are being developed (Figure 1).

Figure 1. Place of Energy Strategy to 2030 in the system of other strategic and program documents



Source: Ministry of Energy of the Russian Federation, www.minenergo.gov.ru 2011

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 under the

leadership of Deputy Prime Minister Igor Sechin, the general scheme of development of the oil industry up to 2020 was approved. The general scheme of development of the oil industry up to 2020 provides for the comprehensive development of all subsectors of the oil sector—exploration, development and construction of oil and gas condensate, and utilization of associated petroleum gas, crude oil and petroleum products, crude oil refining and transportation infrastructure.

The general scheme of 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 the leadership of Prime Minister Vladimir Putin. The document is 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, transportation and storage of gas supply to consumers of hydrocarbons and refined products.

In 2007, the federal government approved the East Gas Program to develop natural gas fields and build extensive trunk gas pipelines in Eastern Siberia and the Russian Far East up to 2030. The program also includes building export pipelines to the East Asian economies. Gazprom, the state gas monopoly and owner of the economy-wide gas pipeline system, is the coordinator of the program and is responsible for conducting long-term sales contracts for natural gas deliveries.

In November 2011, the Ministry of Energy sent to the Russian Government the second phase development plan for the gas and petrochemical industry of the Russian Federation to 2030. The working group for this plan included relevant government authorities, industry, 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 program of placement of petrochemical capacities into six clusters, including pipeline transportation projects, projects to upgrade existing and build new facilities for primary (pyrolysis) and further processing of raw materials, and activities for the scientific and educational support of the industry.

In April 2011 the Government Presidium of the Russian Federation approved the draft of the long-term program of 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 program is the realization of potential competitive advantages of Russian coal companies in the implementation of the long-term national energy policy.

In addition to industrial approaches to energy policy formulation, the Federal Targeted Program 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.

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 for new generation and transmission facilities (with more than 5 MW capacity/110 KV and higher voltage, respectively).

Law and regulations

The basic laws on specific energy-related industries are either being implemented or developed. The set of acting laws includes On Subsoil (since February 1992), On Price Control for Electricity and Heat Supply (since April 1995), On Natural Monopolies (since August 1995), On Production Sharing Agreements (since December 1995), On Energy Conservation (since April 1996), On Gas

Supply (since March 1999), On Power Industry (since March 2003), On Nuclear Industry (since February 2007), On Heat Supply (since July 2010), On Energy Conservation and Increase of Energy Efficiency (since August 2010). The latter is the logical extension of the On 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 On 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 Service for the Oversight of Natural Resources
  - Federal Service for Environmental, Technological, and Nuclear Supervision
  - Federal Agency for Water Resources
  - Federal Agency on Mineral Resources
- Ministry of Industry and Trade
  - Federal Agency for Technical Regulation and Metrology
- 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 the international infrastructure for the reliable maintenance of the nuclear fuel cycle, under strict International Atomic Energy Agency (IAEA) supervision, is another Russian input to the improvement of global energy security.

ENERGY MARKETS

Market liberalization

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 liberalized). 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 centralized heat supply. One of the objectives of the Energy Strategy of the Russian Federation to 2030 is to complete the full liberalization of domestic energy markets, where at least 20% of energy should be traded on commodity exchanges. In December 2006, the government approved the liberalization of natural gas and electricity prices simultaneously in 2011, ensuring the smooth development of the natural gas industry and the restructuring of the power industry. The synchronization of price liberalization 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 liberalized, 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, which is 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 netback 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 privatized 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.

Currently, the oil industry in the Russian Federation consists of nine large companies producing more than 90% of the crude oil, and more than 300 small-scale enterprises, and 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 (ie 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 and fully privatized in the 1990s, and foreign participation in the sector is practically absent. 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 haulage over long distances. Coal is the single largest commodity transported by Russia's railway network, accounting for almost 30% of its total freight.

Power

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 privatized before July 2008. From July 2008, the generation and transmission assets in the Russian Federation have been separated under binding regulations. Generation assets are consolidated into interregional companies of two types: seven wholesale thermal power plant generation companies (WGCs) and 14 territorial generation companies (TGCs). Six thermal WGCs 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 provides 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 organization 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 (RAB) 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 subsidized by local budgets and thus has room for a lot of efficiency improvements. The law On Heat Supply was introduced in July 2010 to create investment opportunities, to minimize 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 (CHP) 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 – AtomEnergoProm (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 original schedule for implementing fuel standards was in 2011 once again delayed by three years, as the federal government amended the schedule ahead of the deadline for the introduction of the Euro-3 standard. This followed an earlier three-year deferment in July 2009. The Euro-3 standards will be mandatory from January 2015, while the Euro-4 standards will be implemented from January 2016. The time for implementing the Euro-5 standard has not been specified.

Strong attention is paid to alternative motor fuels, particularly to LPG and compressed natural gas. Alternative motor fuels are seen as an environmentally compatible and economically viable option for government and public transportation, and their use is consistent with the recently adopted law On Energy Saving and Energy Intensity. Such alternative fuels currently have a 3% share of the total motor fuel consumption in Russia.

FISCAL REGIME AND INVESTMENT

In 2007, dozens of oilfields 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-expensive 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 of 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 tonnes, and fees for the light and dark 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 preferential export duty, which, as from October 2011, is set at USD 204.5 per tonnes. Reduced duty on crude oil is achieved by changing the formula to calculate it. 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 standard price of oil at a rate of USD 182.5 per tonnes. 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 would allow oil companies to obtain additional funds for the exploration of new fields and increase current oil production. In addition, the unification of tariffs on exports of petroleum products at 66% would make exports less competitive on dark petroleum products and more profitable on 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 the improvement of Russia's energy intensity could exceed 300 Mtoe, including more than 160 Mtoe from the energy extraction, transformation and transportation industries only.

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 Russian 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 21 January 2011 the federal government adopted the Federal Targeted Program on Energy Saving and Energy Efficiency Improvement to 2020 (the FTP).

The FTP will be carried out in two stages: from 2010–15 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 program 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 programs; 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 FTP, all regions are required to prepare their respective regional programs on energy efficiency improvements. The implementation of these programs will be financed jointly by regional governments and the federal government.

On 22 December 2009, the government established the Federal Energy Agency within the Ministry of Energy. 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 budget sector (piloting energy performance contracting in schools and public buildings)
- energy efficient district (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.

The 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 has been the absence of appropriate financial mechanisms in Russia. 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 4400 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 2200 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 tying-up renewable energy generators, transmission lines, and guarantor suppliers of energy.

In October 2010, the government published the ruling for federal subsidies for renewable energy generators connection to the power grid, to encourage 'green' energy production in Russia. Conditions of the ruling include the nominal capacity of renewable energy generators should not exceed 25 MW, and 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 standardization, uniform safeguard practices, training and certification, and research and development.

In 2007, the International Uranium Enrichment Center (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 program for the IUEC's expansion at Angarsk to 2015 was developed. The program 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 1000 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 (SWUs) are expected to be commissioned. A target of 5 million SWUs is expected to be achieved in 2017 under the project.

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 (LEU), and to carry LEU supplies for the IAEA member states. This was a breakthrough in the establishment of an international system guaranteeing reliable nuclear energy plant fuel supplies and lowering the risks of 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 at 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 (MOX) fuel. In the period 2020–25, 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 40–46 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 20–25 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 (COP15) 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.

NOTABLE ENERGY DEVELOPMENTS IN 2011

ENERGY EFFICIENCY IMPROVEMENT

Program on energy saving and energy efficiency improvement to 2020

The main objective of the Federal Targeted Program 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 targets of the program are savings of 330 bcm natural gas over the life of the program, energy savings of 630 billion kWh, heat savings of 1550 Gkal million, and petroleum product savings of 17 million tonnes.

The program also aims for a significant reduction in energy costs, and to ensure 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 local budgets 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 of 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

In 2011 the Ministry of Energy in 2011 presented concepts for a program of power sector modernization for the period up to 2020. The central theme of the modernization is to introduce new technologies, both domestic and imported, increasing the reliability of electricity supply and energy security.

OIL AND GAS DEVELOPMENT

There was a wide range of significant developments in the oil and gas sector in 2011:

- On 12 April 2011 the Governmental Commission on the fuel and energy complex and development of mineral resources and energy efficiency of the economy, under the leadership of Deputy Prime Minister Igor Sechin, approved the general scheme of development of the oil industry to 2020..
- The Ministry of Energy has finalized the second phase of plan development of gas–chemical and petrochemical industries in Russia for the period up to 2030. Implementation of the document will allow the best use of light hydrocarbons in Russia. The plan provides for an increase in domestic demand for petrochemical products, increasing the competitiveness of domestic petrochemical products' deep redistribution and the efficient use of increasing amounts of raw materials.
- On 26 July 2011 in Moscow, the first meeting of the Russian–Japanese working group on cooperation in oil and gas took place. Considerable attention was paid to the construction projects relating to the LNG plant near Vladivostok, as well as options for joint Russian–Japanese companies to cooperate in the exploration and subsequent development of oil and gas resources on the continental shelf of the Okhotsk Sea and the licensed areas in Eastern Siberia.
- The first stage of the Sakhalin–Khabarovsk–Vladivostok main gas pipeline became operational on 8 September 2011 on the island of Russky (Vladivostok). Commissioning of this pipeline is a significant step in the Eastern Gas Program. The Sakhalin–Khabarovsk–Vladivostok transmission system is the biggest infrastructure project in the Russian Federation. The pipeline will provide gas supply to Vladivostok, as well as to generating capacities in the Primorsky region. It will also provide infrastructure for the 2012 APEC summit, and will supply gas to consumers in most of the Khabarovsk and Primorye territories and Sakhalin region.

- Rosneft and ExxonMobil have executed a Strategic Cooperation Agreement under which the companies plan to undertake joint exploration and development of hydrocarbon resources in Russia, the United States, and other countries throughout the world, and to commence technology and expertise sharing activities. The agreement includes approximately USD 3.2 billion funding for exploration and development of East Prinovozemelskiy Blocks 1, 2 and 3 in the Kara Sea and the Tuapse Trough License Block in the Black Sea, some of the most promising and least explored offshore areas globally.
- Gazprom and Kogas signed the roadmap for a project for pipeline gas supply to Korea.
- A Memorandum of Understanding was signed between Gazprom and North Korea's Ministry of Oil Industry.
- The Purpe–Samotlor oil pipeline became operational, allowing oil from the Yamal–Nenets region and north of Krasnoyarsk Krai to get into the Eastern Siberia–Pacific Ocean pipeline system and thus on to Eastern refineries by the shortest route.
- On 8 November 2011 in Lubmin (Germany), a commissioning ceremony for a new Nord Stream gas pipeline was held. The Nord Stream pipeline is considered essential for Russia and for the EU, and the European Union has made the pipeline a priority within the EU Directive on trans-European energy networks. After the completion of the two threads in 2012, the pipeline will deliver 55 bcm of natural gas annually to the European gas transport network, from where gas will be supplied to consumers in Germany, Denmark, Great Britain, the Netherlands, Belgium, France, the Czech Republic and other countries.
- On 15 November 2011, Doha (Qatar) hosted the first summit of the Gas Exporting Countries Forum. The summit discussed issues of cooperation between suppliers and consumers, the development of new technologies, and the current state and prospects of the gas market.
- Gazprom and Beltransgaz signed the contracts for gas supply to, and transit across, Belarus from 2012 through 2014. Gazprom and the State Property Committee of the Republic of Belarus also entered into the purchase and sale agreement for a 50% stake in Beltransgaz. The documents have been signed in accordance with the agreements reached by the Russian Federation Government and the Government of the Republic of Belarus, which identify the formation of gas prices and transmission tariffs as well as terms and conditions for purchase and sale of shares and further activities of Beltransgaz.

COAL INDUSTRY DEVELOPMENT

- On 26 April 2011, the OJSC Siberian Coal Energy Company (OJSC SUEK) celebrated its tenth anniversary. SUEK is the leading producer in Russia in terms of output, and retains a strong position among the largest coal producers in the world. Since its foundation in 2001, SUEK has almost tripled its coal production.
- On 12 September 2011 in Istanbul (Turkey), a long-term program for development of the Russian coal industry to 2030 was presented during the 22nd World Mining Congress and Exhibition of Equipment and Technologies in Mining. The document was developed taking into account the basic factors in the development of the coal industry, and contains measures to facilitate the realization of the potential competitive advantages of Russian coal companies. A key condition for achieving the stated goals of the program is the use of government–business partnerships.

- Mechel OAO, one of the leading Russian mining and metals companies, announced the first results of mining in Yakutugol Holding Company OAO's Elga Coal Complex. In accordance with plans announced earlier, mining at the Elga deposit started in August. The Elginsky open pit yielded some 21,000 tonnes of coal in less than a month. The start of the mining process was timed to coincide with the commissioning of the Ulak–Elga railway from point 1 to the 209-km point, with the railway planned to be fully completed in 2012. Until then, coal is due to be transported by heavy-duty trucks from the open pit to the 209-km point, which is equipped with a trans-shipment station to transport coal further by rail.
- The government has approved a long-term program for development of the Russian coal industry to 2030 during the conference on the subject of "The Outcome of the Restructuring and Development Prospects of the Coal Industry" that was held in Kemerovo under the guidance of Russian Federation premier V.V. Putin on 24 January 2012.

NUCLEAR AND RENEWABLE ENERGY DEVELOPMENT

- On 11 October, Atomstroyexport (a Rosatom company) and MD Directorate for Construction of the Nuclear Power Plant (Republic of Belarus) signed an agreement concerning construction of Units 1 and 2 of the nuclear power plant (NPP) in Belarus. The contractual agreement defines the basic provisions of a general contract for the turnkey construction of two NPP units of a total power capacity of up to 2,400 MW with V-941 reactor installations. The Belarus NPP will be built on condition of full responsibility being accepted by the prime contractor.
- The Russia–China deal to build the second stage of the Tianwan nuclear power plant came into effect in October. The Tianwan NPP is the largest facility involved in the Russian–Chinese economic cooperation. Its first stage includes two power units with VVER-1000 reactors. The first stage was commissioned in 2007.
- 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 efficiency of electric power generation using renewable energy sources in 2020. Currently, the project aims at the harmonization of relevant federal agencies.
- The Ministry of Energy has prepared a draft program for the improvement of power generating facilities using renewable energy sources in the Russian Federation.

ENERGY SECURITY IMPROVEMENTS

- October 2011, 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 maximize the contribution of the energy sector in reconstruction and economic development, enhance energy security in the world, and reduce the environmental impact caused by energy production and consumption.

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USEFUL LINKS

OFFICIAL BODIES OF THE RUSSIAN FEDERATION

Structure of the Government of the Russian Federation—http://government.ru/eng/power/

Ministry of Energy—www.minenergo.gov.ru/

Ministry of Natural Resources—www.mnr.gov.ru/

Federal Service on Ecological, Technological and Nuclear Supervision—www.gosnadzor.ru/

Ministry of Economic Development—www.economy.gov.ru/minec/main/

Federal State Statistics Service—www.gks.ru/

Ministry of Industry and Trade—www.minprom.gov.ru/

Federal Agency on Technical Regulating and Metrology—www.gost.ru/wps/portal/pages.en.Main

Federal Antimonopoly Service—www.fas.gov.ru/

Federal Customs Service—www.customs.ru/en/

Federal Tariff Service—www.fstrf.ru/

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

Non-commercial Partnership of the Wholesale Power Market—www.np-ats.ru/

Federal Power Grids—www.fsk-ees.ru/

RusHydro—www.rushydro.ru/

AtomEnergoProm—www.atomenergoprom.ru/en/

Gazprom—www.gazprom.ru/

Rosneft—www.rosneft.ru/

Transneft—www.transneft.ru/

Transnefteprodukt—www.transnefteprodukt.ru

STATE ENERGY-POLICY-RELATED RESEARCH CENTRES

Institute of Energy Strategy—www.energystrategy.ru/

Energy Research Institute of the RAS—www.eriras.ru/

Energy Systems Institute of the SB of RAS—www.sei.irk.ru/eng/index.htm

Centre for Energy Policy—www.cenef.ru/

IMPORTANT ENERGY-RELATED MEDIA IN THE RUSSIAN FEDERATION

Official newspaper, *Rossiyskaya Gazeta*—www.rg.ru/

Central Dispatching Unit of the Fuel and Energy Complex—www.riatec.ru/

SINGAPORE

INTRODUCTION

Singapore is situated in South-East Asia, south of the Malaysia Peninsula between the Strait of Malacca and the South China Sea. In 2009, Singapore had a total land area of 710.3 square kilometres and a population of 4.987 million, of which 1.254 million were non-residents. Despite its small land area and population, Singapore is one of the most highly industrialized and urbanized economies in South-East Asia.

Singapore is a highly developed and vibrant free-market economy. In 2009, its gross domestic product (GDP) declined by 0.8% from 2008 to USD 204.29 billion in 2009; per capita GDP was USD 40 960 (both in USD (2000) at PPP).

In Singapore's 2009 GDP, the services sector accounted for 67.2% of the overall value added, goods production accounted for 28.4%, and ownership and dwellings accounted for the remaining 3.5%. In 2009, the largest subsectors of the service industry were wholesale and retail trade, which accounted for 16.5% of the value added, financial services (11.9%), and business services (14.0%). Manufacturing in the goods production industry is Singapore's single largest economic subsector, accounting for 21.4% of GDP.

In 2009, Singapore's exports were worth USD 391.12 billion; of this 51.1% were domestic exports and the remainder were re-exports. The biggest category of exports was electronics (37.3%), followed by mineral fuels (20.5%), other machinery and equipment (15.8%), chemicals and chemical products (12.2%), and other manufactured goods, crude materials, food and beverage, and tobacco (the remainder). Most of Singapore's manufacturing output is exported.

Strategically located, Singapore is one of the world's busiest shipping ports, an important petroleum hub, a major equipment supplier for the oil and gas industry in South-East Asia, and an emerging leader in the biotechnology industry.

Table 29 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	710.3	Oil	–
Population (million)	4.987	Gas	–
GDP (USD (2000) billion at PPP)	204.29	Coal	–
GDP (USD (2000) per capita at PPP)	40 960		

Source: EDMC (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Singapore's total primary energy supply (TPES) in 2009 was 26 775 kilotonnes of oil equivalent (ktoe). Singapore almost entirely relies on energy imports to meet its domestic energy needs. In 2009, the economy imported 44 136 ktoe of crude oil and 86 266 ktoe of petroleum products. Crude oil refined in Singapore's oil refineries produced 38 740 ktoe of petroleum products. Some 87.9% 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 109 937 ktoe.

Natural gas supply grew by 1.1% between 2008 and 2009, to 6233 ktoe (a lower rate of increase than the 3.5% between 2007 and 2008). Petroleum product supply declined by 25.4%

from 2008 figures, to 20 421 ktoe; by comparison, oil supply declined by 5.4% between 2007 and 2008.

In 2009, 41 810 gigawatt-hours (GWh) of electricity was generated, which is a 0.2% increase over the 41 717 GWh generated in 2008.

Peak demand for electricity was 6041 megawatts (MW) in 2009 compared with 6073 (MW) in 2008. Singapore's power generation is based entirely on thermal power plants, with the exception of small photovoltaic installations connected to the grid. In 2009, the licensed power generation capacity of thermal power plants was 10 230 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 2009, Singapore has 31 grid-connected solar photovoltaic installations with total capacity of 442.2 kWp.

The fuel mix for power generation in 2009 is dominated by natural gas (82.1%) with some petroleum products (15.4%) and other fuels (waste & solar) (2.5%). The power generation reserve margin is about 37%, well in excess of Singapore's 30% minimum reserve margin for power system security.

Table 30 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	121	Industry sector	8 163	Total	41 810
Net imports and other	63 041	Transport sector	5 578	Thermal	40 403
Total PES	26 775	Other sectors	2 372	Hydro	–
Coal	–	Total FEC	16 114	Nuclear	–
Oil	20 421	Coal	–	Geothermal	–
Gas	6 233	Oil	12 771	Other	1407
Other	121	Gas	113		
		Electricity and other	3 230		

Source: EDMC (2011).

FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (FEC) was 16 114 ktoe in 2009, a decline of 0.1% from 2008 (16 129 ktoe). Petroleum products accounted for 79.3% of the energy used, electricity 20.0%, and natural gas 0.7%. The energy consumption share by sector was: industry 50.7%, transport 34.6%, and other sectors 14.7%.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In 2007, the interagency Energy Policy Group, chaired by the Permanent Secretary of the Ministry of Trade and Industry, 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 our 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 our energy and carbon footprint. Businesses and households can benefit from energy and cost savings through various EE measures. However, there are market barriers impeding EE implementation and investments by businesses, for example lack of awareness and limited capital. 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 carbon footprint of our economy.

- *Strategy 4:* ***Strengthen the Green Economy***. To meet Singapore's energy challenges and facilitate the growth of the clean energy sector, we 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 RD&D such as the Energy National Innovation Challenge (NIC) and the Energy Innovation Programme Office (EIPO) [1] , 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 would 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 our 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 standard cubic feet per day (MMscf/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 MMscf/D) of natural gas; large customers use about 98% of the gas. Sembcorp Gas (SembGas) 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

[1] The National Research Foundation allocated $300 million for the Energy NIC in 2010 and $195 million to EIPO in 2011.

supplying gas to Singapore in September 2003. It supplies 9.9 million cubic metres per day (350 MMscf/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 MMscf/D) of natural gas mainly for power generation. Keppel Gas Pte Ltd is the importer for 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) per year. The LNG terminal will 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 utilized.

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.

The 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 the 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 and demonstration (RD&D) 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 our sustainable development objectives. The Energy Innovation Programme Office (EIPO), formerly 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. The EIPO has launched several initiatives including the Clean Energy Research Programme, 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 grid, green building, clean mobility and carbon capture and utilisation (CCU). Under the EIPO, we have 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 NTU (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), which is 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-Megawatt 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 our long-term energy challenges, the government has 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 started to restructure its energy sector in 1995 with the corporatization of the electricity and gas industries as vertically integrated companies. Notable milestones since mid-1995 have included corporatization and industry structure 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 liberalized the electricity retail market.

In April 2001, the Energy Market Authority (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 liberalization 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 liberalization (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 of how best to introduce retail competition, which would leverage on 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.

On 15 September 2008, Sembcorp Gas, which had diversified interests in gas transportation, import and retail businesses, exited from 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 liberalization 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.

The Energy Market Authority (EMA) and Land Transport Authority (LTA) co-lead a multi-agency Electric Vehicle (EV) Taskforce comprising members across different ministries and statutory boards, including MEWR, MTI, NEA and EDB, to test-bed EVs in Singapore.

Launched on 25 Jun 2011, the test-bed aims to evaluate the feasibility of using EVs in Singapore when the cost of EVs becomes commercially viable. Vehicular tax exemption under the enhanced Transport Technology Innovation and Development Scheme (TIDES-PLUS)[2] scheme is provided as an incentive for test-bed participants. The test-bed will be completed by the end of 2013.

There are four EV models currently available under the EV test-bed: 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 test-bed. Other CSPs can set up EV charging infrastructure on a

[2] Jointly administered by EDB and LTA, the purpose of TIDES is to support effort in attracting automotive companies in knowledge-based manufacturing and conducting R&D activities and testing of vehicles in Singapore. TIDES was enhanced on 1 July 2010 with a cap of 1300 vehicles to be released in phases. Under the new enhanced TIDES, programmes with new technology vehicles undergoing R&D and test-bedding (e.g. the EV test-bed) in Singapore are granted COE, ARF and Road Tax exemptions for 6 years upon approval. Duty exemption permits can also be applied from the Customs & Excise Department.

commercial basis, as long as they comply with the safety requirements prescribed by the Technical Reference for EV Charging Systems (TR25:2010).

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 thrusts:

- 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. 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 program 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 program 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 program 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 workshop 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 system 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 the road use. In addition, the Singapore 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 trial 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 take-up 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 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 & sustainable development—and it covers various aspects of an RTS line (rolling stock, electrical & mechanical system, 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, there may be more of these diesel hybrid buses being 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 HDB Towns as well as Marina Bay. More and better designed bicycle parking facilities are 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.

Buildings

Sustainable development remains a key national priority for Singapore. Energy efficiency is one of the main considerations for achieving a sustainable built environment. To realize 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*. The SCEM programme and grant is also 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 2000 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^{PLUS}, URA will grant additional floor area over and above the Master Plan Gross Plot Ratio (GPR) control.
- *Green Mark Incentive Scheme for New Buildings (GMIS-NB).* A sum of SGD 20 million was set aside for the Green Mark Incentive Scheme for New Buildings (GMIS-NB) on 15 December 2006 for a period of three years. The scheme offers cash incentives to developers, building owners, project architects and engineers who make efforts to achieve at least a BCA Green Mark Gold rating or higher in the design and construction of new buildings. The fund is fully committed.
- *Green Mark Incentive Scheme for Existing Buildings (GMIS-EB).* A sum of SGD 100 million was set aside for the Green Mark Incentive Scheme for Existing Buildings (GMIS-EB) on 29 April 2009 for a period of five years. The GMIS-EB provides a 'cash incentive for 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 the 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^{Plus}) 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 to 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 more than 5000 square metres must attain the Green Mark Platinum rating, while existing public sector buildings with air-conditioned area of more than 10 000 square metres must attain the Green Mark Gold^{Plus} rating by 2020.

Households

Households account for about a sixth of the electricity consumed in Singapore. Households are encouraged to purchase energy-efficient appliances and adopt energy-efficient habits. Programs 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 removes 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 2000 square metres 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 keen to pursue 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 2.5 million tonnes of biomass and wastes.
- 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) currently has a SGD 31 million solar test-bed programme that involves solar capability trials in 30 HDB precincts (EDB 2010).
    - 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 (HDB 2011).
    - 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.

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. We have limited access to alternative, low-emission energy sources such as wind, hydro, biomass, geothermal or nuclear power, marking us as an alternative-energy disadvantaged city-state. However, as a responsible global citizen we must still play our part in addressing climate change by reducing emissions. Hence, in 2009, Singapore had pledged in the context of the United Nations Framework Convention on Climate Change negotiations to reduce emissions by 16 percent from 2020 business-as-usual (BAU) levels in the event of a legally binding global agreement where all countries will implement their commitments. Ahead of the pending conclusion of a legally binding global agreement, we have begun to implement measures that are expected to lead to a 7 – 11 percent reduction in emissions from BAU-levels.

NOTABLE ENERGY DEVELOPMENTS

SUSTAINABLE DEVELOPMENT BLUEPRINT

Singapore's Sustainable Development (SD) Blueprint was unveiled on 27 April 2009 by the Inter-Ministerial Committee on Sustainable Development (IMCSD). The SD Blueprint contains strategies and initiatives for achieving both economic growth and a good living environment for Singapore over the next 20 years.

It details new targets and initiatives to improve resource efficiency and to enhance Singapore's urban environment. Being more efficient in the use of resources such as energy, water and land will contribute to 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 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 investment in the third tank will give Singapore greater flexibility to meet its future gas needs and to pursue new business opportunities in the LNG market (SLNG 2010).

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 to use the LNG terminal for the trans-shipment of LNG cargoes throughout the region.

GAS SALES AND LNG SUPPLY

In March 2010, BG signed the first tranche of LNG gas sales agreements with six Singapore power generation companies. The initial total of gas 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 around 3600 MW of new gas-fired power generation capacity. 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 NExBTL proprietary 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 sidestream. The renewable diesel product is clear and colourless paraffin, with 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 30-year-old 3 x 250 MW oil-fired steam plants into 2 x 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 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 318.2 million (70 million gallons) of desalinated water a day over a 25-year period from 2013 to 2038, under a Design, Build, Own, and Operate (DBOO) model. The Tuaspring Desalination Plant is Singapore's second and largest seawater reverse osmosis desalination plant (Hyflux 2012).

Keppel Seghers won the 25-year construct and operate contract for Singapore's fifth incinerator, which began commercial operations in October 2009. The plant can generate up to 22 MW of power 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 Design, Build, Own and Operate contract. With the operation of this incinerator, Singapore's waste incineration capacity is 3.28 million tonnes a year (Keppel Seghers 2010).

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USEFUL LINKS

APEC Biofuels—www.biofuels.apec.org

BG Group—www.bg-group.com

Economic Development Board—www.edb.gov.sg/edb/sg

Energy Market Authority—www.ema.gov.sg

Economic Strategies Committee (ESC) Recommendations – www.mof.gov.sg/esc Land Transport Authority—www.lta.gov.sg

Ministry of the Environment and Water Resources—www.mewr.gov.sg

Ministry of National Development—www.mnd.gov.sg

Singapore LNG Corporation—www.slngcorp.com

Solar Energy Research Institute of Singapore (SERIS)—www.seris.nus.edu.sg

Temasek Holdings—www.temasekholdings.com.sg

CHINESE TAIPEI

introduction

Chinese Taipei, consisting of the islands of Taiwan, Penghu, Kinmen and Matsu and several islets, is located in the middle of a chain of islands stretching from Japan in the north to the Philippines in the south. Its position, just 160 kilometres off the south-eastern coast of China, makes it a natural gateway to East Asia. It has an area of around 36 189 square kilometres. 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 2009, Chinese Taipei's gross domestic product (GDP) was USD 622.18 billion, and its per capita income was USD 26 919 (USD (2000) at PPP), a decline of 1.93% from the previous year due to the global economic crisis. 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 2009, the services sector contributed 69.3% to GDP, followed by the industrial sector (29%) and the agriculture sector (1.7%). Chinese Taipei is one of the most densely populated areas in the world, but its rate of population increase has been relatively mild. The economy's population of 22.979 million grew at a rate of 0.36% between 2008 and 2009. This was slower than the average annual population growth rate of 0.4% between 2000 and 2009.

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 6.2 billion cubic metres (EIA 2011). In 2009, installed electricity generation capacity totalled 47 976 MW.

Table 31 Key data and economic profile, 2009

Key data		Energy reserves[b]	
Area (sq. km)[a]	36 189	Oil (million barrels)	–
Population (million)	22.979	Gas (billion cubic metres)	6.2
GDP (USD (2000) billion at PPP)	622.18	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	26 919		

a Directorate-General of Budget (2011).
b EIA (2011).

Source: EDMC (2011).

Energy supply and demand

PRIMARY ENERGY SUPPLY

A lack of energy and mineral resources has forced Chinese Taipei to import 99.4% of its energy requirements. The independent nature of its energy supply systems has resulted in fragile energy security for the economy. Therefore, improving self-reliance with respect to energy supply is 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 4.92% over the past 20 years. The growth has mainly concentrated on fossil fuels such as coal, oil, and gas, which have increased from 83% of primary energy suppy in 1989 to more than 87% in 2009.

In 2009, 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 (41%), followed by coal (35%), natural gas (11%) and other fuels (13%).

In 2009, Chinese Taipei imported almost its entire crude oil requirement. The Middle East is its major supplier, accounting for 82% of total oil imports. In 2009, Chinese Taipei imported 54.9 million tonnes of crude oil. 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 84% of total coal imports. In 2009, Chinese Taipei imported 5.85 million tonnes of coal. Most of the coal (78%) was used for power generation.

As its natural gas resources are also limited, Chinese Taipei's domestic demand is almost entirely met by imports of liquefied natural gas (LNG). Indonesia and Malaysia are its major suppliers, accounting for 64% of total natural gas imports. LNG imports in 2009 were 8.8 million tonnes, a 3% decrease from 2008.

Table 32 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	13 801	Industry sector	19 978	Total	229 694
Net imports and other	93 122	Transport sector	11 480	Thermal	179 945
Total PES	104 568	Other sectors	32 532	Hydro	6, 907
Coal	38 916	Total FEC	63 990	Nuclear	41 571
Oil	42 865	Coal	5 926	Other	1 271
Gas	11 280	Oil	38 789		
Other	11 507	Gas	1 833		
		Electricity and other	117 442		

Sources: EDMC (2011); BOE (2011).

Chinese Taipei generated 229 694 gigawatt-hours (GWh) of electricity in 2009. The Taiwan Power Company's (TPC's) thermal power generation contributed 44.1% (28% from coal, 2.7% from oil and 13.4% from LNG) and its nuclear energy generation 18.1%; privately owned cogeneration contributed 17.3%; independent power producers (IPPs) 17.4%; hydropower 3%; and wind power 0.16%. TPC dominates Chinese Taipei's electric power sector; IPPs account for 17.35% 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 1350 MW advanced light water reactors in the fourth nuclear energy project are under construction to boost electricity generation (EDMC 2011).

FINAL ENERGY CONSUMPTION

Final energy consumption in Chinese Taipei was 63 990 ktoe in 2009, 0.53% lower than in 2008. Other sectors (including residential and services) consumed 50.84% of the total energy used, followed by the industry sector (31.22%) and the transport sector (17.94%). By energy source, petroleum products accounted for 60.62% of total final energy consumption, followed by electricity (27.1%), coal (7.49%) and city gas (2.86%). In 2009, energy used in the industry sector decreased by 5.8% due to the global economic crisis, but energy consumption in other sectors increased.

Policy overview

ENERGY POLICY FRAMEWORK

POLICY

The Bureau of Energy is responsible for formulating and implementing Chinese Taipei's energy policy. It is also charged with enforcing the Energy Management Law and the Electricity Law; regulating natural gas utilities, and petroleum and liquefied petroleum gas (LPG) filling stations; regulating the importation, exportation, production and sale of petroleum products; maintaining an energy database; evaluating energy demand and supply; promoting energy conservation; implementing research and development programs; and promoting international energy cooperation.

The Bureau of Energy released the Framework of Taiwan's Sustainable Energy Policy in July 2008 (BOE 2008). The framework includes:

- Policy objectives—to achieve a win-win-win solution for energy, environment and 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 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.

To enforce these sustainable energy policies and strategies, Chinese Taipei has formulated Sustainable Energy Policy Action Plans. In 2010, the total fiscal budget was TWD 87.1 billion. There were 371 action plans working together having the potential to reduce 8.43 million tonnes of CO_2 emissions by 2010. These action plans are regularly reviewed under the supervision of the Council for Economic Planning and Development.

In April 2010, 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/strategies set up in the Framework of Taiwan's Sustainable Energy Policy 2008, the conclusions of the 2009 National Energy Congress, and the action plans for the promotion of the green energy industry (BOE 2010).

Reducing its excessive dependence on conventional energy imports is crucial to enhancing the safety and stability of Chinese Taipei's energy supply. 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. The high costs and the stability of supply are the two problems that remain to be solved by the development of new energy technologies. The development of accessible and affordable clean energy produced domestically has become a major challenge for technological research and requires new technology breakthroughs.

ENERGY SECURITY

As Chinese Taipei is almost completely dependent on oil imports, the government has been working to secure supply. To stabilise oil supply, private oil stockpiling could replace the Petroleum Administration Act's requirement for refiners to maintain 60 days of sales volumes (defined as the average domestic sales and private consumption over the past 12 months). Using the Petroleum Fund to finance the storage of oil, the government is responsible for stockpiling 30 days of oil demand. Under the Act, the LPG stockpile should be more than 25 days of supply.

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 the energy supply safety mechanism 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. In 2010, CPC engaged with international oil companies in cooperative exploration in 18 fields in seven economies.

In 2010, CPC acquired new exploration blocks in the United States, Indonesia and Chad, and continued its cooperation with mainland China to expand cross-straits joint efforts in the exploration of overseas blocks with a high recoverable potential of oil and gas. Within Chinese Taipei, CPC continued to rejuvenate old oilfields, which brought good news by the end of 2010. CPC's drilling at Chuhuangkeng Well No. 145 discovered large amounts of natural gas, with new recoverable reserves estimated at 1 billion cubic metres; and CPC got 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.

In its future strategic deployment, CPC will seek to create a more promising situation in its overseas exploration and production operations. It will do this by raising the value of its existing overseas oil and gas field assets and establishing core areas with high rates of growth, by participating actively in bidding for open blocks, by seeking opportunities to take over fields from large oil companies, and by pursuing opportunities for mergers and acquisitions in new oil and gas fields to add more to the company's reserves (CPC 2011).

The Formosa Petrochemical Corporation established a mining subsidiary in the United States in late 2006 to enter the field for oil exploration.

ENERGY MARKETS

MARKET REFORMS

The Petroleum Administration Act has been amended to further liberalize the petroleum market. The government is coordinating with the relevant agencies to implement the amendments. Key progress at the end of 2010 includes the following:

- Two companies were granted a petroleum refining business license, two companies were granted a LNG import license, and 205 companies were granted a gasoline and diesel wholesale license. A total of 1815 oil import and export agreements were also issued in 2010.
- The number of gas refilling stations decreased a little from 2698 to 2696; the number of natural gas refilling stations increased to 44, reflecting the growth of LNG and hybrid vehicles.
- Twenty-four natural gas companies economy-wide provided natural gas to about three million users (residential, business, service and partial industry customers). The market cover rate is about 44.1% (BOE 2011).

ELECTRICITY MARKETS

The Chinese Taipei Government aims to have a total electricity supply that provides a reserve capacity of 16% (BOE 2011), 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 reserve capacity between 1990 and 2004. Reserve capacity was 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%. Power produced by IPPs is sold to TPC through TPC's transmission lines. To

prevent electricity supply outages, the Ministry of Economic Affairs (MOEA) announced the Fourth Stage of Opening the Electricity Market to IPPs, in June 2006. IPP investors did not meet the bidding price offered by TPC for this stage. To avoid electricity shortages, the MOEA asked TPC to adopt several new management actions (such as demand-side control, increasing the purchase of electricity from cogeneration systems, electricity discounts, and energy conservation). Fortunately, electricity demand has reduced since 2007, and electricity supply is expected to be enough in the short term.

To comply with the schedule for privatising TPC and promoting the liberalization of the domestic power market, the MOEA has completed a program of liberalizing the electricity industry. Based on the program, a draft amendment to the Electricity Act was submitted to the Legislative Yuan for review. The legislative process to amend the Electricity Act was completed in early 2011. This enables the 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 resources so it has no formal policy on investment in upstream assets. Foreign investors are welcome to participate in the IPP electricity market bidding process discussed above.

ENERGY EFFICIENCY

In overall energy consumption, the industry sector is Chinese Taipei's major energy user, accounting for 53% of total energy consumed, with residential and commercial consumption following at 23%. The transport sector accounts for 13%. The government considers it important to improve the energy efficiency of all industry sectors, especially the energy management of energy-intensive industries and major energy users. It amended the Energy Management Act to establish an energy development and utilization evaluation mechanism and to foster the gradual improvement of energy efficiency in newly constructed or expanded factory plants via advanced management mechanisms.

In 2010, Chinese Taipei's energy intensity was 8.46 litres of oil equivalent per TWD 1000, a 14% reduction over the 2001 rate. This indicates Chinese Taipei's energy intensity has improved in recent years, but there is 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 high compared with Japan, the EU, and other advanced economies.

The major activities and achievements of Chinese Taipei as the economy sought to reduce its energy intensity and to reach the government's targets were:

- Carried out energy audits of the major energy users and helped them to set up an internal energy auditing system and to report the results to the government. A total of 4475 high-energy users (3006 manufacturers and 1399 non-manufacturers) were audited by the government in 2010. The audits showed energy savings of 1.33% for the 3006 manufacturers and 0.72% for the others, compared with 2009 figures.
- Established the energy service team and provided energy technology services to help energy users diagnose their energy systems and improve their energy efficiency. A total of 997 companies were visited in 2010 and shown an energy saving potential of 13.4 million litres of oil equivalent (MLOE), with 6.1 MLOE being achieved.
- Since 2001, promoted the voluntary accreditation of high energy efficient products and an energy labelling system. A total of 29 product categories were included in the energy labelling system, and 287 manufacturers and 4646 brands gained accreditation by the end of 2010. More than 8.69 million labels were issued by the end of 2010.

- Since July 2010, enforced the mandatory multi-level energy efficiency labelling mechanism. Four product categories were included in this first stage—air conditioning units, refrigerators, vehicles and motorcycles. Humidifiers and fluorescent lamps are expected to be added to the mandatory labelling mechanism in 2011.
- Promoted energy service companies (ESCOs) by helping and 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. Thirty-six cases were carried out under the Energy Saving Performance Contract mechanism by the end of 2010, with an average energy savings up to 48.5% compared with pre-improvement performances. Since 2010, Chinese Taipei has also expanded the subsidies to cover the development of a low-carbon community.
- Continued to focus on technology R&D (research and development) programs. The major programs and achievements were:
  - *Key technology for smart energy-saving network systems*. This program integrates energy management technology, sensing and monitoring technology and information communication technology to develop the key technology, products and modules for smart energy network systems. It can be employed to existing systems without changing any equipment, to increase the flexible management of an energy-efficient living environment and the efficiency of an industry manufacturing process. In 2010, this system was used in 305 convenient stores in Chinese Taipei and is ready for export or technology transfer to other economies.
  - *Air conditioning and refrigeration technology*. This technology development is the gradual integration of the capacity of different industries. It includes the upstream magnetic materials and IC (integrated circuit) chips, the middle stream motors, compressors, and inverter controllers, and the downstream heat pumps, air conditioning and refrigeration products. The R&D efforts focused on patent ideas, prototype designs, manufacturing capabilities through to systems testing and analysis. The program gradually set up the industry capability for inverter-fed technology/products and improved the energy efficiency of air conditioning and refrigeration systems in Chinese Taipei. The major achievements in 2010 were:
    - Commercialization of centrifugal-type chiller units (maximum capability reaches 1,200 RT) with COP = 6.3 and $IPLV_{COP}$ = 6.7.
    - Development of the first prototype CO_2 heat pump (employing its own CO_2 compressor) with COP = 4.25 at rated condition and COP = 3.76 at winter condition.
    - Setting up of the manufacturing capability and key components supply chain for inverter-fed air conditioning units (both single and multi-unit systems). The domestic parts for these unnits is more than 90%. The improvements mean the new system exceeds Chinese Taipei's 2011 energy standard.
  - *Combustion and heat recovery technology*. The key R&D effort is to develop industrial energy-saving technologies and products to reduce energy consumption and environmental impacts in the industry sector. It will also help domestic industry to increase its global market competitiveness. The major achievements in 2010 were:
    - Development of oxygen-rich combustion technology and its use in heavy-oil combustion systems. It can reduce NO_x gases to lower than 200 ppm *(*parts per million) and increase efficiency more than 10%, due to the lower exhaust temperature.
    - Completion of reliability testing for the inverter-fed air-fuel control system. The system can save the electricity consumption of a combustion system by up to 80%, compared with a traditional control system.

- *Advanced lighting technology*. New generation lighting systems emphasize energy savings and environmental protection by considering the human factor. 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/modules in a variety of styles. The purpose is to replace the current high level of environmental pollution and energy consumption of traditional lighting systems. The major achievements in 2010 were:
  - Initiation of a draft lighting index and management regulations.
  - Development of high-efficiency LED indoor lighting modules equipped with a remote control capability for lighting intensity, and coloured temperature control.
  - Replacement of 74 520 sets of traffic indicating lamps with new LED lamps, and setting up of an LED street lighting demonstration site with 5353 sets.

RENEWABLE ENERGY

To effectively promote renewable energy and to respond to the requirements of the private sector for institutionalised incentive measures, Chinese Taipei passed the Renewable Energy Development Act in July 2009. 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 will be established to subsidise utilities when they produce or purchase renewable electricity. Chinese Taipei has set an ambitious target, and expects that 8450 MW of renewable power generation units will be installed by 2025, of which 3000 MW will be wind power units, and 1000 MW will be solar power units. It is hoped electricity from renewable resources will account for 8% of total electricity generation by 2025.

PROMOTION OF RENEWABLE ENERGY INDUSTRIES

The main three green energy industries in Chinese Taipei are photovoltaic, 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 2010 were:

- 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 2010, the total capacity installed was 15 548 kWp (kilowatts-peak).

  Chinese Taipei's PV industry is based on crystalline silicon solar cell materials/components, combined with upstream semiconductor materials and downstream industrial power systems. In 2010, there were about 189 companies with a combined revenue of about TWD 1938 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 BIPV (building integrated photovoltaic) demonstration system.

- The promotion of wind power systems

  The development of a wind power industry is mainly for the domestic market. The Taiwan Power Company and private wind-energy developers continued to develop the onshore wind turbine system. By the end of 2010, Chinese Taipei had installed 268 sets of wind turbines economy-wide, with a total installed capacity of 518.7 MW, and an annual output of 1.297 billion kWh of electricity. This will supply electricity for one year to 324 000 households.

- The development of a bioenergy industry

Commercial biodiesel production technology has matured in Chinese Taipei. By the end of 2010, 10 companies were approved as qualified biodiesel manufacturers with a total annual production capacity of about 130 MLOE. The biodiesel industry mainly uses waste cooking oil as its raw material.

RESEARCH AND DEVELOPMENT PROGRAMS

The Chinese Taipei Government will continue to focus on technology R&D programs. The major programs and achievements in 2010 were:

- The application of solar heating

  The 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 the optimization, structural safety and anti-wind damage technology for solar water heating systems. The major achievements in 2010 were:

  - The solar heat collection system with GPS and solar orbit tracing mechanisms. The 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 PV modules verification technology and facility was also set up in 2010. The major achievements in 2010 were:

  - Development of new high-efficiency heterojunction solar cells by the integration of the interface processing technology, a p-type amorphous silicon layer to enhance the conductivity and optimization of the transparent conductive layer to improve solar cell efficiency to 16.7%.
  - Completion of a BIPV experimental platform (housing) to facilitate long-term experiments and demonstrations of BIPV modules. The platform can also be used for monitoring and analysing building energy consumption.
  - Setting up of several testing facilities following the International Electrotechnical Commission's standards—IECs 61730, 61710, 61646 and 61730—to help local industry to shorten the testing and verification processes.

- Bioenergy

  This R&D focus included the development of key energy technologies, including algae and industrial bio-fuel technology, and materials 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 requirement for the product differentiation and energy security to develop specific projects for enhancing the global competitiveness of the local wind power industry. The major achievements in 2010 were:

  - Completion of the feasibility study for the combination of wind turbines and other renewable energy technologies/facilities.
  - Development of a design concept for an offshore wind turbine based on the domestic characteristics of offshore wind farms.
  - Development of a fault diagnosis program for a wind turbine intelligent maintenance system.

- Fuel cell and hydrogen application

  To promote the hydrogen and distributed power generation technology, 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 2010 were:

  - Completion of a 3000-hour test for a motorcycle's fuel cell module under an indoor city mode.
  - Completion of a 6000-hour drive test for a fuel cell motorcycle.
  - Completion of more than 5118 hours of long-term testing for a fuel cell system connected with the operation of a natural gas reformer (including 2000 hours of continuous operation).

- Electric vehicles

  This R&D effort focused on hybrid vehicle technology, to analyze and improve the mileage of hybrid vehicles to ensure reliability.

NUCLEAR

To diversify the electricity generation mix, the government encourages the development of nuclear energy. At the end of 2010, there were three nuclear energy plants with six units and a total installed capacity of 5144 MW. The first unit of the fourth nuclear energy plant (1350 MW) will be completed in 2014, and the second (1350 MW) will be completed in 2015. By 2015, there will be 7844 MW of installed nuclear energy generation capacity. However, Chinese Taipei is reviewing its policy of nuclear-energy power generation after the Fukushima Daiichi nuclear plant disaster in Japan in March 2011.

CLIMATE CHANGE

GREENHOUSE GAS EMISSIONS

Chinese Taipei produces CO_2 emissions that account for 1% of global emissions. Therefore it has a moral obligation to reduce emissions even though the economy is not a member of the United Nations. As a consequence, it 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. So, it is necessary for Chinese Taipei to seek alternative ways to reduce the impact of its carbon emissions.

Emission from fossil fuel combustion is the major source of greenhouse gas (GHG) emissions in Chinese Taipei. The economy emitted 240 million tonnes of CO_2 in 2009. The growth of CO_2 emissions used to be equivalent to the economic growth rate, but the average growth rate of CO_2 emissions has slowed significantly in the past decade. CO_2 emissions grew 1.2% annually after year 2000, slower than the economic growth rate (3.1% annually), and the economy's CO_2 intensity has steadily declined since 2003. It seems the rates of CO_2 emissions and economic growth have started to decouple in the economy over the past three years. To reduce the 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.

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 to competition, it is necessary for Chinese Taipei to gain full access to key, innovative technologies. Faced with fierce competition globally, the economy is strengthening its R&D and innovative capabilities so 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 right development in the past. Chinese Taipei has gradually changed its mainstream original equipment manufacturer (OEM) and original design manufacturer (ODM) industrial models. The focus now is on enhancing the integration of the industrial chain, and transforming the development strategy from one of manufacturing key components into one that uses 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, Chinese Taipei has selected seven green energy industries it has the potential to develop. 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 pillars of Chinese Taipei's green energy industry. The wind power, biomass, hydrogen and fuel cell, Energy Information Communication Technology (EICT), and electric vehicle industries are considered potential and promising.

Notable energy developments

PEER REVIEW ON ENERGY EFFICIENCY

Chinese Taipei hosted an APEC Peer Review on Energy Efficiency during 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.

MANDATORY MULTI-LEVEL ENERGY EFFICIENCY LABELLING

Chinese Taipei launched its mandatory energy efficiency labelling mechanism in July 2010. Four products are included in the first stage—air conditioning units, refrigerators, vehicles and motorcycles. Humidifiers and fluorescent lamps are expected to be added in 2011.

MASTER PLAN ON ENERGY CONSERVATION AND GHG EMISSION REDUCTION

In May 2010, the Executive Yuan of Chinese Taipei approved the Master Plan on Energy Conservation and GHG Emission 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_2 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 system, 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.

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useful links

Bureau of Energy, Ministry of Economic Affairs—www.moeaboe.gov.tw

Chinese Petroleum Corporation—www.cpc.com.tw

Directorate General of Budget, Accounting and Statistics, Executive Yuan—www.dgbas.gov.tw

Industrial Development Bureau, Ministry of Economic Affairs—www.moeaidb.gov.tw
Ministry of Economic Affairs—www.moea.gov.tw
Ministry of Transportation and Communications—www.motc.gov.tw
Taiwan Power Company—www.taipower.com.tw

THAILAND

INTRODUCTION

Thailand is in South-East Asia and shares borders with Malaysia to the south and Myanmar, the Lao People's Democratic Republic and Cambodia to the north and east. It has an area of 513 115 square kilometres and had a population of about 67.76 million at the end of 2009. In 2009, Thailand's GDP was USD 436.05 billion, and GDP per capita was USD 6435 (USD (2000) at PPP).

Thailand is highly dependent on energy imports, particularly oil. In 2009, net energy imports accounted for 55% of energy supply in the economy; down significantly from 96% in 1980. According to statistics from the Department of Mineral Fuels and the Department of Alternative Energy Development and Efficiency of the Ministry of Energy, Thailand had proven onshore and offshore reserves of 180 million barrels of crude oil, 255 million barrels of condensate, and 11 026 billion cubic feet of natural gas. Total reserves of lignite, including the remaining resources in areas currently in production and the proven and probable reserves in undeveloped areas, were 2075 million tonnes.

Table 1 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	513 115	Oil (million barrels)[a]	180
Population (million)	67.76	Condensate (million barrels)[a]	255
GDP (USD (2000) billion at PPP)	436.05	Natural gas (billion cubic feet)[a]	11 026
GDP (USD (2000) per capita at PPP)	6 435	Coal (million tonnes)[b]	2 075

a Proven reserves.
b Proven, probable and possible reserves.
Sources: EDMC (2011); DMF (2010); DEDE (2010a); EPPO (2010).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Total primary energy supply in 2009 was 113 710 kilotonnes of oil equivalent (ktoe). Oil accounted for 37% of total primary supply, while gas, coal and other accounted for 31%, 12% and 20%, respectively. Most of Thailand's proven coal reserves are lignite coal of low calorific value. This means imported coal is needed for both electricity generation and the industry sector. In 2009, coal supply was 14 207 ktoe, down 5.0% from the previous year, mainly due to decreasing consumption in the industry sector. In the power generation sector, coal accounted for 21.4% of the total fuel used in power generation. The total oil supply was 42 343 ktoe in 2009, a 1.2% decrease from 42 868 ktoe in 2008, due to an increase in oil products exports.

In 2009, the natural gas supply was 34 819 ktoe, a 4.8% increase from 33 230 ktoe in 2008. Natural gas is mainly used for power generation, which accounted for 64.8% of gas consumption. In Thailand, natural gas use is promoted, particularly in the power generation and transport sectors, to replace petroleum products such as fuel oil, diesel and gasoline. Because world oil prices have increased in recent years, more industries have switched from oil to natural gas. There is a tendency the economy will increasingly rely on imported natural gas, both pipe gas and LNG. Imported pipe gas accounted for 31.3% of the natural gas supply in 2009, with Thailand's first imported LNG cargo expected in 2011. 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 and coal (with clean coal technology) will be the main sources of energy diversification. However, following the serious damage to Japan's Fukushima Daiichi nuclear plant after the earthquake and tsunami in March 2011, the Thai Government has postponed the construction of nuclear energy plants for two years. It has pushed forward the construction of some thermal power plants to bring them on line earlier than expected. Purchasing power from its neighbours is also considered a viable option.

In 2009, total electricity generation was 148 390 GWh, a 0.7% increase from 2008. Thermal generation, mostly from natural gas and coal, accounted for 85% of production; hydropower accounted for 5%. Natural gas made up about 72% of the fuel used for power generation; the balance came from fuel oil, coal, diesel, and hydro and other renewable fuel sources. In addition to its domestic capacity, the economy purchased power from the Lao People's Democratic Republic and Malaysia.

Table 2 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	64 890	Industry sector	23 798	Total	148 390
Net imports and other	48 820	Transport sector	24 132	Thermal	126 318
Total PES	113 710	Other sectors	18 768	Hydro	7 148
Coal	14 207	Total FEC	66 698	Nuclear	–
Oil	42 343	Coal	7 493	Other	14 944
Gas	34 819	Oil	31 661		
Other[a]	22 341	Gas	3 568		
		Electricity and other	23 976		

a Including renewable energy and biofuel.
Source: DEDE (2010a) and DEDE (2010b).

FINAL ENERGY CONSUMPTION

Thailand's total final energy consumption in 2009 was 66 698 ktoe, an increase of 1.2% from the previous year. The transport sector was the largest energy-consuming sector, accounting for 24 132 ktoe, or 36% of total final energy consumption. The second largest consumer of energy was the industry sector, which consumed 23 798 ktoe in 2009, a slight decrease of about 1.6% from 2008. By fuel type, oil accounted for a 47% share (31 661 ktoe) of total energy consumption in 2009, followed by electricity and other (36%), coal (11%) and gas (5%).

The consumption of oil increased by 1.4%, from 31 207 ktoe in 2008, to 31 661 ktoe in 2009. Natural gas consumption dramatically increased by 13.2%, mainly due to the economy's promotion of natural gas for vehicles. Natural gas consumption by the transport sector grew by 93%, from 654 ktoe in 2008, to 1262 ktoe in 2009. Coal consumption decreased by 3.4% to 7493 ktoe in 2009, compared with the previous year.

Domestic electricity demand slightly increased by 0.8% from the previous year. The growth in demand was mainly due to increased consumption in the transport, residential and commercial sectors.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Energy's aim is for sustainable energy management so 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 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 energy including renewable energy policy is to encourage the production and use of alternative energy, particularly biofuel and biomass such as gasohol (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 of 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 biodiesel B5 mandatory economy-wide
   - Phasing out ULG91 by October 2012 to promote the use of 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 NGV's 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, providing incentives similar to the adder provision, but by using the Oil Fund to support the costs incurred in the adder provision to oil refineries that purchase oil derived from plastic waste for further processing
   - Monitoring the incentive program and developing a feed-in-tariff instead of the adder to support alternative energy for power generation.
4. *Carry out research and development of 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 on energy from plants, in terms of both the second generation biofuels and equipment for generating energy from biomass and biogas
   - Supporting the R&D on modifying old-modelled cars to use gasohol E20 and E85
   - Supporting the R&D on car engines to use biodiesel B10
   - Supporting research on 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 the 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 technique development institute, including procuring product-testing equipment, developing safety standards suitable for Thailand's energy businesses, and disseminating the safety standards to provincial areas and local administration 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 Centers, 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 prices 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 the market mechanism 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 the 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/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. It will do this by fostering an energy-saving discipline and conscience and promoting effective energy use; providing incentives to the private sector to invest in energy-saving appliances; setting incentive measures for the household sector to reduce electricity consumption during peak periods; supporting research and development and standard-setting for electrical appliances and energy-saving buildings; and supporting the development of a mass public transport and railway system to improve energy efficiency, deferring the economy's investment in energy procurement. The strategies with targets and actions to achieve the policy are:

1. Promote energy development and energy conservation.

Target

- To increase the energy conservation target set out in the Energy Conservation Program to 20%, focusing on increasing energy savings in the industry and transport sectors.

Action

- Draft the Energy Conservation Program, Phase 4 (2012–16) 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 conscience and provide knowledge about energy conservation.

Targets

- To speed up the implementation of 11 Energy-Saving Measures for the People to quickly attain practical achievements and set an energy-saving target at THB 100 000 million per year (approx. USD 3300 million per year)
- To enhance local administration organisations (LAOs) as focal agencies in creating and THB disseminating an energy-saving culture to 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 1000 million per year (approx. USD 33 million per year)
- To set the energy credit provision target at THB 60 000 million per year (approx. USD 2000 million per year), contributing to energy savings at no less than THB 40 000 million per year.

Actions

- Implement the 11 Energy-Saving Measures at three scales in pilot provinces (i.e. large-scale province: Nakhorn Ratchasima; medium-scale provinces: Phitsanulok and Krabi; small-scale province: Mae Hong Sorn), and emphasise community participation through Community Energy Volunteers, before expanding the scheme to other provinces in 2011
- Continue to enforce measures on mandatory energy performance labelling, starting with refrigerators and air conditioners by upgrading/increasing the efficiency of No. 5 refrigerators and air conditioners by at least 10%
- Coordinate with the Office of the Consumer Protection Board (OCPB) and concerned agencies to enable the mandatory measure on Standby Power 1-Watt to be issued in early-2010 for pilot appliances such as televisions and air conditioners, and set a target of electricity savings worth THB 4000 million per year (approx. USD 130 million per year)
- Issue relevant ministerial orders and announcements under the Building Energy Code by 2010, and organise training/conferences for architects, engineers and concerned institutions to attain at least a 10% energy saving in new buildings, accounting for electricity savings of 2365 GWh per year
- Speed up the enforcement of laws and announcements about the regulation of energy conservation in factories (ISO–Energy) by 2010, to attain energy savings worth THB 90 000 million (approx. USD 3000 million) by 2011
- Assign the Energy Mobile Units, via the Regional Energy Coordination Offices of all 12 Provincial Energy Offices, to carry out their field work in at least 576 sub-districts economy-wide
- Review the Clean Air-conditioners Increase Money for Households and the Engine Tune-up to Reduce Oil Consumption projects, and implement them on an annual basis, especially in summer.

3. Devise incentives and provide privileges to induce investment in energy saving.

Target

- 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.

Action

- Promote four major measures:
  - Energy Credit and Revolving Fund for energy efficiency and alternative energy
  - Tax measures and privileges on both a cost-based and performance-based basis

- Joint ventures using the Energy Services Company (ESCO) Fund (the government's co-investment program)
- DSM (demand-side management) bidding.

4. Promote R&D on energy-saving systems and technologies.

Target

- To put in place integrated resources planning for energy conservation R&D.

Actions

- Gather information about energy-saving innovations in local communities and encourage further development
- Determine the ratio of state budget and budget from the Energy Conservation Promotion Fund to be used for R&D promotion.

5. Set standards, rules and regulations for energy-saving equipment, materials and energy management.

Targets

- To announce the Minimum Energy Performance Standards (MEPS) for 50 electrical appliances by 2011
- To issue ministerial orders, particularly on the Building Energy Code and the International Organisation for Standardization (ISO)–Energy.

Action

- Issue ministerial orders with immediate effect.

6. Promote the creation of prototype networking, e.g. small and medium enterprises (SMEs) with distinguishing features or with interests in energy-saving.

Target

- To make the Thailand Energy Awards recognised by the groups targeted for energy savings.

Actions

- Intensify the implementation of the Thailand Energy Awards project economy-wide.

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_2 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 and labelling on appliances such as light bulbs, air conditioners, and refrigerators
- Setting up supporting programs for industries and SMEs, e.g. USD 4 billion has already been approved and allocated to finance energy efficiency projects.

RENEWABLE ENERGY

In 2009, the Thai Cabinet adopted the 15-year Renewable Energy Development Plan (REDP) (2008–22) to increase the proportion of renewable energy in the energy mix. It expects the percentage share of clean energy will increase from 8% in 2009 to 20% by 2022. The renewable energy will be used for power generation, thermal applications, and in the production of biofuels such as ethanol and biodiesel. The government is adjusting the current plan by type of renewable energy, e.g. increasing the goals of solar energy from 400 MW to 2000 MW and wind energy from 800 MW to 1900 MW due to the private sector's interest, and reducing the goal of biomass from 2600 MW to 1600 MW due to the public's protest.

To achieve these targets, Thailand has set up incentive programs and mechanisms to encourage investment, such as the Fund for Energy Services Companies that act as the special purpose vehicles (SPVs) for the 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, 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 down CO_2 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 program is a step 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's) 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 the total power generation capacity (e.g. 2022—6%, 2030—11%); the expected total capacity of nuclear energy plants by 2030 will be 5000 MW (updated from 2000 MW in the previous PDP plan). However, the Thai Government has postponed the construction of nuclear energy plants for two years due to the damage done to Japan's Fukushima Daiichi nuclear plant by the earthquake and tsunami in March 2011. Instead, the 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 a viable option.

The commissioning schedule for nuclear energy plants in the current plan (PDP 2010–30) is:

2022	First Nuclear Power Plant	1000 MW
2023	Second Nuclear Power Plant	1000 MW
2026	Third Nuclear Power Plant	1000 MW
2027	Fourth Nuclear Power Plant	1000 MW
2030	Fifth Nuclear Power Plant	1000 MW.

The US consultant, Burns & Rolls, reports the most effective places for the site of the First Nuclear Power Plant are the provinces of Nakorn Sawan (central) and Ubon Rachathani (northeast).

CLIMATE CHANGE

Thailand has a strong policy of protecting the environment from the impact of energy production and consumption, especially impacts from 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 the 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 caused by energy production, conversion and use.

Target

- To 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_2 emissions by at least 1 million tonnes per year.

Actions

- 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.

Targets

- To enable Thailand to submit energy projects for certification under the CDM, at a total of 1 million tonnes CO_2 per year
- To enhance Thailand as a leading exporter of carbon credits in Asia.

Actions

- 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 on the 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 the volatile organic compounds (VOC) emissions from petrochemical and refining industries to minimise the environmental impact.

Targets

- To control the VOC emissions of all factories to meet the standards
- 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.

Actions

- Further implement the policy on vapor 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 01 January 2012.

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USEFUL LINKS

Department of Alternative Energy Development and Efficiency (DEDE)—www.dede.go.th

Electricity Generating Authority of Thailand (EGAT)—www.egat.co.th/en

Energy Policy and Planning Office (EPPO)—www.eppo.go.th

Ministry of Energy (MoEN)—www.energy.go.th/en

Prime Minister's Office—www.opm.g

UNITED STATES

INTRODUCTION

The United States (US) is the world's largest economy, with a GDP of USD 11.4 trillion (USD (2000) at PPP) in 2009 (EDMC 2011). The US spans 9.8 million square kilometres and has a population of 307 million people (2009) (EDMC 2011). The population has grown steadily, at a rate near 1% per year, since 2000 (EDMC 2011).

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 2010). 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 peaked at 10.2%, the highest level in over 25 years (BLS 2010).

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, 7700 billion cubic metres of natural gas reserves and 237 billion tonnes of coal reserves (BP 2011). According to the US Department of Energy's Energy Information Administration (EIA), total (net summer) electricity generating capacity across all sectors was 1025.4 GW in 2009, of which approximately 75.5% was fossil fuels, 9.9% was nuclear, 9.8% was hydro (conventional and pumped storage), 3.3% was wind, and 1.4% was other renewable energy (biomass, geothermal, solar etc) (EIA 2011a). The economy consumed 7.5 tonnes of oil equivalent per capita in 2008, over three times the APEC average and in excess of domestic energy production (EDMC 2011).

Table 33 Key data and economic profile, 2009-2010

Key data 2009		Energy reserves 2010	
Area (sq. km)	9 826 675	Oil (billion barrels)	30.9
Population (million)	307	Gas (billion cubic metres)	7 700
GDP (USD (2000) billion at PPP)	11 357	Coal (million tonnes) – recoverable	237 000
GDP (USD (2000) per capita at PPP)	36 993	Uranium (million tonnes) – recoverable [a]	0.472

a NEA (2010).

Sources: EDMC (2011), BP (2011).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2009, total primary energy supply in the US was 2171 million tonnes of oil equivalent (Mtoe). By fuel type, 40% of supply came from crude oil and petroleum products, 2% from coal, 25% from natural gas and 11% from nuclear, hydro, geothermal and other fuels. Net imports provided about 33% of the US primary energy requirement in 2009 (EDMC 2011).

In 2009, oil provided 861 Mtoe of the US primary energy supply. Though this represented a decline to pre-2000 levels, import dependence was still high. 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

2010 net imports declined to 49%. The decline in imports is the result of several factors, including a decline in consumption from the economic crisis, improving efficiency, and changing consumer behaviour. In addition, domestic oil and biofuel production increased. Canada is the single largest supplier in 2010 with a 25% share of imports (EIA 2011a). The US maintained its position in 2009 as the third-largest crude oil producer in the world, with production averaging 7.2 million barrels per day (EDMC 2011). Of the states, Texas, Alaska, California and North Dakota are the largest oil producers. Oil production from North Dakota will soon exceed that of California with rapid growth in unconventional shale oil (EIA 2011b).

The US primary natural gas supply totalled 534 Mtoe in 2009 (EDMC 2011). Consumption growth was assisted by a period of falling wellhead gas prices following deregulation in the 1980s and by an expanding pipeline network that made gas more widely available. From 1990 to 2000, the annual growth rate of 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 2009 total primary gas supply was close to the 2000 peak (EDMC 2011). 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 34 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 694 897	Industry sector	256 626	Total	4 188 963
Net imports and other	720 587	Transport sector	589 731	Thermal	2 731 340
Total PES	2 171 177	Other sectors	157 201	Hydro	298 460
Coal	484 978	Total FEC	1 472 251	Nuclear	838 732
Oil	861 016	Coal	21 271	Other	320 441
Gas	534 359	Oil	774 768		
Other	360 186	Gas	312 081		
		Electricity and other	313 229		

Source: EDMC (2011).

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

The US held about 4.1% of the world's natural gas reserves in 2010 (BP 2011). 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 18% of annual consumption in 2009, compared to a peak of 40% in 1986 (EIA 2011c).

From 2006 the introduction of horizontal drilling in combination with hydraulic fracturing has enabled the economic extraction of gas from shale formations. Between 2006 and 2010 US shale gas production increased by approximately 48% per year (EIA 2011d). Further increases in shale gas production are anticipated, with total production expected to increase close to threefold from 2009 to 2035. The size of recoverable shale gas reserves is still uncertain; however, the EIA predicts that even in a low discovery projection, recoverable shale gas may still exceed 11 trillion cubic metres. Interest in liquefied natural gas (LNG) has grown in the US as a means to export excess shale gas production and to support gas prices to encourage further investment. Proposals to construct new LNG exporting are facing environmental and regulatory hurdles and construction of an LNG exporting terminal will likely take 4–5 years from approval (EIA 2011d).

Primary energy supply of coal in the US totalled 524 Mtoe in 2010 (BP 2011). 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 2010, 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 2011e). Western coal production, which first surpassed eastern production in 1999, was given a major boost by the Clean Air Act Amendments of 1990, which have required the reduction of sulphur emissions from coal combustion since 1995 (EIA 2011e, EPA 2008).

The US is the seventh largest coal exporter in the world, behind Australia, Indonesia, Russia, South Africa, China and Colombia (EIA 2009a). After 1998, US coal exports dropped sharply due to lower world coal prices. In 2010 coal exports were 74.1 million tonnes (81.7 million short tons). Coal imports have steadily declined from 32.9 million tonnes (36.3 million short tons) in 2007 to 17.6 million tonnes (19.4 million short tons) in 2010 (EIA 2011e). Canada is the primary destination for steam coal exports, and Europe is the largest consumer of coking coal exports (EIA 2008).

The US produced 4.2 million gigawatt-hours of electricity in 2009; of that total, 65% came from thermal plants, 20% from nuclear power, 7.1% from hydropower and 7.9% from other sources (EDMC 2011).

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 Watts Bar 2 partially built reactor that had ceased construction in 1985; completion of this reactor is expected in 2013 (WNA, 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 remained through 2007 (EIA 2011e). Moreover, many nuclear plants have applied to the Nuclear Regulatory Commission (NRC) for 20-year extensions of their operating licences, to 60 years. By November 2011, the NRC had approved licence extensions for 72 nuclear reactor units and had applications for another 15 extensions under review, while 15 other units had informed the agency of their intention to seek extensions between 2012 and 2017 (NRC 2011a).

Total renewable energy production in the US in 2010 was approximately 253 Mtoe, or 10.3% of total primary energy supply, according to the EIA. Production from non-hydro sources increased 12.6% from the previous year, and at an annual rate of 6.8% since 2006 (EIA 2011a 2011d). By consumption of renewable energy type, biomass as a whole represented 53.3% of the total, hydroelectric power 31.2%, geothermal 2.6%, wind 11.5% and solar/photovoltaic 1.4%. Since 2006, there has been particularly rapid expansion for biomass used for biofuels (25% annual growth) as well as wind power (37% annual growth) (EIA 2011d). Government incentives, including subsidies and renewable energy mandates (discussed below), and cost reductions relative to fossil-fuelled alternatives, spurred the growth of renewable energy production.

FINAL ENERGY CONSUMPTION

In 2009, total final energy consumption in the US was 1472 Mtoe, a decrease of 5.1% from the previous year. By sector, transport consumed 40%, industry accounted for 17%, and other sectors (including non-energy uses) consumed 43%. By fuel, petroleum accounted for 53% of final consumption, natural gas 21%, coal 1%, and electricity and other fuels 25% (EDMC 2011).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Jurisdiction and Policy

Within the US Government, jurisdiction over the production, transformation, transmission and consumption of energy is shared by several agencies in the executive branch. Supervision of the use of natural resources falls under the Department of the Interior. Energy-related research, development and deployment (RD&D) are under the auspices of the Department of Energy. The Federal Energy Regulatory Commission (FERC) oversees the interstate transmission of energy, and the Environmental Protection Agency (EPA) regulates the environmental impacts of energy transformations throughout the economy. The Department of Transportation (DOT) also plays an important role as the regulator of vehicle fuel economy. A new White House Office of Energy and Climate Change Policy was created in 2009 to coordinate some of the activities of these agencies.

While all of these federal agencies have some voice in energy policy, the US Congress is responsible for creating the laws that govern the activities of these agencies and set the rules for energy markets. Since the 1970s, several major legislative packages have been introduced to define US energy policy. The National Energy Act of 1978 included legislation to promote energy conservation, to shift towards alternative energy sources, to create a market for independent power producers, and to give 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 utilization 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 the funding of many federal energy programs. Key elements of these recent acts are described in the following thematic discussions.

Energy Security

Given the high dependence of the US on imported oil, policies meant to improve energy security have often focused on three areas: 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, reaching 14.9 kilometres per litre (35 miles per gallon), and required study of 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 and 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 deepwater resources, low-

production wells and unconventional resources. 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 commercialization 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_2 emissions present a challenge for US climate policy, which is discussed below.

ENERGY MARKETS

In 2007, US consumers spent an estimated USD 1.2 trillion on energy purchases and major US energy companies' domestic operations netted around USD 63 billion (EIA 2011a). 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 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 2010a).

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 2009b).

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 (constant 2005 dollars) (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 7.6 billion in royalty payments in 2009 (ONRR 2010). 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 0.49 per litre (18.6 cents per gallon) and on diesel is USD 0.64 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 2010). 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 programs.

A variety of tax breaks have been introduced by the federal and state governments to promote investments in energy-related infrastructure. Two key federal instruments are investment tax credits 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 2011). 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 may 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 2011). Much of the Recovery Act allocation for energy efficiency will be distributed through state energy programs that provide loans, grants and other assistance for energy-efficiency projects in homes, businesses and public facilities (CRS 2009). Locally, utilities are generally required to consider energy efficiency on an equal basis to new generation in their planning, and many utilities administer demand-side management programs that provide incentives and technical assistance to reduce demand for electricity and natural gas (DSIRE 2011, US House 1992).

RENEWABLE ENERGY

In the first quarter of 2011, US cumulative wind energy capacity reached 41 400 megawatts (MW) or approximately 2.5% of US electricity demand. Total 2010 wind energy installations were 5116 MW, and from 2007 to 2010 wind installations accounted for over 35% of all new US

electricity generating capacity (AWEA 2010). 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 (DSIRE 2011). 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 programs also exist to encourage the development of renewable energy and other advanced energy facilities (DSIRE 2011).

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 2011).

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 program 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 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 2010b). However, the EPA engenderment finding has been challenged through the Court of Appeals and a court decision on its validity is expected by mid-2012 (American Thinker 2011).

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 California Governor Arnold Schwarzenegger noted that the state was particularly vulnerable to the impacts 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 program in the 2012–20 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 and 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 US and 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 (DOE 2009, 2010b, and 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. The participants of the Clean Energy Ministerial together launched 11 initiatives designed to increase the spread of clean energy technologies (DOE 2010e).

The GULF Oil spill

On 20 April 2010, the blowout of a well being drilled by BP in the Gulf of Mexico caused an explosion on the Deepwater Horizon drilling rig. The accident killed 11 workers and the millions of barrels of oil that poured from the damaged well over the next three months caused considerable environmental damage (DOI 2010a). In response to this accident, the government imposed a moratorium on drilling and reorganized the office of the Department of Interior responsible for oversight of offshore drilling. Previously, the Minerals Management Service of the Department of Interior provided safety and environmental oversight, as well as revenue collection. The reorganization separated those activities into three new offices: the Bureau of Ocean Energy Management, Regulation and Enforcement; the Bureau of Safety and Environmental Enforcement; and the Office of Natural Resources Revenue (DOI 2010b). After this reorganization was completed and new rules were introduced to improve the safety of drilling operations, the moratorium was lifted in October 2010 (DOI 2010c).

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). California agreed to amend to the federal standard from 2012 to 2016. However, with the waiver decision, States will be able to regulate vehicle emissions using the California standards before the federal standard takes effect in 2012, and in the period after 2016. In total, 15 states including California, have adopted California's vehicle emissions standards, and new bills are under discussion in several other states (C2ES 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, 13% in the past four decades (or +0.3% per annum) from 2.3 kilometres per litre (5.5 miles per gallon) in 1968 to 2.6 kilometres per litre (6.2 miles per gallon) in 2008 (EIA 2011a). 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).

Recovery act programs

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 8.9 billion has been spent. More than USD 1.8 billion has been spent through the Weatherization Assistance Program, which invests in energy efficiency improvements for the homes of low-income families. Other large investment programs are the State Energy Program and the Energy Efficiency and Conservation Block Grant Program, which fund state and community projects to improve energy efficiency and to address other energy goals. More than 5000 separate funding awards had been made through November 2010 (DOE 2010c). The EIA estimated that the provisions of the Recovery Act would result in over 50% more generation of renewable electricity (excluding hydro) in 2012, as well as efficiency measures that reduce residential and commercial energy expenditures by 2.6% in 2020 (EIA 2009b).

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Federal Energy Regulatory Commission—www.ferc.gov

Fuel economy—www.fueleconomy.gov

Nuclear Regulatory Commission—www.nrc.gov

VIET NAM

Introduction

Viet Nam is in South-East Asia; it shares a border with Cambodia and Laos to the west and China to the north. The Gulf of Tonkin lies to the east, the Gulf of Thailand to the south. Viet Nam has an area of 331 501 square kilometres, and a marine exclusive economic zone stretching 200 nautical miles from its 3260 kilometre coastline. In 2009, Viet Nam's population was 86.025 million. Market-oriented reforms since 1986 and rapid economic development have transformed the economy of Viet Nam. In 2009, Viet Nam had a GDP of USD 207.45 billion and an income per capita of USD 2412 (both in USD (2000) at PPP). GDP grew at an average annual rate of 7.3% from 2000 to 2009.

The government set targets for average annual GDP growth of 7.5% from 2005 to 2010, based on export growth increasing by 16% per year, total annual capital investment in the economy reaching around 40% of GDP, and population growth staying under 1.1%. However, due to the economic recession in 2008 and 2009, the government's targets for the annual average GDP growth rate for 2005–10 was changed to 7%.

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 is relatively rich in diverse fossil energy resources, such as oil, gas and coal, as well as renewable energy such as hydro, biomass, solar and geothermal. In 2009 Viet Nam's proven energy reserves consisted of 615 million tonnes (Mt) of oil, 600 billion cubic metres (bcm) of gas, 5883 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; its main energy exports are crude oil and coal.

Table 35 Key data and economic profile, 2009

Key data		Energy reserves	
Area (sq. km)	331 501	Oil (million tonnes)[a]	615
Population (million)	86.025	Gas (billion cubic metres)[a]	600
GDP (USD (2000) billion at PPP)	207.45	Coal (million tonnes)	5 883
GDP (USD (2000) per capita at PPP)	2 412		

a Proven reserves as at 2005 – the most recent official data available.

Sources: EDMC (2011); GSO (2009).

Energy demand and supply

PRIMARY ENERGY SUPPLY

Viet Nam's total primary energy supply in 2009 was 39 600 kilotonnes of oil equivalent (ktoe), an increase of 9.53% from 35 331 ktoe in 2008. By energy source, 43% of this came from oil, 32% from coal, 18% from natural gas and 7% from other resources.

Viet Nam's proven 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 2749 ktoe in 1990 to 17 329 ktoe in 2009. From 2000 to 2009, oil production and exports grew slowly at an average annual rate of 0.3%. By 2009, Viet Nam had 28

producing oil and gas fields (PVN 2011). Most oil exploration and production occurs offshore in the Cuu Long and Nam Con Son.

Oil product imports increased from 8882 ktoe in 2000 to 14 805 ktoe in 2009 at an average annual growth rate of 9.2%. Oil is still the most important energy source in Viet Nam, accounting for 43% of the economy's primary supply in 2009, compared to 41% in 2008.

Viet Nam's gas reserves are more promising than its oil reserves. In 2005, the latest year for which figures are available, proven gas reserves were estimated at 600 bcm, although that figure is likely to increase as more oil and gas are discovered. Gas resources are found in many parts of Viet Nam, but large gas reserves are almost all found in offshore basins.

Viet Nam has two large coal fields. In Quang Ninh Province in northern Viet Nam, where anthracite coal is found, there are about 5.83 billion tonnes of reserves at a depth of 300 metres, and over 10 billion tonnes atadepth of 1000 metres. 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 investmentin the next 10 years. Viet Nam's commercial coal production increased steadily from 4.6 Mt in 1990 to 43.7 Mtin 2009, matched by a growth in exports and domestic demand. In 2009, Viet Nam exported 24.992 Mt, an increase of 4.295 Mt compared to 2008. Primary coal supply increased by 12.4% per year from 2000 to 2009, from 4397 ktoe to 12 606 ktoe.

Electricity generation increased at an average annual rate of 13.0% between 2000 and 2009, from 26,562 GWh in 2000 to 83,191 GWh in 2009. 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 43% in 2009. The share of coal declined from 33% in 1995 to 18% in 2009. In the meantime, hydropower decreased from 72% of total generation to 36% in 2009due to the rapid expansion of natural gas use and foreign companies becoming increasingly involved in the growing power market of Viet Nam. In 2009, the economy's installed generating capacity was 18 481 MW; of that total, 69% was managed by Viet Nam Electric Power Group (EVN) and 29% was managed by others. In addition, more than 4100 GWh was imported from China.

Table 36 Energy supply and consumption, 2009

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	51 477	Industry sector	13 724	Total	79 461
Net imports and other	-13 787	Transport sector	10 274	Thermal	49 480
Total PES	39 600	Other sectors	8 072	Hydro	29 981
Coal	12 606	Total FEC	32 071	Nuclear	
Oil	16 954	Coal	8 966	Other	
Gas	7 101	Oil	15 851		
Other	2 938	Gas	639		
		Electricity & Others	6 616		

Source: EDMC (2011).

For full details of the energy balance table see: APEC Energy Statistics 2009

FINAL ENERGY CONSUMPTION

In 2009, Viet Nam's total commercial final energy consumption (FEC) was 32 071 ktoe, up 12.6% from 2008. By fuel source, oil contributed the largest share (49%), followed by coal (28%),

electricity and others (21%) and gas (2%). Between 2000 and 2009, consumption of electricity grew rapidly, at an annual growth rate of 13%.

Industry remains one of the biggest energy consumers, accounting for 43% of final energy consumption in 2009. The steel, construction materials, pulp and paper, and fertilizer manufacturing industries consumed the most energy. From 2000 to 2009, the annual average growth rate of energy consumption in industry was 10%.

The transport sector'sshare was 32% in 2009 compared 30% in 2008. Oil products (diesel, gasoline and fuel oil) are mainly used in transportation.

Other sectors (electricity, excluding biomass) consumed 20.6% of Viet Nam's FEC, a very slight change compared with 2008-(20.7%.

Policy overview

ENERGY POLICY FRAMEWORK

The Ministry of Industry and Trade (MOIT) was formed after the merger of the Ministry of Industry and the Ministry of Trade. MOIT is in charge ofactivities 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) administersthe Viet Nam Electric Power Group (EVN), the Viet Nam National Coal and Mineral Industries Group (Vinacomin) and theViet Nam Oil and Gas Group (PetroVietnam, PVN).

Many other ministries also have responsibilities relating to energy. The Ministry of Planning and Investment setsthe Socio-economic Development Strategy and Plan, coordinates the distribution of economy-widecapital investment among projects submitted by ministriesand 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.

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 energy program for rural and mountainous areas, and increasing the proportion of rural households using commercial energy to 50% in 2010 and 80% 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 growing 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 is 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 early stages of reform; electricity shortages still occur; 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 fuels, especially nuclear and 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 2009, over 30% (29 977 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 subsidized power
- Level 2 (2015–2022): the establishment of a competitive wholesale power market
- Level 3 (after 2022): the realization 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 part of the reform of the electricity sector, EVN has been proceeding with plans to corporatize member enterprises since the early 2000s. So far, the restructuring of the generating and distributing companies has been completedand four power transmission companies have been merged into one national company, the National Transmission Company, which is separate from EVN. However, big hydropower plants (including Hoa Binh, Tri An and Yaly), and nuclear power plants (in the future), remain under the management of EVN.

Coal sector

The Prime Minister's Decision No. 199/2005/QD-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 has been 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 the main aims is to speed up the corporatization of coal production companies and the creation of a coal market with diversified ownership and business activities.

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 come into operation), and the Oil Refining and Petrochemical Corporation (established when the group's refining and petrochemical plants come into operation). PVN also includes joint stock companies, joint venture enterprises, scientific and technological enterprises, and training organizations.

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 (vnexpress2011), the electricity sector needs 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 Dung Quat oil refinery, the Ca Mau gas–electricity–fertilizer complex, and Nam Con Son Gas Pipeline Project No.2.

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 for 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 406-kilometre pipeline from gas fields in Blocks B and 52 to O Mon, Can Tho Province. The pipeline capacity is to be 6.4 bcm per year, and the project is expected to be operational in 2013. 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 was in 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 20 Mt of crude oil.

Four petrochemical centres will be completed by 2020. Three will be combined with oil refinery plants and the other, in the western area of the south of Viet Nam, will use natural gas resources in the area to produce fertilizer and other products from ammonia.

Coal sector

The government of Viet Nam has at times, in the interests of economic stability, requested Vinacomin supply coal to the market at below cost price. This subsidizing 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 the domestic coal price. Since July 2009, Vinacomin has been allowed to set the price for local customers (except power generators) at rates lower than the export price, up to a maximum 10% discount. In addition, the government is preparing a strategy to deregulate the price of coal used for power generation.

ENERGY EFFICIENCY

In April 2006, the Prime Minister approved the Viet Nam National Energy Efficiency Program (VNEEP) for the 2006–15 period (PMVN 2006b). The program's overall objectives cover community stimulation, motivation and advocacy; science and technology; and mandatory management measures for carrying out coordinated activities related to the economical and efficient use of energy in the whole society. The aim of the program is to save 3%–5% of total energy consumption over the 2006–10 period and 5%–8% in the 2011–15 period. The program includes six components: strengthen state management of energy efficiency and conservation by developing a management system for energy saving; strengthen education, disseminate information and enhance public awareness to promote energy efficiency and conservation (EE&C) as well as environmental protection; develop and popularize 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 1 of VNEEP for the period 2006–10 has been implemented; phase 2 is now operating, for the period 2011–15.

MOIT is the focal coordinator of EE&C and is authorized to administer the implementation of VNEEP. As part of this mechanism, the Energy Efficiency and Conservation Office within the Ministry of Industry and Trade was established 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 as 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 recently have 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 to implement the project at 500 SMEs operating in the areas of clean production, ceramics, weaving, paper and pulp manufacture, and food processing. The project included six sub-programs: 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_2 emissions by 962 000 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 Center, 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 4000 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 2000 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 are not expected to have access to electricity by 2012. The government has provided significant support and legislateda 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 program 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%) by 2025 and 35 Mtoe (11%) 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.

NUCLEAR

In June 2010, the Prime Minister approved the 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 2000 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 1000 MW would be operating by 2020.

The construction of both plants will begin in 2014–15, and that would be followed by the further development of the economy's nuclear energy capacity to reach 10 000 MW by 2030 (IOE 2011).

CLIMATE CHANGE

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.

In December 2008, the Prime Minister of Viet Nam approved a budget of about VND 1965 billionfor the National Targeting Program 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 program aims to achieve two general objectives: to evaluate the potential impacts of climate change in each sector and area 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.

The World Bank is helping Viet Nam to build particular projects, such as risk management of 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 Cuu Long River delta to cope with climate change.

Notable energy developments

ENERGY EFFICIENCY

In a statement to the Energy Working Group (EWG 2010) in November 2010, Viet Nam highlighted these achievements in the area of energy efficiency in the economy:

- Approval of alaw on energy efficiency and conservation by the National Assembly (in June 2010).
- Creation of a standard for energy efficiency for electrical equipment including refrigerators, airconditioners, electrical cookers, street lights, and six sets of energy efficiency standards and testing procedures for household appliances (Center 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 is issuing related legal documents, including the Decree on Detail Regulations and Measures for Implementation of the Law (released in March 2011), the Road map for Labelling Energy Equipment, and the Decree on Public Lighting Management.

RENEWABLE ENERGY

Some recent wind power developments include a 15 kW solar PV–wind power hybrid system in a 40-household village. The project was implemented by the Institute of Energy with a grant from Tohoku ElectricCompany of Japan. Another is an 800 kW wind power generator in Bach Long Island, financed completely by the government of Viet Nam.Future wind energy developments, with a total installed capacity of 385.5 MW, include the Ly Son island project

(2 MW), the Phuong Mai wind farm in Binh Dinh province (65 MW), a wind power project in Ninh Thuan province (126 MW), a wind farm in Phu Yen Province (15 MW), a wind farm in Binh Thuan province (165 MW), the Con Dao island project (2.5 MW) and the Phu Qui island project (10 MW).

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Useful links

Ministry of Industry and Trade—www.moit.gov.vn

PetroVietnam—www.pvn.com.vn

United Nations Development Programme in Viet Nam—www.undp.org.vn

Vietnam Economic Times—www.vneconomy.com.vn

Vietnam Electric Power Group—www.evn.com.vn
Vietnam News Agency—http://vietnamnews.vnagency.com.vn