ASIA PACIFIC ENERGY RESEARCH CENTRE

APEC ENERGY OVERVIEW

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FOREWORD

The events of the past eighteen months, in particular the global financial crisis and ensuing recession, have had a significant effect on world energy markets. In 2009, world energy demand fell dramatically as a result of the economic contraction and energy investment dropped as tighter credit conditions forced firms to take a more cautious approach with investment decisions. The effects of these events are likely to persist over the next few years.

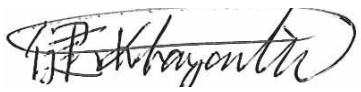
It is clear that the sustainable development and use of energy resources is at the forefront of energy policy in APEC with a number of economies adjusting or introducing policies relating to energy strategy, energy efficiency and conservation and low carbon energies over the last eighteen months.

The desire to maintain economic growth and prosperity while addressing the mounting challenges of supply security and environmental concerns has prompted a number of economies to review their energy strategies. These plans consider how to reduce energy use (mainly through energy efficiency measures) and increase the uptake of lower carbon energy options.

Energy efficiency improvements will help APEC economies chart new pathways for secure and sustainable development. APEC economies have been working hard to develop plans and measures to improve energy efficiency across all sectors of the economy. Most economies have introduced action plans to improve energy efficiency; embarked on awareness raising campaigns; promoted good energy management practices and facilitated investment in energy efficiency.

APEC economies have also been trying to reduce the effect that energy use is having on the environment by establishing plans to reduce emissions and implementing measures to stimulate investment in low carbon energies. The 15th Conference of the Parties to the United Nations Framework Convention on Climate Change was held in Copenhagen in December 2009. A number of APEC economies announced updated pledges to reduce emissions to coincide with this conference. As part of these efforts, APEC economies have been looking for ways to accelerate the development of low carbon energies and ensure that they play a greater role in the energy mix.

Sustainable energy development can be achieved by employing highly effective government policies and broader 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 policy updates, upstream development, energy efficiency, low carbon energy, and environmental issues. We hope that this report helps to deepen mutual understanding among APEC economies on energy issues in the APEC region.



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ABBREVIATIONS AND SYMBOLS

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

ACRONYMS

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

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

CURRENCY CODES

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

AUSTRALIA

INTRODUCTION

Australia is the world's largest island economy and the sixth largest economy (in land area) in the world. 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 to 2007. In 2007, GDP reached USD 609.82 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 energy sector is important to the Australian economy, to which the coal, petroleum, gas and electricity industries contributed AUD 57 billion, or 6% of the total, to industry gross value added in the 2006–07 financial year (July–June) (ABARE 2009c:1). The resources sector is the largest export earner, accounting for 39% of Australia's export earnings in 2008–09 (ABARE 2009a). 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, 2007

Key data		Energy reserves	
Area (sq. km)	7 692 024	Oil (billion barrels)	4.2
Population (million)	21.02	Gas (billion cubic metres)	2 510
GDP (USD (2000) billion at PPP)	609.82	Coal (million tonnes)	76 600
GDP (USD (2000) per capita at PPP)	29 018		

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan (IEEJ); *BP Statistical Review of World Energy 2008*.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Australia's total primary energy supply was 127 479 kilotonnes of oil equivalent (ktoe). Around 43% of supply came from coal, 31% from oil, 20% from gas and the remainder from other sources. Between 2000 and 2007, gas supply grew fastest, at an average annual rate of 4.1%, followed by coal (1.9%), other (1.5%) and oil (1.3%).

Australia accounts for around 6% of world 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. Coal is Australia's largest commodity export, earning AUD 54 671 billion in 2008–09 (ABARE 2009b). It is also an important component of domestic energy supplies, accounting for around 84% of fuel used in electricity generation. Total coal production in 2007 was 218 406 ktoe, around 73% of which was exported. Australian coal production increased at an average annual rate of 4.1% between 2000 and 2007, 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 2007, Australia's production of gas was 38 534 ktoe. Around 46% of this was exported as LNG to consumers in Japan, Chinese Taipei, Korea and China.

Australia is a net importer of crude oil and petroleum products, but a net exporter of liquefied petroleum gas (LPG). More than 60% of crude oil production is exported, while around 70% 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 (ABARE 2009c). In 2007, Australia's crude oil, LNG and condensate production was 25 302 ktoe.

In 2007, 244 245 GWh of electricity was generated, mostly from thermal sources (91%). 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 2007 was 79 052 ktoe. The transport sector accounted for 38% of the total, industry 33% and the other sectors, which include residential and commercial, 28%. By energy source, petroleum products accounted for 50% of consumption, electricity 29%, natural gas 17% and coal 4%.

Table 2 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	289 540	Industry sector	26 494	Total	244 245
Net imports and other	–156 291	Transport sector	30 248	Thermal	222 568
Total PES	127 479	Other sectors	22 310	Hydro	14 725
Coal	54 754	Total FEC	79 052	Nuclear	–
Oil	40 068	Coal	3 445	Other	6 953
Gas	25 359	Oil	39 535		
Other	7 298	Gas	13 440		
		Electricity and other	22 632		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

POLICY OVERVIEW

FISCAL REGIME AND INVESTMENT

The taxation treatment of corporations operating in the energy sector is generally the same as the treatment of all other industries. Corporations earning an income in Australia are taxed at a flat rate of 30%. Corporations 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 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. On 12 May 2009 the Australian Government announced it will replace the existing R&D Tax Concession with a new

R&D Tax Credit. The R&D Tax Credit will come 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 and thereby creates certainty in the level of assistance to be provided.

Corporations involved in energy extraction activities are also required to pay royalties to the governments for the use of the 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/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 net wellhead value of production. A Commonwealth excise applies to crude oil and condensate production, with the first 30 million barrels' 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 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 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 is comprehensively reviewing the taxation system through the Australia's Future Tax System Review, which will make recommendations on the structure of the future tax system to accommodate demographic, social, economic and environmental changes. The review delivered its report to the government in December 2009.

Australian Government policy 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. Proposals by foreign corporations to establish a business with 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 investment by foreign governments or their agencies, regardless of the size of the investment (RET 2008).

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 land or inside the first three nautical miles of the territorial sea ('onshore').

In 2001, the Council of Australian Governments (COAG) established the Ministerial Council on Energy (MCE) to provide policy leadership and oversight to ensure that the Australian energy sector could take advantage of opportunities and address emerging challenges. The council comprises the ministers with responsibility for energy from all 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 the Australian Energy Market.

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 White Paper will focus on the provision of clean, adequate, reliable and affordable 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. A preliminary document (a Green Paper) is expected to be released in early 2010.

The Energy White Paper will also incorporate elements of other reviews and initiatives, including the design of the Carbon Pollution Reduction Scheme (a proposed emissions trading scheme), the Australia's Future Tax System Review, the Garnaut Climate Change Review, the Review of Export Policies and Programs (the Mortimer Review) and the Strategic Review of Australian Government Climate Change Programs (the Wilkins Review).

MARKET REFORMS

The MCE has responsibility for ensuring that Australian energy markets are operating efficiently. In 2003, the MCE agreed to a package of market reforms that included governance and institutions, economic regulation, electricity transmission, user participation, gas market development and reducing greenhouse gas emissions. MCE-led reforms have included:

- the creation of the National Electricity Market (NEM)
- consistent economy-wide regulation of natural gas and electricity transmission and distribution infrastructure through:
  - the National Electricity Law (governance and enforcement, key obligations and access regulation)
  - National Electricity Rules (electricity market operation and network regulation)
  - National Gas Law (governance and enforcement, key obligations for pipeline access and the establishment of the Gas Bulletin Board)
  - National Gas Rules (details of access regime and the Gas Market Bulletin Board)
  - Australian Energy Market Commission Establishment Act 2004 and Part IIIAA of the Trade Practices Act 1974 (establishes the Australian Energy Regulator)
  - Australian Energy Market Act 2004 (applies the National Electricity and Gas Laws to offshore areas and Commonwealth involvement in energy regimes)
- the establishment of the Australian Energy Market Operator (AEMO)
- the introduction of a NEM transmission planning function (which now sits in the AEMO) that produces a National Transmission Statement each year
- the introduction of a consumer advocacy panel to allow greater stakeholder participation in the Australian energy market (MCE 2003).

Current activity streams include:

- development of a short-term wholesale gas trading market

- development of a National Energy Customer Framework to streamline the regulation of energy distribution and retail functions and to include consumer protection in an efficient retail energy market
- the development of a framework for the rollout of smart meters
- improving the market's capacity to integrate growing intermittent generation (such as wind energy), including the development of a wind forecasting system, technical standards and new dispatch arrangements
- further market development to improve transparency, competition and trading opportunities.

In the transition to a lower carbon economy, the MCE tasked the Australian Energy Market Commission to assess energy market frameworks, in the light of climate change policies. The recommendations in the commission's report, which was released in September 2009, will form a significant input to the MCE's forward energy market reform agenda.

ENERGY SECURITY

In 2009, the Australian Government released the *National Energy Security Assessment* (NESA), which assessed the challenges that could affect 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 has 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 that governments need to address to maintain or 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. The NESA will be a key input into the development of the new Energy White Paper.

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 development 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 development; government interventions should be transparent and allow commercial interests to seek least-cost solutions to government objectives (for example, environment, safety or good resource management objectives)
- Government objectives should generally be driven by sector-wide policy mechanisms, rather than impose 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. A comprehensive package, including details of the acreage release, bidding requirements and permit conditions, is distributed worldwide.

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 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), 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; oversighting 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 Australian energy markets. It will prepare and publish 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 will also maintain the Gas Market Bulletin Board.

The AEMO now oversees Australian 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.

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 Carbon Pollution Reduction Scheme (CPRS).

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 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 mandates that firms using more than 0.5 petajoules (PJs) of energy per year (equivalent to the energy used by about 10 000 Australian households) undertake rigorous assessments to identify and evaluate cost effective energy savings opportunities. Firms are not required to implement savings measures, but requirements for public reporting on the business response approved by the Board encourage senior managers to carefully consider energy use in a strategic business context. Approximately 226 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 2009b).

RENEWABLE ENERGY

The Renewable Energy (Electricity) Amendment Bill 2009 and the Renewable Energy (Electricity) (Charge) Amendment Bill 2009 were passed in August 2009. The Renewable Energy (Electricity) Amendment Bill 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.

The 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 the new target of 45 000 GWh of new renewable electricity generation, on top of 15 000 GWh of existing renewable electricity generation, compared with 9500 GWh by 2010 under the old MRET. The RET also brings existing state-based targets, such as the Victorian Renewable Energy Target and proposed New South Wales Renewable Energy Target, into a single Australia-wide scheme. The RET is scheduled to end in 2030, when the proposed CPRS is expected to be the primary driver of investment in renewable energy (DCC 2009b).

The Australian Government offers a number of programs to encourage the development, commercialisation and deployment of renewable energy technologies. In 2009, the Australian Government announced that it would establish a new Australian Centre for Renewable Energy to promote the development, commercialisation and deployment of renewable energy and enabling technologies. Details of some of the current programs are outlined in the 'Notable energy developments' section. State and territory governments also have programs to encourage the development of renewable energy resources.

There is no Australia-wide feed-in tariff scheme to support small-scale renewable technologies; however, most state and territory governments have implemented, or are planning to implement feed-in tariffs (Clean Energy Council 2009).

CLIMATE CHANGE

The Australian Government is committed to a long-term goal of reducing Australia's greenhouse gas emissions to 60% below the 2000 level by 2050. The 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.

Australia is considering a scheme to curb carbon emissions, in line with its ratification of the Kyoto Protocol. The CPRS will use a cap and trade mechanism to impose a price on carbon, which is expected to make gas and renewable energy resources more competitive against coal. It is expected to directly affect around 1000 entities. The CPRS will incorporate all greenhouse gases included under the Kyoto Protocol, which represent around 75% of Australia's total emissions. Emissions from industrial processes, stationary energy (including electricity generation), transport, waste, and oil and gas fugitive sources will be covered. Emissions from agricultural sources are not included at this stage. The Australian Government has announced that it intends to provide varying levels of support to emissions-intensive, trade-exposed industries; the coal-fired electricity generation sector; and businesses and households. The government will establish the Australian Climate Change Regulatory Authority to oversee the operations of the CPRS. If passage of the legislation is successful, emissions trading will begin in Australia in mid-2011 (DCC 2009a).

ENERGY TECHNOLOGY/R&D

The Australian Government is promoting the development of clean energy technologies through the programs that make up the Clean Energy Initiative. Further detail is 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.

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

Australia's energy policy framework changed significantly in 2009 through amendments to existing policy and legislation. Developments included the Review of Australia's taxation system; updating the Energy White Paper; the release of the National Energy Security Assessment; the establishment of the Australian Energy Market Operator; the release of the National Strategy for Energy Efficiency; passing of the Renewable Energy (Electricity) Amendment Bill 2009 and the Renewable Energy (Electricity) (Charge) Amendment Bill 2009 to expand the renewable energy target; and the proposal for an emissions trading scheme. Details of these developments are in the 'Policy overview' section.

CLEAN ENERGY

In April 2009, the Australian Government formally launched the Global Carbon Capture and Storage Institute (GCCSI). Funding of AUD 100 million a year has been allocated to the GCCSI. More than 20 governments and more than 80 corporations, non-government bodies and research organisations have signed as foundation members or collaborating participants. The GCCSI aims to facilitate the development and deployment of carbon capture and storage technologies. It will work in collaboration with governments, non-government organisations and the private sector to build confidence in the sector (GCCSI 2009).

To complement the CPRS and the RET, in the May 2009 federal Budget, the Australian Government announced the AUD 4.5 billion Clean Energy Initiative (CEI) to support the research, development and deployment of low-emissions technologies. The CEI has four major components:

- *Carbon Capture and Storage Flagships Program.* AUD 2 billion over nine years has been dedicated to the Flagship Program to fund two to four industrial-scale carbon capture and storage demonstration plants. Four projects have been shortlisted (Wandoan and ZeroGen in Queensland; Collie South West Hub in Western Australia and CarbonNet in Victoria). A final decision on the successful projects is expected to be made the second half of 2010. The demonstrations will contribute to the overall target of 1000 MW of low-emissions fossil fuel electricity generation. Commissioning is expected to take place from 2015. This is complemented by the National Low Emissions Coal Initiative (AUD 400 million), which includes:
  - the National Coal Research Program (AUD 75 million)
  - the National Carbon Mapping and Infrastructure Plan (AUD 50 million)
  - a pilot coal gasification research plant in Queensland (AUD 50 million)
  - a post-combustion capture project with carbon capture and storage (AUD 50 million)
  - a post-combustion capture project with carbon capture and storage using lignite in Victoria (AUD 50 million)

  - the Australia–China Joint Coordination Group on Clean Coal Technology (AUD 20 million)
  - CS Energy oxy-fuel demonstration project (AUD 50 million).
- *Solar Flagships Program*. AUD 1.5 billion has been allocated to support the construction and demonstration of up to four large-scale solar generation plants. The program has an overall target capacity of 1000 MW, the equivalent of a coal-fired station. The first two flagship projects will be selected in 2010, with construction commencing from 2012 and commissioning from 2015. A second round of the program is expected to open in 2013.
- *Australian Solar Institute*. The Solar Flagships program will be complemented by the creation of the Australian Solar Institute, which will build research capacity in solar thermal and photovoltaic technologies and foster collaboration between universities, research institutions and industry. AUD 100 million between 2008 and 2012 has been allocated to the institute. As part of the initial funding for the work of the institute, AUD 15 million has been provided for three foundation projects: AUD 5 million to support the development of a crystalline silicon plant line at the University of New South Wales; AUD 5 million to establish a new state-of-the-art solar thermal tower at the CSIRO in Newcastle; and AUD 5 million to assist in the establishment of a world-class process and characterisation solar research facility at the Australian National University. A further five grants worth AUD 11 million were awarded to four universities and the CSIRO on 17 December 2009.
- *Australian Centre for Renewable Energy*. The Australian Government launched the Australian Centre for Renewable Energy (ACRE) in October 2009. ACRE's objective is to promote the development, commercialisation and deployment of renewable energy technologies. Over AUD 560 million has been allocated to the development of the centre, which will act as a 'one-stop shop' for renewable energy businesses, consolidating the following programs:
  - Renewable Energy Demonstration Program (competitive grants program to support the development of large-scale renewable projects other than solar) (AUD 235 million in grants has been announced)
  - Second Generation Biofuels Research and Development Program (AUD 15 million)
  - Geothermal Drilling Program (AUD 50 million)
  - Advanced Electricity Storage Technologies Program (AUD 20 million)
  - Wind Energy Forecasting Capability Program (AUD 14 million)
  - Renewable Energy Equity Fund (AUD 18 million)
  - new initiatives, (AUD 150 million including funding from the formerly proposed Clean Energy Program) (RET 2009a).

NEW ENERGY PROJECTS

Australia's production and infrastructure capacity was expanded in 2009 following the completion of:

- the Darling Downs coal-seam gas development (capacity of 44 petajoules a year) to supply gas to the domestic Queensland market
- a 17 million tonnes per year expansion to the Dalrymple Bay Coal Terminal, bringing total capacity to 85 million tonnes a year
- the Abbot Point Coal Terminal X25 expansion
- four Queensland Rail projects (Jilalan Rail Yard Upgrade; Stanwell–Wycarbah upgrade; Vermont Rail Spur and Balloon Loop; and Grantleigh to Tunnel rail duplication)

- the Lake Lindsay mine in Queensland, with production capacity of 4 million tonnes (1.9 million tonnes of hard coking coal, 1.8 million tonnes of pulverised coal injection coal and 0.3 million tonnes of thermal coal)
- the Vermont Coal Project (capacity of 4 million tonnes a year)
- the Rocglen mine (annual production capacity of 1.5 million tonnes of thermal coal)
- three gas pipelines—QSN Link (capacity of 60 petajoules a year) connecting the South West Queensland Pipeline to the Moomba gas hub in north-east South Australia; Berwyndale to Wallumbilla pipeline connecting coal-seam methane fields around Berwyndale (300 kilometres north-west of Brisbane) to the Wallumbilla gas hub; and the Bonaparte gas pipeline linking the Bonaparte Basin to the Alice Springs – Darwin pipeline
- the Van Gogh oil project with production commencing in early 2010
- the Longtom gas project which will supply an additional 30 tera-joules per day into the east coast market
- Ranger laterite processing plant (increasing annual production capacity by 4000 tonnes of uranium oxide).

In other developments, in September 2009 a final investment decision for the Gorgon LNG project was announced by joint venture partners Chevron, Shell and ExxonMobil. The project will have a production capacity of 15 million tonnes of LNG a year and is scheduled to be completed in 2015. With an estimated capital expenditure of AUD 43 billion, it is the largest minerals and energy project to be undertaken in Australia (ABARE 2009d, 2009e). Construction of the Gorgon LNG project commenced in December 2009.

USEFUL LINKS

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Australian Bureau of Statistics—www.abs.gov.au

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

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

Australian Energy Regulator—www.aer.gov.au

Australian Government—www.australia.gov.au

Australian Government Department of Climate Change—www.climatechange.gov.au

Australian Government Department of Resources, Energy and Tourism—www.ret.gov.au

Commonwealth Law—www.comlaw.gov.au

Ministerial Council on Energy—www.mce.gov.au

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BRUNEI DARUSSALAM

INTRODUCTION

Brunei Darussalam (the Abode of Peace) is located on the north-west coast of the island of Borneo. It has a total land area of around 5765 square kilometres and 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. The small economy is a mixture of foreign and domestic entrepreneurship, government regulation, welfare measures, and village tradition. In 2007, the population of Brunei Darussalam was around 390 000.

In 2007, Brunei Darussalam's GDP was USD 16.33 billion (USD (2000) at PPP). GDP per capita was USD 41 946 (USD (2000) at PPP), a decrease of around 1.3% from 2006. Brunei Darussalam's economy has relied heavily on oil and gas since they were first discovered in 1929. The oil and gas sector is the 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 2007, crude oil and condensate production averaged 194 thousand barrels per day (Mbbl/D). Gas production was around 34 million cubic metres a day, most of which was exported to the major markets of Japan and South Korea as liquefied natural gas (LNG).

Table 3 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (sq. km)	5 765	Oil (billion barrels)	1.1
Population (million)	0.39	Gas (trillion cubic metres)	0.34
GDP (USD (2000) billion at PPP)	16.33	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	41 946		

a Proven reserves at the end of 2007, from *BP Statistical Review of World Energy 2009*.

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (IEEJ) (www.ieej.or.jp/egeda/database/database-top.html).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Brunei Darussalam's total primary energy supply was 3949 kilotonnes of oil equivalent (ktoe). Natural gas represents 80.2% of the total energy supply, while oil represents 19.2%. Oil and gas production was 20 834 ktoe in 2007, a decline of 9.6% from 2006 production (23 038 ktoe). Brunei Darussalam exported 81.3% of its oil and gas production in 2007.

At the end of 2007, according to the BP Statistical Review of World Energy 2009, Brunei Darussalam's proven crude oil reserve was 1.1 billion barrels, and its natural gas reserve was 0.34 trillion cubic metres. Most of the economy's oil and gas fields are considered mature. Intensive exploitation of oil resources for over 75 years and of natural gas resources for over 35 years has required the industry to change recovery techniques. At current production rates, the 2007 proven oil and gas reserves are expected to be depleted within 20 and 30 years, respectively.

Most of Brunei Darussalam's oil exports are to Australia, Japan, Korea, Thailand, Indonesia and India, and most of its natural gas is exported, in the form of LNG, to Japan and South Korea.

In 2007, the economy generated 3395 gigawatt-hours (GWh) of electricity, entirely from thermal sources. Almost all of the electricity generated was supplied by natural gas.

Table 4 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	20 834	Industry sector	102	Total	3 395
Net imports and other	-16 936	Transport sector	434	Thermal	3 395
Total PES	3 949	Other sectors	273	Hydro	–
Coal	–	Total FEC	810	Nuclear	–
Oil	783	Coal	–	Geothermal	–
Gas	3 166	Oil	513	Other	–
Other	–	Gas	29		
		Electricity and other	268		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

In 2007, Brunei Darussalam's total final energy consumption was 810 ktoe, an increase of 3.2% from 2006. The sectoral shares of final energy consumption remained unchanged from 2006. The transportation sector consumed 53.6% of the total, followed by the residential, commercial and non-energy sectors combined (33.8%) and the industrial sector (12.6%). By energy source, oil contributed the largest share, accounting for 63.4% of consumption, followed by electricity (33.1%) and gas (3.5%). Natural gas accounts for 99% of the fuel use to generate electricity and only 1% is 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, planning for and regulation of energy matters and issues affecting Brunei Darussalam. The Petroleum Unit, which regulates the oil and gas industry, 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 (2007–2012) is in force. Under the plan, energy policy is directed towards efforts to strengthen and expand the oil and gas industry. In line with this plan, the economy has also launched a long-term development plan, the Brunei Vision 2035. The plan states that the economy's major goal for the next three decades is economic diversification, along with strengthening of the oil and gas sector. The latter is to be achieved by expanding the sector'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 production of 219 Mbbl/D by 2006.

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

The Brunei National Petroleum Company Order, introduced in January 2002, empowers the Brunei National Petroleum Company Sdn Bhd (PetroleumBRUNEI) to act as the economy's oil company. Among others, PetroleumBRUNEI is given designated Areas for which the company has the right to negotiate, conclude and administer petroleum sharing agreements. Currently, PetroleumBRUNEI's designated Areas are the onshore Block L and Block M and the offshore Block J and Block K.

MARKET REFORMS

The energy market in Brunei Darussalam is regulated by the government. Energy prices are subsidised. However, it has increased considerably the price of Motor gasoline (Premium 97) and diesel for vehicles and vessels not registered in Brunei Darussalam in the wake of increased smuggling of fuels to neighbouring economies. The government is concerned about the increasing cost of maintaining fuel subsidies, and in 2008 began a Subsidy Awareness Campaign.

ENERGY SECURITY

Brunei Darussalam, as a member of the Association of Southeast Asian Nations (ASEAN), has signed the ASEAN Petroleum Security Agreement. Under the agreement, Brunei Darussalam and other ASEAN members have agreed to cooperate closely on energy security relating to oil supply. Furthermore, Brunei Darussalam is working with other ASEAN members on the Trans-ASEAN Gas Pipeline project and the ASEAN Power Grid project to promote and enhance energy security through energy-market integration in the region.

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. However, new discoveries are being found further out, in water approaching 200 metres deep. There is also potential for more discoveries onshore.

Most of Brunei Darussalam's oil and gas fields are considered mature. Intensive exploitation of oil resources for 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'.

An important milestone for Brunei Darussalam was the signing of new Production Sharing Agreement for the oil and gas blocks: offshore Block J and Block K in 2003, and onshore Block L and Block M in 2006. These blocks are considered important for the economy to be able to maintain and extend oil and gas production in the future. The awarding of Block J and Block K by the government has been disputed by Malaysia because of overlapping sovereignty claims for the offshore area included in those two blocks. The two economies have been negotiating to resolve this conflict and an important milestone was achieved when a Letter of Exchange was signed on this matter by both economies early 2009. Prospects for oil and gas discoveries in Block J and Block K are considered high. There remains an area of some 19 889 square kilometres beyond Block J and Block K within the boundary of the EEZ that is allocated for future development.

Brunei LNG will also refurbish existing capacity to extend its operating life to 20 years, or up to 2033.

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 generation in Brunei Darussalam. The National Development Plan for 2007–2012 proposes that the three power grids will be interconnected by 2012. The economy also expects to harness the hydroelectric potential of the Temburong River. This project has a potential capacity of around 80 MW and could produce an estimated 300 GWh a year.

ENERGY EFFICIENCY

The government is actively promoting energy efficiency and conservation in various sectors in the economy. These activities include economy-wide public education awareness campaigns, talks, publications on energy efficiency & conservation issues as well as voluntary energy labelling scheme for air-conditioners. In addition, the economy is also enhancing its human capacity building through seminar-workshops on energy management, energy audit and energy education in schools.

RENEWABLE ENERGY

The economy is assessing the viability of large-scale photovoltaic electricity generation. To promote this effort, the government has initiated a solar-energy demonstration project known as Tenaga Suria Brunei. The project will be located at the Seria power station in the Belait district. The on-grid photovoltaic system will have a nominal capacity of 1.2 MW, and will be commissioned in 2010.

CLIMATE CHANGE

Brunei Darussalam's major greenhouse gas emissions are from the oil and gas production industry. The main emissions from this industry are methane and carbon dioxide, which stem from venting, instrument gas, flaring and fugitive emissions. As part of Brunei Darussalam's environmental initiatives, there are plans for the major oil and gas producers to reduce the disposal of gas by continuous venting and flaring. The efforts undertaken to mitigate greenhouse gas emissions are:

- simplifying and rationalising old facilities, centralising processes at main complex facilities, and improving operations to reduce venting from compressor trips, fugitive losses, atmospheric gas disposal and the use of instrument gas
- converting existing vent stacks to flare stacks
- simplifying and rationalising facilities to recover and recompress vented flash gas from surge vessels and to reduce instrument gas consumption.

NOTABLE ENERGY DEVELOPMENTS

ENERGY PROJECTS

The Government of Brunei Darussalam seeks to maximise the economy's oil and gas resource 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. The petrochemical industry would consist of a methanol plant to be located at the Sungai Liang Industrial Park, a world-class industrial complex in the Belait district.

Experienced investors are also welcomed to set up an export-oriented refinery and petrochemicals plant. The growing domestic requirements for the products is also planned to be met by this refinery as the existing refinery is not able to meet increased requirements. Brunei

Economic Development Board (BEBD) plans to have this plant based on the island of Pulau Muara Besar, in the Brunei-Muara district.

The methanol plant, owned by the Brunei Methanol Company, is expected to begin production in 2010, with an annual production of 850 000 tonnes. Methanol will initially be produced for export. There is potential to add further processing capacity at a later date to produce chemicals such as acetic acid, formaldehyde, chloromethane and methyl methacrylates. Natural gas is the primary feedstock for the plant.

USEFUL LINKS

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

Brunei LNG Sdn Bhd—www.blng.com.bn

Brunei National Petroleum Company Sdn Bhd—www.pb.com.bn

Brunei Shell Petroleum Company Sdn Bhd—www.bsp.com.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 million, of which approximately 39% is concentrated in the province of Ontario (EDMC 2009; Statcan 2009). Canada is known for its wealth of energy and other natural resources. In 2007, its GDP amounted to roughly USD 1045 billion, a 1.4% increase over 2006, and USD 31 680 per capita (both in USD (2000) at PPP) (EDMC 2009). Inflation remained low and stable, with consumer price inflation of 2.3% in 2008 (Statcan 2009). Unemployment averaged 6.1% in 2008 (Statcan 2009). Due to the high standard of living, cold climate, long distances between major cities, and many energy-intensive and bulk-goods industries, Canadians are large energy consumers. Canada's final energy consumption per capita in 2007 was 6.2 tonnes of oil equivalent (EDMC 2009).

Canada is the fifth largest energy producer in the world (behind the US, Russia, China and Saudi Arabia) and is a major energy exporter, being the most important source of US 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 amounted to 124 gigawatts (GW) in 2007 (Statcan 2009). Energy production is very important to the Canadian economy, accounting for approximately 7% of GDP and 363 000 jobs, representing 2% of the Canadian labour force in 2008 (NEB 2009a).

Table 5 Key data and economic profile, 2007

Key data		Energy reserves[b]	
Area (sq. km)[a]	9 984 670	Oil (billion barrels)	28.6
Population (million)	33.0	Gas (trillion cubic metres)	1.63
GDP (USD (2000) billion at PPP)	1 045	Coal (million tonnes)	6 578
GDP (USD (2000) per capita at PPP)	31 680	Oil sands (billion barrels)	150.7

a NRCan (2009a).

b BP (2009).

Source: EDMC (2009).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

In 2007, Canada's domestic energy production reached 414 Mtoe (million tonnes of oil equivalent). Oil and natural gas accounted for most of the supply, at 39% and 36% respectively, followed by coal (8%), hydropower (8%), nuclear power (6%) and other sources (3%). After imports and exports, Canada's primary energy supply totalled 270 Mtoe in 2007. Oil accounted for 35%, gas 29%, hydropower 12%, coal 11%, and nuclear power 9% (EDMC 2009).

Canadian 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). Drilling levels began to decline in mid-2006 as increasing capital and labour costs combined with declining productivity in new gas wells to reduce profitability. Just over 10 000 gas wells were drilled in 2008, 17% less than in 2007 (NEB 2009a). The success in developing the US 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 in order to support growing production from this

region. The decline in drilling grew steeper in the fourth quarter of 2008 as the recession took hold and the price of gas plummeted (NEB 2009a).

Net natural gas exports totalled approximately 80 Mtoe in 2007, an increase from 76 Mtoe in 2006 (EDMC 2009). Cooler temperatures and the resulting increase in US demand for natural gas for heating drove the increase. Net exports fell in 2008, when US demand for Canadian gas was reduced by the onset of the recession and displaced by growing US gas production (NEB 2008; NEB 2009a). Canada's import capacity was expanded in 2009, with the opening of Canada's first LNG (liquefied natural gas) 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 2007, crude oil production increased to 113 Mtoe from 108 Mtoe in 2006 (EDMC 2009). The decline in conventional oil production in the Western Canada Sedimentary Basin (WCSB) was offset by double-digit increases in oil production from offshore fields in the Atlantic Ocean (16%) and the oil sands deposits of northern Alberta (13%). About 44% of Canada's oil production in 2007 was synthetic crude oil and bitumen from oil sands, up from 43% in 2005 (NEB 2008). With the onset of the recession at the end of 2008, many projects to expand production from oil sands were slowed or postponed; but production is expected to rise again with the economic recovery.

Table 6 Energy supply and consumption, 2007

Primary energy supply (ktoe)[a]		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	413 806	Industry sector	57 099	Total	629 964
Net imports and other	–149 810	Transport sector	58 821	Thermal	156 577
Total PES	270 487	Other sectors	89 741	Hydro	368 518
Coal	30 075	Total FEC	205 661	Nuclear	93 492
Oil	95 546	Coal	3 249	Other	11 377
Gas	79 021	Oil	92 986		
Other	65 845	Gas	55 814		
		Electricity and other	53 613		

a Excludes Stock Changes and International Marine Bunkers.

Source: EDMC (2009).

In 2007, 77 Mtoe of crude oil was exported, nearly all of it to the US. Exports equalled 68% of Canadian production. Nearly 43 Mtoe of crude oil was imported into eastern Canada, as refineries located in Ontario, Quebec, and Atlantic Canada sourced a portion of their crude oil from abroad. Thus, net oil exports of 34 Mtoe equated to 30% of production (EDMC 2009). The 2007 total crude oil exports consisted of 38% light crude oil (including synthetic crude) and 62% heavy crude oil (NEB 2008). Canada is also a net exporter of petroleum products, mainly to the US. Construction of two export pipelines began in 2008 to allow for further oil sands production to meet continued demand in the US (NEB 2009a).

Canada generated about 630 terawatt-hours (TWh) of electricity in 2007, 3.6% more than in 2006. The increase was supported by favourable conditions for hydro-electric generators and greater natural gas–fired generation. Canada is the world's second largest producer of hydro-electricity, and hydropower dominates the generation mix with a 58% share. Thermal plants contribute 25% to the generation mix and nuclear power contributes 15%. Canada and the US have an active electricity trade, and the electricity networks of the two economies are heavily integrated. In 2007, Canada exported 44.7 TWh of electricity to the United States while importing 19.4 TWh. Net electricity exports to the US in 2007 increased to roughly 4% of production from 3% in 2006 (EDMC 2009).

Canada's coal production in 2007 was 33.9 Mtoe, a 4.8% increase from 2006 (EDMC 2009). Canada produced 69.4 million tonnes (Mt) of coal in 2007 and exported 30.7 Mt, of which 26 Mt

was coking coal. In 2007, Canada's exports to Asia increased by 19% to 18 Mt; its exports to Europe held steady; and its exports to the Americas fell by about 8%. Canada imported, mostly from the US, 18.5 Mt of coal, of which 15.1 Mt was steam coal, mostly for electricity generation in the eastern provinces (NRCan 2009b).

In 2007, Canada remained the world's leading producer and exporter of uranium, with output totalling 9476 tonnes of uranium metal (tU). Canada provides 23% of total global production from its Saskatchewan mines, the centre of its uranium production. Canada's recoverable uranium resources amounted to 484 400 tU at 1 January 2008, compared with 423 200 tU at 1 January 2007, with the large increase mostly attributable to formal reporting of reserves at previous discoveries (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 2007, renewable energy production (excluding large hydro) increased by 21% from renewable energy production in 2006 and accounted for 0.1% of Canada's primary energy supply (EDMC 2009). The wind industry has grown rapidly in recent years. Installed capacity reached 2369 MW in 2008, an increase of 523 MW from 2007. The contribution of wind energy to electricity generation is expected to grow steadily (Canwea 2009).

FINAL ENERGY CONSUMPTION

In 2007, total end-use energy consumption in Canada reached approximately 206 Mtoe. Industry accounted for 28% of energy use, transport for 29%, and other sectors for 44%. By energy source, petroleum products accounted for 45%, natural gas 27%, electricity 26%, and coal 2% (EDMC 2009).

Total final energy consumption increased by 4.2%. Energy consumption in the industrial sector increased by 5.7%, while real GDP of goods-producing industries increased by less than 1% (EDMC 2009; Statcan 2009). Some of this increase in industrial energy intensity is due to lower prices for industrial products, but growth in energy-intensive, resource-extracting industries may also contribute. After industry, the transportation sector showed the next largest growth in energy use, with an increase of 4.4% from 2006 (EDMC 2009). This large increase in energy use occurred in spite of a considerable increase in the price of transportation fuels. In 2007, petroleum products dominated the transportation sector, accounting for 99% of energy consumption (excluding pipeline transport) (Transport Canada 2009).

In 2007, final energy consumption in the residential and commercial sector increased by 3.2% from final energy consumption in 2006, but remained slightly below the 2005 level (EDMC 2009). Although contributing factors have yet to be analysed, population growth, strong economic growth and cooler weather are likely causes of this rebound in final energy demand.[1] Energy consumption in the commercial sector has been relatively flat, with consumption in 2007 nearly equal to that of 2004 (NEB 2009a). Of the total residential and commercial energy consumption, the largest end uses are space and water heating (69%), residential appliances (14%), and commercial lighting (4%) (NRCan 2009d).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In Canada, jurisdiction over energy matters is shared between the provincial and federal governments. Under the Canadian Constitution, provinces are the owners and managers of energy resources (except for uranium), while control of international and interprovincial trade is a federal responsibility. Through Natural Resources Canada (NRCan), the National Energy Board

[1] Natural Resources Canada's Office of Energy Efficiency applies a factor analysis technique to isolate the impact of energy efficiency on changes in energy use.

(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. Due to its abundant and diverse resource base, physical energy security is not an issue in Canada. However, sustainable development of existing resources to ensure adequate supplies for the future is a key priority. Policies are therefore 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; policies and programs that encourage scientific and technological research, promote energy efficiency, and assist the development of renewable and alternative energy sources.

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 2009e; 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 (COGOA), the NEB continues to develop and maintain regulations regarding 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 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 US Energy Policy Act of 2005 called for the creation of an Electric Reliability Organization (ERO) to address reliability concerns 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 governments of Canada and the US also established the Bilateral Electric Reliability Oversight Group as a forum in which the US 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 2007, Canada's nuclear plants generated 15% of Canada's electricity (EDMC 2009). 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 power plants. Most of the nuclear electricity plants are located in the province of Ontario, where nuclear power 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 2009f).

Atomic Energy of Canada Limited (AECL), which is wholly owned by the Government of Canada, is the designer and builder of CANDU (Canada Deuterium Uranium) power reactors. AECL also delivers research and development (R&D) support and services, such as consulting and maintenance, to nuclear utilities. In 2006, the Government of Canada launched the 5-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 Government of Canada 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 to maintain 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 other economies, while reducing the risks carried by taxpayers. The federal government will assess how well the proposals received meet its aims of preserving the Canadian nuclear industry and the employment it provides, and of controlling costs and achieving maximum value for taxpayers (Natural Resources Canada, Departmental Data, March 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 2009d). The goal of the Act is to transform the market by eliminating the least efficient products and 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 of the amendments will ensure a level playing field for dealers of affected products and will improve the well-known EnerGuide label to make it even easier for Canadians to make informed choices when shopping for energy-using products (NRCan 2009g).

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 in common use today (Gazette 2009b).

END-USE EFFICIENCY

To promote energy efficiency and conservation in end-use markets, the Government of Canada 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, R&D, and education programs. The federal, provincial and territorial governments, municipalities, utilities and some nongovernmental 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 testing and labelling of vehicle fuel economy, and impose fines for noncompliance (Minister of Justice 2009c). However, in 2009 the government proposed to introduce mandatory vehicle greenhouse gas emission standards, effectively controlling fuel economy, under the Canadian Environmental Protection Act. These standards, which will begin in model year 2011, will be equivalent to those announced by the US in 2009 (Gazette 2009a).

CLIMATE CHANGE

Energy production and use is responsible for the majority of Canada's greenhouse gas (GHG) 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 (Natural Resources Canada, Departmental Data, March 2010).

The Government of Canada is pursuing a number of actions to reduce emissions including funding programs to help Canadians use energy more efficiently, boost renewable energy supplies, and 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 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 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 2009h).
- **Transportation:** A series of ecoTRANSPORT initiatives (more than CAD 463 million) are being implemented to reduce the environmental impacts of transportation and secure Canada's future prosperity and competitiveness by making the transportation system more sustainable, both economically and environmentally. One example of this is ecoENERGY for Personal Vehicles Program (CAD 21 million over 4 years) which provides assistance with buying, driving and maintaining cars to reduce fuel consumption and GHG emissions (Environment Canada 2007).
- **Biofuels:** The government is also supporting the expansion of 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% renewable fuel in gasoline by 2010 and 2% renewable fuel in diesel and heating oil by 2011. Further, in 2007, the government committed 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 2009i). The federal government has also announced funding of CAD 345 million to bolster the development of biofuels and other bio-products (Natural Resources Canada, Departmental Data, March 2010).

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

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

NEW CLEAN ENERGY TECHNOLOGY INVESTMENT

The 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 Government of Canada and Government of Alberta 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 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 Government of Alberta 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 (Natural Resources Canada, Departmental Data, March 2010).
- **Sustainable Communities:** The EQuilibrium™ Communities Initiative will seek to improve community planning and develop healthy sustainable communities that are energy-efficient and economically viable by providing financial, technical and promotional assistance to community projects chosen through economy-wide competition (Natural Resources Canada, Departmental Data, March 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 Initiative program (bringing the total to CAD 675 million) to fund an estimated 200 000 additional home retrofits. The program is expected to achieve substantial energy-use reductions. By 31 March 2011, it is estimated that it will have contributed to reducing energy use by between 12.7 petajoules (PJ) and 14.2 PJ and to reducing GHG and other emissions by between 1.0 Mt and 1.1 Mt (Department of Finance 2009; NRCan 2009h).

OIL SANDS

Canada is endowed with large oil sands reserves. At the end of 2007, oil sands accounted for 98% of Canada's 177 billion barrels of established oil reserves (NEB 2009a). If oil sands reserves are included, Canada's proven crude oil reserves are the second largest in the world, surpassed only by those of Saudi Arabia (BP 2009). Despite decreasing production of conventional crude oil, between 2002 and 2007, Canada's crude oil production increased at an annual rate of 3.3% (Statcan 2009). This robust growth was largely a result of increased oil sands production. For example, the share of total crude oil production accounted for by oil sands production increased from 31% in 2002 to 44% in 2007 (Statcan 2009).

While some deposits of oil sands extend into Saskatchewan, at present the only recoverable resources are located in north-eastern Alberta. At the end of 2008, the oil sands recoverable reserves stood at 170 billion barrels at the end of 2008. According to the Alberta Department of Energy, bitumen production averaged 1.31 million barrels per day (MMbbl/D) in 2008, up from 1.26 MMbbl/D in 2006. Of this total, 59% is upgraded to synthetic crude oil and distillates and the rest is sold as bitumen. Driven by high oil prices, and supported by Canada's stable business environment, oil sands production is projected to reach 3 MMbbl/D by 2018 (Government of Alberta 2009).

In recent years, the run up on oil prices and technological improvements 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, Canada's National Energy Board forecasts oil sands crude production to rise to 2.8 million barrels per day by 2020. This production would contribute to Canada's overall crude oil production, which is forecasted to rise to 3.8 million barrels per day by 2020, despite declining production from other sources (NEB 2009b).

Depending on the geology, generally two different production methods are used. For oil sands near the surface, 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. About 20% or 34.5 billion barrels of the resource is accessible through mining operations with the remaining 80% or 135.8 billion barrels requiring some form of in-situ production techniques. Currently about 45% of bitumen is produced in-situ (584 thousand barrels) and 55% by mining operations (722 thousand barrels) (ERCB 2008; ERCB 2009).

New technologies and extraction methods are being developed to improve recovery and reduce costs, including vapour recovery extraction, toe-to-heel air injection, and froth treatment (Government of Alberta 2009). There are a number of environmental impacts associated with oil sands development. 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 (GHG) 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.

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 2009c). However, most of the import proposals are on hold due to: 1) difficulties in securing long-term supply; 2) concerns over existing excess regassification capacity in North America; and; 3) the prospects for domestic shale gas as a new long term source of natural gas (Natural Resources Canada, Departmental Data, March 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 an LNG export facility. This move reflected increased optimism over new shale gas developments in North Eastern British Columbia. and North America more broadly; and the expectation that 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 (Natural Resources Canada, Departmental Data, March 2010).

USEFUL LINKS

Atomic Energy of Canada Ltd—www.aecl.ca

Canada Gazette—www.gazette.gc.ca

Canadian Nuclear Association—www.cna.ca

Environment Canada—www.ec.gc.ca

National Energy Board—www.neb.gc.ca

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

Statistics Canada—www.statcan.ca

Transport Canada—www.tc.gc.ca

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CHILE

INTRODUCTION

Chile is one of the two Asia–Pacific Economic Cooperation (APEC) economies in South America. 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, it 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. In 2007, the population was 16.59 million, about 85% of whom live in urban areas. Of those, 40.2% live in the Santiago metropolitan area. Other regions with large populations include Maule (33%) and La Araucanía (32%). From 1997 to 2007, Chile's population increased by 12.1%, and is expected to reach 20.2 million by 2050 (INE 2009a). 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 has been one of the fastest growing economies in Latin America. In 2007, Chile's GDP reached USD 192.17 billion and GDP per capita USD 11 580 (USD (2000) at PPP). The economy grew at an average annual rate of 4.8% during the 1980–2007 period, and at 4.6% from 2006 to 2007. In 2008, major contributions to GDP came from financial services (17.8%) and the manufacturing industry (16.7%). Other economic sectors that made important contributions to GDP include personal services (11.5%), construction (7.9%), transport (7.7%) and mining (7.1%) (INE 2009c). Chile's economy is still dependent on commodity prices, particularly copper prices. Chile continues to attract foreign direct investment, mostly focused on developing gas resources, water, electricity and mining.

Chile's primary energy intensity is lower than that of developed economies, but higher than that of Brazil and Mexico. In 2007, it was 157.5 kilotonnes of oil equivalent (ktoe) per USD billion (USD (2000) at PPP). This was 5% higher than in 2006, meaning that the economy improved its energy efficiency through reduced energy consumption and increased GDP. In 2007, energy consumption per capita fell by 1.5% to 1.82 tonnes of oil equivalent.

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 7 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)[a]	756 102	Oil (million barrels)—proven[b]	150
Population (million)	16.59	Gas (trillion cubic feet)—proven[b]	3.46
GDP (USD (2000) billion at PPP)	192.17	Coal (million tonnes)[c]	700
GDP (USD (2000) per capita at PPP)	11 580		

a Compendio Estadístico 2009, Instituto Nacional de Estadística de Chile.

b Oil & Gas Journal, 105(48), 24 December 2007.

c Comisión Nacional de Energía, Política Energética: Nuevos Lineamientos, Chile, 2009.

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan.

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Chile's total primary energy supply (TPES) grew at an average annual rate of 2.4% from 2000 to 2007. In 2007, TPES reached 30 273 ktoe, of which 55.4% came from crude oil, 11.1% from natural gas, 11.0% from coal and 22.6% from other sources, mainly biomass and hydropower. Chile is a net importer of primary energy. In 2007, it imported around 77.5% of TPES, an increase of 5% compared with 2006. Most primary energy imports are of crude oil. Domestic energy production is limited, and declined by 12% from 9691 ktoe in 2006 to 8529 ktoe in 2007. 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 2009).

CRUDE OIL AND PRODUCTS

Chile has limited crude oil reserves of around 150 million barrels (about 20.7 million tonnes of oil equivalent) (O&GJ 2007), or 1.8 years supply at 2008 demand levels. All of Chile's crude oil reserves are in the southern Magallanes region in onshore and offshore fields. Onshore production fields account for 64.1% of total production, while offshore fields account for 35.9%. To meet crude oil demand, 98.5% of total crude oil supply was imported in 2008. There was an emphasis on diversification of suppliers of crude oil imports by the state-owned oil company, ENAP (Empresa Nacional del Petróleo), in 2008 to reduce import dependency on Argentina (which has accounted for around 74% of total imports since 2002). Crude oil imports in 2008 were sourced from Brazil (25%), Ecuador (23%), Angola (20%) and Colombia (17%); the remaining 15% came from Turkey, Argentina and Peru. Oil production in Chile (in the Magallanes region), was 965.6 thousand barrels in 2008, a 3.7% increase compared with 2007 (ENAP 2008).

Within the refining sector, ENAP has a subsidiary (ENAP Refinerías S.A., within the company's Refining and Logistics Business Line), which owns three refineries: Bío Bío refinery (113 000 barrels per day), Aconcagua refinery (97 650 barrels per day) and Gregorio Magallanes refinery (15 750 barrels per day). ENAP Refinerías also operates the Storage and Oil Pipelines Department, which runs the storage plants of Maipú, San Fernando and Linares, as well as an oil pipeline between the Bío Bío and San Fernando refining plants. In 2008, total processing of crude oil was 201 664 barrels per day, 7% less than in 2007. The crude oil used by ENAP's refineries is mostly sourced from imports from seven economies, depending on the price and crude quality. Only 1% of the demand is satisfied by the domestic deposits in Magallanes.

In 2008, ENAP refineries supplied 76.7% of their petroleum products production to the domestic market (equivalent to 96.2 million barrels). Sales to other markets in the region have continued, Peru, Ecuador and Central America being important clients. Exports of petroleum products were 10.1 million barrels, a 5.8% decrease compared with 2007.

NATURAL GAS

Chile's domestic natural gas production comes from offshore facilities in the XII Region of Magallanes. Proven reserves are estimated at 16 750 million cubic metres (CNE 2008b:104). Chile has a high demand for natural gas, and its domestic production does not satisfy consumption. In order to meet domestic demand, imports of natural gas are necessary. The most important source has been Argentina, which began providing natural gas for electricity generation in 1996.

Domestic production of natural gas was 2108 million cubic metres in 2008, an increase of 2.1% from 2007. Imports of natural gas declined significantly in 2008 (a 72% decline from 2007) as a result of the total restriction on natural gas exports to Chile from Argentina and the ensuing acute energy crisis in the Chilean economy. As a consequence, the total supply of natural gas was 2654 million cubic metres in 2008, a 42% decline from 2007 (CNE 2008a).

Table 8 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	8 529	Industry sector	10 314	Total	58 510
Net imports and other	23 468	Transport sector	8 258	Thermal	32 349
Total PES	30 273	Other sectors	6 108	Hydro	22 763
Coal	3 319	Total FEC	24 679	Nuclear	–
Oil	16 768	Coal	674	Other	3 398
Gas	3 353	Oil	12 877		
Hydro	31 693	Gas	2 326		
Other	4 735	Electricity and other	8 802		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

COAL

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 2008b:106). In 2008, domestic coal production increased by around 62%, reaching 395 000 tonnes and accounting for around 2.9% of total domestic primary energy supply. Chile is a net importer of coal, importing a total of around 6.2 million tonnes in 2008 from Canada, Indonesia, Australia and Colombia. Coal is mostly used in transformation centres, specifically for electricity generation, and accounts for 90.8% of total consumption. Total coal supply in Chile was 6.24 million tonnes at the end of 2008.

ELECTRICITY

In 2008, Chile's installed electricity capacity was 14 296 MW, including public service (91.8%) and self-suppliers (8.2%). On the public service side, four separate power grids provide electricity: Sistema Interconectado Central (SIC), Sistema Interconectado del Norte Grande (SING), Sistema Aysén and Sistema Magallanes. SIC is the largest grid, accounting for more than 65.7% of the total installed capacity in Chile, or about 9386 MW, at the end of 2008, an increase of 286 MW from 2007. SING is the second largest grid, with 3602 MW (about 25.2%). Sistema Aysén and Sistema Magallanes represent only a small portion of the overall installed capacity, with a combined capacity of 130 MW.

Thermal power plants have traditionally accounted for the bulk of installed electricity capacity. At the end of 2008, thermal power represented 64.7% of the total capacity (self-suppliers included). The share of hydropower has declined from 47.7% in 1998 to 35.3% in 2008, with a total installed capacity of 5046.6 MW.

Chile's electricity generation totalled 60 858 GWh in 2008, of which 60.1% came from thermal power generation and 39.9% from hydropower (CNE 2008a). Most of the power was generated by public service providers (93.4% of total generation). SIC generated 68.9% of the total, or 41 971 GWh. SING accounted for 23.8%, or 14 488 GWh, an increase of 4% compared with 2007. The other two public providers (Sistema Magallanes and Sistema Aysén) accounted for 0.4% and 0.2% of the total, respectively. Generation by self-suppliers reached 4010 GWh in 2008, an increase of 5.9% from 2007; thermal power plants accounted for 89.5% of that total.

Chile generates a very small proportion of electricity from renewable energy sources. In 2008, the total installed capacity of renewable energy was 187 MW. The use of wood and wind energy contributes to Chile's electricity generation. In the case of wind energy, Sistema Aysen has 20 MW of installed capacity. During 2008, electricity generation from renewable energy sources totalled 891 GWh, a share of 1.6% of total energy generation. Chile does not export electricity; however, the economy has grid connections with Argentina. In 2008, electricity imports from Argentina reached around 1154 GWh.

Chile is working to analyse the potential role of nuclear energy, which may possibly be incorporated into the energy mix after 2020, provided that major analytical studies are presented beforehand. The Chilean Government has received international recognition for implementing best practices and methodologies for the evaluation of the introduction of nuclear energy in the economy's energy mix (CNE 2009b).

RENEWABLES

Renewable energy (hydro, wind and biomass) makes a large contribution to domestic energy production in Chile, accounting for 75.3% of the total domestic production, or 7270 ktoe, in 2008. Most domestic renewable production comes from biomass, using wood as the principal energy resource. Chile is dependent on wood for domestic energy production (53% of the total). Production of wood in 2008 totalled 14.62 million tonnes (or 35.9 million barrels of crude oil equivalent), while crude oil production was only 0.97 million barrels in the same year. Around 89.5% (13.08 million tonnes) of the total wood supply was for final consumption. The residential sector accounted for 57.7%, the industry and mining sector for 31.8%, and the electricity generation sector for the remaining 10.5%.

In addition, Chile also has a small volume of electricity generation powered by wind. In 2008, wind electricity generation was 38.3 GWh (CNE 2009b). Chile does not have any nuclear or geothermal energy development projects; however, studies have been undertaken by the Chilean Government to examine the potential of both resources.

FINAL ENERGY CONSUMPTION

Chile's total final energy consumption grew at an average annual rate of 3.3% over the past seven years, reaching 24 679 ktoe in 2007, an increase of 8.6% from 2006. The main energy-consuming sector was industry (including the mining sector), which used 41.8%. The second largest was transport (33.4%), which consumed mainly petroleum products. The remaining 24.7% was used by other sectors (principally the services–residential sector and the commercial, public, agriculture and fishing sectors). By energy source, petroleum products accounted for 52.1% of final consumption, electricity 35.6%, natural gas 9.4% and coal 2.7%.

The industrial sector has been the fastest growing end-use sector, increasing at an average annual rate of around 8.6% between 2000 and 2007. Between 2006 and 2007, growth was 22.1%.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Chile's energy policy rests on two basic pillars: assurance of supplies and source diversification. Energy security has emerged as one of the main challenges facing Chile today. The economy depends on imports of different fuels to produce the energy required for transport, electricity generation, industrial uses, home heating and all other energy needs. In this context, the Chilean Government introduced the Energy Security Policy in 2006 to diversify the economy's energy matrix (in fuels and suppliers), achieve greater energy autonomy and encourage the efficient and intelligent use of energy.

ENERGY SECTOR STRUCTURE

OIL SECTOR

Under the Chilean Constitution, exploration and exploitation activities for hydrocarbon resources are reserved for the state. However, private (foreign and domestic) companies can participate in these activities through Contratos Especiales de Operación Petrolera (Oil Operation Special Contracts, or CEOPs). During the first half of 2009, 14 CEOPs were in effect and one was in the process of being approved. Of the CEOPs in force, 11 were in the Magallanes area, one in Arauco and two in Iquique. As a result of an international tendering process, nine CEOPs were in their initial development stage and involved commitments valued at around USD 250 million to invest in exploration.

The Public Treasury of Chile, through the Ministry of Finance, is entitled by Law 1263/1975 to order the transfer to the economy's general revenues of advances and/or profits generated by ENAP. During 2008, Supreme Decree 148 was enacted by the President of the Republic, the Ministry of Finance and the Ministry of Mining. Due to the enacted decree, in 2008 a profit transfer of USD 38.2 million was made from ENAP to the Public Treasury through the offsetting of treasury credits in favour of ENAP.

In addition, in January 2009, Office Letter 64 of the Ministry of Finance approved the transitory interruption, for 2009, of the policy of profit transfer from ENAP to the Public Treasury (stipulated by Office Letter 25 in 2005, which stated that ENAP must transfer a minimum of resources to the Public Treasury, as income tax and/or as a profit advance) (ENAP 2008).

POWER SECTOR

The regulatory framework for Chile's electricity supply industry is based on the principle of competitive markets for generation and supply. The main law that governs the operation and regulation of the electricity sector in Chile is the Ley General de Servicios Eléctricos (General Electric Services Law) of 1982, which was amended by the Ley Corta I (Short Law I) of 2004 and the Ley Corta II (Short Law II) of 2005 to provide adequate incentives for private sector investments in electricity projects.

The Short Law I of March 2004 (Law 19.949) regulates transmission, creating incentives for investment in that segment of the industry. The Short Law II of May 2005 (Law 20.018) creates conditions for the economy's energy development by providing regulatory and economic incentives for private sector investment in generation, including both conventional projects (hydroelectric and thermoelectric) and alternative renewable energy sources. As a result of this regulation, investment in the generation subsector has been undertaken. To date, 75% of the electricity demand of distribution enterprises from the SIC is engaged until 2010. In the case of SING, the electricity requirements are in the bidding phase, to be supplied by 2012. A proposal to modify the bidding basis is under development in order to minimise risks to electricity supply between 2010 and 2011 from environmental factors such as reduced water availability for hydropower plants.

In general, the Chilean Government has strengthened techno-economic regulation through the publication of several regulations, such as those covering power transfer between power generation enterprises (Supreme Decree 62, June 2006); the bidding for distribution supply (Supreme Decree 4, April 2008); the structure, performance and financing of CDEC (Supreme Decree 291/2007); and safety plans.

RENEWABLES

The new Interministerial Biofuels Commission

Biofuels receive special attention in Chile because of its desire to reduce dependence on imported fossil fuels. In May 2006, a government working party formed by the Comisión Nacional de Energía (CNE), the Ministry of Agriculture, the Ministry of Transport, CONAMA (the National Environment Commission, or Comisión Nacional del Medio Ambiente) and the Superintendent of Electricity and Fuels was established to study a proposal for a public policy on liquid biofuels (ethanol and biodiesel). In 2008, the Chilean Government created the Interministerial Biofuels Commission to bring concrete actions, plans, policies and the development of the value chain to all ministries of state and public institutions, as well as to undertake other activities.

Law of Renewable Energy Use

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. The objective was to send the new revision to Congress for discussion and approval in 2007. This initiative was a priority in the government's energy policy as a complementary measure to address energy security. In April 2008, Law 20.257 (the Law of Non-Conventional Renewable Energy) was

published to provide an incentive for the inclusion of non-conventional renewable energy in the economy's electricity systems. In addition, Law 20.258 of March 2008 established a provisional mechanism for refunding the specific tax on diesel purchases in favour of the electricity-generation companies.

UPSTREAM ENERGY DEVELOPMENT

ENAP, a state-owned enterprise, is the major oil producer and refiner in Chile. ENAP has played a crucial role in the development of Chile's energy policy by providing leadership in two ways: covering diesel demand during the shortage of natural gas from Argentina, and leading major investment projects intended to diversify the Chilean energy matrix. During 2008, ENAP implemented projects in exploration and production, refining and commercialisation of fuels, as well as complementary activities such as liquefied natural gas projects. ENAP's international body, Enap Sipetrol S.A., also holds equity in production operations in Argentina, Ecuador, Egypt and Iran.

ENERGY EFFICIENCY

In Chile, the organisation in charge of promoting, developing and implementing energy efficiency policy and programs is the National Energy Efficiency Program, or Programa País de Eficiencia Energética (PPEE), a program of the CNE. In addition, important policies and development programs related to energy efficiency take place within other government agencies responsible for transport, housing, economic development and technology transfer.

One of the most important policies on energy efficiency was the government's proposal to establish a new institutional structure. A bill to create the Ministry of Energy was presented to the Chilean parliament in 2008, and was finally approved and signed by the president in November 2009. The Ministry of Energy started operations on 1 February 2010, 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. As part of the creation of the new ministry, the government intends to create the Chilean Energy Efficiency Agency (Agencia Chilena de Eficiencia Energética). The fundamental purpose is promotion, information, development and coordination of research initiatives, and the transfer and distribution of economic, technological and experiential knowledge in the energy arena, as well as the energy efficiency of the economy.

Among the energy-efficiency programs implemented in Chile is a labelling program for appliances that draws on the European comparative labelling scheme. All similar models of a product are assigned to one of seven efficiency categories: A (most efficient) to G (least efficient). Five products have been labelled under the Chilean scheme (including incandescent and CFL light bulbs and one- and two-door refrigerators), while another five to six are planned for introduction in 2009–10. The products covered are mostly residential appliances, but future coverage is aimed at residential and small commercial applications.

Chile is developing a strategy to establish mandatory minimum energy performance standards (MEPS) for electric appliances, following the approval of the law that creates the Ministry of Energy, which establishes the power of the minister to dictate MEPS. The establishment of MEPS to cover residential products, including those that are already labelled or planned for labelling, as well as commercial and industrial products, would be very effective in reducing energy demand in Chile. At the time of writing, the first MEPS were under development for light bulbs.

Finally, as part of the new policy strategy in Chile, CNE is working on the publication of the National Action Plan on Energy Efficiency 2010–2020 (known by its Spanish acronym, PAEE), which is expected to be available during the first quarter of 2010 (APEC 2009). The plan will help guide and encourage energy-efficiency policy development and implementation, capturing synergies between policies and avoiding duplication while also prioritising resource allocation across the energy-efficiency portfolio. As part of the internal working plan for the publication of

the National Action Plan, the CNE established the Advisory Working Group of the PAEE in July 2009.

CLIMATE CHANGE

In 1995, Chile signed the United Nations Framework Convention on Climate Change. It also ratified the Kyoto Protocol in 2002. Currently, the economy has no international or domestic obligations to reduce greenhouse gas (GHG) emissions. Chile contributed almost 3.9 tonnes of CO_2 emissions per capita in 2004, making it the 90th largest per capita emitter. In 2006, the Chilean Government published the National Strategy on Climate Change as a measure to promote action plans in that area. In December 2008, to complement the strategy, Chile published the *National Action Plan on Climate Change 2008–2012* in order to assign institutional responsibilities for adaptation, mitigation and strengthening Chile's capacities to address climate change (CONAMA 2008). Although the economy has no obligations to reduce GHG emissions, the government announced during the Conference of Parties 15 (COP15) held in Copenhagen at the end of 2009, its compromise to reduce GHG emissions by 20 percent (under its base line or BAU) by 2020. This effort will be largely financed by economy-wide funds. Chile has started with mitigation programs as energy efficiency, renewable energies, forestation and reforestation, as well as activities in the natural forest conservation and improvements in public transport (CONAMA 2010).

On the adaptation side, the action plan identified hydro resources, food production, urban and coastal infrastructure and energy supply as the four areas most vulnerable to climate change. For mitigation, the strategy identifies tangible steps to reduce emissions by targeting sectors with the highest levels of GHG emissions and strengthening research and development. According to the Chilean Government, the ability to address climate change is directly connected to the education of the population on environmental issues and climate change; therefore, the action plan also calls for a climate change educational campaign.

RESEARCH AND DEVELOPMENT

Chile, with abundant renewable energy resources and a high dependency on fossil fuels, is in need of a strategic policy on research and development (R&D) covering basic and applied research and the demonstration, deployment and commercialisation of new technologies. The Chilean Government recognises the need for a more competitive approach to energy R&D, and is working to develop a long-term strategy (IEA 2009).

Chile has a number of institutions that are involved in various aspects of energy R&D policy and funding, among which are the National Innovation Council for Competitiveness (CNIC), the National Commission for Science and Technology Research (CONICyT) and the Chilean Economic Development Agency (CORFO). Despite the involvement of such institutions in energy R&D, Chile has no economy-wide policy in this area and no comprehensive energy strategy linked to R&D priorities.

On the other hand, energy R&D and demonstration programs are being developed in academia. Several Chilean universities have carried out studies related to energy issues; however, only one university is working in this field with special emphasis on energy efficiency (the Energy Studies and Research Program of the University of Chile).

NOTABLE ENERGY DEVELOPMENTS

PETROLEUM SECTOR

EXPLORATION AND PRODUCTION

During 2008, ENAP's Exploration and Production Business Line (E&P) continued to strengthen its natural gas exploration strategy and concentrated its efforts on the optimisation of its production facilities, with the purpose of fulfilling its gas delivery commitments to clients in the Magallanes region. The urgent challenge for ENAP E&P is to find and certify new

hydrocarbon reserves through a new exploratory model. As result of its exploration efforts, ENAP drilled six wells at Magellan (the Dorado Riquelme Tertiary Project) with a high rate of exploration success, and is starting the drilling of a seventh. In 2009, ENAP drilled 13 new exploration wells in the Tertiary Project, plus 10 wells in the Palenque area.

Investments made by ENAP and its subsidiaries in 2008 exceeded USD 371 million, and were within the framework of the Strategic Plan stipulated for the 2007–11 five-year term (ENAP 2008). Of the total investment, USD 176.6 million was used for E&P. Subsidiary ENAP Sipetrol S.A. invested USD 105.7 million abroad. Investments made in Chile by this line of the business were USD 70.9 million, concentrated mainly on the Magallanes and Pecket–Esperanza gas pipeline; the latter was inaugurated in August 2008, ensuring natural gas supply for Puerto Natales city.

REFINING

During 2008, total investment in the Refining and Logistic line of business was USD 194.5 million. Most of this was directed to the Aconcagua and Bío Bío refineries, which received funding of USD 62.5 million and USD 81.2 million, respectively. The remaining investment was devoted to activities at the Gregorio refinery and to the Storage and Oil Pipelines Department. One important project carried out during 2008 was the conclusion of the FCC Gasoline Desulphurisation Unit at Bío Bío Refinery to reduce the sulphur content of its gasoline. In addition, the construction of the Coker Complex at Aconcagua refinery was finished, allowing increased use of heavier crude oil, which is cheaper than light crude oil.

During 2008, ENAP Refinerías S.A. continued with the design of the Topping 3 Unit Project, the new alkylation unit and the new boiler project for the supplier area for the Aconcagua Refinery, and the adaptation for heavy crude project at Bío Bío Refinery.

GAS AND PETROCHEMICALS

Drilling natural gas wells is part of the ENAP's strategic plans because of the lower availability of natural gas from Argentina. ENAP has explored 14 wells directly and more than 13 000 square kilometres using 3D seismic technology.

LIQUEFIED NATURAL GAS

In May 2004, ENAP progressed a liquefied natural gas (LNG) project to provide the economy with energy autonomy after successive cuts in the supply of Argentinean gas to Chile. The LNG complex project promoted by ENAP, together with Endesa Chile (20% holding), Metrogas (20%) and BG Group (40%), consisted of the construction of the basic infrastructure for importing LNG from overseas markets and distributing it in Chile as natural gas. The project included the installation of a regasification plant in Quintero Bay, 110 kilometres from Santiago. The plant includes two 160 000 cubic metre LNG storage tanks and has an initial send-out capacity of 340 million standard cubic feet per day on a sustainable basis and 510 million standard cubic feet per day on a peaking basis—the equivalent of approximately 40% of the economy's demand for natural gas.

In October 2009, the early phase of the LNG terminal in Quintero Bay was officially inaugurated. Before inauguration, the first LNG shipment from Trinidad and Tobago arrived at the terminal on 27 June. A shipment of 145 000 cubic metres, the property of BG Group, arrived in July 2009, and a third (also 145 000 cubic metres and owned by BG Group) arrived from Egypt in September 2009 aboard the tanker *Methane Rita Andrea*. One of the advantages of LNG is the number of suppliers, including Equatorial Guinea; Egypt; Algeria; and Trinidad and Tobago.

The LNG project cost a total of USD 1.07 billion and is already supplying natural gas to the economy through the distribution companies Metrogas, Energas and GasValpo. ENAP's own refinery, Aconcagua refinery, requires LNG to be able to operate and needs 1.7 million cubic metres a day.

POWER SECTOR

During 2008, there were several developments in the electricity sector in Chile, most of which were augmentations to the SIC grid. Around 458 MW of new installed capacity was developed in the grid. On 31 December 2008, the total installed capacity of the grid was 9910 MW (CDEC–SIC 2008). The most important projects (in terms of installed capacity) were the Central Térmica San Isidro II (raising its installed capacity from 248 MW to 353 MW by combined cycle technology), the Central Térmica Los Olivos (80 MW), the Central Térmica Colmito (58 MW), the Hornitos Power Plant (55 MW), Unit III of the Central Campanario (56 MW), the Central Térmica FPC—Forestal y papelera Concepción (12.5 MW), the Hydroelectric Coya power plant (11 MW) and the Central Térmica Quellón II (10 MW).

During 2008, the SING grid reached a new maximum gross generation level of 1897 MW, while its annual gross energy contribution was equal to 14 502 GWh (an annual increase of 3.9% from 2007). Important projects carried out in the SING grid included the start-ups of the Gaby substation (67 MW), the Llanos and Aguas Blancas substations and the Aggreko diesel power station (72 generating units of 1.03 MW each), and the installation of backup generation units in the Minera Cerro Colorado facilities (five generating units of 1.27 MW each) (CDEC–SING 2008).

Work on the transmission system continued. In the SIC grid, the main 500 kilovolt (kV) systems were installed in the new yard of the Polpaico substation, and the Alto Jahuel – Polpaico 500 kV line was strengthened. In the SING grid, the Laberinto–Gaby 220 kV line project began with 62 kilometres of line, and a 220 kV line was installed at the 189 MVA Laberinto–Gaby substation.

RENEWABLE ENERGY

Chile has a substantial potential for the exploitation of renewable energy, such as wind, solar, hydro, geothermal, biomass and biofuels. The economy has abundant water resources and good slopes to exploit them; it is also rich in biomass, which is located in the south. Other renewable energy sources, such as wind and solar, have been developed but make a negligible contribution. Chile's renewable energy policy has been implemented only recently, after the first measures for its support were introduced in 2004. Currently, the Chilean Government is implementing a comprehensive policy framework for the development of renewable energies, with attention focused on solar thermal energy and biofuels.

WIND ENERGY

Wind power installations under construction or planned are expected to bring total installed wind capacity in the SIC to 193 MW by the beginning of 2010. At the end of March 2009, wind projects under evaluation in Chile's Environmental Impact Assessment System (Sistema de Evaluación de Impacto Ambiental) and those approved in the period from 2006 to 2009 had a potential new capacity of around 1500 MW; however, only a fraction of that potential will be developed in the coming years (IEA 2009).

SOLAR ENERGY

Solar energy is potentially abundant over a large part of Chile, but exceptional levels of solar radiation are available in the north.

Recent studies estimate the gross potential of solar energy for electricity generation in Chile to be between 40 GW and 100 GW, and estimate a potential of 1 GW for solar photovoltaics capable of being exploited in small power systems for the residential, industry and service sectors (IEA 2009). There is also potential for solar space heating and cooling in residential, commercial and other buildings, using both thermal and photovoltaic technologies. The potential for solar heating to provide hot water for a large portion of the population through the installation of solar water heaters has been identified. However, a number of barriers currently hinder the development of this market.

In December 2009, CNE and CORFO jointly opened a meeting for the development of the first thermo-solar power plant of 10 MW in the north of Chile and one photovoltaic farm in San

Pedro de Atacama for the generation of 500 kW. A water pump driven by solar panels provides a surplus of energy for the existing electricity network and runs water pumps that are connected to the irrigation system. This is the first solar energy project launched by CNE together with the government of Region IV and the Ministry of Agriculture. Four new irrigation systems are capable of producing 500 watts each and cover from half to one hectare of cultivated land.

GEOTHERMAL ENERGY

Chile does not have geothermal developments for electricity generation. However, Law 19657, Geo-thermal Energy Concessions, promulgated on 7 January 2000, permits the participation of ENAP in the geothermal industry and the involvement of companies with a shareholding of less than 50% to develop the business. ENAP has become associated with top-level Chilean and international companies to develop this non-conventional renewable energy to the highest standards.

According to ENAP estimates, Chile has the potential to produce 3350 MW of electricity from geothermal energy. This kind of energy is particularly interesting for Chile from the point of view of supply security. ENAP participates in three companies that are implementing research projects to study the potential of geothermal energy use and its incorporation in the energy matrix. Since 2005, ENAP has formed strategic alliances with the Italian company ENEL for exploration and production projects in Chile. In 2006, the strategic alliance was extended with the acquisition by ENEL of 51% of the shares in Geotérmica del Norte S.A. (the remaining 49% of the shares are held by ENAP and CODELCO). In October 2008, ENAP and Antofagasta Minerals S.A. formed a company, Energía Andina S.A. (ENAP 2008).

During 2008, the principal geothermal exploration projects included the drilling of the first deep well at Quebrada del Zoquete in Region II, where Zoquete 1 well drilling was scheduled for the first quarter of 2009. Another project was the geothermal exploitation concession in the Apacheta area, based on the results of geochemical studies, and the drilling of a gradient well in 2007, which showed the existence of a reservoir at a temperature of 212° Celsius. In the meantime, Empresa Nacional de Geotermia S.A. decided to interrupt the program of well exploration at Chillan and Calabozo concessions, proposing to first drill thermal gradient wells at both concessions during 2009.

Two bidding processes were conducted in 2008, the first in March for a second drilling team at Apacheta geothermal concession, and the second by ENAP and its partner ENEL for the exploration of Polloquere 2 geothermal concession. The first thermal gradient well drilling at Polloquere 2 is expected at the beginning of 2010.

BIOFUELS

The Chilean Government has increased support for the development of the biofuels industry. First-generation biofuels are limited in Chile. However, because of the availability of natural resources and the latest technological advances, there is considerable potential for the production of second-generation biofuels from forestry residues in the south and from algae over the entire coastal area. Currently, there is no production or consumption of biofuels in Chile, but a decree published in January 2008 authorised the sale of bioethanol–gasoline and biodiesel–petroleum diesel mixtures composed of 5% biofuel, which can be used without making any adjustments to vehicles (IEA 2009). In the first sign of governmental interest, the Ministry of Agriculture devoted USD 1 million to studying the optimal feedstock for a biofuel industry. Recent studies carried out by CNE suggests that biofuels could account for as much as 10% of motor vehicle fuel consumption by 2020 (CNE 2008b).

ENAP is investigating the feasibility of producing second-generation biofuels in Chile through two entities: ForEnergy and Biocomsa. ForEnergy was formed in 2007 and is dedicated to the production of second-generation biodiesel from forestry biomass and to finding business opportunities. Biocomsa is a consortium formed in 2008 by the subsidiary ENAP Refinerías S.A., Consorcio Maderero and Universidad de Chile, and its objective is to seek technical and scientific solutions in the bioenergy area in Chile (ENAP 2009).

INTERNATIONAL COOPERATION

Chile has taken an active role in international cooperation among energy institutions around the world. So far, it has signed international agreements with 58 economies in different regions (IEA 2009). In energy policies, Chile been formed alliances with major international institutions such as the International Energy Agency, the International Atomic Energy Agency, the APEC region and the International Renewable Energy Agency.

Among its most important achievements in energy policy has been the publication of the Energy Policy Review of the International Energy Agency in October 2009, the Peer Review on Energy Efficiency by the Energy Working Group of APEC in 2009, and support for the creation of the International Renewable Energy Agency, which was officially established on 26 January 2009.

On the regional side, Chile participates with regional entities that analyse energy policies, including the United Nations Economic Commission for Latin America and the Caribbean, the Energy Experts Group of the Union of South American Nations, the Latin American Energy Organisation, the Commission for Regional Energy Integration, the Ibero-American Association of Energy Regulation, and the Mercosur Energy Subgroup.

In addition, Chile has signed several non-binding cooperation agreements with other institutions that provide some assistance on energy efficiency. Among the agreements signed are memorandums of understanding with the state of California, United States (June 2008); the Ministry of Commerce, Industry and Tourism of Spain (October 2008); the Department of Energy of the United States (on cooperation in clean, efficient energy technologies, June 2009); and the Portuguese Government (on energy issues, December 2009).

USEFUL LINKS

Government of Chile—www.gobiernodechile.cl

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

Ministry of Energy—www.minenergia.cl

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

National Energy Efficiency Program (PPEE)—www.ppee.cl

National Environment Commission (CONAMA)—www.conama.cl

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

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CHINA

INTRODUCTION

China is the third-largest economy in the world, next to Japan and the United States, when measured by its nominal GDP of USD 4.4 trillion in 2008 (APERC 2009). It is located in north-east Asia, and is bordered by the East China Sea, Korea Bay and the South China Sea, and lies between North Korea and Viet Nam. Its population of 1.3 billion is roughly one fifth of the world's population. Its diverse landscape consists mainly of mountains, deserts and river basins and covers around 9.6 million square kilometres.

Currently, China is the world's largest energy producer and second-largest energy consumer (after the United States). Based on provisional statistics, total energy consumption in 2008 was 2.85 billion tonnes of coal equivalent (tce) or 2 billion tonnes of oil equivalent (toe), 4% more than in 2007. However, its per capita primary energy consumption, at 2.15 tce (1.5 toe) in 2008, is far lower than that of many developed economies and below the world's average (NDRC 2009).

Over the 30 years from 1978 to 2008, the average annual growth rate of primary energy consumption in China was 5.5% and the average annual growth rate of GDP was 9.8%, so China achieved its goal of quadrupling GDP supported by a doubling of energy consumption. Since 2001, along with strong GDP growth, industrialisation, urbanisation and motorisation, energy consumption has grown rapidly. In 2008, China sustained relatively rapid growth in its economy while overcoming the adverse impacts of the Sichuan earthquake, a huge snowstorm and the global financial crisis. GDP per capita in 2008, however, was still quite low at USD 3268. China's GDP grew by 9.0%, with the primary, secondary and tertiary industries accounting for 11.3%, 48.6% and 40.1%, respectively (NDRC 2009).

China is rich in energy resources, particularly coal. In 2008, it was the largest producer and consumer of coal in the world, as well as the fifth-largest producer and second largest consumer of oil. However, after a long history of being a net oil exporter, China became a net oil importer in 1993. According to recent estimates, China had recoverable coal reserves of around 114.5 billion tonnes, proven oil reserves of 16 100 million barrels and proven natural gas reserves of 2260 billion cubic metres (bcm) at the end of 2007. In addition, China is endowed with 400 gigawatts (GW) of hydropower potential, more than any other economy. Coal and oil resources have been utilised more extensively than natural gas and hydro for power generation and industrial development.

Table 9 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (sq. km)	9 600 000	Oil (million barrels)—proven	16 100
Population (million)	1 318.31	Gas (billion cubic metres)—proven	2 260
GDP (USD (2000) billion at PPP)	5 929.91	Coal (billion tonnes)—recoverable	114.5
GDP (USD (2000) per capita at PPP)	4 498.12		

a Proven reserves at the end of 2007.

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan; *BP Statistical Review of World Energy 2009*.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001, driven mainly by rapid growth, especially by the energy consumption of heavy industry. In 2007, the total primary energy supply was 1797.04 million tonnes of oil equivalent (Mtoe), of which coal was the dominant source, accounting for 72.6%, followed by oil (20.2%), gas (3.7%) and others. In 2008, the total primary energy production reached 2600 million tonnes of coal equivalent (Mtce), or 1820 Mtoe. Of that total, coal accounted for 76.6%, oil for 10.4% and natural gas for 3.9%, while hydropower, nuclear power and others contributed 9.0% (NBS 2009a).

China has provided a lot of political and financial support for the development of its abundant indigenous coal reserves to ensure the security of energy supply. However, since as early as the 1990s, Chinese authorities have been encouraging the switching of fuels (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. The use of coal reached its peak in 1996, and then declined significantly between 1997 and 2000. However, it recovered in 2001, followed by strong growth during the next five years. Coal production reached 1803 Mtce (1262 Mtoe) in 2007 and climbed to 1994 Mtce (1396 Mtoe) in 2008, reaching a new historic high (NBS 2009a).

Table 10 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 637 717	Industry sector	593 085	Total	3 281 553
Net imports and other	176 322	Transport sector	129 984	Thermal	2 722 933
Total PES	1 797 040	Other sectors	332 167	Hydro	485 264
Coal	1 304 830	Total FEC	1 055 236	Nuclear	62 130
Oil	362 959	Coal	392 470	Other	11 226
Gas	65 784	Oil	326 157		
Other	63 466	Gas	53 248		
		Electricity and other	283 362		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

In 2008, China's domestic crude oil output reached 190 million tonnes (Mt), of which 84.8% came from onshore fields. Net oil imports were nearly 197 Mt, and import dependency on oil reached 51% (Xu 2009). Primary natural gas supply totalled 101 Mtce (71 Mtoe) in 2008, and the share of natural gas in total primary energy supply remained at 3.9%. Although the proportion of natural gas in total primary energy supply is still quite small, supply has increased very rapidly at an average annual rate of 14% since 2000, with the construction of natural gas pipelines and increases in gas reserves. The growth rate of gas production in China since 2000 was faster than the growth rate for coal and oil, and was the fastest in the world. In this period, Chinese coal production and oil production grew by 10% and 2% per year, respectively, while global gas production grew by 3% per year (Xu 2009).

China's electric power industry experienced a serious oversupply problem in the late 1990s, due largely to demand reduction from 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. Since that time, the installed generation capacity increased steadily at an annual average rate of 10% over the period from 2001 to 2004. Since 2004, the installed generation capacity has increased at an annual average rate of 100 GW, and China has been the world's second-largest economy, measured by the installed generation

capacity, since 1996. In 2008, installed generation capacity reached 793 GW and annual power generation reached 3466.9 TWh (EOC 2009).

In 2007, total power generation in China was 3281.55 TWh. The shares of power generation were 83% for thermal power (2722.93 TWh), 14.8% for hydropower (485.26 TWh), 1.9% for nuclear power (62.13 TWh) and 0.3% for other (11.23 TWh).

FINAL ENERGY CONSUMPTION

Final energy consumption in China reached 1055.24 Mtoe in 2007, or 8% higher than in the previous year. Industry was the largest consumer, accounting for 63.6% of total final energy consumption, followed by the transportation sector (12.3%) and other sectors, including residential and commercial (24.1%). Of energy sources, coal (69.5%) remained the most important in 2007, followed by oil (19.7%); electricity, heat and other fuels (7.3%); and natural gas (3.5%) (NBS 2009a).

Coal consumption in 2007 reached 392 Mtoe from 375 Mtoe in 2006. China's electricity and metallurgical industry sectors were the biggest coal consumers. In 2007, around 50.5% of coal consumption was by the power sector (EOC 2009), followed by the metallurgical industry sector, the building materials sector, the chemical sector and others.

Electricity demand increased by 15% from the previous year and reached 229.95 Mtoe in 2007. The high demand growth resulted mainly from increased consumption in the commercial and residential, industrial and transport sectors (increases of 11.0%, 17.7% and 13.8%, respectively). The highest electricity consumption was by the industrial sector (71.0%, or 162.64 Mtoe), followed by the residential and commercial (17.0%, or 39.152 Mtoe) and agriculture (3.7%, or 8.42 Mtoe) sectors (EDMC 2008–2009).

China consumed 326.157 Mtoe of oil in 2007, making it the second biggest oil consumer behind the United States. The industrial sector was the largest oil-consuming sector, accounting for 39% of total final oil consumption, or 127.38 Mtoe. The transport sector, the second-largest oil consumer and the fastest growing oil-consuming subsector, accounted for 36.7% of total oil consumption or 119.93 Mtoe, an increase of 12.6% over the previous year (EDMC 2008–2009).

The market for gas is mainly in south-east China, which accounts for a third of total natural gas consumption. However, the market is moving to north China and east China with the completion of the Shaanxi–Beijing gas pipeline and the West–East gas pipeline. Before 2000, Chinese gas consumption was dominated by industrial fuel and chemical sector use. As long-distance pipelines were completed, the gas consumption mix changed greatly: from 2000 to 2008, city gas consumption grew from 18% to 34%, industrial fuel consumption declined from 41% to 28%, chemical sector use declined from 37% to 23%, and consumption in power generation grew from 4% to 15% (Xu 2009).

China's energy structure is being continuously optimised, and the proportion of low-carbon energy has increased significantly. The proportion of coal was down to 68.7%, the proportion of oil and natural gas consumption rose from 19% in 1990 to 22.5% in 2008, and that of hydropower, nuclear power and wind power rose from 5% to 8.9% (NBS 2009a).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In recent years, energy consumption grew rapidly with robust economic development and accelerated industrialisation. Energy has become an important strategic issue for China's economic growth, social stability and security.

To strengthen coordination and decision-making, China has established a high-level coordinating body—the National Energy Committee, which 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. The organisation is responsible for developing and

implementing energy industry planning, industrial policies and standards, and assuming the responsibilities of the Office of the National Energy Committee. Mr. Zhang Guobao, the president of NEA, has been appointed as the vice-director of this office. In line with the State Council's approval, the National Energy Administration comprises nine divisions and 112 employees. In 2009, the National Energy Conservation Centre was formed in the National Development and Reform Commission (NDRC), which is responsible for giving technical support to the government to implement energy efficiency and conservation management initiatives Its main duties include energy-efficiency and conservation policy research; assessment of fixed asset investment projects; information dissemination; promotion of technologies, products and new mechanisms; label management; and international cooperation in the field of energy conservation.

There are a series of laws related to energy in China today, such as the Law of Coal, the Law of Electricity, the Law of Renewable Energy, the Law of Energy Conservation, the Law of Environmental Protection, and the Cleaner Production Promotion Law. The drafting of a comprehensive legal basis for the energy sector, the Energy Law, has also made positive progress.

The Law to Promote Circular Economy came into effect on 1 January 2009. The law stipulates that the Chinese economic cycle should focus on reducing, recycling and changing waste into a resource. The objective of this law is to promote a circular economy and enhance the efficiency of resource use, to protect and improve the environment, and to achieve sustainable development.

MARKET REFORMS

Reforms of the energy sector have been pushed steadily. 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 commercialisation forward (EOC 2009). Positive achievements have been made in the management of energy, and legislation covering energy conservation has been noticeably strengthened.

China has particularly promoted the reform of the power system, realised 'the separation of plant and grid' and broken up the previous industrial monopoly. Rural power grids, supply capacity and supply reliability have been improved significantly, and more than 30 million people who were previously without electricity have been supplied through grid extensions (NEA 2008).

ENERGY SECURITY

Recognising its vulnerability to international market changes, China has been trying to increase the security of its oil supply by intensifying its upstream investment activities in Kazakhstan, Venezuela, Sudan, Iraq, Iran and Peru. It also began developing a second cross-border oil pipeline project between China and Kazakhstan in 2008. After 15 years of Sino-Russian negotiations, China formally signed a package of cooperation agreements, and a China–Russia crude oil pipeline has been under construction since April 2009 (CE 2009).

Oil tax reform took effect from 1 January 2009. Domestic refined oil prices are to be controlled by indirect integration with the international market price of crude oil.

COAL AND PETROLEUM MARKETS

COAL

To further improve legislation for the coal industry, a draft China Coal Legal System Framework Program was submitted to the State Council in September 2008 after three years' revision. After comments are collected from the public, the program will come into effect if it is adopted by the National People's Congress Standing Committee.

The draft program puts forward a legal system framework for coal for the last years of the Eleventh Five-year Plan and also for the Twelfth Five-year Plan period. China's recent focus in coal legislation is to establish a complete legal system for coal that will fully protect the development of the Chinese coal industry and help it progress in a healthy and sustainable direction. Compared with the current coal law, the revised version focuses on increasing the qualification requirements needed for coal development and raising the ratio of industrial concentration, as well as proposing to establish a coal strategic resources reserve system.

The Coal Industrial Policy, which is the first industrial policy for China's coal industry, was issued by the NDRC on 23 November 2007. The policy will help to build a new coal industry system, change the industry's mode of economic development, and promote its healthy development in China. The policy includes 10 charters, including for a development target and measures for industrial distribution; industrial access; industrial organisation; industrial technology; safety; trade and transportation; economical use and environmental protection; and labour protection.

OIL

When the National Standardisation Technical Committee for the Oil and Natural Gas Industry was set up on 9 May 2008, China's oil and natural gas industry standardisation 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.

On 5 December 2008, based on the People's Republic of China Highway Law and other relevant regulations, the NDRC, the Ministry of Finance, the Ministry of Transport and the State Administration of Taxation 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 standardise 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 the government approval of road charges on secondary loans, which will be done gradually and in an orderly fashion. Second, the reform raises the gasoline consumption tax allowance from CNY 0.2 to CNY 1 per litre for gasoline and from CNY 0.1 to CNY 0.8 for diesel; the unit tax on other oil products also increases similarly. For gasoline and diesel oil, the consumption tax aims to implement a fixed amount of taxation rather than ad valorem taxation.

NATURAL GAS

The production and consumption of natural gas have increased strongly in recent years. Since Shanghai raised the sale price of natural gas on 11 November 2008, more Chinese cities, such as Zhengzhou, have followed its example. The price rise shows that the Chinese Government has been accelerating the establishment of a market-based pricing mechanism for natural gas products. A reform program for natural gas prices was under study in 2009.

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.

In 2008, China issued the Emission Standard of Coal-bed Methane/Coal Mine Gas, and called for better utilisation of coal-bed methane/coal-mine gas and the development of small-scale power sources based on use of the gas (NDRC 2009).

ELECTRICITY MARKET

The overall policy goals set by China for the development of an efficient power sector are to:

- promote the construction of highly efficient large-scale power plants, such as supercritical and extra supercritical coal-fired generation
- restrict the construction of small and medium-sized conventional coal plants (300 MW and below) and close inefficient small thermal power plants
- promote the construction of highly efficient combined heat and power plants to supply district heating in medium-sized and large cities
- promote the construction of safely designed nuclear power plants (NEA 2008).

The State Electricity Regulatory Commission regulates electricity trading and ensures that markets play a greater role in resources allocation. Its main aims are to:

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

Development of nuclear power has become an option to optimise China's energy structure, ensure energy security and improve environmental protection. The National Energy Administration is responsible for formulating and implementing development plans, access requirements and technical standards for nuclear power, organising the coordination of scientific research work related to nuclear power, and administering nuclear accident emergency preparedness in nuclear power stations. To support the development of nuclear power, in April 2008 the Ministry of Finance and the State Administration of Taxation jointly issued a notice about taxation policy for the nuclear power industry (Tax 2008, no. 38). According to the notice, the sale of electric power generation products, after the month that commercial nuclear power 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.

China approved four nuclear power projects totalling 14 million kilowatts in 2008, and had under construction units totalling almost 23 million kilowatts, giving it the biggest nuclear power program in the world (EOC 2009). The *Medium and Long-Term Nuclear Power Development Plan (2005–2020)*, issued in 2007, planned for the total nuclear power installed capacity to reach 40 million kilowatts by 2020, and for the annual generation capacity of nuclear power to reach 260 billion kilowatt-hours to 280 billion kilowatt-hours. An additional 18 million kilowatts of installed capacity is expected to be under construction at the end of 2020.

Recently, the NDRC, the State Electricity Regulatory Commission and the National Energy Board jointly issued a tariff adjustment program, which came into effect from 20 November 2009. Under the program, the average sales price of electricity in the economy would increase by CNY 0.028 per kilowatt-hour. At the same time, opinions are being widely sought on a draft document about accelerating tariff reform.

ENERGY CONSERVATION AND EMISSIONS REDUCTIONS

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, and reducing emissions of major pollutants by 10% by 2010—the equivalent of reducing energy consumption from 1.22 tonnes to 0.98 tonnes of coal per CNY 10 000 of GDP. If this target were achieved, it could save 620 Mt of standard coal equivalent and reduce CO_2 emissions by 15 Mt. A number of

measures have been implemented to achieve the target, including the modernisation of energy industries; the closure of small coal mines, electricity plants, refineries and iron and steel production plants; and the introduction of efficient technologies throughout the energy supply chain, from production and transportation through to consumption. The Chinese Government considers the adjustment of economic structures and the transformation of economic development patterns to be important. It has formulated and implemented a series of industrial policies and special programs with resource and energy conservation as important components, and has promoted the optimisation and upgrading of industrial structures, to form a pattern of economic growth with less input, less consumption, fewer emissions and higher efficiency.

In order to implement the *Outline of the Eleventh Five-year Plan for National Economic and Social Development* and to attain the energy consumption goal, in July 2006 the NDRC and other departments issued the *Opinion on Implementing 10 Key Projects of Energy Conservation in the 'Eleventh Five-year Plan' Period*, based on the *Mid- and Long-term Special Plan for Energy Conservation*. The economy is expected to conserve 240 Mtce (168 Mtoe), and thereby reduce CO_2 emissions by 550 Mt, in the Eleventh Five-year Plan period (NDRC 2009).

In 2008, the State Council issued several important laws and regulations on energy conservation. Besides the revised Energy Conservation Law (issued on 28 October 2007, effective from 1 April 2008), the State Council issued the Public Sector Energy Saving Regulation on 2 August 2008 (effective from 1 October 2008). On the same day, the General Office of the State Council distributed the notice of *In-depth Development of Energy Saving Action to All Chinese People*. On 7 August 2008, the Civil Energy Bill was published. The Chinese Government also published the *Notification about Further Strengthening Fuel-Efficiency and Power-Saving*.

The Standardization Administration has approved 46 economy-wide standards supporting the Law of Energy Conservation since 2007, most of which have been in effect since 1 June 2008, including 22 mandatory standards on the limitation of energy consumption of energy-intensive products, 11 mandatory energy efficiency standards for energy end-use products, and five vehicle fuel economy standards. China issued catalogues of the fifth batch of products for energy-efficiency labelling in 2009 together with implementation rules, increasing the number of products subject to energy-efficiency labelling to 19 at the end of 2009.

China lowered the excise tax for small cars to encourage the purchase of energy-saving cars from September 2008. In February 2009, the *Provisional Measures for the Administration of the Public Finance Funds for Subsidizing the Demonstration and Promotion of Energy-efficient Vehicles and New Energy Vehicles* were issued by the Ministry of Finance and the Ministry of Science and Technology. This supported 13 cities, including Beijing, to take the lead in popularising the use of these vehicles in the public service sectors (such as public transport, taxi services, government work, sanitation and postal services) and provided subsidies for the purchase of the cars and the construction of required facilities.

On 18 May 2009, the NDRC and the Ministry of Finance jointly published a notification about the *Program of Benefiting the Public through Energy Efficient Products*. On 19 July 2009, the General Office of the Chinese State Council distributed the notice of *Energy Conservation and Emission Reduction Work in 2009*.

PROGRAM OF BENEFITING THE PUBLIC THROUGH ENERGY EFFICIENT PRODUCTS

The Program of Benefiting the Public through Energy Efficient Products, implemented from May 2009, covers financial subsidies for energy-efficient products with first or second grade energy efficiency in 10 categories (air-conditioner, refrigerator, washing machine, flat panel television, microwave oven, electric cooker, induction cooker, water heater, computer monitor and electric motor). The subsidies are based on the price gap between energy-efficient products and other products. For example, the subsidy for room air-conditioners with second grade energy efficiency is about USD 44–96 per unit, and for the first grade is about USD 74–125 per unit. The implementation of the program is expected to increase the demand for energy-efficient products (USD 60–75 billion each year) and to increase their market share by 10–20 percentage

points, reaching 30%. It could save more than 75 billion kilowatt hours of electricity each year and reduce CO_2 emissions by 75 Mt.

ADJUSTMENT OF CONSUMPTION TAX RATE FOR PASSENGER CARS

The Ministry of Finance and the State Administration of Taxation announced that the policy on car consumption tax would be adjusted from 1 September 2008. The change raised the rate of this tax from 15% to 25% for large passenger cars (3–4 litre engine capacity) and from 20% to 40% for cars with engines over 4 litres, and lowered the rate from 3% to 1% for cars with engines of 1 litre or less.

WORK IN 2009

Because 2009 was a decisive year for China's Eleventh Five-year Plan energy conservation and emissions reduction targets, the work plan encouraged everyone to work hard to achieve results. The work plan included 11 specific items, such as strengthening energy conservation responsibility assessments, promoting the implementation of key projects, strictly controlling the expansion of industries with high energy consumption and high emissions, focusing on key sectors of energy conservation and emissions reduction, vigorously developing the circular economy, perfecting related economic policies, accelerating the development of regulations and standards, strengthening the supervision and management of energy conservation and emissions reduction, improving monitoring capacity, and conducting research on important issues.

CLIMATE CHANGE

Deeply cognisant of the complexity and impacts of climate change and fully aware of the difficulty and urgency of the task of addressing climate change, the Chinese Government is determined to do so while pursuing sustainable development. In June 2007, China's National Climate Change Programme was issued by the State Council. In 2008, the Chinese Government published a White Paper on *China's Policies and Actions for Addressing Climate Change*, describing the policies and actions that the economy had adopted for addressing climate change and the progress it had made. A follow-up progress report, briefly describing progress since 2008, was issued in November 2009 (NDRC 2009).

On 25 November 2009, the State Council decided on an action target for greenhouse gas emissions, cutting CO_2 emissions per unit of GDP by 40%–45% by 2020 from the 2005 level. This target will be integrated into the long- to medium-term plan for economic and social development, with corresponding measures for domestic statistics, monitoring and evaluation. China will intensify efforts to conserve energy and improve energy efficiency; vigorously develop renewable energy and nuclear energy; increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020; energetically increase its forest carbon sink (increasing forest coverage by 40 million hectares and forest stock volume by 1.3 bcm by 2020 from 2005 levels); step up efforts to develop a green, low-carbon and circular economy; and enhance research, development and dissemination of climate-friendly technologies (PD 2009).

RENEWABLE ENERGY

The Renewable Energy Law came into effect from 1 January 2006. The law covers four schemes (a cost-sharing scheme, a feed-in-tariff scheme, a mandatory grid-connection system and an economy-wide target system). Supporting regulations on renewables were then formulated, and a draft amendment to the Renewable Energy Law was submitted to the economy's top legislature on 24 August 2008. The amendment provided that power grid companies would receive all of the revenue generated from the surcharge on retail power tariffs, and also set a minimum target for the amount of electricity that the grid companies must buy from renewable energy projects. Regulations were issued on renewable power pricing and cost sharing, covering wind, biomass, solar, ocean and geothermal energy.

China also announced the Medium- and Long-term Development Plan for Renewable Energy in September 2007, the general goal of which is to raise the share of renewables in total primary energy consumption to 10% in 2010 and 15% in 2020. It also aims to promote the

development of renewable energy technologies and industries so that essential renewable energy equipment can be produced domestically by 2010, and local manufacture can be based mainly on homegrown intellectual property rights by 2020 (CREIA 2009).

Since 2008, China has introduced a series of financial and tax policies to boost the development of renewable energy power projects, including the following:

- The Interim Measures for the Administration of the Special Funds for the Industrialization of Wind Power Generation Equipment (2008) stipulate that a subsidy be granted to any qualified enterprise for its first 50 wind power units at the rate of CNY 600 per kilowatt.
- The Measures for the Administration of the Subsidy Funds for the Utilization of Straws for Energy (2008) stipulate that the types and quantities of crop straws consumed by a qualified enterprise be calculated according to the types and quantities of straw energy products that it actually sells each year and that a comprehensive subsidy, with funds from the central government, 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 (2009) stipulate that the standard for the subsidy be, in principle, CNY 20/Wp in 2009 and that 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 (2009) state 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 Notice on Perfecting the Policy on the On-grid Prices of Wind-generated Power (2009) stipulates that the benchmark prices for wind-generated power will be CNY 0.51, 0.54, 0.58 and 0.61 in four types of resource areas, further standardises the administration of wind power prices, and promotes the healthy development of the wind power industry (NDRC 2009).

ENVIRONMENTAL PROTECTION

In 2008, the Ministry of Environmental Protection and the State General Administration of Quality Supervision, Inspection and Quarantine jointly issued the *Coal-bed methane (gas) emissions standard* (provisional), the *Solid waste landfill pollution control standard*, the *Heterocyclic water pollutant emission of industrial chemicals standard* and the *Heavy-duty motor and gasoline engine vehicle exhaust emission limits and methods of measurement* (stage IV).

In order to ensure the realisation of the Eleventh Five-year Plan's environmental objectives, the Ministry of Environmental Protection prepared the *Eleventh Five-year Plan of National Environmental Monitoring Capacity-Building*. The plan will have a total investment of CNY 14.959 billion for 50 key projects, of which the central government will invest CNY 7.847 billion.

In addition, the Ministry of Environmental Protection took pollution reduction as the starting point and gradually formed an improved system for evaluations of emissions reductions, monitoring, statistics, verification, scheduling, direct reporting, filing, early warning and information disclosure. The ministry promulgated and implemented a series of policies in conjunction with relevant departments, such as: the *Energy conservation and environment friendly power generation scheduling approach* (trial), the *Operation and electricity management approach of coal-fired generating units desulfurisation facilities*, the *Interim measures of the central government special funds for major pollutants emissions*, and so on, which strongly promoted the construction and operation of emissions reduction projects.

To cope with the international financial crisis and to accelerate the development of new industries, the NDRC is stepping up efforts to develop the *Industrial Development Plan of Energy Conservation and Environmental Protection*, which has been sent to the relevant departments for comments. The *Twelfth Five-year Plan of National Environmental Protection*, which is being developed by the Ministry of Environmental Protection, will stress the strategy's basic position of environmental protection.

NOTABLE ENERGY DEVELOPMENTS

ENERGY DEVELOPMENT REPORT

The National Bureau of Statistics of China released a report on 23 September 2009 showing that, in the 60 years since the founding of new China in 1949, there has been a significant development in China's energy industry. During that period, China's investment in the energy industry has increased rapidly, with an average annual growth of 14%; and total investment in the energy industry accounted for more than 15% of investment in fixed assets. Investment in the power sector has seen an average annual growth of about 15.3%, as have investments in coal mining (12.8% average annual growth), oil and natural gas mining (17.4%), and petroleum processing and coking (15.2%).

Through large-scale investment, China's energy supply has increased rapidly. In 2008, its total energy production amounted to 2.6 billion tonnes of standard coal (1.82 Mtoe), which has enhanced the security of its economic development. At the same time, China has progressed in oil exploration and development, hydropower, and coal mining technologies. New renewable energy sources have developed rapidly in recent years.

China has also progressed in energy conservation and environmental protection. During the period from 2006 to 2008, 34.2 million kilowatts of small thermal power capacity was closed, and China eliminated 60.59 Mt of outdated iron-smelting capacity, 43.47 Mt of backward steel production capacity, and 140 Mt of backward cement production capacity. The energy consumption of the main production industries, such as iron and steel and cement, has gradually declined, residual heat and pressure utilisation has increased, the energy consumption structure has become more rational, energy efficiency has been greatly improved, and the energy intensity of production has declined (NBS 2009b). In 2009, the State Council decided the action target to control greenhouse gas emissions: cutting CO_2 emissions per unit of GDP by 40%–45% from the 2005 level by 2020.

ENERGY STATISTICS SERVICE

The National Statistics Bureau has done a lot of work to strengthen energy statistics during recent years, especially in the areas of energy statistical report design, upgrades of statistical agencies, improved statistical indicators and so on. Energy consumption statistics, which were only provincial-level statistics in the past, have been further refined to the local city level, while the timeliness of statistical data on energy consumption has been greatly enhanced. The implementation plan for a statistical indicator system using energy consumption per unit of GDP was issued in 2007; the plan guides the establishment of an energy statistic and survey system using the two aspects of energy supply and energy consumption.

COAL INDUSTRY

China issued a notice on closing small coal mines during the last three years of the Eleventh Five-year Plan period in October 2008. The plan was to close, retrofit and upgrade almost 4000 small coal mines during the period 2008 to 2010, to bring the number of small coal mines to below 10 000 at the end of 2010. The small coal mines are township mines with production capacity below 0.3 Mt per year. From 2006 to 2008, China also closed down coke production capacity of 64.45 Mt (NDRC 2009).

In December 2009, after 16 years of coal price controls ended, the government completely pulled out of negotiations on coal.

Besides optimising the primary energy mix, China is committed to the efficient use of coal and strives to increase the proportion of coal in processing conversion. End-use coal as a proportion of total coal consumption decreased to 25.2% in 2007. At the same time, power generators continue to upgrade as technology progresses. By the end of 2008, there were 11 ultra-supercritical generator units in operation, with a capacity of 1 million kilowatts. The proportion of stand-alone units with 600 MW or greater capacity reached 31.3%, 300 MW and above units accounted for 65.2%, and the proportion of units under 100 MW units decreased to 13.4% (EOC 2009).

NATURAL GAS INFRASTRUCTURE DEVELOPMENT

China's proven gas reserves and production have expanded rapidly. Since 2000, gas reserves have grown by an annual average of 475.3 bcm. Remaining recoverable reserves grew by an average of 226 bcm per year, from 940.5 bcm in 1998 to 3.2 trillion cubic metres in 2008. Since 2000, gas production in China has continued a rapid growth rate of 14% on average per year to reach 77.5 bcm in 2008 (Xu 2009). The reserve/production ratio has been kept at a high level of 49, indicating a good reserve foundation for gas production growth.

In 2008, China drained 5.3 bcm of coal-mine gas (130% more than in 2005), of which 1.6 bcm was recovered and utilised; built surface coal-bed methane production capacity of 2 bcm; and achieved an annual output of 500 million cubic metres. More than 900 000 households were coal-mine gas and coal-bed methane customers, and the installed capacity fuelled by coal-bed methane reached 920 MW. In 2008, total consumption of natural gas, coal-mine gas and coal-bed methane increased by 10.1% over 2007 (NDRC 2009).

Construction of natural gas pipelines also proceeded rapidly. By the end of 2008, about 35 000 kilometres of pipeline had been built in China. The total trunk-line transmission capacity is nearly 40 bcm per year. Pipelines such as the second West–East gas pipeline and the Sichuan – East China gas transmission pipeline are under construction. Over 25 000 kilometres of pipeline are expected to be commissioned in the next 10 years, to form a gas trunk-line network 'running through east-west and north-south and connecting overseas'. The second line of the West–East gas pipeline will be a main energy artery totalling 9139 kilometres and passing through 14 provinces and municipalities in China. In December 2009, the China – Central Asia natural gas pipeline was completed, passing through China, Turkmenistan, Kazakhstan and Uzbekistan (CE 2009).

In addition, China has achieved international cooperation on natural gas. Since 2000, it has signed long-term gas supply agreements with Turkmenistan and Myanmar and long-term LNG contracts with Australia, Indonesia, Malaysia, Qatar and other economies. In the next few years, China will establish a multisource gas supply system covering domestic and overseas resources. The imported gas volume is expected to reach about 100 bcm by 2020 (Xu 2009).

ELECTRICITY

In 2008, total generated electricity in China reached a new record of 3466.9 TWh. Installed power capacity reached 793 GW, placing China second in the world since 1996. The average annual increase in installed power capacity has been nearly 100 GW since 2004. On 16 April 2009, Qinghai Laxiwa No. 6 unit began operations, marking a breakthrough in China's installed power capacity to 800 GW (CE 2009). The tension of electricity supply has now been reversed, and most parts of China have realised a basic balance of electricity supply and demand. The pace of grid construction also increased. By the end of 2007, the 220 kV and above transmission line circuit totalled 327 100 kilometres, and 220 kV and above transformer capacity reached 1178 million kilowatts (the highest in the world). The standard coal consumption of power generation in units larger than 6000 kW in 2008 was 322 grams/kWh (a decline of 12 grams/kWh from 2007), the plant self-consumption rate was down to 5.9%, and the line loss rate decreased to 6.8% (a decline of 0.05% from 2007). China had installed thermal power plant flue gas desulphurisation, capacity totalling about 363 GW, by the end of 2008—accounting for 60.4% of all thermal power generation (EOC 2009).

New and renewable energy sources have developed rapidly, and the share of renewable energy in total primary energy consumption has increased significantly. In 2008, newly installed hydropower capacity increased by 20.1 GW and total hydropower capacity reached 172 GW (the highest in the world). By the end of 2008, annual renewable energy use reached 250 Mtce (175 Mtoe), accounting for 8.9% of total primary energy consumption. Total electricity generation from renewable sources was 586.7 TWh (17% of China's electricity production).

Wind power capacity doubled for three consecutive years. The annual addition of installed wind power in 2008 was almost 6000 MW, the cumulative installed capacity by the end of 2008 was 12 GW, and the total production capacity in 2008 was near to 16 GW. Currently, six 10 GW-class wind power stations are under construction in Jiuquan (Gansu), eastern Inner Mongolia, western Inner Mongolia, Hebei, Jilin, and Hami (Xinjiang), as well as a 10 GW-class marine power base along the Jiangsu coast. With the Jiuquan wind power station, the wind power industry in China starts a new phase of large-scale development. The Chinese Government has implemented a program of wind power concession bidding and published the benchmark on-grid price of wind power, which has played a positive role in stabilising the main power market. It has also granted tax preferences on import and export duties and value-added tax, as well as financial subsidies for the development of wind power (NDRC 2009).

Solar photovoltaic (PV) cell production capacity was about 4 GW and PV module capacity was about 3 GW in 2008, and the cumulative capacity of installed PV power was 150 MW by the end of that year. Of that, 55% was in independent PV systems (CREIA 2009). Meanwhile, solar water heaters in China cover more than 125 million square metres (60% of the world's total).

The development and utilisation of biomass in China have also made great progress. Key areas of biomass development in China are biogas, biomass power generation and liquid biofuels, but the major uses of biomass in China are for power generation and heat generation rather than for biofuel production. By the end of 2008, the installed capacity of biomass power generation reached 3150 MW, China had built more than 1600 large-scale digesters and more than 30 million household biogas digesters, the annual output of biogas was about 14 bcm and the annual output of biofuel was 1.65 Mt (EOC 2009). Aside from biogas utilisation, other biomass energy applications in China are still in the initial development stages.

By the end of 2008, China had put into operation 11 nuclear reactors with a total installed capacity of 9.1 GW, accounting for 1.3% of the total installed capacity in the economy. Fourteen gigawatt-level nuclear power units were newly approved and 24 nuclear power units with a total installed capacity of 25.4 GW were being built, making China the economy with the most nuclear power capacity under construction (NDRC 2009). In April 2009, the world's first reactor with third-generation AP1000 nuclear power units was under construction in Zhejiang Province.

China has sped up the elimination of small thermal power units with high energy consumption and high pollution. By 30 June 2008, 7467 such units, totalling 54 070 MW, had been shut down since the beginning of the Eleventh Five-year Plan. Closing these units achieved total savings of 160 Mt of coal and decreased annual sulphur dioxide emissions by more than 1.06 Mt and CO_2 emissions by 124 Mt (EOC 2009).

The Electric Power Law of the People's Republic of China is being revised. The Regulation on Nuclear Power Management of the People's Republic of China and the Management Method of National Energy Storage for Natural Uranium are also being drafted. The Eleventh Standing Committee of the National People's Congress voted through the decision to amend the Renewable Energy Law at its twelfth meeting in December 2009, and the revised law will come into force from 1 April 2010 (CE 2009).

ENERGY CONSERVATION AND EMISSIONS REDUCTIONS

China has strengthened accountability systems for energy efficiency performance, reinforced statistical work and monitoring and assessment systems for energy efficiency, and continued phasing out backward production capacity in key industries and sectors, thus effectively promoting energy conservation and emissions reductions. Progress has been made towards

achieving the 20% energy intensity reduction target: after the achievement of reductions of 1.8% in 2006, 4.0% in 2007, 4.6% in 2008 and 3.4% in the first half of 2009, the total reduction is more than 13% so far (NDRC 2009). From 2006 to 2008, China has saved about 290 Mtce (203 Mtoe) and effectively reduced CO_2 emissions by 670 Mt.

The NDRC, together with other relevant departments of the State Council, reviewed and assessed the performance of the 31 provinces, autonomous regions and municipalities directly under the central government in 2008 in fulfilling their energy conservation targets and implementing energy conservation measures. The results were published, heightening the primary responsibility of the governments for this work. The NDRC also organised performance assessments of 1000 enterprises to determine whether they had fulfilled the annual energy conservation targets of 2007 and 2008 and published the results, which show that the enterprises accomplished their energy conservation targets for the Eleventh Five-year Plan period two years ahead of schedule.

Phasing out backward production capacities has further improved energy efficiency. In 2008, small thermal power units with a total capacity of 16.29 GW in 325 power plants were shut down, as were backward production capacities of 53 Mt of cement, 6 Mt of steel, 14 Mt of iron, 1.04 Mt of calcium carbide, 1.17 Mt of ferroalloy, and 30.54 Mt of coking coal. In the first half of 2009, following the guideline of 'building big ones and shutting down small ones', an installed capacity of 19.89 GW of small generation units was closed down, bringing the total capacity of phased-out small generating units to 54.07 GW. Thus, the shutdown target for the Eleventh Five-year Plan period, which was 50 GW, was accomplished one and half years early (NDRC 2009).

In 2008, the central budget arranged CNY 27.0 billion as a special fund to give emphatic support for energy conservation and emissions reductions. With the three batches of investment that the central government has added since the fourth quarter of 2008, investment in energy conservation, pollution reduction and ecological restoration and improvement reached CNY 22.4 billion (NDRC 2009).

As well as reinforcing economic incentives, China has popularised energy conservation products. In 2008, utilising the subsidies provided by public finance, China distributed 62 million energy-saving lamps, which is expected to save 3.2 TWh of electricity and reduce CO_2 emissions by 3.2 Mt. China plans to distribute 120 million more such lamps in 2009 (NDRC 2009). Relevant departments also sped up the creation of incentive mechanisms for energy conservation, improved the new mechanism of using special funds from public finance as 'bonus instead of subsidy', and perfected the preferential tax policy for comprehensive utilisation of resources.

USEFUL LINKS

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

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

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

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

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

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

National Energy Administration, PRC (NEA)—http://nyj.ndrc.gov.cn

Standardization Administration, PRC—www.sac.gov.cn

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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 6.93 million people situated at the south-eastern tip of China. As 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 2007, the per capita GDP of Hong Kong, China, was USD 35 355, among the highest of the Asia–Pacific Economic Cooperation (APEC) economies. GDP expanded by a robust 6.4% in real terms in 2007, down from the 2006 rate of 7.0%. The services sector remained the dominant driving force of overall economic growth, accounting for 86.4% of GDP in 2007. Along with improving labour demand growth, the average unemployment rate reached 3.5% in the third quarter of 2008, the lowest rate in five years.

The economy of Hong Kong, China, has been 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 globalisation 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 liberalisation of trade in goods under CEPA, all products of Hong Kong origin enjoy tariff-free access to Mainland China on application by local manufacturers provided that all CEPA rules of origin are agreed and met. In trade in services, the economy's service suppliers enjoy preferential treatment in 38 service areas in mainland China, effective from January 2008 (HKTID 2009). In addition, the Pan-Pearl River Delta Regional Co-operation Framework Agreement has brought more business opportunities for Hong Kong, China. In October 2007, the government of Hong Kong, China, announced that it was undertaking 10 major infrastructure projects, including some cross-boundary infrastructure projects such as the Guangzhou – Shenzhen – Hong Kong Express Rail Link, Hong Kong – Zhuhai – Macao Bridge, and Hong Kong – Shenzhen Airport Cooperation. The value added of the 10 major projects is expected to be more than HKD 100 billion annually, amounting to 7% of GDP in 2006; 250 000 jobs are expected to be created.

Table 11 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	1 104	Oil (million barrels)	–
Population (million)	6.93	Gas (billion cubic metres)	–
GDP (USD (2000) billion at PPP)	244.87	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	35 355		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan.

ENERGY SUPPLYAND DEMAND

PRIMARY ENERGY SUPPLY

Hong Kong, China, has no domestic energy reserves or petroleum refineries and therefore imports all of its primary energy needs. It generates some electricity. Total primary energy supply in Hong Kong, China, was 17.8 million tonnes of oil equivalent (Mtoe) in 2007, increasing 2%

from 2006. Oil maintained the highest share of the total primary energy supply (43%), followed by coal (42%), gas (11%) and other sources (4%) (Table 12).

In 2008, the total installed electricity generating capacity in Hong Kong, China, was 12 644 MW (CSD 2009:30), including imported power from Guangdong, China. All locally generated power is thermal fired. Electricity is supplied by CLP Power Hong Kong Limited (CLP Power) and the Hong Kong Electric Company Limited (HEC). 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 currently the main fuels used for electricity generation at the Black Point and Castle Peak power stations. The natural gas is imported from the Yacheng 13-1 gas field off Hainan Island in southern China via a 780-kilometre high-pressure submarine pipeline. CLP Power is contracted to purchase around 70% of the electricity generated at the two 984 MW pressurised water reactors at the Guangdong Nuclear Power Station at Daya Bay to help meet the long-term demand for electricity in its supply area (CLP 2009). It also has the right to use 50% of the 1200 MW capacity of Phase 1 of the Guangzhou Pumped Storage Power Station at Conghua. Electricity for HEC is supplied from the Lamma Power Station, which has a total installed capacity of 3756 MW. Natural gas used in the power station is mainly imported through submarine pipeline from Dapeng liquefied natural gas (LNG) terminal in Guangdong, China. HEC has also operated its first commercial wind turbine (800 kW) since February 2006 (HEC 2009).

Table 12 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	98	Industry sector	656	Total[a] (gross)	45 782
Net imports and other	17 678	Transport sector	6 237	Thermal	44 642
Total PES	17 776	Other sectors	4 020	Hydro	–
Coal	7 480	Total FEC	10 914	Nuclear	–
Oil	7 732	Coal	2	Other	1 141
Gas	1 870	Oil	6 742		
Other	694	Gas	646		
		Electricity and other	3 523		

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

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

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 both naphtha and natural gas (starting from October 2006) 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 2009).

FINAL ENERGY CONSUMPTION

In 2007, the total final energy consumption in Hong Kong, China, reached 10.9 Mtoe, almost 3% higher than in the previous year. The transport sector accounted for the largest share at 57%, followed by the 'other' sector (37%) and the industrial sector (6%). Because of the dominance of transport consumption, the most important end-use fuel was petroleum, accounting for 62% of energy use. Electricity and others made up 32% of end-use consumption, while gas accounted for only 6%.

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 the Hong Kong Special Administrative Region (HKSAR) has pursued two key energy policy objectives. The first is to ensure that 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 promote the efficient use and conservation of energy. In keeping with the free market economic policy of Hong Kong, China, the government intervenes only when necessary to safeguard the interests of consumers, ensure public safety and protect the environment. The government works with the power, oil and gas companies to maintain strategic reserves of coal, diesel and naphtha. It monitors the performance of the power companies through the Scheme of Control Agreements. In consultation with the power companies, the government also promotes energy efficiency and energy-saving measures. In addition, the government has entered into an information and consultation agreement with the Hong Kong and China Gas Company Ltd to make the town gas tariff adjustment mechanism more transparent.

ENERGY SECURITY

A memorandum of understanding signed between the government and the National Energy Bureau on 28 August 2008 ensures a long-term and stable supply of nuclear electricity, and the supply of natural gas from three different sources: offshore gas, piped gas and LNG to be supplied through an LNG terminal to be built, as a joint venture, on a neighbouring mainland site. Twenty-eight per cent of electricity in the economy is generated by gas-fired power plants. To improve air quality and address the challenges posed by global warming, the government will actively explore ways to gradually increase the use of clean energy by, for example, increasing the proportion of natural gas for local electricity generation to 50%.

ENERGY EFFICIENCY

The voluntary Energy Efficiency Labelling Scheme (VEELS) has now covered 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. The voluntary EELS was extended to cover petrol passenger cars in February 2002, to raise the level of public awareness of vehicle energy efficiency.

To further encourage the use of energy-efficient products (EMSD 2009a), the government introduced a mandatory EELS through the Energy Efficiency (Labelling of Products) Ordinance. The initial phase of the mandatory EELS, covering room air conditioners, refrigerating appliances and compact fluorescent lamps, has been in full implementation since November 2009. The government has also submitted proposed amendments to the Energy Efficiency (Labelling of Products) Ordinance to the Legislative Council for the second phase of the scheme to include washing machines and dehumidifiers.

The government has been promulgating voluntary building energy codes (BECs) since 1998 through its Hong Kong Energy Efficiency Registration Scheme for Buildings (HKEERSB). The set of five codes cover prescriptive minimum energy performance standards (MEPS) on lighting, air conditioning, electrical and lift and escalator installations and also a performance-based approach on a building's total energy consumption as compared to the energy budget of a hypothetical building which can meet all prescriptive code requirements. Starting in March 2007, an alternative certification path for energy-audited buildings with good energy performance is also provided. By December 2009, 1086 building venues had been registered under the scheme. To further enhance energy efficiency in buildings, the government launched a public consultation on the proposed mandatory implementation of the BECs by way of legislation in December 2007.

The consultation ended on 31 March 2008. The vast majority of the returns received in the consultation were in support of the proposal. The government introduced the Buildings Energy Efficiency Bill into Legislative Council on 9 December 2009 to commence the vetting procedure. It is estimated that for new buildings the proposal will result in an energy saving of 2.8 billion kWh in the first decade of implementation, which contributes to a reduction in carbon dioxide emissions of 1.96 million tonnes. Commercial buildings accounted for 37% of Hong Kong city's total energy end use in 2005. Because of that high energy use, in 2006, the government developed a software tool for assessing the energy use and the environmental and cost impact of commercial building development. The government has been trialling the software tool in several selected government building projects and will review the outcome at a later stage. The tool is available free of charge to the local industry.

A competition entitled 'Eco-drivers' was launched in September 2008. This fuel economy run aims to raise drivers' awareness of energy and fuel conservation. By highlighting the important role of energy conservation in sustainable development, the event also called for public actions to realise this principle in daily life, particularly through driving. The competition received more than 500 entries, and the run was completed in December 2008.

To help monitor the energy situation, Hong Kong, China, has developed an energy end-use database. The database provides useful insights into the energy supply and demand situation, including energy consumption patterns and trends, and the energy-use characteristics of individual sectors and subsectors. A basic dataset is publicly available on the internet (EMSD 2009b).

The Electricity Ordinance and the Gas Safety Ordinance regulate the safe supply of electricity and gas. Among other things, the ordinances cover the registration of generating facilities, workers and contractors for electrical and gas installations; wiring and gas installation standards; and the safe distribution and use of electricity and gas. Most provisions of the Electrical Product (Safety) Regulation, which regulates the safety of household electrical products, came into effect in May 1998. To regulate the import, supply and installation of domestic gas appliances for use in Hong Kong, China, the Gas Safety (Installation and Use) Regulation and the Gas Safety (Miscellaneous) Regulation were amended in 2002.

As outlined in the latest 2009–10 Policy Address, the government will continue to support environmental protection and promote sustainable development by taking vigorous measures for air quality improvement. For example, the government has reached a consensus with the Guangdong Provincial Government on jointly transforming the Pan-Pearl River Delta region into a green and quality living area under the principle of promoting environmental protection and sustainable development. To achieve this goal, Hong Kong, China, and Guangdong will work together on post-2010 emissions reduction arrangements, the optimisation of the fuel mix for electricity generation, the development and wider use of renewable energy, vehicle emissions reductions, enhanced conservation and greening, and scientific research, as well as publicity and education.

To further promote energy efficiency and conservation, and to reduce carbon dioxide emissions substantially, the government of Hong Kong, China, plans to implement a district cooling system at the Kai Tak Development to supply chilled water to buildings in the new development area for centralised air conditioning.

In response to public concerns about fuel prices, the government has asked oil companies to promptly adjust prices in tandem with international oil price movements and be more transparent in price setting so that the public can monitor their retail prices.

RENEWABLE ENERGY

The government commissioned a study to investigate the viability of using renewable energy technologies in Hong Kong, China, and the findings of the study suggested that the eastern side of Hong Kong, China may have sufficient wind resources for commercial wind farms. Five wind monitoring stations were erected at the Government Logistics Centre, Pottinger Peak, Town

Island, Tung Lung Chau and Miu Tsai Tun to gather wind resource data in the region. The wind data collection at the five stations was completed in mid-2006. All the wind data collected from the stations have been analysed. The analysed wind data, together with data collected from the Hong Kong Observatory, were used to produce a detailed wind resource map, completed in 2007, covering all parts of the Hong Kong territories. The map and an online wind resources calculator have been uploaded for public access through the HK Sustainable Technology Net internet platform (EMSD 2008a). To help the public better understand the technical issues and the application procedures relating to grid connections of renewable energy installations, a working group was formed in 2005 to develop a set of technical guidelines. Members of the working group included representatives from power companies, professional institutions, consultants and contractors, property developers, renewable energy interest groups and others. The Technical Guidelines on Grid Connection of Small-scale Renewable Energy Power Systems were published in 2005.

In December 2007, a revised edition of the technical guidelines, titled the Technical Guidelines on Grid Connection of Renewable Energy Power Systems (2007 edition), was made available to the public on the website of the Electrical and Mechanical Services Department (www.emsd.gov.hk). The new edition extends the applicable capacity limit of the original guidelines from 200 kW to 1 MW.

To facilitate the wider adoption of renewable energy technologies in Hong Kong, China, the Hong Kong Renewable Energy Net website (HK RE Net) was developed. The aim is to provide comprehensive information on renewable energy technologies, with an emphasis on those technologies suitable for applications in Hong Kong, China (EMSD 2007).

In Hong Kong, China, almost all diesel taxis have been replaced by LPG models. In August 2002, the government launched a voluntary incentive scheme to encourage owners of existing diesel public and private light buses to replace their vehicles with LPG or electric models. At the end of December 2007, there were more than 2700 LPG light buses in operation (more than 40% of all public/private light buses in Hong Kong, China). In 2005, the government introduced petrol–electric hybrid vehicles into the vehicle fleet, taking the leading role in the use of green vehicles. In addition, the government is continuing to identify possible ways to encourage vehicle owners to use cleaner alternative fuels.

CLIMATE CHANGE

To demonstrate its commitment to protecting the environment, the government set targets in 2003 to cut down the annual electricity consumption of government departments. Since then, the government has provided technical support and expert advice to the departments by publishing energy-saving tips and guidelines, organising experience-sharing workshops, advising on good housekeeping practices, and implementing energy-saving retrofits. Through these efforts, the government reduced its electricity consumption by about 7% between 2003 and 2007.

To help the users and managers of buildings to enhance their awareness of greenhouse gas (GHG) emissions, measure the GHG emissions performance of their buildings and voluntarily participate in reducing and/or offsetting GHG emissions to combat climate change, the government published the first edition of Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings of Commercial, Residential or Institutional Purposes in Hong Kong (also known as the carbon audit guidelines) in July 2008. The guidelines have been designed for voluntary and self-reporting by the reporting entities, and provide a systematic and scientific approach to account for and report on GHG emissions and removals from buildings. In February 2010, a revised edition of the guidelines with some updated emission factors was made available to the public. The revised guidelines can be downloaded from the Environmental Protection Department website (EMSD 2008b).

The government has continued to raise community awareness of environmental protection and conservation and has increased public participation by implementing a range of programs and initiatives. In October 2007, the government launched the 'I Love Hong Kong, I Love

Green' campaign to engage the public in protecting the environment. It called for a collective effort to change various aspects of daily living for a cleaner, greener and better lifestyle.

NOTABLE ENERGY DEVELOPMENTS

INDICATORS AND BENCHMARKS

Energy consumption indicators and benchmarks have been developed for hospitals, clinics, universities, schools, hotels and boarding houses; offices and commercial outlets in the commercial sector; private cars; light, medium and heavy goods vehicles; and private light buses and non-franchised buses in the transport sector. The indicators and benchmarks enable users in the targeted group to compare their energy-efficiency performance with other, similar users, and to identify and implement improvement measures. The indicators, as well as online benchmarking tools, are available at the Electrical and Mechanical Services Department website and are updated as appropriate (EMSD 2009c).

ENERGY-SAVING PROGRAMS

The government has completed three studies of the energy-saving potential of water-cooled air-conditioning systems: one on the territory-wide implementation of such systems, and the other two on the implementation of district cooling systems in a new development area and an existing developed area. The government is implementing some recommendations put forward in the studies. In 2000, the government launched a pilot scheme for the wider use of freshwater cooling towers in air-conditioning systems, beginning with six designated areas. The number of designated areas was expanded to 85 by December 2008, covering about 78% of the non-domestic floor area of the economy. By December 2008, 135 installations of freshwater cooling towers had been completed and put into operation. It is estimated that the completed installations could save 108 million kilowatt-hours of electricity consumption and reduce carbon dioxide emissions by 76 400 tonnes a year. In view of the support from property owners and the environmental benefits, the scheme has operated on a standing status from June 2008.

LOW-CARBON ECONOMY

More than 800 applications were received for the Building Energy Efficiency Funding Scheme. The response encouraged the government to introduce a bill into the Legislative Council by the end of 2009 to enforce mandatory compliance with building energy codes.

The government is working on a strategy and specific measures to promote the use of electric vehicles. The Environment Bureau has been working with a number of electric vehicle manufacturers. The government expects a supply of around 200 electric vehicles for the local market in 2010, and will work with the two power companies to launch an electric vehicle leasing scheme by the end of the year. Upon implementation of these two programs, Hong Kong, China, will rank second in Asia for electric vehicle use after Japan (HKSAR 2009:28).

USEFUL LINKS

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

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

Environmental Protection Department—www.epd.gov.hk

Environment Bureau—www.enb.gov.hk

Transport Department—www.td.gov.hk

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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 1.8 million square kilometres. The population was 225.63 million in 2007.

Indonesia had a gross domestic product (GDP) of USD 699.59 billion and a per capita GDP of USD 3101 in 2007 (USD (2000) at PPP). Manufacturing accounted for the largest component of GDP in 2007 (27.1%), followed by finance, leasing and services (17.8%); retail, hotel and restaurant (14.9%); agriculture, livestock, forestry and fisheries (13.7%); mining and quarrying (11.2%); transport and communications (6.7%); construction (7.7%); and electricity, gas and water supply (0.9%). In 2007, Indonesia attained economic growth of 6.3%, an increase from 5.2% in 2006.

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 2008, oil and gas exports contributed the largest share (21.1%) of Indonesia's total exports of USD 136.76 billion, followed by minerals (including coal) at 18.8%. Overall, tax and non-tax revenue from oil, gas and minerals accounted for 27.2% of the Indonesian Government's budget in 2008.

Indonesia's proven fossil energy reserves at the end of 2008 comprised 3.7 billion barrels of oil (2007: 4.0 billion barrels); 3.18 trillion cubic metres of natural gas (2007: 3.0 trillion cubic metres); and 4328 million tonnes (Mt) of coal (2007: 4968 Mt).

Table 13 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (million sq. km)	1.83	Oil (billion barrels)	3.7
Population (million)	225.63	Gas (trillion cubic metres)	3.18
GDP (USD (2000) billion at PPP)	699.59	Coal (million tonnes)	4 328
GDP (USD (2000) per capita at PPP)	3 101		

a Proven reserves at the end of 2007 from *BP Statistical Review of World Energy 2008*.

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Indonesia's total primary energy supply (TPES) was 170 247 ktoe (thousand tonnes of oil equivalent), including biomass energy of 36 491 ktoe. TPES of commercial energy (excluding biomass) was 133 746 ktoe, made up of oil (44.4%), coal (25.7%), natural gas (24.0%) and other energy (mainly hydropower and geothermal) (5.2%). Indonesia is a net exporter of energy, and overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal were 106 864 ktoe in 2007. Total energy exports in 2007 increased by 8.8% from 2006 (98 240 ktoe). Increased total energy exports were driven primarily by coal exports.

OIL

In 2007, Indonesia produced 46 073 ktoe (40 587 ktoe of crude oil and 5486 ktoe of condensates), and exported 17 633 ktoe (15 438 ktoe of crude oil and 2195 ktoe of condensates). Exports of crude oil and condensates declined by 2.1% from 18 019 ktoe in 2006. To meet domestic oil requirements, Indonesia imported 37 226 ktoe in 2007 (15 483 ktoe of crude oil and 21 743 ktoe of petroleum products), up 12% from 33 230 ktoe in 2006. Oil production declined over the past decade (in 1996, Indonesia produced 64 720 ktoe of crude oil).

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 in the eastern coast of central Sumatra. The two fields are mature, and the Duri field is the site of one of the world's largest enhanced oil recovery efforts. In 2007, 81.2% of Indonesia's oil was produced from the province of Riau. Other principal oil-producing regions are South Sumatra, onshore and offshore East Kalimantan, the Natuna Sea (east of Java), Jambi on the east coast of central Sumatra, and the province of Papua.

NATURAL GAS

Indonesia produced 63 537 ktoe of natural gas in 2007. Natural gas production declined by 6.5% from 67 942 ktoe in 2006. In 2007, 55.1% of Indonesia's natural gas production was processed to LNG for export. The economy produced 23 329 ktoe of LNG in 2007. LNG exports declined by 9.8% from 25 575 ktoe in 2006. LNG export destinations in 2007 were Japan (65.3% of the total share), Korea (18.4%) and Chinese Taipei (16.3%). In 2007, Indonesia exported 7230 ktoe of natural gas (11.4% of total natural gas production) by pipeline to Singapore and Malaysia. Overall, 66.5% 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, and in South Sumatra, the Natuna Sea, the Makassar Strait, the Timor Sea and Papua; smaller gas fields are offshore from West and East Java. The LNG project in Tangguh, Papua, began LNG exports in 2009; its gas supply comes from the onshore and offshore Wiriagar and Berau gas blocks, which are estimated to have reserves of at least 14 trillion cubic feet (Tcf). Indonesia's current large-scale gas developments include the following:

- The Kutei Basin deepwater gas fields in the Makassar Strait (the Gendalo, Maha and Gendang gas fields in the Gendalo Hub; the Gehem and Ranggas gas fields in the Gehem Hub; and the Bangka gas field). Combined gas production at its peak is expected to be 1 billion cubic feet per day. The combined gas reserve of these fields is over 3 Tcf. Commercial production is expected in 2015–16.
- The Masela Block in the Abadi gas field in the Arafura Sea. Development of the Abadi gas field will require a floating LNG liquefaction facility. The field has gas reserves of 14 Tcf. Commercial production is expected to commence in 2015–16.
- The Donggi and Senoro blocks, offshore from central Sulawesi. Initially, the development plan for these blocks was to dedicate their entire gas reserves to LNG production for exports; the LNG liquefaction plant would have a capacity of 2 Mt per year. However, in view of the critical energy demand in the region, Indonesia expects that some of the gas production will supply the domestic market. Certainty for buyers of gas and LNG is expected in early 2010. Production of LNG was initially planned to commence in 2013. The Donggi and Senoro Blocks have combined gas reserves of 2.23 Tcf.

COAL

In 2007, Indonesia produced 121 445 ktoe of coal, an increase of 15.3% from 105 348 ktoe in 2006. In 2006, Indonesia's coal production increased by 27.2% from 82 754 ktoe in 2005. Most of Indonesia's coal (78 093 ktoe or 74.1% of total production) was dedicated for export. The destinations of Indonesia's coal exports in 2007 were Japan (14.1%), Chinese Taipei (10.4%), other Asian economies (30.1%), Europe (13.4%), the Pacific area (1.5%) and other destinations (30.5%). Domestic consumption of coal was 34 337 ktoe in 2007; most (52.8%) was consumed in

power generation; the remaining 42.2% was used to meet final energy demand, primarily in the cement industry and other non-metals industries.

About 57% of Indonesia's total recoverable coal reserves 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%).

The total electricity generating capacity of the state-owned electricity company, PLN, and independent power producers (IPPs) was 29.71 MW in 2007. Indonesia's total electricity generation to the grid was 142 439 GWh in 2007, of which 21.9% was supplied by IPPs and captive power. In 2007, Indonesia's electricity generation was based on coal (44.8%), oil (25.2%), natural gas (17.1%), hydropower (7.9%), geothermal (4.9%) and biomass (0.03%).

Table 14 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	238 064	Industry sector	33 098	Total	142 439
Net imports & other	–106 864	Transport sector	26 515	Thermal	124 096
Total PES	133 746	Other sectors	28 684	Hydro	11 286
Coal	34 337	Total FEC	88 297	Nuclear	–
Oil	59 425	Coal	16 207	Geothermal	7 021
Gas	32 975	Oil	51 733	Others	38
Others	7 009	Gas	9 912		
		Electricity	10 435		

Note: Excludes biomass.

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

Total final energy consumption (TFEC) of commercial energy (excluding biomass) was 88 297 ktoe in 2007, which was a 17.9% increase from 74 906 ktoe in 2006. The share of TFEC by sector in 2007 was 42.6% for industry, 30.0% for transport and 27.4% for other sectors. Indonesia's economy is highly dependent on oil; final energy consumption of oil in 2007 was 51 733 ktoe, or 58.6% of TFEC, which was a 20.3% increase from 43 021 ktoe in 2006.

POLICY OVERVIEW

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). Under Indonesian taxation law, special tax rates may apply to petroleum (oil and gas) companies, general mining companies (including coal) and geothermal companies.

OIL AND GAS

Indonesia uses a fiscal contractual system or regime of production sharing contracts (PSCs) in oil and gas exploration and production. 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 state-owned oil company).

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

Table 15 Main features of Indonesia's production sharing contracts

Elements	3rd generation PSC (1988–present)
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:[a] Government/Contractor:	
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).

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). The main features of Indonesia's PSCs are presented in Table 15.

Indonesia has other types of joint contracts in oil and gas: 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). Specific corporate tax and VAT may apply to these contracts; tax exemptions may apply on imports of oil and gas exploration equipment.

Indonesia expects to apply a tax regime, based on the new Indonesian taxation law, to components of recovery costs of PSCs. The specific tax regime for oil and gas recovery costs will be regulated by government regulation—the PP (*Peraturan Pemerintah*)—expected to be effective in 2010 and applicable only to new PSCs.

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.

MINING

Indonesia's new Minerals and Coal Mining Law (Law No. 4/2009) changed the fiscal regime for Indonesia's mining industry. The new law replaced the systems of contract of work (CoW) and work agreements of coal mining enterprises (PKP2B) with two forms of permits—mining business permits (IUPs, *Izin Usaha Pertambangan*) and citizens mining permits (IPRs, *Izin Pertambangan Rakyat*), the former applying to large-scale mining—and a contract, the mining business contract (PUP, *Perjanjian Usaha Pertambangan*). A PUP is a contract between the government and a private mining company. The government is represented by an implementing body.

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 also requires mining companies to construct smelters and implement land reclamation programs. 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 article on transition states that existing contracts will be upheld, but the transition of specific 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 POLICY FRAMEWORK

THE ENERGY LAW

On 10 August 2007, Indonesia enacted the Energy Law (Law No. 30/2007). The Energy Law elucidates principles for the utilisation of energy resources and final energy use, security of supply, energy conservation and protection of the environment with regard to energy use, pricing of energy, and international cooperation. The Energy Law sets out the content of the National Energy Policy (KEN, *Kebijakan Energi Nasional*); the roles and responsibilities of the central government and regional governments in planning, policy and regulation; development priorities for energy research and development; and the role of enterprises.

Under the Energy Law, the National Energy Policy will address the availability of energy to meet the economy's requirements, energy development priorities, the utilisation of domestic energy resources, and the economy's energy supply reserves.

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

- draft the National Energy Policy, to be endorsed and promulgated by the government, with due consent of parliament (the DPR)
- draft the National Energy Master Plan (RUEN, Rencana Umum Energi Nasional)
- declare measures to resolve conditions of energy crisis and energy emergency
- provide oversight on the implementation of cross-sectoral policies on energy.

The assembly of DEN members is chaired by the President and in their absence is chaired by the Vice 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 consumers. The selection and appointment of members of DEN was finalised in late 2008.

DEN expects that the draft of the National Energy Policy as defined in the Energy Law will be finalised in early 2010 for approval by parliament and enactment by the government. It is expected that the policy will be integrated into the Mid-Term Development Plan 2010–2014 (RP-JM, *Rencana Pembangunan Jangka Menengah*) in 2010. Until the new National Energy Policy is enacted, the existing National Energy Policy by Presidential Regulation No. 5/2006 applies.

At the time of enactment of the Energy Law, Indonesia also had laws covering oil and gas (Law No. 22/2001), geothermal energy (Law No. 27/2003), and electricity (Law No. 15/1985, provisionally reinstated by the Constitutional Court after Law No. 20/2002 was annulled in December 2004). These laws apply to specific energy sectors. They were designed to promote a greater role for enterprise and for specialised and competing businesses within the energy supply chain on a level playing field.

OIL AND GAS LAW

Indonesia's oil and gas sector experienced important structural change with the enactment of a new Oil and Gas Law (Law No. 21/2001) in 2001. The new law created an upstream oil and gas implementing body (BP MIGAS, *Badan Pelaksana Hilir Minyak dan Gas Bumi*), and a downstream oil and gas regulatory body (BPH MIGAS, *Badan Pengatur Hilir Minyak dan Gas Bumi*). These entities report to parliament and are not part of government departments. BP MIGAS's tasks include signing cooperation contracts, including PSCs; approving plans of field development; approving contractors' work programs and budgets, and authorisations for expenditure; and monitoring the realisation of contracts. The Oil and Gas Law ruled that the state-owned oil company, Pertamina, would relinquish its governmental roles.

MINING LAW

On 16 December 2008, parliament passed a new law on 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 works agreements of coal mining enterprises (PKP2B, *Perjanjian Karya Perusahaan Pertambangan Batubara*). 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 licensing, 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 includes rulings 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
- the requirement to submit post-mining and reclamation plans before applying for a permit
- the obligation on permit holders to build smelters
- the obligation on foreign companies to divest shares to the government, state-owned enterprises and private companies
- taxes, fees and allocation of profits
- reclamation and post-mining costs.

The government expects that the five government regulations required for the implementation of the Mining Law will be enacted in early 2010.

ELECTRICITY LAW

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

A notable difference between Law No. 30/2009 and Law No. 15/1985 is the absence of the Holder of Electricity Business Authority (PKUK, Pemegang Kuasa Usaha Ketenagalistrikan). Under Law No. 15/1985, the government assigned the state-owned electricity company (PLN) as the sole PKUK. As the PKUK, PLN, on behalf of the government, is responsible for providing electricity across the whole of Indonesia and for developing the electricity sector.

Under the current Electricity Law, the electricity industry is based on licences for electricity supply businesses (IUPTL, *izin usaha penyediaan tenaga listrik*), specifically in the areas of generation, transmission, distribution, retailing, and integrated supply. Indonesia's electricity system will be based on vertically integrated configurations comprising the power system of PLN, electricity companies (to be established, where necessary) owned by provincial governments, and other licensed integrated entities that will operate within their respective business areas (*wilayah usaha*). Various electricity supply business licence holders will participate in these integrated structures; holders of electricity generation licences will basically be IPPs. The Electricity Law appoints the Indonesian Government and regional governments to regulate the electricity industry within their respective jurisdictions and through 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 on whether PLN will implement tariff differentiation over its extensive power system across Indonesia.

Law No. 30/2009 states that three government regulations will be formulated, covering electricity supply businesses, electricity support businesses, and the setting of selling prices for electricity, charges for the use of power lines, and electricity tariffs. Other specific regulations for the electricity industry will be formulated by the Indonesian Government and the provincial governments. This will include government regulations on the buying and selling of electricity across Indonesia's borders.

MARKET REFORM

Indonesia's current energy market reform seeks a greater role for the private sector, a level playing field, direct contracts between energy producers and buyers, and more transparent regulatory oversight. The government is also seeking to align regulations across sectors, to simplify the process of applying for licences, to introduce more attractive fiscal policy and to eliminate subsidies on energy.

Indonesia has made significant gains in eliminating energy subsidies, but there are still regulated subsidised prices for certain refinery products and for certain classes of electricity for residential use. Subsidised refinery products are lower octane gasoline (that is, RON 88 octane marketed by Pertamina under the Premium brand), diesel oil for use in transport; and kerosene for residential use. Premium and diesel oil constitute the bulk of fuels used in the transport sector.

In December 2009, phase 1 of the government's kerosene-to-LPG (liquefied petroleum gas) conversion program was completed. The program distributed 23.8 million three-kilogram LPG canisters to the densely populated provinces of Jakarta DKI, Banten, West Java, Yogyakarta DI, and South Sumatra. The program averted the need for Pertamina to supply 5.21 billion litres of heavily subsidised kerosene for use in households in those provinces.

Nevertheless, Indonesia's energy subsidies remain substantial. A *Jakarta Post* report on 16 January 2010 estimated that, under the current revised government budget for 2010 and using the government's estimate of an average oil price of USD 65 per barrel in 2010, oil subsidies would amount to IDR 58.9 trillion (USD 6.0 billion) in 2010—an increase on the IDR 54.0 trillion in oil subsidies allocated in the 2009 budget. In addition, the government and parliament agreed on subsidies for the electricity sector of some IDR 37.8 trillion (USD 3.85 billion), down from IDR 40.6 trillion in 2009, and approved plans by the state-owned electricity company (PLN) to raise electricity tariffs for industry and services by a maximum of 30%. Oil subsidies, which are direct energy subsidies, equal 6.5% of the state budget.

ENERGY SECURITY

Energy security has been central to Indonesia's energy policy since its first General Policy on Energy (KUBE, *Kebijakan Umum Bidang Energi*) in the early 1980s, and thereafter in the Energy Policy of 2006. Basic policy principles on energy are *diversification of energy* away from oil through the development of natural gas, coal and renewable energy resources to establish major shares in the primary energy mix; *energy conservation* in all activities of the economic sectors; and an *intensified search for new energy resources* to increase Indonesia's energy reserve base.

In view of its large energy resource base and widening net balance of oil imports, Indonesia recently took significant diversification measures. Indonesia expects greater allocations of gas to the domestic market, including expected gas supply from coal-bed methane reserves. Rapid increases in geothermal power will begin in the next five years, including new geothermal capacity additions of 1685 MW under the Accelerated Development of Power Generation program, Phase II. The program will include the development of hydropower, with an addition of 300 MW. Indonesia has set a goal for geothermal installed capacity of 6000 MW in 2020. The power development plan foreshadows the addition of at least 34 300 MW of non-oil power generation capacity in the period from 2006 to 2015. By Ministerial Regulation No. 32/2008, the government has set out plans for a greater role for biodiesel and ethanol-blend fuel in transport in the future (APERC 2008). Indonesia seeks to acquire coal-to-liquids facilities, and signed a memorandum of understanding covering that sector in December 2009. The expected technology would be able to produce 80 thousand barrels per day of high-quality ultra-clean transport fuels from Indonesia's lignite coal reserves (Energy-pedia 2009). It would use the latest clean production technologies and abatement and treatment processes.

UPSTREAM ENERGY DEVELOPMENT

OIL AND GAS

New investments in oil and gas exploration increased steadily from 2005 after an extended lull that followed Indonesia's economic crisis of 1978. Committed new investment in oil and gas exploration was USD 5.87 million in 2005, increasing to USD 8.17 million in 2006, USD 9.66 million in 2007 and USD 14.38 million in 2008.

On 30 November 2009, the government and contractors signed cooperation contracts (PSCs) to develop eight new oil and gas work areas (blocks) and five new coal-bed methane (CBM) work areas. Five of the oil and gas contracts are the result of second-round regular

tenders for oil and gas work areas in 2008 that were postponed to 2009; two contracts are the result of first-round direct offers of oil and gas work areas in 2009; and one contract resulted from the first-round regular tender of oil and gas work areas in 2009.

The contracts cover exploration activities in the next three years, including a geological and geophysical study (USD 12.4 million), a 2-D seismic survey of 10 500 kilometres (USD 9.5 million) a 3-D seismic survey of 10 500 kilometres over an area of 3100 square kilometres (USD 28.75 million), and the drilling of six exploration wells (USD 75.5 million). Total commitment for exploration is USD 126.2 million; in addition, the government receives a 'signature bonus' in the form of direct payments of USD 23.25 million.

The outcome of the 2009 bid round for new oil and gas work areas fell far short of government expectations. In early 2009, the government offered a total of 31 blocks (16 blocks through regular tender and 15 blocks through direct tender).

The CBM cooperation contracts consist of three contracts that are the result of the first-round direct offer tender of CBM work areas in 2009 and two contracts resulting from the direct offer of CBM cooperation contracts in existing work areas. The CBM contracts from the first-round direct offer tender commit the parties to exploration in the next three years requiring investments of USD 53 million; in addition, the government receives a signature bonus in the form of direct payment of USD 8 million.

On 30 November 2009, the government offered 24 oil and gas work areas to bidders; 12 were offered in the second-round regular offer, while the other 12 work areas identified in joint studies were offered in the direct offer of new oil and gas blocks for 2009. Most of the blocks are in the eastern part of Indonesia.

COAL

Indonesia is currently the world's largest exporter of thermal coal, exporting 160 Mt from production of 217 Mt in 2007. Indonesia is planning to build coal railway lines in coal-producing regions of South Sumatra and East Kalimantan, and to build and expand coal terminals, including one in West Java with an annual handling capacity of 5 Mt of coal from Sumatra.

The government is planning to construct 1461 kilometres of railways for coal transport in six regions of East Kalimantan: Mahakam, Sengata, South Balikpapan, Selatan, Mangkupadi and Batu. Foreign direct investment of USD 1 billion is expected to build a rail link and terminal to ship coal from East Kutai in East Kalimantan. In South Sumatra, the state-owned Bukit Asam coal company has approval for a 302-kilometre railway line connecting its mine in Central Bangko to the port of Tarahan, Lampung, on the southern tip of Sumatra. The company had previously relied on rail transport to deliver coal from its large coal mine in Tanjung Enim to Tarahan.

ELECTRICITY MARKETS

The Indonesian power system is currently made up of a large interconnected system that integrates the power systems in the islands of Java, Bali and Madura; in addition, there are several large and small isolated and partially interconnected power systems in the other islands. These systems have been developed around major load centres, but electricity is often delivered through extensive 20 kV rural electrification systems. The initial steps in restructuring the Indonesian electricity industry took place in 1994, when PLN was converted from a state enterprise to a government-owned limited liability company.

Restructuring efforts continued in 1995 with the unbundling of PLN's Java, Bali and Madura generation, distribution and transmission assets. Generation assets were unbundled into two wholly owned subsidiaries of PLN: PJB (Pembangkit Jawa-Bali) and Indonesia Power (IP). The distribution unit was separated into four distribution entities (East, West and Central Java, and Jakarta). Each distribution unit operates semi-autonomously, with an allocated budget to cover operational expenses in meeting the performance targets set out in its contract with PLN. The Java–Bali transmission business was transferred to the Java–Bali Electricity Transmission Unit and Load Dispatch Centre. The market has since become a single buyer market, in which the

PLN transmission unit coordinates the dispatch of PLN and IPP generators. Outside Java, Bali and Madura, restructuring is taking place through the decentralisation of PLN's assets.

TRANSPORTATION

The number of registered motorised road vehicles of all types in Indonesia increased rapidly over the period from 2000 to 2008. Most privately owned road vehicles in Indonesia are motorcycles. In 2008, according to the Central Statistical Agency (BPS), Indonesia had 47.7 million registered motorcycles, 9.8 million passenger vehicles, 3.5 million trucks and 2.6 million buses. In 2009, 5.9 million new motorcycles were sold in Indonesia[2], increasing its motorcycle stock to 53.6 million. Some 486 662 new passenger vehicles were sold in 2009, a decline of 19.9% from 2008 sales.

The Jakarta metropolitan area introduced three new bus-way corridors in 2009, increasing the total to 10 corridors, and plans to have 15 corridors in the long term. Some corridors have been extended to outlying suburbs. The bus-ways consist of dedicated bus-only lanes and mixed lanes. Buses in certain corridors run on compressed natural gas. While 75 million people used the bus-way system in 2009, the system has provided only a partial solution to overall congestion in the Jakarta metropolitan area.

ENERGY EFFICIENCY

GOVERNMENT REGULATION ON ENERGY CONSERVATION

On 16 November 2009, the government issued Governmental Regulation (PP, *Peraturan Pemerintah*) No. 70/2009 on Energy Conservation, as called for by Law No. 30/2007 (the Energy Law).

Regulatory measures addressed included:

- the formulation of a National Energy Conservation Master Plan (RIKEN, Rencana Induk Konservasi Energi Nasional), which is to be updated every five years or annually, as required
- the mandatory assignment of an energy manager, energy auditing, and the implementation of an energy conservation program for users of final energy of 6000 toe (tonnes of oil equivalent) or more
- mandatory energy-efficiency standards and energy labelling
- the implementation of government incentives, including tax exemptions and fiscal incentives for imports of energy-saving equipment and appliances, and special low interest rates for investments in energy conservation
- the implementation of government disincentives, including written notices to comply, public announcements of noncompliance, monetary fines, and reductions in energy supply for noncompliance.

At the time of writing, the government was drafting specific rulings and regulatory frameworks to implement Governmental Regulation No. 70/2009 regarding Energy Conservation in Indonesia.

ENERGY CONSERVATION PROGRAMS

Indonesia currently has 10 minimum energy performance standards for selected electrical appliances, based on SNI (*Standar Nasional Indonesia*) and other technical standards for energy performance testing of electrical appliances. Four SNI standards on energy saving for buildings cover the building envelope, air-conditioning, lighting and building energy audits. Energy performance standards for electrical appliances and energy standards for buildings are currently implemented voluntarily. Indonesia began a pilot energy labelling program, initially for refrigerators, in 1999; an updated energy labelling program has been considered more recently.

[2] *Kompas Otomotif*, 18 January 2010.

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

Since 2002, Indonesia has been implementing a government-funded public–private partnership program in energy auditing for industry and commercial buildings. The program requires participating companies to implement energy-saving measures identified in energy audits. About 292 industries and commercial buildings have participated in the program so far. Indonesia is an active participant in the ASEAN Energy Awards program (Best Practice Competition for Energy Efficient Buildings and Best Practice Competition for Energy Management in Buildings and Industries).

Indonesia has a lighting program for households, primarily as a demand-side management measure, to promote energy savings. The program provides subsidised, and in certain cases free, compact fluorescent lamps to eligible low-income households. Some 51 million compact fluorescent lamps were distributed by PLN in 2008; the number distributed each year depends on the availability of subsidies.

RENEWABLE ENERGY

BIOFUELS

In 2008, Indonesia passed legislation (Ministerial Regulation No. 32/2008) that makes biofuel consumption mandatory, commencing in 2009. Minimum obligations for biofuels use are shown in Table 16.

Table 16 Minimum obligations for biofuel use (percentage of 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).

Estimates of volumes of biofuels required to fill mandates, based on current production capacities, are shown in Table 5.

Palm oil is the main biodiesel feedstock in Indonesia. In 2008, the economy produced 20 Mt, making Indonesia a leading producer and the second-largest exporter of palm oil. In the future, Indonesia expects to use extracted oil from *Jatropha curcas* seeds as feedstock for biodiesel; new areas planted to *Jatropha* are expected to total 1.69 million hectares in 2010. Indonesia's biodiesel blend production capacity in 2009 was 2865 million litres (ML) and was estimated to be 4680 ML in 2010, far exceeding the volumes needed to fulfil the mandates in those years.

By June 2008, there were three commercial-scale fuel ethanol facilities in Indonesia. The facilities use sugar molasses or cassava as feedstock. Ten new commercial facilities are planned for 2010, as well as several smaller-scale facilities. The new facilities and the expansion of existing plants could result in production capacity of almost 4 billion litres in 2010, far exceeding the volume required to fulfil the mandate in that year. The government expects land dedicated for fuel ethanol feedstock to increase to almost 1.4 million hectares by 2010.

Table 17 Estimated volumes of biofuels required to fulfil mandates

	Units	2009	2010	2015	2020	2025
Biodiesel						
Consumption requirement	%	0.01	0.025	0.05	0.1	0.2
Volume required to fulfil mandate	ML	290	748	1 820	4 430	10 780
Estimated production capacity	ML	2 865	4 680			
Ethanol						
Percentage blending requirement	%	0.01	0.03	0.05	0.1	0.15
Volume required to fulfil mandate	ML	200	635	1 285	3 120	5 695
Estimated production capacity	ML	213	3 955			

Source: GSI (2008).

Since biofuels were introduced in Indonesia in 2006, the price of biodiesel (fatty acid methyl ester, or FAME) has been higher than the price of MOPS (Mean of Platts Singapore) petroleum diesel oil (Duniani and Agung 2009) and higher than subsidised diesel oil. The market price of fuel ethanol (anhydrous denatured bioethanol) was usually higher than the price of MOPS gasoline until the end of 2008. Over the period to January 2009, domestically produced fuel ethanol was on average more costly than subsidised gasoline (Premium brand RON 88 octane).

Notably, the price of crude palm oil correlates closely with oil prices. The price of crude palm rose dramatically from late 2006 to mid-2008 to become significantly higher than the price of petroleum diesel. Crude palm oil prices reached record highs in March 2008 of over USD 1410 per tonne, before dropping significantly, along with petroleum prices, in the second half of 2008. Most of Indonesia's biodiesel is exported, primarily to Australia, the European Union and the United States.

Subsidies provided by the government to the biofuel program have been increasing. Overall direct biofuel subsidies from 2006 to June 2008 were IDR 2302 billion (USD 253 million). However, the subsidies did not cover Pertamina's actual costs, and the company incurred a loss of some IDR 359 billion (USD 40 million) in the supply of biofuels over the period (GSI 2008). Besides direct subsidies to biofuels, the government provided funding or subsidies to the biofuel program to cover infrastructure, interest payments, intermediate inputs (such as seedling development, training and R&D) totalling IDR 14.795 billion (USD 1.625 billion) from 2006 to June 2008 (GSI 2008).

BIODIESEL

Pertamina is the only commercial blender and retailer of biodiesel blend fuels in Indonesia, and relies on two suppliers for its biodiesel (FAME). Pertamina began selling biodiesel blended with petroleum diesel in May 2006 under the brand name Bio Solar. Initially, Bio Solar was a blend of 95% automotive diesel oil and 5% biodiesel (B5). Due to high biodiesel prices, Pertamina lowered the biodiesel content of Bio Solar to 2.5% in April 2007. Some 555.1 ML of the blend was sold in 2007; the amount of pure biodiesel consumed in 2007 was estimated to be 18.5 ML. Pertamina further reduced the biodiesel content of the blend to 1% in May 2008, but

reinstated the 5% blend in November 2008. Bio Solar consumption was 599.2 ML in 2008. By November 2008, Bio Solar was sold in 411 retail stations (381 in Jakarta; 19 in Surabaya and 1 in Malang, in East Java; and 11 in Bali).

BIOETHANOL

Pertamina is currently the only retailer of ethanol blend fuels in Indonesia. The company introduced two bioethanol fuel grades at the end of 2006 under the brand name Bio Premium and a high-octane gasoline–ethanol blend called Bio Pertamax. All ethanol blend fuels initially contained 5% ethanol (E5), but Pertamina reduced the ethanol content of Bio Premium to 3% in June 2007 due to increasing costs that could not be covered by subsidy. In April 2008, biofuel content in Bio Premium specifically for Jakarta was lowered again, to 2%; Bio Premium in other cities and Bio Pertamax retained a 5% ethanol blend. Fuel subsidies are not provided for Bio Pertamax. Pertamina is unable to procure less expensive ethanol from foreign suppliers due to high import duties, so it relies on Indonesian-produced fuel ethanol. Overall sales of ethanol blend fuels were about 133.8 ML in 2008. By November 2008, there were 14 Bio Premium outlets in Jakarta and 1 in Malang, East Java; and 46 Bio Pertamax retail stations (22 in Jakarta, 7 in Surabaya, 3 in Malang and 11 in Bali).

BIOFUEL SUBSIDIES

In February 2009, the government expected subsidies to biofuels for 2009 to be IDR 774.469 billion (about USD 69.1 million) for the supply of 580 ML of biodiesel and 194 ML of ethanol blend fuels (ESDM 2009).

In December 2009, the chair of the Indonesian Bio-fuel Producers Association, at a hearing of the House Commission on Energy and Mineral Resources, said that the government would need to allocate subsidies of some IDR 1.25 trillion (USD 120 million) to meet mandatory targets in 2010. The subsidy is to achieve at least 5% biodiesel blend in subsidised diesel fuel (for use in transport) and at least 1% bioethanol blend in subsidised gasoline, for an expected demand of 562.5 ML of biodiesel and 214.5 ML of bioethanol blend fuels in 2010 (The Jakarta Post 2009).

CLIMATE CHANGE

Indonesia strongly supports the objective of the United Nations Framework Convention on Climate Change (UNFCCC) to prevent atmospheric concentrations of anthropogenic gases exceeding a level that would endanger the existence of life on Earth. To indicate its firm decision and serious concerns about global warming, Indonesia signed the convention on 5 June 1992. On 1 August 1994, the President of the Republic of Indonesia formalised the Act of 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 stipulated in the convention.

A World Bank study, as summarised in PEACE et al. 2007, claimed that Indonesia's greenhouse gas (GHG) emissions from energy use accounted for 9.1% of the economy's overall GHG emissions; the largest source of GHGs was forestry (largely due to deforestation), which accounted for 85%. The study considered Indonesia to be the world's third-largest emitter of GHGs, and that the economy was not taking sufficient steps to mitigate CO_2 emissions from energy sources by developing its renewable energy resources and increasing energy efficiency.

However, a formal government report on the state of Indonesia's emissions submitted to the secretariat of the UNFCCC in November 2009 explained that the World Bank study was wrong. The report, Indonesia's Second National Communication, found that, under the same observation time frame (2000 to 2005), Indonesia's average yearly greenhouse gas emissions were around 1416 million tonnes of CO_2 equivalent, far lower than the 3014 million tonnes that the World Bank study claimed. The report did not provide its own world ranking.

ENERGY TECHNOLOGY/R&D

Research in Indonesia is coordinated by the National Research Council (DRN, Dewan Riset Nasional), which is chaired by the State Minister of Research and Technology. Institutions doing

research on energy include the Agency for the Assessment and Application of Technology (BPPT, Badan Pengkajian dan Penerapan Teknology); research institutions under the Ministry of Energy and Mineral Resources working on research into oil and gas, coal, geothermal, and new and renewable energy; and research centres in the field of energy operating under universities and technical institutions.

Indonesia has a broad range of R&D into new and renewable energy technology (such as solar energy, small-scale wind power and hydropower) and into technologies that use biomass and plant-based oils as fuels. Research in this area is directed in many cases at applications in rural development. Other notable research concerns the uses of coal (such as clean coal briquettes, coal upgrading and clean coal technology) and meeting energy and environmental needs in oil and gas production.

Indonesia has four decades of experience in nuclear technology, gained from operating its four nuclear research reactors. The current energy policy calls for four nuclear plants of 1000 MW each in 2025, to be located on the Muria Peninsula on the north coast of Central Java. Indonesia expects a smooth adoption of nuclear power.

NOTABLE ENERGY DEVELOPMENTS

ENVIRONMENTAL ISSUES

INDONESIA CLIMATE CHANGE TRUST FUND (ICCTF)

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 (RPJM, *Rencana Pembangunan Jangka Menengah*) and the launching of the Indonesia Climate Change Trust Fund (ICCTF) on 14 September 2009.

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

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

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

The ICCTF consists of two funds: the Innovation Fund and the Transformation Fund. The Innovation Fund is a grants-based fund to finance demonstration and innovation projects, pilot projects, and research and development. The Transformation Fund is used to finance low-emitting activities, projects and initiatives by private 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.

NEW PROJECTS

UPSTREAM OIL AND GAS

In December 2009, the Indonesian Government announced its mid-term oil and gas management road map, which includes a target of USD 31.2 billion in investments for oil and gas infrastructure from 2010 to 2014. Of the total investment, 69.5% (USD 21.68 billion) is for gas facilities, including LNG and LPG receiving terminals, LPG refineries and residential gas pipeline networks. The remaining 30.5% (USD 9.53 billion) is for oil facilities, including refineries and rigs. The government expects total investment to peak in 2013 at USD 10.57 billion.

Projects under consideration include two new gas rigs for Lapangan Rambutan in South Sumatra and Pondok Tengah in West Java, with a total investment of USD 2.42 billion. The two rigs are expected to produce up to 1020 million standard cubic feet per day (MMscf/D) of natural gas. In 2011, the government is planning to build five gas processing plants for gas fields: Block A in Nanggroe Aceh Darussalam; Jambi Merang in Jambi; Randublatung in Central Java; Gajah Baru in the offshore Riau Islands in the Natuna Sea; and Kepodang near Bawean Island, offshore from East Java.

By 2014, the government plans to build at least 16 new gas rigs with a capacity of up to 20 261 MMscf/D of natural gas. To process gas from the new rigs, the government plans to construct LNG and LPG refineries with a total investment of USD 3.65 billion. In addition, the government expects total investments in new oil rigs and oil refineries of USD 3 billion and USD 6.52 billion, respectively.

Indonesia's largest newly developed oil reserve, the Cepu Block in East Java, jointly developed by ExxonMobil and Pertamina, is expected to reach peak output of 165 thousand barrels per day in 2012. Some matters in relation to this project need to be resolved, including securing land rights.

OIL REFINERIES

In December 2008, Pertamina signed a joint shareholder agreement to build an oil refinery near Bojonegara in the province of Banten, in the western part of Java. In its first phase, the refinery will have an intake capacity of 150 thousand barrels of crude oil a day, to expand to an ultimate intake capacity of 300 thousand barrels a day. Signatories to the agreement and stakeholders in the project are Pertamina (40%), the National Iranian Oil Refining & Distribution Co. (40%) and Petrofield Refining Company (Malaysia) (20%). Investment for the project is estimated at USD 6 billion; loans will provide 65% of the financing. The three parties have agreed to set up a joint venture company, Banten Bay Refinery, in Indonesia.

Crude oil supply for the refinery is expected to be Iranian extra heavy crude and Iranian heavy crude in equal parts. The refinery is expected to come onstream in 2015 and to produce a broad range of refinery products. It will require 110 million cubic feet of gas per day, to be supplied in part by PGN (*Perusahaan Gas Negara*).

In June 2009, Pertamina confirmed plans to expand the intake capacity of its Balongan oil refinery on the north coast of West Java from its current 125 thousand barrels of crude oil a day to 325 thousand barrels a day. However, Pertamina has postponed its other refinery projects, including the Tuban oil refinery in East Java (planned intake capacity of 300 thousand barrels of crude oil per day). The decision was made after some difficulties in securing financing and crude oil supply.

LIQUEFIED NATURAL GAS TERMINALS

In January 2010, the government and related companies confirmed plans to build Indonesia's first series of three floating LNG receiving terminals, to be located in Jakarta Bay, East Java and North Sumatra. The Java terminals will have capacities of 500 million cubic feet per day or about 4 Mt of LNG per year. Investment in each terminal is expected to be USD 230 million. The terminal in East Java will be built by Pertamina, while the terminal in Jakarta Bay will be built jointly by Pertamina and PGN; the government has a 51% share in the company. Completion of the LNG receiving terminal in East Java is expected in September 2011. The LNG terminal in North Sumatra, to be built by PGN, will have a capacity of about 150 million cubic feet a day.

LNG supply is expected to come from the LNG plants in Tangguh, Papua, and Bontang, East Kalimantan, with an option of LNG imports from Qatar.

ACCELERATED DEVELOPMENT OF ELECTRICITY GENERATION

In December 2009, the government revised Presidential Regulation No. 71/2006 regarding the Accelerated Development of Electricity Generation 10 000 MW—Phase I. The revision calls for the addition of coal-fired power plants in the provinces of East Kalimantan and Riau; each province will receive capacities of 2 × 100 MW. In 2009, 915 MW of new generating capacity was completed in Java. PLN expects that the additional power plants will be completed by 2012 during Phase I, which has been extended by two years due to delays in securing financing. Other planned completions are:

2010: 3240 MW in Java and 121 MW elsewhere

2011: 1975 MW in Java and 1558 MW elsewhere

2012: 700 MW in Java and 368 MW + 400 MW elsewhere

2013: 660 MW in Java.

Overall capacity increases from Phase I will be 9937 MW: 7490 MW in Java and 2447 MW elsewhere (including 1424 MW in Sumatra).

The Adipala 660 MW supercritical power plant in Cilacap, on the south coast of Central Java, will be completed in 2013. Financing for the plant was secured in mid-2009.

PLN expects the Phase I additions of generation capacity to able to meet short-run power demand, which has been growing at an average annual rate of 6.8%. To meet mid-term electricity demand beyond 2012, PLN is implementing the Accelerated Development of Electricity Generation 10 000 MW—Phase II, which will build 10 677 MW of new generating capacity by the end of 2015.

Phase II will consist of PLN and IPP power plants. PLN will invest around USD 7.605 billion for 6415 MW, while the IPPs are expected to invest USD 8.45 billion for 4.26 MW, for a total investment of around USD 16.055 billion. Phase II additions will comprise coal-fired plants (4294 MW), geothermal plants (3583 MW), gas combined cycle plants (1626 MW) and hydropower (1174 MW). In Phase II, 44.6% of the planned power generation will be based on renewable energy, of which 33.6% will be geothermal power.

SOLAR ENERGY

In 2009, Indonesia distributed 77 433 photovoltaic solar home systems of 50 W peak photovoltaic modules to individual households and nine photovoltaic array systems of 150 000 W peak each to communities in rural and remote areas all over Indonesia. The number of home systems distributed in 2009 was lower than the 40 598 units distributed in 2008; however, the number of photovoltaic array systems distributed increased from the five systems of 102 400 W peak distributed in 2008.

Indonesia is utilising photovoltaic systems to increase its electrification ratio target, which was 66.2% in 2009. In 2009, the government allocated IDR 658.7 billion (about USD 65 million) to provide new and renewable energy–based power generation for Indonesia's distributed power

systems. The program provided electricity to around 94 000 households, particularly households in 18 of the outermost islands of Indonesia and in remote areas along the Indonesian border. In addition, the government allocated IDR 841.3 billion for the extension of PLN's 20 kV rural electrification network and generation capacity.

In the 2010 budget, the government expects to allocate IDR 561.5 billion to electrifying 81 000 households in very remote areas (based on new and renewable energy), and to allocate IDR 591.5 billion to further extend PLN's rural electrification network.

USEFUL LINKS

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

BPH Migas—www.bphmigas.go.id

BPMIGAS—www.bpmigas.com/ENGLISH/

Department of Energy and Mineral Resources (DESDM)—www.esdm.go.id

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

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

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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 second largest economy after the United States. Japan's real GDP in 2007 was about USD 3621 billion (USD (2000) at PPP). Japan's population of 128 million people, had a per capita income of USD 28 339.

Up to the early 1990s, Japan enjoyed a long period of rapid socioeconomic development. In 1992, however, Japan's economy entered a decade of stagnation. GDP grew 1.2% per year between 1992 and 2002, whereas during the previous decade it had grown by 3.9% per year. In 2003, with the annual GDP growth rate at 2.1% (2002–03), the Japanese economy showed signs of recovery. By 2006 and 2007, when GDP growth was 2.4% and 2.1%, respectively, economic activity remained resilient. The recovery was driven by exports, mainly to China, and strengthened domestic capital investment.

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 2007, proven energy reserves included around 44 million barrels of oil, 21 billion cubic metres of natural gas and 355 million tonnes of coal.

Table 18 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	377 800	Oil (million barrels)—proven	44
Population (million)	127.77	Gas (billion cubic metres)	21
GDP (USD (2000) billion at PPP)	3 620.86	Coal (million tonnes)—proven	355
GDP (USD (2000) per capita at PPP)	28 339		

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan; Oil & Gas Journal, Vol.106.48 (December 22, 2008).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Japan's total primary energy supply was 522 million tonnes of oil equivalent (Mtoe), 0.5% less than in 2006. Of fuel types, oil contributed the largest share (45%), followed by coal (22%) and natural gas (16%). In 2007, net imports of energy sources accounted for 82% of the total primary energy supply. With limited indigenous energy sources, Japan imported almost 99% of its oil, 99% of its coal and 96% of its gas.

In 2007, Japan was the world's third-largest oil consumer after the United States and China (IEEJ 2006:259)[3], and almost all of the oil was imported. The bulk of the imports (86% in 2007) came from economies in the Middle East such as the United Arab Emirates, Saudi Arabia, Iran, Qatar and Kuwait (IEEJ 2009:258–259). Japan's Middle East oil import dependency rose steadily from 68% in 1985 to 89% in 2004 at its peak, due mainly to a decline in oil imports from Asian

[3] In 2003, China overtook Japan to become the second-largest consumer of oil in the world.

economies such as Indonesia and Malaysia. The Middle East oil import dependency rate in 2007 was 86%. In 2007, the primary oil supply was 236 Mtoe, a decline of 2.9% from the previous year.

Japan is endowed with only limited coal reserves (355 million tonnes). The small amount of coal production was heavily subsidised until January 2002, when Japan's last coal mine in Kushiro, eastern Hokkaido, was closed. Japan is the world's largest importer of steam coal for power generation, pulp and paper and cement production and coking coal for steel production. Japan's main steam coal suppliers are Australia, China, Indonesia, Russia, the United States, South Africa and Canada. Coking coal is imported from Australia, Indonesia, Canada, China, Russia, the United States and South Africa. In 2007, primary coal consumption increased by 5.5% from the previous year, reflecting increased use for power generation.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 738 billion cubic feet, and are located in Niigata, Chiba and Fukushima prefectures. Domestic demand is met almost entirely by imports of liquefied natural gas (LNG) (BP 2008:30), which come from Indonesia (20% of imports in 2007), Malaysia (19%), Australia (17%), Qatar (12%), Brunei Darussalam (10%), the United Arab Emirates (8%), Oman (5%) and others. In 2007, LNG imports to Japan comprised 39% 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 2007, primary natural gas supply was 82 Mtoe, an increase of 7.7% from the previous year.

Japan has 276 GW of installed generating capacity and generated about 1179 TWh of electricity in 2007. Electricity is generated by thermal fuels (coal, natural gas and oil—66%), nuclear (24%) and hydro (7%); geothermal, solar and wind technologies produce the remainder.

Table 19 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	96 361	Industry sector	156 733	Total	1 178 998
Net imports and other	428 359	Transport sector	90 197	Thermal	781 259
Total PES	521 865	Other sectors	105	Hydro	85 033
Coal	112 630	Total FEC	352 799	Nuclear	279 009
Oil	236 011	Coal	37 752	Other	33 698
Gas	81 865	Oil	194 112		
Other	91 358	Gas	28 487		
		Electricity and other	92 448		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

After the first oil crisis in 1973, Japan invested heavily in nuclear power generation to reduce its reliance on oil. Despite Japan's desire to increase the share of nuclear, the Japanese nuclear power industry has faced several challenges in recent years. In 2002, Tokyo Electric Power Company (TEPCO) was found to have falsified safety reports in the latter half of the 1980s and during the 1990s. This led to the closure for inspection of all 17 nuclear units belonging to TEPCO for several months. In early August 2004, an accident in one of the Kansai Electric Power Company's nuclear reactors was caused by a fracture on one of the secondary piping systems at Mihama Unit 3. In July 2007, Kashiwazaki–Kariwa nuclear plants stopped operation following an earthquake that hit Niigata and Nagano prefectures and caused a leakage of a small amount of radioactive material from the nuclear power plant. The safe performance of the Kashiwazaki–Kariwa nuclear power plant was confirmed, according to an International Atomic Energy Agency report published on 29 January 2009 (IAEA 2009).

FINAL ENERGY CONSUMPTION

In 2007, Japan's total final energy consumption was 353 Mtoe, or 2.2% less than in the previous year. The industrial sector consumed 44% of the total, followed by the

residential/commercial sector at 30% and the transportation sector at 26%. By energy source, petroleum products accounted for 55% of total final energy consumption, followed by electricity and other (26%), coal (11%) and city gas (8%).

Energy consumption by the industrial sector increased by almost 0.4% in 2007, while the residential/commercial sector's energy consumption decreased by 2.7% and the transport sector's consumption declined by 5.5%. The decrease in transport's energy consumption in 2007 is explained by such factors as a shift to smaller passenger vehicles, operational improvements in freight transport, and an overall improvement in fleet efficiency. In addition, slow population growth contributed to the negative growth of passenger-kilometres in 2007. All these factors translated into the decline in transport energy consumption.

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, while the Ministry of Foreign Affairs formulates international policies.

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:17): 'assurance of a stable supply', 'adaptation to the environment', and 'use of market mechanisms'. The Basic Energy Plan based on this law was revised in 2007 (METI 2008a:17). 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:18). 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%.

Japan is faced with future energy challenges. The first is to secure a stable energy supply at reasonable prices, despite the economy's reliance on imports for 85% of its total energy supply. The second is to meet the Kyoto Protocol commitment for reducing greenhouse gas emissions to 6% below the 1990 level between 2008 and 2012. The third is to improve the economic efficiency of Japan's industries (including the energy sector), thereby increasing their domestic and international competitiveness.

OIL, NATURAL GAS AND COAL MARKETS

OIL

Japan aims to decrease its oil dependency, partly because of its experiences during oil crises. However, oil still accounts for around 50% of Japan's total primary energy supply and is expected to take the dominant share of Japan's future energy supply. Securing a stable supply of oil will continue to be one of Japan's major energy policy issues.

Japan's oil supply structure is vulnerable to supply disruption incidents because Japan imports almost all of its crude oil. In preparation for possible supply disruptions, Japan has been pursuing emergency measures by holding emergency oil stockpiles and by conducting the independent development of resources and promoting 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 2008, Japan held the equivalent of 151 days of net imports, including state-owned and private-sector stocks.

Currently, Japan's ratio of oil consumption to total primary energy consumption is around 45%, which is a significant reduction from the 1973 level of about 75%. According to the New National Energy Strategy, Japan aims to reduce the ratio to less than 40% in 2030.

Japan is trying to lower oil demand through the introduction of biofuels for transport. It has introduced a goal for biofuels in transport of 0.5 million kilolitres (crude oil equivalent) for 2010. In addition, as a means to enhance oil supply security, the New Energy Strategy aims to increase the ratio of oil imports from Japanese overseas projects to 40% in 2030 from 15% in 2004.

NATURAL GAS

Demand for natural gas has been increasing rapidly over the past two decades. Between 1980 and 2007, natural gas demand grew at an annual rate of 5%—the fastest growth in all primary energy sources. This robust growth is expected to continue, partly for environmental reasons and 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. To date, Japan has taken three steps to liberalise the gas market:

- The Gas Utilities Industry Law was amended in 1995. The law allowed industrial customers with contracted amounts of more than 2 million cubic metres per year to directly negotiate prices with suppliers.
- The Gas Utilities Industry Law was further amended in 1999. The scope of deregulation for large volume supply was extended by lowering the annual contract volume to 1 million cubic metres per year and over. Regulations for third-party access for the supply of large volumes of natural gas were also established.
- In June 2004, the Diet passed the amended Law on the Gas Utilities Industry. The amendment stipulated that customers with the contracted amount of 0.5 million cubic metres per year could freely choose suppliers.
- The law was further amended in April 2007, and those customers with contracted amounts of 0.1 million cubic metres per year are allowed to choose their suppliers. With this amendment, about 59% of total city gas customers, or 10 100 customers, can choose their suppliers.

Natural gas is supplied almost entirely by imports in the form of LNG from Indonesia, Malaysia, Brunei Darussalam and Australia. 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.

Now 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. For example, the agreement reached by Tokyo Electric Power Company (TEPCO) and Tokyo Gas for their purchase of LNG from Malaysia's MLNG Satu project includes outstanding features: first, some of the LNG will be shipped free on board (f.o.b.), rather than ex-ship; and second, the agreement increased both the upward and the downward quantity tolerance.

Some Japanese gas and electric utilities have purchased upstream stakes in order to ensure security of gas supply. Examples include a project in Darwin, Australia, in which TEPCO and Tokyo Gas acquired 6.7% and 3.4% shares, respectively. Also, Osaka Gas has bought a 3% upstream stake of Qalhat LNG.

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

COAL

In 2007, 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. Coal mines in Japan have become increasingly deeper and remoter, and the cost of domestically mined coal is approximately three times that of imported coal. The government used to subsidise the domestic coal mining industry; however, through structural adjustments and the reduction of subsidies, coal production has gradually decreased. The domestic production of commercial coal ended at the end of the 2001 fiscal year.

Japan is the biggest coal importer in the world, importing over 20% of total global coal imports. 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. To secure a stable supply of overseas coal, Japan is implementing a five-year plan to transfer coal-mining technologies overseas to economies that still have abundant coal resources. Some concrete measures to support overseas coal development include subsidies for investigations prior to mine exploration and development, and loans for mine exploration; technology cooperation with coal-producing economies, including to address environmental concerns; development of technology to improve heat efficiency, such as pressurised fluidised-bed combustion technologies; coal gasification; combined cycle electricity generation; coal gas production for fuel cells; support for the introduction of high-efficiency coal boilers; and development and diffusion of clean coal technologies.

ELECTRICITY MARKET

Electricity was the second-largest contributor (next to petroleum) to total final energy consumption in 2007. 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 was 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.

The Electricity Utilities Industry Law (the main legislation covering the electricity industry) was amended in 1995 to address global energy sector reform, comparatively high electricity tariffs in Japan and deteriorating load factors. The amendments permitted the entry of independent power producers into the Japanese electricity market. The 10 major electric utilities, each of which holds a regional monopoly, were given the right to accept tenders for independent investment in generation to cover short-term thermal power requirements.

Subsequent amendments in 1999 allowed the partial liberalisation of retail sales, starting in March 2000. Eligible customers, either high-voltage users (20 kV) or users with contracted demand over 2000 kW, can now freely enter into contracts with power suppliers.

In June 2004, the Japanese Diet passed an amendment to the Electricity Utilities Industry Law. The amendment includes a plan to permit more eligible customers to choose their electricity supplier. According to the law, customers consuming 500 kW can directly negotiate with suppliers. This was followed by a plan to open the electricity market in 2005 for those customers using 50 kW. Although there had been some discussion about opening the remainder of the retail market and introducing full competition in 2007, in July 2008 full liberalisation was put off due to a renewed emphasis on improving competition in the already liberalised markets.

Japan aims to boost its solar power capacity to 10 times the 2005 level by 2020 and to 40 times by 2030 to help it cut greenhouse gas emissions. To meet these high targets, Japan started an economy-wide feed-in tariff system[4] in November 2009 (European Environment Agency 2009), under which utilities buy surplus solar power produced by households and factories at a guaranteed price for about 10 years. The guaranteed price started at JPY 48/kWh for residences using less than 10 kW, and at JPY 24 /kWh for residences using more than 10 kW and for non-residential producers. The cost of introducing the system is passed on to consumers evenly, resulting in a rise in electricity fees per family of about JPY 100 a month in ten years.

NUCLEAR ENERGY

Nuclear energy is perceived to address two key energy issues: supply stability and environmental protection (as no CO_2 emissions are produced during generation). It has now become a major source of electricity and will most likely play a big role in the future. The New National Energy Strategy plans to increase the share of nuclear in total electricity generation from the current 29% to between 30% and 40% by 2030. To achieve the two goals of supply stability and environmental sustainability, Japan is expected to install about nine additional nuclear power stations by 2020, according to the Long-term Energy Supply–Demand Outlook released in August 2009.

It has been necessary to disseminate sufficient information about the safety and necessity of nuclear power in order to facilitate domestic and regional support for the construction of additional nuclear power stations. The government has undertaken several promotional measures for the location of the new power stations.

The Japanese Government has also taken measures to increase human resources in nuclear engineering. The government launched a three-year program from 2007 to strengthen the university educational programs in nuclear studies.

To ensure the efficient use of nuclear resources, it is essential to work out measures to establish the nuclear fuel cycle. Japan's low-level radioactive waste disposal centre, part of Japan Nuclear Fuel Limited's nuclear fuel cycle facilities, has been in operation at Rokkasho-mura in Aomori Prefecture since 1992.

In May 2000, the Specified Radioactive Waste Disposal Act was approved to ensure the planned and, most importantly, the reliable disposal of high-level radioactive waste. In October 2000, METI authorised the establishment of the Nuclear Waste Management Organisation, which is responsible for identifying the disposal site; constructing, operating and maintaining the repository; the eventual closure of the facility; and post-closure institutional control.

The pluthermal program is a pillar of Japan's policy for creating a nuclear fuel cycle. In the pluthermal program, plutonium is extracted from spent nuclear fuel, mixed with uranium, and reused to generate power. Kyusyu Electric Power Co. began using plutonium–uranium mixed oxide fuel at the Genkai Nuclear Power Station in Genkai, Saga Prefecture, in November 2009.

ENERGY EFFICIENCY

Within Japan's May 2006 National Energy Strategy, the Energy Conservation Frontrunner Plan reinforces the economy's strategy to reduce petroleum consumption. Setting a target to

[4] The European Union Environmental Agency defines the feed-in tariff as 'the price per unit of electricity that a utility or supplier has to pay for renewable electricity from private generators'.

improve energy efficiency by 30% relative to 2006 by 2030, the Japanese Government pledged to establish a state-of-the-art energy supply–demand structure within a market of high prices, which the government expects to endure for the medium to long term. Beyond a sustained promotion of energy efficiency, the Japanese Government pledged to optimise energy use by reducing oil dependence through improvements in the energy intensity of the oil-intensive transport sector. The Energy Conservation Frontrunner Plan sets a strategy to achieve this energy efficiency target through strategic planning in the medium and long term. It establishes a plan to develop energy conservation technology and to develop and disseminate a benchmarking approach, so that the energy conservation effect can be quantitatively verified (METI 2006).

On 17 December 1996, the Keidanren Voluntary Action Plan on the Environment was presented. Goals for voluntary action plans, such as CO_2 unit goals and energy efficiency goals, are individually formulated in 36 industries (represented by 137 organisations) in the industrial, commercial, transportation and energy-conversion sectors (Keidanren 1996).

RENEWABLE AND LOW CARBON ENERGY

METI passed the following two bills on 1 July 2009 (METI 2009):

- Bill on the Promotion of the Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Materials by Energy Suppliers
- Bill to Amend the Act on the Promotion of the Development and Introduction of Alternative Energy.

The aim of the bills is to appropriately ensure stable energy supply to Japan by reviewing current alternative-energy policies and facilitating the use of non-fossil energy sources and the effective use of fossil energy materials.

Japan has been lowering its dependence on oil through alternative-energy policies set pursuant to the Act on the Promotion of the Development and Introduction of Alternative Energy (the Alternative Energy Law), which was instituted in response to the oil crisis.

However, Japan's dependence on fossil fuels, including coal and natural gas, remains more than 80%. Because global demand for energy has surged recently, this raises the concern that, in the future, Japan may no longer be able to secure sufficient fossil fuels (in either quantity or quality).

In addition, the economy's goal of creating a low-carbon society has made it essential to take measures directed at each stage at which energy is supplied and used.

To respond to these challenges, the government needs to review its alternative-energy policies and promote the use of non-fossil energy sources and the effective use of fossil energy materials by energy suppliers, and thereby ensure stable energy supply. Two bills are proposed:

- Bill on the Promotion of the Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Materials by Energy Suppliers
  - use of nuclear power, solar power and other non-fossil sources of power
  - use of biofuel and biogas
  - purchase, at fair prices, of electricity generated from solar power (METI 2009). Measures include subsidies and tax breaks for the introduction of devices for residential and non-residential use; a legislative requirement for electric power suppliers to introduce a certain amount of new energy; support for technological development; and a system for buying surplus solar electricity at high prices.
  - effective use of crude oil and natural gas in producing gasoline and town gas.
- Bill to Amend the Act on the Promotion of the Development and Introduction of Alternative Energy
  - The current alternative-energy policies are to be reviewed in order to change the type of energy to be developed and introduced pursuant to this law, from

'alternative energy' (for example, coal and natural gas) to 'non-fossil energy' (such as renewable energy and nuclear energy).

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 will 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 agreement by those economies on ambitious targets.

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

Japan's policy framework for non-fossil energy sources and alternative energy changed in 2009, following the introduction of new policies. Details are contained in the 'Policy overview' section.

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

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KOREA

INTRODUCTION

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 48.5 million. Approximately 21% of the population lives in Seoul, Korea's largest city and the capital.

In the last few decades, Korea has been one of Asia's fastest growing and most dynamic economies. GDP increased at an unprecedented rate of 6.8% per year over the period from 1980 to 2007, reaching USD 1109.3 billion (USD (2000) at PPP) in 2007. Per capita income in 2007 was USD 22 893, 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 very few indigenous energy resources. It has no oil resources, and only 209 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. In 2007, Korea was the fourth-largest importer of oil and the second-largest importer of both coal and liquefied natural gas in the world.

Table 20 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	99 538	Oil (barrels)	–
Population (million)	48.46	Gas (billion cubic metres)—recoverable	3
GDP (USD (2000) billion at PPP)	1 109.3	Coal (million tonnes)—recoverable	209
GDP (USD (2000) per capita at PPP)	22 893		

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

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased almost six fold between 1980 and 2007, from 38 million tonnes of oil equivalent (Mtoe) in 1980 to 225 Mtoe in 2007. In particular, in the period from 1990 to 2000, energy supply increased at an annual average rate of 7.7%, far exceeding the economic growth rate of 6.2% for the same period. Likewise, per capita primary energy supply grew from 1.0 tonnes of oil equivalent in 1980 to 4.6 tonnes of oil equivalent in 2007. The level of increase was similar to that of Japan and most European economies.

In 2007, Korea's total primary energy supply was 225.5 Mtoe, a 4.2% increase from the previous year. By energy source, oil represented the largest share (43%), followed by coal (25%) and gas (14%). The remaining 18% of primary energy came from other fuels, nuclear and hydro. Korea imported around 84% of its total energy needs in 2007, including all of its oil and gas requirements and 97% of its coal supply.

Oil consumption in 2007 was 97.6 Mtoe, a 4.3% increase from the previous year. In spite of high oil prices, naphtha and petroleum consumption showed stable growth rates. In 2007, the economy imported about 80% of its crude oil from the Middle East.

Coal use in 2007 totalled 56.3 Mtoe, a 7.0% increase from the previous year. This substantial increase resulted from the power sector's increased demand for coal, due to its cost competitiveness against other fuels. Korea has modest reserves of low-quality, high-ash anthracite coal that is not sufficient to meet 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, reaching 31 Mtoe in 2007, with its share in the primary energy supply mix increasing to 14%. The bulk of Korea's LNG imports come from Qatar, Indonesia, Oman, Malaysia and Brunei Darussalam (MKE 2009c). Korea began producing natural gas domestically in November 2004, after a small quantity of natural gas was discovered in the Donghae-1 offshore field south-east of the economy.

Korea's electricity generation in 2007 was 391 terawatt-hours, a 5.5% increase from 2006. Generation by thermal sources, including coal, oil and natural gas, accounted for 62% of total electricity generation, followed by nuclear at 37% and hydro at 1%.

Table 21 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	42 559	Industry sector	46 955	Total	390 684
Net imports and other	190 293	Transport sector	33 263	Thermal	241 839
Total PES	225 483	Other sectors	69 598	Hydro	5 042
Coal	56 307	Total FEC	149 816	Nuclear	142 937
Oil	97 626	Coal	8 600	Other	866
Gas	31 187	Oil	83 900		
Other	40 362	Gas	16 995		
		Electricity and other	40 321		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

Korea's total final energy consumption in 2007 was 150 Mtoe, a 0.9% increase from the previous year. Industry accounted for the largest share at 31%, followed by the residential and commercial sector (25%) and transport (22%). The remainder was consumed by agriculture and industry as non-energy use such as petrochemical feedstock. In general, industry demand growth has weakened since the late 1990s, while the rate of demand growth in the transport and commercial sectors has increased.

By energy source, petroleum products were the most important, accounting for 56% of total demand, followed by electricity (27%), natural gas (11%) and coal (6%). Because of strong policy measures, natural gas consumption has increased significantly, particularly in the residential and commercial sector, from 3% in 1990 to 31% in 2007.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Supporting high levels of economic growth despite inadequate indigenous energy resources has been the key driver of Korea's energy policy platform. The Ministry of Knowledge Economy (MKE) is responsible for developing and implementing energy policies and programs, administering the energy industry, supporting research and development of new energy

technologies and formulating international cooperation on energy-related matters. MKE was established in 2008 by merging the Ministry of Commerce, Industry and Energy with elements of the Ministry of Information and Communications, the Ministry of Science and Technology, and the Ministry of Finance and Economy, with the aim of creating an enhanced government instrument capable of meeting the new challenges of the twenty-first century.

In the past, Korea's energy policy has focused on ensuring a stable energy supply to sustain economic growth. The changing situation has, however, induced the government to seek a new direction in energy policy that could support sustainable development in full consideration of the 3Es (Energy, Economy, and Environment).

Faced with high energy prices and rising concerns over climate change, in September 2008 Korea announced a long-term strategy that will determine the direction of its energy policy to 2030. The plan'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 million toe.
- *increase the supply of clean energy and reduce the use of fossil fuels*. By 2030, the share of renewable energy in total primary energy will reach 11% from 2.4% in 2007.
- *boost the green energy industry*. By 2030, Korea's green energy technologies will be comparable to levels of most advanced economies.
- *ensure that citizens have access to affordable energy*. The government will ensure that energy sources are accessible and affordable to low-income households.

ENERGY MARKET REFORM

Korea has been pursuing the restructuring of its energy sector since the late 1990s, when it introduced the principle of free competition in industries such as electricity and natural gas, which were traditionally considered natural monopolies. In January 2009, in a move to introduce competition into the electricity industry, the government announced the Basic Plan for Restructuring the Electricity Industry, which included unbundling and privatisation 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 Co., LTD). The five thermal generation companies that split from KEPCO were to be privatised in stages. However, in July 2008, the government announced that there would be no further privatisation 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/distribution in Korea (KEPCO 2009).

As well as restructuring the electricity market, the Korean Government restructured the gas industry. In November 1999, the government sold 43% of its equity in 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; promote the development of the gas industry and enhance consumer choice and service quality. A detailed implementation plan was announced in October 2001. The plan covers how to achieve smooth succession of existing import and transportation contracts, privatisation of import/wholesale businesses, stabilised price and balanced supply and demand, and revision of related legislation and enforcement (KEEI 2002).

With regard to introducing competition into the import/wholesale sectors of KOGAS, the final decision will be made on whether to split the sectors from KOGAS or to introduce new companies following discussion among stakeholders. Given strong public interest in this sector, the existing public utility system is expected to be maintained. Competition in the retail sector,

currently operated under a monopoly system within each region, will be introduced in stages, in conjunction with progress made in the wholesale sector.

OIL, GAS AND ELECTRICITY MARKETS

OIL

Due to Korea's complete dependence on oil imports, the government has been trying to secure supplies for the short and long term. To ease short-term supply disruptions and meet International Energy Agency (IEA) obligations, the Korean Government has been increasing its stockpile since 1980. In March 2009, the government had 120 million barrels of stockpile facilities and 104 million barrels of oil reserves. The government plans to further increase strategic oil stocks to 141 million barrels (72 days of net imports) by 2010. The combined oil inventories of public and private oil companies equate to about 109 days of net imports, substantially exceeding the IEA 90-day requirement.

In the longer term, the Korea National Oil Corporation (KNOC) has been actively exploring and developing oil and gas locally and abroad to improve energy security. 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. At the end of February 2009, KNOC had equity stakes in 46 overseas exploration and production projects in 17 economies, including Indonesia, Viet Nam, Yemen, Nigeria, the United States and Peru (KNOC 2009). The present long-term strategy for overseas oil and gas development includes raising Korea's crude oil and natural gas self-sufficiency level from 4.2% in 2007 to 18.1% by 2012, and increasing KNOC's daily production from 50 000 barrels per day in 2007 to 300 000 barrels per day in 2012 (MKE 2008).

Korea has also been trying to diversify its crude oil supply sources. The number of source economies increased from nine in 1980 to 29 in 2004, but oil import dependency from the Middle East remains high (81% in 2006). Korea is also actively strengthening its bilateral relations with oil-producing economies as well as multilateral cooperation through the IEA, APEC, ASEAN+3, the International Energy Forum and the Energy Charter, to enhance its crisis management capabilities (MKE 2009e). In particular, the government plans to play a leading role in energy resource development and trade in Northeast 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, replacing coal and oil in the residential sector; in 2007, its share of primary energy supply was 14%. KOGAS has a monopoly over Korea's natural gas industry, including the import, storage, transport and wholesale businesses (KOGAS 2009). Thirty city gas companies operate in the gas retail business in each region of the economy. Not only is KOGAS the world's largest LNG importer; it also promotes the development of natural gas resources abroad, in economies such as Australia, Uzbekistan and Nigeria.

The Ninth Plan of Long-term Natural Gas Demand and Supply, which was finalised by MKE in December 2008, projected that natural gas demand would grow by 0.2% per year from 2007 to 2030. By sector, the city gas sector's natural gas demand is projected to increase by 2.0% per year, while the gas demand for power generation is projected to decrease by 3.8% per year.

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 2007, installed capacity increased more than threefold, from 21 GW in 1990 to 73 GW in 2007. The Fourth Basic Plan of Electricity Demand and Supply (2008–2022), which was finalised by MKE in December 2008, projects that electricity demand will grow by 2.1% per year from 2008 to 2022 and that 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.

To rectify an energy supply and demand structure that was overly dependent on oil, 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, which were introduced in 1986 and in 2006, accounted for about 20% of total electricity generation in 2007. According to the Fourth Basic Plan, gas-fired generation is expected to reduce its share of total generation to 6.2% by 2022.

Korea has been building nuclear power plants since the 1970s. In 2007, the 20 power reactors operating in Korea accounted for around 26% of total electricity production capacity. Nuclear energy is a strategic priority for the Korean Government, and its share of total electricity production capacity is projected to increase to 32.6% in 2022, surpassing the share held by coal-fired power plants, which traditionally held the largest share. The Fourth Basic Plan forecasts that nuclear power generation will account for 48% of all electricity generated in Korea in 2022, a sharp rise from 36% in 2007 (MKE 2009a).

ENERGY EFFICIENCY

The Korean Government has allocated around USD 14.2 billion for an energy efficiency initiative that will be effective until 2012 (KEEI 2008). This initiative aims to improve energy efficiency by 11.3% by 2012 compared with 2007 and 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, begin phasing out incandescent lamps by 2013, and implement a program modelled on Japan's Top Runner Program to complement the current Energy Efficiency Label and Standard Program.

Other actions include:

- The government will invest about USD 930 million in seven core technologies-building energy management systems, electric power IT, energy storage, green vehicles (MKE 2009d), LEDs, technologies to improve the energy efficiency of the most energy-intensive appliances, and green home appliances.
- By 2012, average fuel economy for automobiles (MKE 2009g) will be improved by 16.5%. This means that the fuel economy for engine sizes below 1.5 litres (L) will be improved from the current 12.4 km/L (29.2 miles per gallon (mpg) US) to 14.4 km/L (33.9 mpg US), while the fuel economy for engine sizes above 1.5 L will be improved from the current 9.6 km/L (22.6 mpg US) to 11.2 km/L (26.3 mpg US).
- For buildings with the highest level of energy efficiency (grade 1), the government will increase the maximum floor area ratio by 6%.
- When purchasing appliances for use in government buildings, the government will give preference to those models with the grade 1 energy efficiency label and products that deliver less than 1 watt of standby power (MKE 2009f).
- To encourage businesses to improve energy efficiency, the government will divide businesses into four categories according to energy consumption. Specific measures such as negotiated and voluntary agreements will be introduced for each category.

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 2009b). The plan covers areas such as investment, infrastructure, technology development and programs to promote renewable energy.

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 now and 2030, of which nearly a 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) will be used to develop green technologies. After 2020, when renewable energy sources become more economically viable, the proportion of private investment will increase steadily. In 2009, private investment is expected to surge to KRW 3.1 trillion (about USD 2.4 billion, a 103% increase from 2008) and the renewable industry is expected to create nearly 2050 jobs to augment its existing work force, which presently consists 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. Furthermore, the government will strengthen the role of local governments in encouraging the wider use of renewable energy.
- *improve infrastructure for renewable energy*. Measures will take the form of a renewable energy investment fund; amendment of any regulations that may be hindering the transition to renewable energy; promotional efforts to raise public awareness of the benefits of renewable energy; a more detailed classification system, which conforms to the system used by the International Energy Agency and which will facilitate more effective analysis of statistics; and human resources programs to foster technical professionals with the necessary expertise.

NOTABLE ENERGY DEVELOPMENTS

POLICY DEVELOPMENTS

Korea's renewable energy policy framework changed in 2009, through the introduction of a new policy. Details are contained in the 'Policy overview' section.

CLEAN ENERGY

On 15 August 2008, the sixtieth anniversary of the founding of the Republic of Korea, President Lee Myung-bak proclaimed 'Low Carbon, Green Growth' as Korea's new vision. This vision aims to shift the current development model of fossil-fuel dependent growth to an environmentally friendly one (Republic of Korea 2009).

To realise this vision, the Presidential Commission on Green Growth was established in February 2009. The Basic Act on Low Carbon and Green Growth was subsequently submitted and is now pending in congress. This legislation will provide 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 (2009–2050) master plan to address challenges caused by climate change and resource depletion. It 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 2009h)
  - reduction in the use of fossil fuels 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
  - greening of existing industries and promotion of green industries
  - advancement of industrial structure
  - engineering of a structural basis for the green economy
- improvement in quality of life and enhanced international standing
  - greening the land and water, and building a green transportation infrastructure
  - building 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 decided to adopt the practice of five-year planning. Five-year plans are mid-term programs designed to implement the long-term strategy for green growth. Table 22 outlines the policy indicators of the first plan, for 2009–2013.

Table 22 Policy indicators, Five-year plan, 2009–2013

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

The Five-year Plan for Green Growth envisages fiscal spending of KRW 107 trillion (USD 86 billion) for 2009–2013. Under the plan, three objectives and 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, restoration of the four major rivers, and green transportation. As the economy recovers, the weight given to R&D will become more significant.

Roughly 2% of annual GDP is allocated to green investment, which is twice the amount recommended by the Green Economy Initiative advocated by the United Nations Environment Programme (1% of GDP). Table 23 shows rates of green investment to 2013.

Table 23 Rates of green investment, 2009–2013 (KRW trillion)

Category	Total	2009	2010–20	2012–13	Rate of increase (%)
Total	107.4	17.5	48.3	41.6	10.2
Mitigation of climate change and achievement of 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
Improvement in quality of life and enhanced international standing	27.9	5.2	10.5	12.2	3.6

USEFUL LINKS

Korea Energy Economics Institute (KEEI)—www.keei.re.kr
Korea Energy Management Corporation—www.kemco.or.kr

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

Korea Gas Corporation—www.kogas.or.kr

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

Statistics Korea—www.kostat.go.kr

Ministry of Knowledge Economy—www.mke.go.kr

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MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia. Its territory covers 330 242 square kilometres, spread across the southern part of the Malay Peninsula and the Sabah and Sarawak states on the island of Borneo. In 2007, Malaysia's population was around 27.4 million. Since 2000, Malaysia's GDP has grown steadily, at an average rate of 5.1% a year. Between 2006 and 2007, GDP grew by 6.4%, to USD 299.9 billion (USD (2000) at PPP). The GDP per capita increased by 4.6%, to USD 11 926 (USD (2000) at PPP) in 2007.

Malaysia's economy depends heavily on manufacturing and resource extraction, although there are ongoing initiatives to expand services and higher-value-added activities. In 2007, the manufacturing sector's share accounted for 30.3% of GDP. The major energy-intensive segments of the manufacturing sector are iron and steel, cement, wood, food, glass, pulp and paper, ceramics and rubber industries. During the same period, the mining sector, including oil and gas extraction, accounted for 8.6% 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 2007, Malaysia's crude oil reserve, including condensate, was 5.5 billion barrels. Malaysia also has an abundant natural gas reserve. At the end of 2007, Malaysia's proven natural gas reserves were 2.39 trillion cubic metres. Malaysia's hydropower potential is assessed at 29 000 megawatts (MW); 85% of potential sites are located in East Malaysia. Biomass resources are mainly from palm oil, wood and agro-industries.

Table 24 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	330 242	Oil (billion barrels)—proven	5.5
Population (million)	27.4	Gas (trillion cubic metres)—proven	2.39
GDP (USD (2000) billion at PPP)	299.9	Coal (million tonnes)	–[a]
GDP (USD (2000) per capita at PPP)	11 926		

a The coal reserve is unknown.

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan (IEEJ). (www.ieej.or.jp/egeda/database/database-top.html); *BP Statistical Review of World Energy 2009*.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 89 000 kilotonnes of oil equivalent (ktoe) in 2007. The largest energy source was gas, which accounted for 28 866 ktoe, or 44.3% of the total primary supply. Oil was ranked second, with 28 344 ktoe, followed by coal, with 7570 ktoe, and other sources, with 363 ktoe. In 2007, Malaysia produced an average of 743 thousand barrels of crude oil per day. During the same period, domestic consumption was around 528 thousand barrels (MEWC 2007). Malaysia exports the majority of its oil to Singapore, Thailand, Japan and South Korea. Malaysia's oil production is expected to fall in future, mainly due to the natural depletion of its reserves.

In 2007, Malaysia's natural gas production was 60.8 billion cubic metres and domestic consumption was 25.05 billion cubic metres (MEWC 2007). The Peninsular Gas Utilisation pipeline system supplied 23 908 ktoe of domestic gas, mainly for power generation and industrial use. Malaysia is one of the world's leading exporters of liquefied natural gas (LNG). In 2007, it exported a total of 23 777 ktoe of LNG to Japan, Korea and Chinese Taipei (PETRONAS 2008).

Coal is one of the primary fuels in Malaysia's energy sector. Coal is used primarily for power generation, and by the iron and steel industry and cement manufacturers. Malaysia's coal consumption in 2007 was 7.1 million tonnes of oil equivalent. Malaysia imports coal from China, Australia, Indonesia and South Africa.

In 2007, total gross electricity generation was 101 325 gigawatt-hours (GWh). Thermal generation, mostly from natural gas and coal, accounted for 93.6% of total generation and hydropower for the remainder. Coal accounted for 34.2% of the total fuels input for electricity generation.

Table 25 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	89 000	Industry sector	18 968	Total	101 325
Net imports and other	-24 069	Transport sector	15 688	Thermal	94 840
Total PES	65 143	Other sectors	8 382	Hydro	6 485
Coal	7 570	Total FEC	43 038	Nuclear	–
Oil	28 344	Coal	1 163	Geothermal	–
Gas	28 866	Oil	24 803	Other	–
Other	363	Gas	9 392		
		Electricity and other	7 680		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

In 2007, total final energy consumption in Malaysia was 43 038 ktoe. The industrial sector was the biggest final energy user at 18 968 ktoe, or 44.1% of total final energy consumption, followed by the transport sector at 15 688 ktoe, or 36.4%, and other sectors (agriculture, residential/commercial and non-energy) at 19.5%. By energy type, petroleum products contributed the largest share, with 57.6% of consumption, followed by gas (21.8%), electricity (17.9%) and coal and coke (2.7%).

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 Office; 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 2007). This includes 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 regulation 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, energy strategies are largely outlined in the government's Malaysia Five-year Plan. The plan sets out goals and indicative targets for Malaysia in a range of fields, including energy. The current plan, the *Ninth Malaysia Plan 2006–2010*, lays out actions that need to be taken in developing a sustainable energy sector, with a focus on renewable energy and energy efficiency (EPU 2006).

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 utilisation 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 utilisation of energy, by minimising the negative impacts of energy production, transportation, conversion, utilisation and consumption on the environment.

The National Depletion Policy was formulated to prolong and preserve the economy's energy resources, particularly oil and gas resources. Under this policy, total annual production of crude oil should not exceed 3% of oil originally in place, which currently limits oil production to around 680 thousand barrels per day (Mbbl/D). 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 generation fuel mix has been significantly reduced and replaced with gas and coal. In 2002, the Four-Fuel Policy was expanded to incorporate renewable energy as the fifth fuel after oil, gas, coal and hydro. Nuclear energy is not used in Malaysia. However, the economy is exploring nuclear potential as one option for its future power generation.

MARKET REFORMS

The Malaysian energy market is regulated and subsidies are provided to energy users. However, the economy is considering implementing energy market reforms by withdrawing energy subsidies gradually. In the Ninth Malaysia Plan, the government has planned to review the energy pricing structure to reflect the real cost of energy supply (EPU 2006). The plan states that a review will be undertaken to gradually reduce energy subsidies. In the 2010 budget report, the Malaysian Government announced that the motor-fuels subsidy will be restructured by implementing a fuel subsidy management system (MOF 2009). Currently, the subsidy is enjoyed by all road transport users. The system aims to limit the fuel subsidy to targeted groups.

ENERGY SECURITY

Malaysia 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.

UPSTREAM ENERGY DEVELOPMENT

Malaysia's upstream energy development is governed by the Petroleum Development Act, which was enacted to streamline the economy's upstream energy development. Under the Act,

Petroliam Nasional Berhad (PETRONAS), is vested with entire ownership and control of petroleum resources in Malaysia. PETRONAS is wholly owned by the Malaysian Government.

PETRONAS is intensifying the exploration of deepwater and extra-deep water areas. In 2008, three new fields came onstream, increasing the total number of producing fields in Malaysia to 88, of which 61 are oil fields and 27 are gas fields. Four new production-sharing contracts were awarded during 2008, bringing the total to 67, with 23 in Peninsular Malaysia, 21 in Sarawak and 23 in Sabah.

The three new fields are Kikeh, Abu and Tabu. Kikeh is the first of Malaysia's deepwater field to come onstream, with a peak production rate of 125 Mbbl/D. The Kikeh field is located about 1120 kilometres from Kota Kinabalu, capital city of Sabah, at a water depth of some 1300 metres and is jointly developed by Murphy Oil Corp and PETRONAS Cari Gali Sdn Bhd, a subsidiary of PETRONAS. Other deepwater fields under development are Gumusut-Kakap and Malikai fields. The Gumusut-Kakap is expected to come onstream by 2011 with a production capacity around 150 Mbbl/D. The economy's deepwater projects will assume a prominent role in providing new growth opportunities in Malaysia. Nine deepwater fields have been identified for commercial operations from 2007 to 2013.

PETRONAS is also stepping up efforts to pursue necessary cost-efficient solutions for small field development. Some 90 'hotspots' have been identified as having marginal field potential and are expected to be developed by 2010. To increase Malaysia's oil and gas supply security, PETRONAS is actively involved in international oil and gas exploration. As of January 2008, PETRONAS's total international reserves amounted to 6.24 billion barrels of oil. During the same period, PETRONAS was awarded 13 new production-sharing contracts internationally, bringing the number of international ventures to 63 in 23 economies.

ELECTRICITY AND GAS MARKETS

Between 1990 and early 1997, annual electricity demand growth in Malaysia averaged 14% a year on the back of 8% to 10% GDP growth. Electricity demand growth then fell to 4.5% in 1999 in the aftermath of the Asian financial crisis. However, the economy's GDP growth rates shot up again between 1999 (6.1%) and 2000 (8.9%), prompting concerns about the threat of a possible shortage of generation capacity if the GDP continued to grow. Electricity demand growth for 2000, for instance, was back at the pre–Asian financial crisis rate of 14%. The immediate reaction was to accelerate previously deferred new generation capacity projects to meet the possibility of continued high growth. However, the GDP growth rate levelled off and fell back to only 5% in 2001, thus creating persistent excess generation capacity in the following years due to the overhang of committed generation projects.

Malaysia is currently working to gradually reduce the excess reserve margin from around 43% to 25% over the long term. It is expected that no new projects will be implemented for the 2006–10 period, except for the already approved 750 MW Combined-Cycle Gas Turbine Tuanku Jaafar phase 2 project and two coal-fired power plants, the 2100 MW Tanjung Bin and the 1400 MW Jimah.

The role of hydropower in the generation fuel mix will be more prominent after 2010. Though most of the potential sites in Peninsular Malaysia have already been developed, there is still some untapped potential in the states of Pahang, Kelantan and Perak. However, the Bakun Hydroelectric Project, which is currently under development, has the greatest potential. The Bakun project will add 2400 MW to hydro-electric generation capacity. The government has also approved the Peninsular Malaysia – Sarawak interconnection link via submarine cable to channel the power generated from the Bakun project. The economy is also studying the possibility of developing more hydropower at the Rejang Basin in Sarawak.

The economy is exploring the possibility of using nuclear power. Currently, nuclear energy has no share in the generation fuel mix. However, recent developments in the world energy market—the volatility of oil and gas and coal prices, depletion of indigenous oil and gas resources, environmental concerns about coal-fired power plants and so on—have made the government consider nuclear energy as an option for 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 2008, the Peninsular Gas Utilisation system supplied 2170 million standard cubic feet per day (MMscf/D) of gas, an increase of 2% from 2007, for domestic consumption and export to Singapore. The power sector remains the largest domestic gas consumer, consuming 60.4% of gas transmitted through the system. Industrial, petrochemical and other users accounted for 32.4%, significantly increasing from 665 MMscf/D in the previous year to 703 MMscf/D in 2008. About 7.2% was exported to Singapore. The Peninsular Gas Utilisation gas input was obtained from the offshore Terengganu gas field and, through imports from the Malaysia–Thailand Joint Development Area, Indonesia and Viet Nam. The gas input from offshore Terengganu increased by 6.6%, and almost 20% of total supply was imported.

ENERGY EFFICIENCY

To enhance Malaysia's energy efficiency, the Efficient Management of Electrical Energy Regulations 2008 was gazetted on 15 December 2008. The regulations required users with a total electricity consumption of 3 million kilowatt-hours or more over six consecutive months to appoint electrical energy managers and to implement efficient electrical energy management. To drive well-managed strategy and programs for energy efficiency development, the government is formulating an action plan for improving energy efficiency. The action plan will put in place a strategic direction for energy-efficiency development in the economy. The strategies under the plan will be focused on the industrial, commercial and residential sectors. The plan is expected to be ready by March 2010.

RENEWABLE ENERGY

Malaysia is continuously encouraging the development of renewable energy (RE) in the economy through policy and various 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 Ninth Malaysia Plan specified a target for electricity grid–connected RE generation: 300 MW in Peninsular Malaysia and 50 MW in Sabah.

To fast-track renewable energy power generation development in Malaysia, the government launched the Small Renewable Energy Power (SREP) program. The SREP program permits power generated from renewable resources to be sold through Malaysia's grid system. SREP developers can sell power to power utilities through the Renewable Energy Power Purchase Agreement (REPPA). The REPPA allows renewable energy power sales for up to 21 years, with a maximum capacity for export to the grid of 10 MW. The program permits the utilisation of all types of renewable energy, including biomass, biogas, municipal solid waste, solar, mini hydro and wind.

The government is formulating various strategies to promote successful renewable energy development, including an action plan for a systematic and holistic approach to assisting renewable energy project developers, especially SREP projects. The plan will include:

- in the short term (up to 2010), a review of the obstacles faced by prospective RE developers. Measures to remove the identified obstacles and to stimulate and re-energise the RE program—particularly the SREP program—will be proposed.
- a review of REPPA and its major issues, to recommend how the terms and conditions can be simplified and standardised, differentiating between bigger projects and smaller and rural projects.
- in the longer term (beyond 2010), new targets for RE utilisation by type of RE sources and by region.
- economic support through fiscal and financial incentives improvement.

CLIMATE CHANGE

Malaysia signed the United Nations Framework Convention on Climate Change in 1993 and ratified the Kyoto Protocol in 1994. The economy is a non–Annex 1 party to the protocol. Malaysia actively participates in the clean development mechanism (CDM) under the protocol. As of October 2009, 67 CDM projects from Malaysia had been registered with the CDM Executive Board; 53 were energy-based projects. On 17 December 2009, at the fifteenth Conference of the Parties to the United Nations Framework Convention on Climate Change in Copenhagen, the Malaysian prime minister pledged that Malaysia would adopt a voluntary greenhouse gases emissions reduction of up to 40% of the 2005 level by 2020. However, the prime minister stressed that, for the target to be achieved, developed economies (Annex 1 parties) must provide strong support in terms of the transfer of technology and adequate financing.

NOTABLE ENERGY DEVELOPMENTS

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
- 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, and 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 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 fund amounting to MYR 1.5 billion. The fund will provide soft loans to companies that supply and utilise green technology.

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

- Building owners obtaining GBI certificates from 24 October 2009 until 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 until 31 December 2014.

USEFUL LINKS

Economic Planning Unit, Prime Minister's Department—www.epu.gov.my

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

Ministry of Energy, Water and Communications—http://medis.ptm.org.my

Ministry of Finance—www.treasury.gov.my/index.php?lang=en

PETRONAS—www.petronas.com.my

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MEXICO

INTRODUCTION

Mexico is in North America, bordered by the United States to the north and Belize and Guatemala to the south. The land area of around 1.96 million square kilometres is divided into 32 states. Mexico is one of the most populated economies in Latin America, with a total population of 106.7 million in 2008, steadily growing at an average annual rate of 0.8%. The population is increasingly urban; the urban population grew from 68.7% in 2001 to 72.1% in 2008, increasing at an average rate of 1.0% per year over the past eight years (CONAPO 2009). The three largest urban metropolitan areas in Mexico are Mexico City, Guadalajara and Monterrey. Mexico City is formed by the Capital City (Distrito Federal) and its metropolitan area, known as Zona Metropolitana del Valle de México. Mexico City is one of the largest urban centres in the world, with around 20.3 million people.

Reflecting global economic conditions, the Mexican economy was less dynamic in 2007 than in 2006; during the first three quarters of 2007 the economy was in recession, as shown by a decline in external demand and internal sales. The last quarter showed negative economic growth, with slow movement of non-commercial goods in the production sector. In 2007, Mexico's real GDP growth was 3.4%, reaching USD 1066 billion (USD (2000) at PPP) (EDMC 2009). However, the rate of GDP growth has been declining over the past two years, after the Mexican economy reached an annual growth rate of 5.4% of GDP in 2006. As a result of the poor economic growth since then, the economy has shown a decline in the employment rate, principally in the formal sector. The per capita GDP increased by 2.1% from 2006 to USD 10 130 per inhabitant in 2007. Mexico's energy intensity decreased by 1.8% over 2006, reaching 183.5 kilotonnes of oil equivalent (ktoe) per USD 1 billion (USD (2000) at PPP) at the end of 2007.

These economic conditions resulted in a reduction in non-petroleum exports, a decline in imports, a drop in external income from family remittances, and both credit and investment restrictions on external capital. Remittances are Mexico's second-largest source of foreign income after crude oil exports; however, after robust average annual growth of 20.4% from 1999 to 2007, remittance incomes grew only slightly by 1% in 2007 to USD 23 979 million, or around 2.6% of GDP. From a sectoral view, primary sector GDP increased by 3.2%, while the secondary sector (industrial) contracted by 0.7%, influenced by a contraction in mining by 2.3%, construction by 0.6%, and manufacturing by 0.4%; however, electricity increased by 2.2% (Banxico 2008).

The global and domestic economic environment in 2007 and 2008 affected Mexico's energy supply and demand. Mexico's primary energy production had a negative growth rate of 0.2% in 2008. However, the economic recession did not have a serious impact on all energy resources; in 2008, electricity and natural gas grew significantly by 23.5% and 12.7%, respectively. Production of other energy products, such as coal, crude oil, condensates, sugarcane bagasse and wood, dropped in the same year (SENER 2008a).

The oil industry plays a crucial role in the economy, accounting for about one-third of total revenues. Mexico has important crude oil and gas production fields and offshore and onshore facilities. The economy's four crude oil and gas production regions are the North-eastern Marine region, the South-western Marine region, the Southern region and the Northern region. In 2008, Mexico ranked seventeenth in the world for its proven crude oil reserves (including gas liquids), totalling 11 866 million barrels (MMbbl); thirty-fifth in proven natural gas reserves, with 13 trillion cubic feet; sixth in crude oil production, with 2792 thousand barrels per day (Mbbl/D); and thirteenth in natural gas production, with 6919 million cubic feet per day (MMcf/D) (Pemex 2009a).

Table 26 Key data and economic profile, 2007

Key data		Energy reserves *	
Area (sq. km)[a]	1 964 375	Oil (million barrels)—proven[b]	11 866
Population (million)[a]	106.7	Gas (trillion cubic feet)—proven[b]	13
GDP (USD (2000) billion at PPP)	1 066	Coal (million tonnes)—recoverable[c]	1 211
GDP (USD (2000) per capita at PPP)	10 130		

* Energy reserves correspond to 2008 figures.

a Instituto Nacional de Estadística, Geografía e Informática (INEGI), Información geográfica.

b As January 1st, 2009; *2009 Statistical Yearbook*, Petróleos Mexicanos, Mexico.

c At the end of 2008; *BP Statistical Review of World Energy 2009*.

Source: Energy and Data Modelling Centre, Institute of Energy Economics, Japan (2009).

At the end of 2008, Mexico had 51 106 MW installed capacity of electricity generation, which was provided by a split ownership of electric utilities (77.6%) and independent power producers (IPPs; 22.4%). Electricity is produced from hydrocarbon resources (oil, natural gas and coal) and from renewable energy, such as nuclear, hydro, geothermal, wind and biomass. Renewable sources and nuclear energy made up 26.9% of the total installed capacity. Hydroelectric plants had an installed capacity of 11 343 MW, and nuclear, geothermal and wind had capacities of 1365 MW, 965 MW and 85 MW, respectively. Mexico generated 235.9 TWh of electricity during 2008, an increase of 1.4% over 2007. Major electricity generation increases came from hydro plants, and 43.8% of growth was provided by the continuous operation of a new hydropower plant at El Cajón (SENER 2008a).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Mexico's total primary energy supply in 2007 was 173 257 ktoe, up 1.0% from 171 574 ktoe in 2006. Oil and gas dominate primary energy supply with shares of 44% and 39.6%, respectively. Primary supply from coal decreased slightly by 3% from 2006 to reach 9121 ktoe (SENER 2008a and EDMC 2009).

CRUDE OIL AND PRODUCTS

Petróleos Mexicanos (Pemex) is one of the largest crude oil and natural gas companies in the world. By law, Pemex is the sole producer of crude oil and its derivatives in Mexico, from upstream exploration to final downstream distribution, by means of its four integrated companies: Pemex Exploration and Production, Pemex Refining, Pemex Gas and Basic Petrochemicals, and Pemex Petrochemicals. In 2008, Pemex commemorated 70 years of fulfilling its responsibility for the exploration for, and exploitation and processing of, hydrocarbons in Mexico, during which it has been a significant taxpayer and an important contributor to Mexico's economy.

Mexico's proven oil reserves have declined in recent years; in 2008, reserves were 10.5% lower than in the previous year. In 2008, Mexico was ranked sixth-largest crude oil producer in the world (with total production of 2.8 MMbbl/D), thirteenth-largest natural gas producer (6919 MMcf/D) and tenth-largest crude oil exporter. Most of the crude oil produced in Mexico is heavy crude oil (63.2%); light crude (29.2%) and extra-light (7.5%) make up the remainder (Pemex 2009a).

In 2008, total oil production was 3 157 million barrels per day (MMbbl/D), a reduction of 9% from the previous year. This negative growth is largely a result of declining production over recent years in the Cantarell field; in 2008, the field produced 33% less than in 2007 (Pemex

2009a). Delays in the start-up of infrastructure at Chicontepec field also contributed to the overall production decrease.

Domestic consumption accounted for 1347 MMbbl/D (48.9% of the total volume produced), and the remaining 1407 MMbbl/D (51.1%) was exported. Of that amount, about 81.4% was exported to the United States, followed by 10.3% to Europe.

Mexico has six major refineries, with a total capacity of 1540 Mbbl/D. The six refineries form the Sistema Nacional de Refinación (SNR), which is administered by Pemex Refining. Pemex has a joint venture with Shell in the Deer Park refinery near Houston, Texas, in the United States. The total volume distributed to the SNR in 2008 was 1261 Mbbl/D, a 0.7% drop from 2007 (Pemex 2008a). The decrease was primarily due to greater scheduled maintenance activity, higher heavy crude oil processing and significantly lower demand for fuel oil from the Mexican electricity sector. The refining margin per barrel in 2008 (USD 2.3) was substantially lower than the margin in 2007 (USD 7.0 per barrel), primarily due to higher crude oil prices in 2008, which averaged 22.7% higher than in 2007. In the petroleum products subsector, Pemex Refining produced a total of 1307 Mbbl/D in 2008, of which 34.4% was gasoline, followed by diesel (26.2%) and fuel oil (22.1%).

Despite its status as one of the world's largest crude oil exporters, Mexico is a big importer of petroleum products. In 2008, it imported 618.9 Mbbl/D of refined products (gasoline, diesel, fuel oil, propane, liquefied gas, dry gas and others), while exports were 207.8 Mbbl/D. Of the imports, gasoline made up about 55.8%, an increase of 9.6% compared to 2007. To increase output volume and improve the quality of petroleum products, the government has carried out a long-term upgrading (or reconfiguration) plan for all six refineries. The plan is to increase the total refinery capacity by about 350 trillion barrels per day (Tbbl/D) and to improve the quality of gasoline by reducing the amounts of sulphur and lead.

Table 27 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	251 288	Industry sector	32 704	Total	230 927
Net imports and other	–76 774	Transport sector	51 554	Thermal	185 812
Total PES	173 257	Other sectors	31 096	Hydro	27 042
Coal	9 121	Total FEC	115 355	Nuclear	10 421
Oil	76 279	Coal	1 106	Geothermal	7 404
Gas	68 659	Oil	75 985	Other	248
Hydro power	6 405	Gas	13 398		
Nuclear power	2 734	Electricity and other	23 759		
Geothermal	1 753				
Other	8 304				

Source: Balance Nacional de Energía 2008, Sener, Mexico (www.energia.gob.mx), and Energy and Data Modelling Centre, Institute of Energy Economics, Japan (2009) (www.ieej.or.jp/egeda/database/database-top.html).

NATURAL GAS

Mexico's proven natural gas reserves at 1 January 2009 totalled 13 trillion cubic feet, of which 65% consists of associated gas and the remaining 35% of non-associated gas. '3P' reserves (proved, probable and possible) of natural gas totalled 60.37 trillion cubic feet, of which 74% was associated gas and 26% was non-associated gas. From 2008 to 2009, 3P natural gas reserves decreased by 984 billion cubic feet (Bcf) as production (2566 Bcf) outpaced the addition of new reserves (1.56 Bcf). By type of facility, 59% of total proven natural gas reserves is in onshore fields and 41% is in offshore fields.

The Burgos natural gas field has been the main producer of non-associated natural gas over the past 10 years; however, there was a significant increase in production from the Cantarell field

during 2008 which subsequently declined in 2009. Production of natural gas from Cantarell increased by 54.0% between 2007 and 2009, while production from Burgos increased by 7.3%. Total natural gas production averaged 7030 MMcf/D in 2009, an increase of 1.6% from 2008. The Northern region is the largest producer, accounting for 36.1% of total production, followed by the North-eastern Marine region (25.4%). By type of natural gas, Mexico produced 3572 MMcf/D of dry gas and 377 Mbbl/D of natural gas liquids. Dry natural gas production increased by 3.2% compared with the previous year.

Exports of dry natural gas decreased by 38.0% from 107.4 MMcf/D in 2008 to 66.5 MMcf/D in 2009. Imports of natural gas decreased by 5.6% over the same period, from 447.1 MMcf/D to 422.0 MMcf/D. Imports came primarily from the United States, while smaller proportions came from Trinidad and Tobago, Egypt and Nigeria.

COAL

In Mexico, coal is the smaller constituent among the primary energy supply sources (2.2% in 2008). Mexico has 1211 million tonnes (Mt) of recoverable coal reserves. Most are in the state of Coahuila in the north-east part of the economy; additional resources are in Sonora (in the north-west) and Oaxaca (in southern Mexico). Around 70% of recoverable reserves are anthracite and bituminous, while 30% are lignite and sub-bituminous. During 2008, coal production decreased by 8.3% from 6.0 Mtoe (12.5 million tonnes) in 2007 to 5.5 Mtoe (11.5 million tonnes) in 2008. This reduction was a result of the lower production of both thermal and coking (metallurgical) coal, which decreased by around 8.3% and 8.2%, respectively.

Mexico's coal exports decreased by 9.1% from 2007, but the reduction was marginal in comparison with the decrease in imports. Total imports were 2.7 Mtoe (4.3 million tonnes) in 2008, a decrease of 20.8% from 2007. The imports came principally from the United States, South Africa, Australia and Colombia. In general, total coal supply was 6.8 Mtoe (13.7 million tonnes) during 2008 (SENER 2008a).

The principal use of coal in Mexico is in the transformation sector (electricity generation and coking plants), which took 91.6% of the total coal supply in 2008. Of the total coal supply, about 70% was distributed to power plants for electricity generation.

ELECTRICITY

The Mexican electricity sector is made up of the public electric power utilities and IPPs (for activities in which private participation by IPPs is allowed). The transmission, transformation, distribution and sale of electricity for public service purposes had been reserved to the federal government through its two companies—Comisión Federal de Electricidad (CFE) and Luz y Fuerza del Centro (LyFC)—until October 2009, when by presidential decree the LyFC company was closed (DOF 2009). Currently, all power activities are controlled by CFE exclusively. The Mexican electricity grid is well developed and is interconnected through the National Electricity System (Sistema Eléctrico Nacional, or SEN), controlled by the CFE through its National Centre of Energy Control (Centro Nacional de Control de Energía, or CENACE).

In 2008, the total installed power capacity was 51 106 MW, an increase of 77 MW from 2007. About 77.6% of installed capacity came from the two public enterprises in 2008, and the remaining 22.4% from IPPs. Total electricity generation was 235.9 TWh, an increase of 1.0% from 2007. Of the total electricity generation, 67.8% was generated by CFE and LyFC enterprises and the remaining 32.2% by IPPs.

Mexico has interconnections with the United States in the north and Belize and Guatemala in the south. In 2008, Mexico exported 1452 GWh, an increase of 0.1% from 2007, and imported 351 GWh, up 26.4% from 2007. Total electricity supply in 2008 was 247 TWh; transmission and distribution losses accounted for 41.4 TWh (or 16.7% of the total). Most of the electricity generated in Mexico is consumed by the industrial sector, which accounts for 58.8% of internal sales (or 107.6 TWh), followed by the residential, commercial and public sectors with 37.1% (or 68.1 TWh).

RENEWABLES

Renewable energy in Mexico is provided by hydro, geothermal, wind, nuclear and biomass (sugarcane and wood). Natural resources such as hydro, geothermal, wind and nuclear are used for electricity generation, while biomass is used for heating purposes. The total installed capacity of renewables was 13.75 GW in 2008, the same as in 2007. Of the total installed capacity, hydro made up 82.4% (SENER 2008a).

Total production from biomass (principally sugarcane bagasse and wood) was 8.25 Mtoe. Sugarcane biomass (28.4% of the total energy biomass production) is used in the industrial sector. Wood made up the remaining 71.6% (or 5.9 Mtoe). The principal use of wood is for heating and cooking in the residential, commercial and public sectors.

FINAL ENERGY CONSUMPTION

In 2007, total final energy consumption in Mexico reached 115 355 ktoe, an increase of 6.7% from the previous year. Total energy consumption was divided primarily between the industrial and transport sectors. Industry consumed 28.3% of energy, the transport sector 44.6%, and other sectors (including residential, commercial and agricultural) 26.9%. By fuel source, petroleum products accounted for 65.8% of consumption, natural gas 11.6%, coal 0.9% and electricity and others 20.6% (SENER 2008a, EDMC 2009).

ENERGY POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Mexican Government has developed an overall long-term policy vision called Visión 2030. It is based on five pillars: the rule of law and public safety; economic competitiveness and the generation of jobs; equality of opportunities; environmental sustainability; and effective democracy and responsible foreign affairs. Each pillar has numerous goals, with detailed strategies. Visión 2030 represents an ambitious new program based on the collaboration of all levels of government. The main goal is to provide all Mexicans with access to a better standard of living. 'Live better' stands for a stronger economy in constant development, with more investment to create more and better jobs for Mexicans.

In Mexico, the state's ownership of natural resources, including oil, and its control over the oil and electricity industries are principles embedded in the Mexican Constitution, Article 27 of which defines strategic areas that are the exclusive responsibility of the government, including the ownership and production of radioactive minerals, oil and all other hydrocarbons, basic petrochemical processes, electricity and nuclear electricity generation.

Mexico's Ministry of Energy (SENER) is responsible for the economy's energy policy within the current legal framework. The Energy Sector Program 2007–2012 was developed from the Visión 2030 project and is linked to the National Development Plan 2007–2012. The main objective of Mexico's energy policy is to ensure supply of the energy required for development, while achieving competitive prices, minimising environmental impacts, and operating at high quality standards. The Energy Sector Program sets out the main policies, strategies, goals and measurable targets set for the energy sector (SENER 2007a):

- Ensure the sustainability and competitiveness of the economy's hydrocarbon industry
- Promote adequate tariff levels to cover the costs associated with the efficient operation of public agencies in the electricity sector
- Promote a diversified portfolio of primary energy sources that includes renewable energy sources
- Promote the efficient production and use of energy and the mitigation of greenhouse gas emissions

- Strengthen the operational standards of the electricity sector's public agencies to enhance the quality and reliability of the network.

Mexico began economic reforms in the 1980s, with the aim of liberalising the economy and opening it to foreign trade and investment. It is now in the middle of significant structural change in its energy policy.

MARKET REFORM

Without a doubt, the most important event in 2008 for energy policy in Mexico was the approval of the Energy Reform. 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. In total, seven laws were approved: 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.

OIL SECTOR

The Law of Petróleos Mexicanos, besides governing organisational and functional aspects, regulates construction projects, acquisitions, the budget and debt, as well as administrative responsibilities. The reform strengthens Pemex to face its present and future challenges more effectively. The Mexican Government will aim for Pemex to have greater flexibility to decide on the optimal way to organise itself in order to best comply with its obligations. As a consequence, to face future challenges, the government established the National Hydrocarbon Commission (CNH, by its Spanish acronym) on 28 November 2008. CNH's objective is the regulation and supervision of the exploration for and exploitation of hydrocarbons, as well as all processing activities, transport and storage from exploration and exploitation projects. CNH, which was officially installed on 20 May 2009, will have all technical and economic capacities for its operation as a decentralised organisation of the Ministry of Energy (SENER 2009a).

On 16 May 2008, as part of the new effort to strengthen the hydrocarbon sector, the Mexican Government, by means of the Ministry of Energy and the Science and Technology National Council (CONACYT), signed the SENER–CONACYT agreement for the establishment of the Hydrocarbon Sectorial Funds (SENER–CONACYT 2009). These are trust funds to overcome problems and exploit opportunities in hydrocarbon resource development through scientific research and applied technology in exploitation, exploration and refining, as well as the production of basic petrochemicals.

POWER SECTOR

On 11 October 2009, as part of the Mexican Government's action plan to improve energy efficiency in the power sector, the decentralised Luz y Fuerza del Centro (LyFC) organisation was abolished by presidential decree (DOF 2009). As a result, lay-offs of all its employees began and the control of all its technical operations was taken over by the Comisión Federal de Electricidad (CFE), now the only public electricity company in the economy.

ELECTRICITY

The Ministry of Energy has formulated plans to meet increasing energy demand in parallel with economic development. The *Electricity Market Outlook 2009–2024*, compiled in 2009, projects that over the next decade domestic electricity demand will grow rapidly, at an annual average rate of 3.6%, with total consumption expected to reach 365.3 TWh in 2024 (SENER 2008b). This growth will be driven mainly by public utilities' sales. Between 2009 and 2024, the public service expansion program will require the addition of 37 615 MW of installed capacity, of which 5113 MW is already in place or in the construction or bidding phase, and an additional 32 096 MW for which no bidding has yet taken place. In addition, a remote self-supply and

cogeneration capacity of 2087 MW, from both private and public sector projects, is under consideration.

ENERGY EFFICIENCY

Since 1989, Mexico has created institutions to promote and develop energy-efficiency programs. Mexico's administrative efforts in energy efficiency and conservation were strengthened through the transformation of the National Commission for Energy Savings (CONAE) into the National Commission for the Efficient Use of Energy (CONUEE) in 2008. The aim was to further promote energy efficiency and provide technical advice on the sustainable use of energy. Although energy-efficiency programs continue, the government has, since 2000, constantly reduced the budgets of the institution charged with their oversight (CONAE, now CONUEE).

Other programs, such as the electricity sector's Energy Saving Program (PAESE) and the Trust Fund for Electricity Savings (FIDE), have developed several initiatives, such as energy-efficiency standards for household appliances. The FIDE program provides financing for energy audits and assessments, and facilitates the acquisition and installation of energy-efficient equipment. The most effective have been the Official Mexican Standards, or Normas Oficiales Mexicanas (NOMs). NOMs contain all the specific mandatory regulations for use, management, description, maintenance and warranty that a product must comply with to be sold on the Mexican market (SE 2009).

For the public sector, the Mexican Government, through CONUEE, launched a program to provide for energy-efficiency action plans in buildings, transport fleets, and facilities of the federal administration (CONUEE 2009a). For the transport sector, the Mexican Government launched a guideline—'Efficient auto driver' (Automovilista Eficiente)—to provide technical assistance, training, information and general tools for efficient use in the transport sector at public, private and social levels (CONUEE 2009b). However, at the time of writing, energy-efficiency programs in the transformation sector (including the crude oil refining and petrochemical industries) continue to have a small impact in Mexico, and levels of energy degradation and greenhouse gas emissions remain high. One opportunity to reduce energy degradation (or improve energy efficiency) in this sector is the implementation of effective and advanced tools, such as exergy analysis or advanced process optimisation, for which relevant projects have been identified in other economies, such as the United States (USDoE 2006) and the Netherlands, and which Brazil's oil sector has recently adopted (Petrobras 2009).

RENEWABLE ENERGY

Mexico has developed new policy and regulatory mechanisms for the introduction of renewable energies as a result of the Energy Reform approved in October 2008. 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 the Energy Transition and Sustainable Energy Use
- the Special Programme for the Efficient Use of Renewable Energy
- the Introduction Programme of Biofuels
- the Advisory Council for Renewable Energies.

With the objective of reducing hydrocarbon fuel dependency and introducing the sustainability concept in the policy frameworks of the Mexican energy sector, the current administration has implemented its strategies in two ways: energy efficiency and renewable energies (SENER 2007a).

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. Biofuels for electricity generation, transport and the rural residential sector have considerable potential in Mexico. The use of this energy would allow the economy to foster sustainable development and create new jobs, combat poverty and increase the renewable element of the energy mix. One estimate puts the potential for bioenergy use in the energy sector at 16% by 2030, based on a high-penetration scenario (SENER 2009b).

CLIMATE CHANGE

In 1992, Mexico signed the United Nations Framework Convention on Climate Change (UNFCCC) as part of the effort to mitigate the effects of climate change by reducing greenhouse gas (GHG) emissions. Mexico contributes nearly 1.6% of the world's GHGs, with total emissions of 715 Mt of carbon dioxide equivalent (CO_2-e) in 2006—the twelfth-largest emitter in the world. As a strategy for mitigation and adaptation to climate change, Mexico presented the National Climate Change Strategy (ENCC, by its Spanish acronym) on 25 May 2007 (CICC–SEMARNAT 2007). As a result of the ENCC, the Special Climate Change Programme 2009–2012 (PECC) was published in 2009. PECC lists specific objectives and goals to reduce GHG emissions by up to 20% by 2020, and by around 50% by 2050, compared to 2000 levels (SEMARNAT 2009). However, in December 2009, the Mexican Government announced during the Conference of Parties of the UNFCCC (COP15) in Copenhagen, Denmark, a compromise to reduce GHG emissions by up to 30% of 2000 levels by 2020 (Presidencia de la República 2009). According to the Mexican Government, with financing and the support of high technology and in cooperation with developing economies, the proposed goals could be achievable with the establishment of a post-2012 multilateral regime.

For short-term mitigation of climate change, Mexico has assumed the compromise to reduce emissions by 51 Mt of CO_2-e by 2012, compared to 2000 levels. To achieve this goal, initiatives will need to be implemented in the energy, agricultural and forestry sectors, as well as others in the areas of land use and waste management. According to the Mexican Government, multilateral measures are needed, and the PECC takes five into account: external policy; institutional strengthening; climate change economy; education, communication and participation; and research and technology development.

Finally, during COP15, the president of Mexico announced its encouragement and leadership of the Global Fund to Fight Climate Change (or Green Fund), a proposal of the Mexican Government. The aim is to expand the participation of all economies that carry out actions to promote clean development, as well as to support, financially and technologically, global warming mitigation and adaptation measures (Presidencia de la República 2009).

RESEARCH AND DEVELOPMENT

In Mexico, R&D for the energy sector is carried out by three research bodies: the Mexican Petroleum Institute; the Electric Research Institute; and the National Nuclear Research Institute.

As a result of the structural reforms, the government will support R&D in strategic areas through its sustainable development vision. One of the most important developments has been the launching of the Sectorial Fund by CONACYT–SENER to promote financing of R&D into the efficient use of energy. The fund's resources will be allocated to finance projects involving scientific research and applied technology for renewable energy sources, energy efficiency, the use of clean technologies and diversification of primary sources of energy, as well as adoption, innovation, assimilation and technological development in those areas. An agreement for the creation of the Sectorial Fund for Hydrocarbons and the Sectorial Fund for Sustainable Energy was signed on 16 May 2008. Both funds will receive resources from the annual payment of duty for scientific and technological research on energy by Pemex Exploration and Production, which in 2012 will reach a rate of 0.6% for crude oil and natural gas. For 2008, the Income Law indicates an amount of MXN 1110 million; 55% will be allocated to the Sectorial Fund for Hydrocarbons, 10% to the Sectorial Fund for Sustainable Energy and 35% to the Scientific Research and Technological Development Fund of the Mexican Petroleum Institute. The main

goals of the Hydrocarbon Sectorial Fund are scientific research and applied technology for the exploration for, and production and refining of, hydrocarbons, such as the production of basic petrochemicals, as well as the adoption, innovation, assimilation, technological development and training of specialised human resources in those areas.

The Sectorial Funds will contribute to development and technological innovation in support of two main priorities: to ensure the energy supply and to combat climate change.

NOTABLE ENERGY DEVELOPMENTS

OIL SECTOR

To meet its challenges in the oil sector, Mexico is focusing not only on discovering more reserves and increasing hydrocarbon production volumes, but also on improving the efficiency of exploration and production and on investment to increase its refining capacity.

EXPLORATION AND PRODUCTION

Pemex Exploration and Production has an extensive portfolio of development projects, including three of great importance: the Chincontepec, Ku–Maloob–Zaap (KMZ) and Cantarell projects.

The Chincontepec project (or Aceite Terciario del Golfo) involves around 39% of the economy's total hydrocarbon reserves (or 17.7 billion barrels of crude oil equivalent). The project's objective is to contribute to the achievement of the goals of the Pemex Exploration and Production Strategic Program by accelerating the recovery of 3412 MMbbl of crude oil and 4123 Bcf of natural gas during the period from 2009 to 2023. Chicontepec reservoirs are characterised by their low hydrocarbon content, permeability and pressure, which result in low well productivity; they require complex exploitation methods. During 2008, the full investment was used for drilling activities and major workover of wells. By the end of that year, 704 wells were operating and producing.

The Ku–Maloob–Zaap (KMZ) project aims to obtain a cumulative production of 4526 MMbbl of crude oil and 1725 Bcf of natural gas during the period from 2002 to 2025. This production will be made possible by drilling wells and by constructing and modernising infrastructure. It will incorporate new reserves of 1630 MMbbl of crude oil equivalent. As of December 2008, KMZ operated with 132 wells and 24 offshore platforms. However, new facilities within the KMZ project are as yet underdeveloped. Dehydration and desalination plants, scheduled for installation in 2009, are expected to increase pumping and power generation capacity to increase production.

The Cantarell project aims to achieve production of 820 MMbbl of heavy crude oil and 1350 Bcf of natural gas during 2009, through activities such as maintaining pressure, drilling development wells and optimising production systems. During 2008, Pemex Exploration and Production invested around MXN 38 billion to manage the natural decline of the Cantarell oil field. It completed 20 wells and installed dehydration and desalination plants. It also installed turbo compressors to minimise gas flaring and to send sour gas to process, as well as to increase gas re-injections.

REFINING

Pemex has completed the reconfiguration of four of its six refineries (Madero, Salamanca, Tula and Cadereyta). Currently, the reconfiguration project at the Minatitlan Refinery is ongoing, and test operations of the new plant began in late 2010. However, the biggest project inside Pemex Refining is the construction of new refining capacity: after the results of economic and technical evaluations were presented in July 2008 (Pemex 2008b), Pemex announced the location of the new Bicentenario Refinery in August 2009 (Pemex 2009c). The company is also evaluating a reconfiguration project for Salamanca Refinery.

In line with the new energy policy, the government intends to construct a new crude oil refinery with 300 Tbbl/D of installed capacity. The project was announced in April 2009 after economic and technical evaluations (Pemex 2009b). The new capacity will produce around 145 Tbbl/D of gasoline, 91 Tbbl/D of diesel and 12 Tbbl/D of jet fuel, all of which will have an ultra-low sulphur content. The new refinery will be built in the state of Hidalgo, which is the most feasible and profitable location, from late 2010 and is scheduled to begin operations in 2015. Total investment for new refinery construction, including pipelines and related infrastructure to connect it to demand centres, is estimated at USD 9.96 billion (MXN 129 000 million). Pemex's strategic plans also cover the revamp of the Salamanca Refinery at an estimated cost of USD 3 billion to help meet the economy's mounting refined products deficit. Petroleum product imports, particularly of gasoline, are expected to decrease by 2015 with the introduction of this additional refining capacity. However, the constant fuel demand in the transport sector and the lack of more efficient and effective refineries mean that Mexico is expected to continue being an importer of gasoline. The incorporation of new distillation capacity is expected to increase diesel production to be able to meet domestic demand.

GAS AND PETROCHEMICALS

Mexico has 12 natural gas processing centres, which processed 4399 MMcf/D of natural gas in 2009. Cactus Gas Processing Centre contributed 23.6% of total processing. Domestic consumption in 2009 was 3119 MMcf/D, an increase of 1.1% from 2008. An important consumption driver is power generation and industrial distribution.

Pemex has eight petrochemical processing centres with a total installed capacity of 12 798 Mt. During 2008, total petrochemical production was 7841 Mt and domestic sales were 2784 Mt. Of total production, 33.2% was ethane derivatives, 25.7% methane derivatives and 17.2% aromatic derivatives; the remaining 23.9% comprised propylene derivatives and others.

In the area of gas development, the most important project for the production of non-associated natural gas is Pemex's Burgos project. This project has accounted for around 21% of Mexico's natural gas production since 2000. Its production of non-associated gas was 1599 MMcf/D in December 2009.

Pemex has also taken up petrochemical projects. As a result of a 2007 cooperation agreement between Pemex and the Brazilian firm Unigel, important advances were achieved in 2008. One business alliance project between Pemex and Unigel involves ethane commercialisation under long-term contract and with a fixed price based on an established formula. Pemex will invest around USD 5.3 million to reactivate an acrylonitrile plant in Pemex Petrochemicals, from which production of 60 000 tonnes per year is expected. In addition, Unigel will invest about USD 20 million to construct a new plant in the same Pemex facilities to produce acrylic sheets and to take advantage of the Pemex's cyanhydric acid production.

Within the business portfolio in Pemex Petrochemicals, this establishment will offer a stable supply to the fertiliser industry, with long-term contracts and fixed prices for ammonia, through the use of hedging. Pemex will also resume ammonia production for the market.

In addition, Pemex has commissioned two enterprises to deliver the Ethylene XXI project: Idesa (from Mexico) and Braskem (from Brazil). Both enterprises will have a long-term contract for ethane supply as raw material for the production of ethylene and other derivatives.

As part of Pemex's environmental protection strategy, and to increase energy efficiency and achieve higher energy savings, a large-scale cogeneration plant will be built within the Nuevo Pemex gas processing complex. The plant under consideration will have an installed capacity of 300 MW of electricity and 800 tonnes per hour of steam. Investment in the project is expected to be USD 461 million, and it will generate around 1500 new jobs. This is an innovative project for the enterprise and will have a strong impact on increasing energy efficiency and reducing GHG emissions in the sector.

LIQUEFIED NATURAL GAS

In order to increase the supply of natural gas, Mexico's energy policy has established strategies to diversify supply. The policy supports the installation of liquefied natural gas (LNG) storage and regasification terminals in the Gulf of Mexico and on the Pacific coast to complement domestic production and to diversify supply sources at competitive prices. Under the policy, Mexico's Energy Regulatory Commission (CRE) has awarded several LNG storage permits.

Two regasification plants in the north of Mexico are currently under commercial operation and will gradually be concessioned by CRE. In September 2006, the Altamira Terminal began operation; by 2007, it reached half of its regasification capacity; on average in 2008 it processed 331 MMcf/D; and by 2010 a maximum capacity of 500 MMcf/D is expected to be achieved. The terminal will supply natural gas to several of CFE's power plants, such as Altamira V, Tamazunchale I, Tuxpan II and Tuxpan V. In addition, Central Valle de México II is expected to receive gas by 2013. Another regasification plant, in Ensenada, Baja California, began LNG imports in April 2008, when testing was carried out at the plant. It finally began operations in July 2008 with an installed capacity of 1000 MMcf/D. The owner of the Ensenada LNG terminal is Sempra Energy, half of whose capacity is claimed by Shell. The terminal is to supply gas to a combined-cycle plant; the remainder is to be traded in the United States (California and Arizona).

A third LNG terminal will be installed in Manzanillo, Colima, by 2011. The natural gas from the terminal will be consumed by CFE. Consumption will be 90 MMcf/D during the first year of operation, rising to 500 MMcf/D by 2018. Manzanillo LNG terminal will be supplied from Peru.

POWER SECTOR

After the Baja California Sur II, La Venta II, El Cajón and Tamazunchale plants started operation in 2007, no new plants were scheduled for start-up in 2008 because of the reserve margin at that time. However, during that period, five power plants were under construction, with designed capacity of 2294 MW and projected investment of about USD 2.3 billion. The CC San Lorenzo power plant began operating in December 2009. The CCC Baja California, CCE Pacífico and CCC Norte plants are expected to start operations in 2010. The La Yesca hydroelectric plant (installed capacity 750 MW) is projected to start operations in June 2012.

In addition, five more power plants are in the construction phase: two wind plants (La Venta III and Oaxaca I); two geothermal plants (Los Humeros Phase A and Los Humeros Phase B); and one combined-cycle plant (Norte - La Trinidad). The total installed capacity of these five plants is projected to be 723 MW. They are to begin operations in 2010 (Norte – La Trinidad and Oaxaca I), in 2011 (Los Humeros Phase A and La Venta III) and in 2012 (Oaxaca I wind power plant and combined-cycle plant) and 2011 (Los Humeros Phase B) (SENER 2008b).

CFE has also undertaken optimisation and modernisation projects for its power facilities. In 2008, three power plants were optimised for USD 37.3 million, and five others are being modernised for about USD 768 million.

RENEWABLE ENERGY

Among Latin American economies, Mexico is one of the most promising areas for renewable energy development. International organisations such as the Global Environmental Facility of the United Nations Development Programme and the World Bank, among others, support large-scale electricity production from renewable energy sources (specifically, wind power), and R&D.

WIND ENERGY

Mexico has wind resource energy potential of an estimated 30 000 MW in the region of the Isthmus of Tehuantepec in the state of Oaxaca, La Rumorosa, Baja California; Zacatecas, Hidalgo Veracruz, Sinaloa and Yucatán. The Mexican Wind Energy Association (AMDEE) currently predicts the development of at least 3000 MW in the period from 2006 to 2014. By December 2008, Mexico had a total installed capacity of 85 MW, and no additional capacity had been installed. However, there is an intention to develop five in-grid, large-scale renewable

energy projects through a USD 70 million donation from the Global Environmental Facility. The projects within the Capacity Requirement Program for the 2009–2024 timeframe are to be put out to bid according to their scheduled start-up date and will start commercial operations from 2011 with the Oaxaca II–IV (304 MW) wind power plants.

SOLAR ENERGY

Mexico has an excellent solar energy resource, with an average of 5 kWh per square metre per day of solar radiation, because of its geographic location. This means that the energy generated by a solar panel of 1 square metre with 50% efficiency could equal the energy contained in 1 cubic metre of natural gas or 1.3 litres of LNG. Although Mexico has this valuable potential, solar energy has not been exploited extensively to change the energy matrix because the economy seeks to be a net oil producer. Mexico has begun a limited number of small-scale solar energy development projects, including the installation of solar water heaters in the residential, commercial and industrial sectors and the construction of a hybrid thermal–solar power plant. The economy's small installed photovoltaic (PV) capacity is used for lighting and pumping.

After the approval of a grant from the Global Environmental Facility for the construction of a new hybrid power plant (combined cycle plus thermo-solar) in 2006, the Agua Prieta II plant project is now at the bidding stage. The plant, in the state of Sonora, will have 477 MW (net) of thermal capacity and 10 MW (peak) of thermo-solar capacity, and is expected to start operations in 2013.

Although the Mexican Government has started such projects, effective energy policy for the large-scale development of this technology is limited. At the time of writing, there is no planning for electricity generation projects using thermo-solar or photovoltaic technologies.

However, through renewable energy projects involving the Ministry of Energy, CONUEE, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German Technical Cooperation) and the National Association of Solar Energy, Mexico has promoted the use of solar water heaters in the residential, agro-industry, commercial and industrial sectors. The goal is to install 1.8 million square metres of solar water heaters by 2012 (SENER 2007b). During 2008, the total installed area of solar water heaters was 1.15 million square metres, up 16.7% from 2007. Most of the area has been installed for heating water for pools (46.2%) and households (32.1%); the remainder is in industry, hotels and other parts of the economy (SENER 2008a).

Most PV technology has been installed in small-scale projects (total installed capacity is 19 406 kW, which was an increase of 4.7% from 2007). This technology is primarily used in the residential and public sectors. Mexico lacks an aggressive energy policy to develop this technology at the industrial scale.

GEOTHERMAL ENERGY

In the Americas, Mexico became the pioneer for the installation of geothermal power plants when the first was installed in the 1950s. Currently, Mexico's geothermal electricity capacity is 964.5 MW (CFE 2008a). Four geothermal fields are now under exploitation: Cerro Prieto, Los Azufres, Los Humeros and Las Tres Vírgenes. The Cerro Prieto geothermal field in the state of Baja California is the second biggest in the world. It has a total installed capacity of 720 MW, producing around 46% of the electricity distributed into the Baja California grid, which is not part of the National Electric System. In 2008, geothermal generation was 7 056 GWh, down 4.7% from 2007.

Mexico is considering expansions in geothermal facilities. During 2008, three projects to expand existing installed capacity were in the bidding phase. The Cerro Prieto V power plant is expected to expand by 107 MW, beginning in 2012. The other two projects are Los Humeros Phase B and Los Humeros Phase A, with increases in gross capacity of 27 MW each one. The former will start operations in 2012 and the latter in 2011. Additional capacity in 2018 is projected to be 75 MW, from the construction of the Azufres III phase I and phase II plant (CFE 2008b).

Several power generation units, totalling 185 MW of installed capacity, will be withdrawn in capacity withdrawals programs. These are units 1-2 and 3-4 of the Cerro Prieto I plant (in 2010 and 2012) and units 2-7 and 9 of the Azufres plant (in 2018).

BIOFUELS

Two types of biofuels are produced in Mexico: biodiesel and bioethanol. Biodiesel production levels are low (around 3.7 million litres per year), and the only producing facility is in Cadereyta, Nuevo León, with a storage capacity of 60 cubic metres. Mexico has a few biofuels projects, but they are small-scale and cover only self-consumption needs. In its first stage, a pioneer pilot project for the use of bioethanol announced in Guadalajara City plans the use of 10% ethanol and 90% gasoline (E10) for a vehicle fleet of the state government. The second stage involves the use of E10 in urban transport and the third (and last) stage involves public consumption. If E10 can be implemented across Mexico, there would be a reduction in gasoline and MTBE (methyl tert-butyl ether) imports, leading to savings in the foreign balance of payments (SENER 2008a).

INTERNATIONAL COOPERATION

Mexico has an important presence in international energy cooperation. During 2008–09, it participated in several international meetings at which bilateral and multilateral energy cooperation agreements were signed with different economies and international organisations. Mexico is a member of many international organisations dealing with energy issues, such as the Energy Working Group of APEC, the Latin American Energy Organisation (OLADE), the World Energy Council, the North American Energy Working Group, the International Energy Forum, and others.

In 2008 and 2009, Mexico had bilateral energy cooperation agreements with the United States, Canada, Germany, Spain, Portugal, Belgium, Norway, the United Kingdom, France, Australia, Japan, the Republic of Korea, Singapore, Costa Rica, Jamaica, Brazil and Colombia. In the area of multilateral cooperation, Mexico has important cooperation mechanisms with APEC, the International Energy Agency, the World Bank, the International Atomic Energy Agency, and others (SENER 2009c).

In May 2009, Mexico's Ministry of Energy endorsed the International Alliance for Energy Efficiency Cooperation among the G8+5 Energy Ministers Meeting, with the objectives of initiatives and information exchange for best international practice in energy efficiency.

USEFUL LINKS

Banco de México (Banxico)—www.banxico.gob.mx

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

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

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

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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-size Asian city. New Zealand's location is remote from other major 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 very 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 148.3 million barrels of oil, 56.0 billion cubic metres of natural gas, and 571 million tonnes of coal. In 2007, hydro, geothermal and wind resources met around 67% of electricity demand.

Table 28 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (sq. km)	268 680	Oil (million barrels)[b]	148.3
Population (million)	4.23	Gas (billion cubic metres)	56.0
GDP (USD (2000) billion at PPP)	101.1	Coal (million tonnes)[c]	571.0
GDP (USD (2000) per capita at PPP)	23 909		

a Ministry of Economic Development, the New Zealand Energy Data File, June 2008.

b Oil reserves include crude oil, condensate, naphtha and LPG.

c *BP Statistical Review of World Energy 2008*.

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html)

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, New Zealand's total primary energy supply (including international aviation bunkers) was 18 633 kilotonnes of oil equivalent (ktoe). A number of energy sources are used to meet these needs, including oil (38%), gas (20%), hydro (11%), geothermal (16%) and coal (8%), with solar, wind, biomass, biogas and waste heat providing the remainder (7%). New Zealand's self-sufficiency in 2007 was 80%, up from 74% in 2006 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 0.4%. The majority of New Zealand's energy supply is sourced from indigenous energy resources. However, domestic oil production is insufficient to meet demand. Therefore, New Zealand imports a large volume of crude oil and petroleum products.

Lignite is New Zealand's largest fossil energy resource. However, almost all production is of sub-bituminous and bituminous coals. In 2007, coal production declined by 19% as a result of lower production from the economy's two largest West Coast mines. Oil production is sourced from 17 fields in the Taranaki region. Production of crude oil, natural gas liquids and condensate

more than doubled in 2007, underpinned by rapid growth in crude oil production following the commissioning of the Pohokura and Tui fields in late 2006 and mid-2007, respectively. Natural gas is produced entirely from 16 fields in the Taranaki region. In 2007, natural gas production increased by 11%. Most of this increase was attributable to increased output from the newly commissioned Pohokura field (MED 2008b).

In 2007, New Zealand generated 41 909 GWh of electricity. New Zealand has plentiful hydro and renewable energy resources. Reflecting this, more than 65% of generation was from hydro and renewable sources. Hydro is the major source of electricity generation, accounting for 56% of the total. Most of New Zealand's hydro energy is generated in the South Island, and all geothermal generation is generated on the North Island. Most of the remaining balance is generated on the North Island using a combination of natural gas, coal, wind and landfill gas.

Table 29 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	14 945	Industry sector	2 951	Total	41 909
Net imports and other	4 366	Transport sector	5 849	Thermal	13 812
Total PES	18 633	Other sectors	4 517	Hydro	23 516
Coal	1 528	Total FEC	13 317	Nuclear	–
Oil	7 087	Coal	535	Geothermal	3 458
Gas	3 649	Oil	6 921	Other	1 123
Other	6 368	Gas	1 434		
		Electricity and other	4 427		

Source: Energy Data and Modelling Center, IEEJ (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

New Zealand's final energy consumption increased by 0.8% in 2007 to 13 317 ktoe compared with the previous year. The industrial sector consumed 22% of energy used, the transportation sector 44% and other sectors 34%. In 2007, final energy consumption was dominated by oil, accounting for 6921 ktoe (52%), followed by 4427 ktoe (33%) for electricity and others (heat etc.), gas 1434 ktoe (11%) and coal 535 ktoe (4%). Domestic transport is the main consumer of petroleum products, accounting for 84.8% of total oil consumption in 2007. Consumption of oil in the other sectors was shared between industrial (10.3%), agricultural (2.2%), and commercial and residential (2.2%).

POLICY OVERVIEW

FISCAL REGIME AND INVESTMENT

Corporations earning an income in New Zealand are taxed at a flat rate of 30% (Inland Revenue 2008). Corporations are also required to pay other indirect taxes such as payroll and fringe benefits. Some capital expenditure, such as environmental expenditure and development costs, incurred by energy companies is tax deductible. In addition, in 2007, the government announced a 15% tax credit for companies undertaking research and development (Inland Revenue 2007).

Corporations involved in energy extraction activities are also required to pay royalties to the government for the use of the community's natural resources. 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 (Crown Minerals 2008a).

For 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 (Crown Minerals 2008b).

In general, New Zealand allows all foreign investment, unless it includes sensitive assets. If a foreign entity wishes to invest in a sensitive asset, it must seek approval from the Overseas Investment Office (LINZ 2009).

ENERGY POLICY FRAMEWORK

Energy policies and strategies are developed by the Ministry of Economic Development (MED); Crown Minerals, a division of MED, is responsible for the management of New Zealand's mineral resources. The Ministry for the Environment is responsible for addressing the effect of energy use on the environment.

The Energy Efficiency and Conservation Act 2000 is the legislative basis for promoting energy efficiency, energy conservation and renewable energy in New Zealand. As a requirement of the Act, the Minister responsible for energy established a strategy for energy efficiency and conservation. This strategy must be reviewed, and updated as necessary, on a regular basis. In addition, the Act established the Energy Efficiency and Conservation Authority (EECA) as a stand-alone Crown entity with a role to promote energy efficiency, energy conservation and renewable energy across all sectors of the economy. It empowers the preparation of regulations implementing product energy efficiency standards and labelling, as well as disclosure of information to compile statistics on energy efficiency, energy conservation and renewable energy (EECA 2009).

The New Zealand Government published a non-statutory New Zealand Energy Strategy (NZES) in 2007. This strategy was the Government's primary statement of energy policy, setting the direction for energy supply as well as demand. The Energy Efficiency and Conservation Strategy (NZEECS) was published at the same time as a companion strategy. Both energy strategies are being updated during 2009 and 2010. It is the Minister's intention that "the new strategy will focus on security of supply, affordability, and environmental responsibility, with the overriding goal of maximising economic growth" (Brownlee 2009). Drafts of the updated strategies are expected to be released in the first quarter of 2010.

MARKET REFORMS

New Zealand's energy sector has been subject to major reforms since the mid-1980s, coinciding with the introduction of broader micro-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 electricity and gas, where the vertically integrated sectors were dismantled to separate the natural monopoly and competitive elements, former government-owned and operated electricity and gas monopolies were either corporatised or privatised, and the electricity market was deregulated.

The Electricity Industry Reform Act 1998 was the major piece of legislation used to achieve these reforms. The Act effectively separated electricity lines from generation and retail where those activities were co-located, promoted competition in electricity generation and retail, and limited barriers to new investment in generation from renewable energy sources. Amendments to restrictions on ownership of electricity generation by line companies were made in 2001 and 2004, followed in 2008 by further policy changes. These changes eased restrictions on the sale of generation output, narrowed the scope of ownership separation requirements, and amended the definition of renewables from 'new renewables' to include traditional hydropower and geothermal electricity generation (MED 2008a).

In April 2009, the Minister of Energy and Resources initiated a Ministerial Review of Electricity Market Performance. The review examined market design, regulation and governance issues. A discussion paper was released in August 2009. Following receipt and consideration of submissions, a suite of changes to New Zealand's electricity system was announced in December 2009, followed by the introduction of the Electricity Industry Bill, which is expected to come into force on 1 October 2010.

The changes covered by the Bill encompass:

- measures to improve competition, including some ownership rearrangement of generation assets held by government-owned companies
- steps to improve security of supply, particularly for years when hydro generation storage is low
- abolishing the Electricity Commission (originally established in 2003) and replacing it with an Electricity Authority with fewer objectives and functions.

Given that the 1998 legislation has been progressively relaxed, the Bill further eases requirements on the type of generation line companies can build, in order to increase opportunities for competition in the electricity market.

UPSTREAM ENERGY DEVELOPMENT

New Zealand's policy for the exploration and development of petroleum and coal resources is set out in the Crown Minerals Act 1991, accompanied by the Minerals Programme for Petroleum 2005 and the Minerals Programme for Minerals (excluding petroleum) 2008.

Although New Zealand has a modest oil and gas producing industry, it depends on imports for 68% of its oil and oil products. It also produces a significant quantity of natural gas, which is used in electricity generation and in methanol and urea production (MED 2008b:30). All gas used is domestically produced and there are no facilities for importing LNG. All of New Zealand's domestic petroleum production is sourced from the Taranaki Basin, which includes several offshore fields. The largest of these fields has historically been the offshore Maui field, which is believed to be nearing depletion. It is expected that production from this field will only be partially replaced by the offshore Pohokura and Kupe fields, prompting concern that New Zealand's gas supply could be inadequate to meet future demand.

New Zealand is underexplored for petroleum. Therefore, the government has been focusing on increasing exploration and improving the knowledge of petroleum basins. To achieve this, it has:

- acquired a large amount of new geophysical data to image frontier offshore basins
- engaged GNS Science to improve the understanding of New Zealand's petroleum basin potential
- commissioned a study by the New Zealand Centre for Advanced Engineering on options for realising methane hydrate potential
- worked with Michael Adams Reservoir Engineering to estimate revenues from the development of New Zealand's petroleum resources under different scenarios
- commissioned a review by Aupec of New Zealand's petroleum regime, policy, regulatory frameworks and areas for improvement to encourage investment
- commissioned a study by McDouall Stuart to assess the domestic, regional and wider economic effects of large-scale petroleum development in New Zealand
- developed an action plan for realising the potential of New Zealand's petroleum resources. The Action Plan for the Development of Petroleum Resources, released in November 2009, aims to ensure that New Zealand is considered an attractive destination for investment in petroleum exploration and production. The plan is based on a number of work streams, including

- explicitly positioning the government as proactive and pro-development of petroleum resources based on a sustained communications strategy to improve the profile of the industry
- developing a coordinated investment strategy by March 2010 to improve the knowledge of New Zealand's petroleum resources, for example by providing government-funded geoscientific data
- conducting a short and focused review of the Crown's capability and resourcing to manage New Zealand's petroleum estate by May 2010
- conducting a review of New Zealand's regulatory, royalty and taxation arrangements for petroleum by December 2010
- conducting a review and amending, if necessary, the legislative framework for the petroleum sector by December 2010
- undertaking further work to develop a roadmap for realising the potential of gas hydrates by June 2010. (MED 2009b).

ELECTRICITY AND GAS MARKETS

The New Zealand electricity market is a competitive market. There is open entry to the market subject to conditions developed by the Electricity Commission. The Commission must make sure that these conditions remain efficient and relevant. The market operates under the Electricity Act Electricity Governance Regulations 2003 and Electricity Governance Rules 2003.

The Electricity Commission is responsible for overseeing New Zealand's wholesale and retail electricity markets; it regulates their operation and promotes and facilitates efficient electricity use. The Commission is also responsible for regulating some elements of transmission—namely, for approving grid investment, determining contracting parties for transmission services and approving transmission pricing. The commission appoints a system operator (Transpower NZ Ltd—a state-owned enterprise) to coordinate supply and demand resources. The system operator is also responsible for long-term planning. Pricing and competitive behaviour is the responsibility of the Commerce Commission (Electricity Commission 2009).

Since 2004, New Zealand's gas sector has been co-regulated by the government and the Gas Industry Co. as the industry body under the Gas Act 1992. The Gas Industry Co. pursues the government's objectives and outcomes as set out in the Gas Act and the Government Policy Statement on Gas Governance (the operation and governance of gas markets; access to infrastructure and consumer outcomes), work driven by ministerial requests and its own engagement with the sector (MED 2009a).

ENERGY EFFICIENCY

As noted in the Energy Policy Framework section, the NZEECS sets the main program of work for promoting energy efficiency in New Zealand. The current strategy, released in October 2007, replaced the inaugural National Energy Efficiency and Conservation Strategy released in 2001. The NZEECS is currently under review, with an updated version expected to be released in early 2010.

The 2007 NZEECS provides government leadership for the energy sector to respond to the challenges of energy security and climate change. It also establishes the action plan for energy efficiency and conservation actions in New Zealand to support increased uptake of energy efficiency and renewable energy. Further, it assigns responsibility for the delivery of each action to a central or local government agency.

The programs contained in the 2007 NZEECS are expected to support the attainment of the following goals:

- savings of 30 petajoules (PJ) in non-transport energy by 2025
- 9.5 PJ of additional direct use renewable energy a year by 2025
- savings of 20 PJ in the transport sector by 2015

- halving of per capita greenhouse gas emissions in the transport sector by 2040
- 90% of total electricity generation from renewable sources by 2025 (NZG 2007).

RENEWABLE ENERGY

As part of the 2007 NZES, the New Zealand Government set a target that 90% of electricity will be generated from renewable sources by 2025. Renewable energy is already an important component of the New Zealand energy supply system, accounting for more than two-thirds of electricity generation. Traditionally, hydropower and geothermal energy have been the major contributors to this total. In addition, renewable energy sources including geothermal and biomass have been used directly for heating and electricity generation in the commercial and industry sectors, and there is a small amount of biofuels production. The 90% target is expected to be retained in the 2010 update of the NZES.

CLIMATE CHANGE

The Climate Change Response (Emissions Trading) 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. All sectors of the economy and six gases covered under the Kyoto Protocol are covered under the scheme—carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride (CCINZ 2009a).

Table 30 Timeframe for entry into the emissions trading scheme

Sector	Voluntary reporting	Mandatory reporting	Full obligations
Forestry			1 January 2008
Transport fuels		1 January 2010	1 July 2010
Electricity production		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

In 2009, the government made number of amendments to the scheme in order to better assist firms and households adjust to emissions pricing over time. These changes included introducing an effective price cap of NZD 12.50 for the first two years of the scheme; shifting to an intensity based model for the allocation of free emissions units to emission intensive trade exposed firms; and changes to the entry dates for sector's entering the scheme.

All sectors of the economy will be included from 2015. They will be introduced gradually over the course of seven years (Table 30). As stipulated under the Act, the emissions trading scheme will be reviewed every five years to assess the effectiveness of the scheme, changes in international agreements, links with other trading schemes and the allocation of free permits.

ENERGY TECHNOLOGY/R&D

New Zealand uses international research on energy while carrying out its own research to establish potential solutions for its distinctive mix of energy resources, infrastructure and cost structure.

The New Zealand Government carries out research and development activities through two agencies. The Ministry of Research, Science and Technology undertakes research to help in the development of science-related policy. The Foundation for Research, Science and Technology distributes public sector investments to public and private sector institutions, such as universities.

Other institutions involved directly and indirectly in research and development activities include the Inland Revenue Department, Ministry of Economic Development and Ministry of Transport.

In 2008, central government funding for energy research and development, through the Foundation for Research, Science and Technology, was NZD 18 million. In addition, the government funded work on marine generation devices (NZD 8 million over four years) and low-carbon energy technologies (NZD 12 million over three years). It also funded the National Energy Research Institute through a NZD 1.5 million grant.

These policies and programs have resulted in the development of an energy research roadmap; increased investment in energy research and development, international partnerships and collaborative research; business and tax credits for research and development expenditure; and capacity building.

In 2006, the Ministry of Research, Science and Technology, in consultation with relevant stakeholders, prepared the *Energy Research Roadmap* to identify the capabilities required to develop sustainable technologies and practices. The report found that New Zealand needed to:

- lead research to reflect its unique energy resources and uses
- adapt more quickly technologies and processes developed overseas to suit its energy situation
- be able to identify and act on opportunities developed overseas for use in New Zealand
- recognise innovations that may provide commercial opportunities for use domestically and abroad (NZG 2007).

NOTABLE ENERGY DEVELOPMENTS

POLICY CHANGES

During 2009, the New Zealand Government announced that the NZES and NZEECS would be reviewed and updated. Work has commenced on the updates, which are expected to be released soon. In addition, the government commissioned reviews of New Zealand's electricity and gas markets. Details are contained in the 'Policy overview' section.

CLIMATE CHANGE

In November 2009, the New Zealand Government passed an Act to revise the emissions trading scheme. Changes to the Act were made with the aim of improving the effectiveness of the scheme and to take into account the global economic recession. Because of the time taken to conduct a review of the emissions scheme (launched in 2008) and other related matters, the scheme entry date of 1 January 2010 for the stationary energy and industrial processes sectors was considered unachievable. Therefore, the entry date was postponed to 1 July 2010. In addition, the entry date for the liquid fuel sector was brought forward to correspond with the stationary energy and industrial processes sectors, mainly for administrative and fiscal reasons, and the entry date for agriculture was postponed to 2015.

NEW PROJECTS

The first well of the Maari project in the Taranaki Basin was completed for production in January 2009. The project reached peak production capacity of 32 000 barrels of oil a day in April 2009. The Kupe gas project in the Taranaki Basin was completed in November 2009. The project is expected to have an annual production of around 20 PJ of sales gas, 90 000 tonnes of LPG and 1.7 million barrels of condensate. In October 2009, Todd Energy announced plans to construct a 27 000 tonne a year LPG plant in Taranaki to process natural gas from the Mangahewa and Pohokura fields.

USEFUL LINKS

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Department of Climate Change—www.climatechange.govt.nz

Electricity Commission—www.electricitycommission.govt.nz

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

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

New Zealand Government—www.newzealand.govt.nz

New Zealand legislation—www.legislation.govt.nz

Transpower—www.transpower.co.nz

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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 2007, real GDP was estimated at USD 11.01 billion (USD (2000) at PPP), an increase of 6.2% from 2006 (USD 10.37 billion).

PNG's primary energy use per capita of 0.29 tonnes of oil equivalent is far below the APEC average of 2.57 tonnes of oil equivalent. Export of energy resources is a very important foreign exchange earner and contributes greatly to national revenue. In 2003, the energy industry accounted for approximately 14% of the economy's GDP and around 20% of total exports. It has also resulted in the employment of more than 1000 Papua New Guineans in both upstream and downstream operations in the oil and gas industry.

Table 31 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	462 840	Oil (million barrels)—proven	200
Population (million)	6.32	Gas (billion cubic metres)	440
GDP (USD (2000) billion at PPP)	11.01	Coal (million tonnes)	–
GDP (USD (2000) per capita at PPP)	1 741		

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html); *BP Statistical Review of World Energy 2008*.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, PNG's net primary energy supply was 1835 kilotonnes of oil equivalent (ktoe), an increase of 12% from 2006. Light crude oil and petroleum products accounted for 78%, gas for 18% and hydro and other fuels for the remaining 4%. Around 72% (2313 ktoe) of indigenous crude oil and NGL production is exported to other economies. To sustain the economy's export goals, the national government allots around USD 20 million of its annual budget to oil and gas exploration.

PNG's crude oil production started in 1992 and peaked at over 150 000 barrels a day the following year. However, since then, production has been declining in spite of exploration activities resulting in the development of some additional oil fields. Oil production in 2008 was 38 080 barrels a day from three oil fields. With the commissioning of its first refinery plant (Napanapa Oil Refinery owned by InterOil) in 2004, crude is now refined locally. 65% of the refinery's output is consumed locally; the remaining 35% is exported overseas.

PNG's total proven and probable gas reserves are over 14 trillion cubic feet, half of which constitutes 1P reserves (proven). Much of these reserves are undeveloped, except for Hides gas field, which supplies around 14–15 million standard cubic feet a day for natural gas power

generation to supply electricity to the Porgera Gold Mine in the central highlands of PNG. Hides gas field has about 4 trillion cubic feet of proven gas reserves.

ExxonMobil and co-ventures (Oil Search, Santos, Nippon Oil, AGL, MRDC and Eda Oil) are targeting the Hides fields plus a string of other gas and associated fields to develop PNG's first LNG project. Under the proposal, ExxonMobil will build an LNG plant with an annual production capacity of 6.6 million tonnes (two trains) and aims to deliver the first sales in 2013 (Downstreamtoday 2009).

As of 2003, PNG's total installed power generating capacity was 487.3 megawatts (MW). In 2007, PNG generated 3112 gigawatt-hours (GWh) of electricity (a 3.3% increase from 2006). The sources of generation were thermal at 72% and hydro at 28% (the share of hydro has remained steady over the past three years so thermal generation increased by 3.3% to meet demand). There is little economic potential for the expansion of large hydro, 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).

The Geothermal Energy Association estimates Papua New Guinea's geothermal potential at 21.92 terawatt-hours (Gawell et al. 1999); the association also categorises Papua New Guinea as an economy that could, in theory, meet all its electricity needs well into the future from geothermal sources alone.

Table 32 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	2 387	Industry sector	588	Total	3 112
Net imports and other	–127	Transport sector	353	Thermal	2 249
Total PES	1 835	Other sectors	114	Hydro	863
Coal	–	Total FEC	1 055	Nuclear	–
Oil	1 435	Coal	–	Geothermal	–
Gas	326	Oil	805	Other	
Other	74	Gas	–		
		Electricity and other	249		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

In 2007, total final energy consumption in PNG was 1055 ktoe (an increase of 2.6% over 2006). The industrial sector accounted for 56% (an increase of 6% over 2006) and was the largest end user, followed by transport (33%) and other sectors, including agriculture and residential/commercial (11%). Petroleum products accounted for 76% of total consumption (an increase of 2.3% over 2006); electricity and others accounted for 24%.

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

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 oil fields 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 terms are 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, a full (100%) tax deduction is available for exploration expenditure, government participation is 22.5%, the effective royalty rate is 2%, and the government take is about 50%.

ENERGY POLICY FRAMEWORK

The Papua New Guinea Government has jurisdiction over energy matters. The PNG National Energy Policy and the Rural Electrification Policy are still being reviewed by the PNG Government Task Force on Policy. Exploration and development of petroleum resources are authorised and administered by the Department of Petroleum and Energy. The 2002 revision of the Oil and Gas Act 1998 gave the Department of Petroleum and Energy authority over the licensing and development of petroleum resources.

The provincial governments work with PNG Power Limited, the Energy Division of the Department of Petroleum and Energy and/or private companies to organise new projects such as grid extensions or the development of small hydro and other renewable energy resources.

ELECTRICITY MARKET

The Electricity Industry Policy has been completed to introduce competition in the electricity industry.

In the Electricity Industry Act 2000, sections 21 and 23 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 to determine the standards, inspection and controlling of applications on all matters relating to the operations of the supply of electricity. 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; therefore, it is responsible for setting prices or tariffs for electricity and petroleum products.

However, because of a lack of technical capacity to perform a technical regulatory role in the electricity sector, the ICCC has outsourced this role to PNG Power Limited on a contractual basis for an initial period of two years ending 2005, which was extended for another three-year period ending 2008.

NOTABLE ENERGY DEVELOPMENTS

RENEWABLE ENERGY

In 2005, Lihir Gold Limited (LGL) commissioned a 30 MW geothermal power plant, additional to its first 6 MW geothermal power plant constructed in April 2003 (Lihir Gold Geothermal Station 2006). Another 20 MW plant was commissioned in February 2007, bringing total capacity to 56 MW, around 75% of total electricity requirements in 2007 (Lihir Gold n.d.)

LGL is the first 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.

PNG Sustainable Energy Limited has secured USD 673 million to enhance electricity under the electrification program in the economy.

UPSTREAM DEVELOPMENT

A number of international companies are showing great interest in investing in PNG's upstream oil and gas sector for the first time in many years. At the end of 2007, the total number of petroleum prospecting licenses (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 November 2002 to attract oil exploration. See the 'Policy overview' section for details.

InterOil Products Limited (IPL) has acquired retail and distribution assets from British Petroleum and an agreement was made between IPL and Shell PNG Limited for IPL to purchase retail and distribution assets owned by Shell PNG Limited in PNG upon government approval.

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, Nippon Oil and local landowners. The project plans 6.3 million tonnes of production a year, and feed gas is to be sourced from the Kutubu, Gobe and Moran oil fields as well as the Hide, Juha and Angore gas fields. In May 2008, a gas agreement was signed by joint project participants and the state of Papua New Guinea. PNG's Deputy Prime Minister, Puka Temu, said in 2008 that 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. The LNG project will cost USD 15 billion.

Liquid Niugini Gas, which was formed in 2007 by InterOil, Merrill Lynch Commodities Inc and Pacific LNG Operations Ltd, has been evaluating reserves in the Elk and Antelope gas fields, which would supply feed gas to the proposed LNG plant, which would have an annual production capacity of 6–9 million tonnes. InterOil (an operator of the gas fields) also operates an oil refinery with a capacity 32 000 barrels a day in Port Moresby. Liquid Niugini Gas, like ExxonMobil with its planned USD 15 billion PNG LNG venture, is seeking to tap fields in PNG to meet rising demand from Asian utilities for cleaner-burning fuel.

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PERU

INTRODUCTION

Peru is located on the Pacific Ocean coast of South America. It shares borders with Chile to the south, Ecuador and Colombia to the north, and Brazil and Bolivia to the east. Its area covers nearly 1.28 million square kilometres. Peru's population grew at an average annual rate of 1.3% from 2000 to 2007. In 2007, Peru had a total population of 28.5 million people. Peru has three main regions: Selva [eastern rainforests], Sierra [Andes mountains], and Costa [coast]. Most of its population (54.6%) live in the Costa region, 32% live in the Sierra region and 13.4% live in the Selva region. Peru is also divided into 25 departments; the major population centre is located in the Lima department, with 8.44 million people. Peru's urbanisation rate is 75.9% (INEI 2008).

Large metal deposits in the Andes make Peru a major metal exporter; it is the world's second-largest silver exporter and third-largest copper exporter (after Mexico and Chile). It is also among the top five exporting economies for gold, zinc, tin and lead.

Peru's GDP in 2007 was USD 182.66 billion, while GDP per capita was USD 6407 (both in USD (2000) at PPP) (EDMC 2009). In the same year, real GDP grew by 8.8%, up from 7.7% in 2006. This rate is higher than the average over the past 10 years despite robust economic growth in the past 8 years. Peru's economic growth was possible thanks to developments in the construction and agro-industrial sectors, which grew by 14.7% and 7.2%, respectively (BN 2008). Overall, real GDP growth is projected to remain favourable, at more than 8.0%, driven by the agriculture industry, construction, manufacturing and the long-expected Camisea energy project.

Peru is currently a net importer of energy. Between 2006 and 2007, Peru increased its primary energy imports by 7.7%. Crude oil comprised the largest share of the total energy imported, 88%, because domestic crude oil is not of adequate quality to use as refinery feedstock. The remainder of Peru's energy imports consist of coal. Its proven energy reserves at the end of 2007 were 1121 million barrels of oil (including crude oil and gas liquids), 334.73 billion cubic metres (bcm) of natural gas and 49.9 million tonnes of coal. Further, Peru has proven uranium reserves of around 1800 tonnes in the Puno region. Natural gas makes up the largest proportion of Peru's energy reserves (around 45%). A considerable proportion of Peru's primary energy supply also comes from non-conventional energy, including wood, biogas, solar and other (MINEM 2008c).

Table 33 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	1 280 000	Oil (million barrels)—proven[b]	1 121.4
Population (million)[a]	28.51	Gas (billion cubic metres)—proven[b]	334.7
GDP (USD (2000) billion at PPP)	182.66	Coal (million tonnes)—proven[c]	49.9
GDP (USD (2000) per capita at PPP)	6 407		

a Instituto Nacional de Estadística e Informática (INEI 2008), Perú.

b As of December 2007, *Anuario de Hidrocarburos 2008*, Ministry of Energy and Mines, Peru, 2008 (includes crude oil and gas liquids).

c *National Energy Balance 2007*, Ministry of Energy and Mines, Peru, 2008.

Source: Energy Data and Modelling Center (EDMC), Institute of Energy Economics, Japan.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2007 was 12 694 kilotonnes of oil equivalent (ktoe). In 2007, strong growth of 10.4% was due mainly to the production of natural gas and its liquids. In 2007, around 52% of TPES came from oil, a decrease of 5.2% from 2006; 20.5% came from natural gas (2597 ktoe), a robust increase of around 40% from 2006; and 8% came from coal (1018 ktoe), a decrease of 18.3% from 2006. Non-conventional energy supply reached 21% of the total primary energy supply, or 2414 ktoe (EDMC 2009).

Peru increased its energy imports by 7.7%, from 3481 ktoe in 2006 to 3749 ktoe in 2007. These imports represented 26.3% of Peru's energy requirements. Crude oil imports made up 89.2% of the total, reaching 3344 ktoe at the end of 2007; coal imports made up the remainder. Energy exports increased by 14.8% from the previous year, with crude oil being the major energy export. The increase was made possible both by increases in existing production as well as by the exploitation of new wells. Total energy exports reached 1382 ktoe in 2007.

CRUDE OIL AND PRODUCTS

Peru had 1121 million barrels of proven oil reserves (including gas liquids) in 2007, an increase of 7.6% compared to 2006 (MINEM 2008b). These reserves amount to about 27 years of domestic production at 2007 levels. Successful results from drilling activities in the Selva [eastern rainforest], the Costa Norte [north coast] and the Zócalo [contintental shelf], as well as the reclassification of reserves and new reconditioning procedures, contributed to the recorded increase. The economy produced 113 869 barrels per day (B/D) of total oil liquids in 2007, a decrease of 1.4% from the previous year. Crude oil made up 68% of total production (77 113 B/D), and natural gas liquids (NGL) made up the remainder (36 755 B/D). Increasing NGL production represents the bulk of the increased oil production in last three years, including a significant increase between 2004 and 2005 of 150%, from 14 260 B/D to 35 840 B/D (MINEM 2008a).

Table 34 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	10 525	Industry sector	4 114	Total	30 025
Net imports and other	3 749	Transport sector	3 780	Thermal	9 884
Total PES	12 694	Other sectors	2 135	Hydro	19 549
Coal	1 018	Total FEC	10 030	Nuclear	–
Oil	6 615	Coal	613	Other	592
Gas	2 597	Oil	6 560		
Other	5 464	Gas	535		
		Electricity and other	2 321		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

Peru has seven major refineries with a total capacity of 197 000 B/D. All refineries are privately operated, with Repsol YPF controlling the largest facility in the economy, La Pampilla refinery, with an installed capacity of 102 000 B/D. Another privately operated refinery is the Purcallpa refinery with 3300 B/D, operated by Maple Gas. Petroperu operates four refineries: Talara refinery (62 000 B/D), Conchán refinery (15 500 B/D), Iquitos refinery (10 500 B/D), and El Milagro refinery (1700 B/D). There is also the Shiviyacu refinery, which is operated by Pluspetrol Norte, with 2000 B/D of installed capacity. In 2007, total crude oil processed in refineries was 158 919 B/D; 31.1% came from domestic production and 68.8% from imports. An increase of 4.6% of processed crude oil was recorded from 2006 to 2007. La Pampilla refinery

was a major player, processing 84 181 B/D of crude oil, 94% of which came from imports from Ecuador, Angola, Nigeria, Brazil, Colombia, Venezuela and Iran.

In 2007, production of petroleum products was around 172 595 B/D, an increase of 4.1% from 2006. Diesel made up 32.4% of total petroleum production; industrial fuel oil, 28.8%; and gasoline, 22.4% (MINEM 2008a).

NATURAL GAS

Peru had proven natural gas reserves of 334.73 bcm in 2007, ranking fifth in South America (MINEM 2008b). During the same year, the economy produced around 6663 million cubic metres of natural gas (associated (17%) and non-associated (83%) natural gas), showing an increase of 1.3% compared to the previous year. Pluspetrol, in the Selva region, is the largest company producing domestic natural gas; it produced 71.6% of the total 2007 production. Almost all the natural gas processed by Pluspetrol is non-associated natural gas and comes from the Camisea gas basin.

The Camisea basin consists of several natural gas fields in the Ucayali basin in south-eastern Peru, principally in Block 88 along the Camisea River. The project currently provides natural gas for domestic consumption, but its ultimate goal is to develop an export market. The initial production capacity at Camisea was 12.74 million cubic metres per day of natural gas and 34 000 B/D of NGL. However, output capacity is expected to increase steadily as drilling continues on Camisea's Block 56, adjacent to Block 88. Besides Camisea, a large concentration of Peru's natural gas lies in the Aguayita gas field in central Peru, Block X in the north-west region, and Block Z-2B located off the north-western coast.

COAL

At the end of 2007, Peru had proven coal reserves of around 50 million tonnes, enough for around 70 years of domestic consumption at 2005 levels. Almost 97% of coal reserves are anthracite, the remainder bituminous coal. The Libertad region contains 88% of total coal reserves; the Ancash region, 9%; and the Lima region, 3%. In 2007, domestic coal production accounted for 111.65 million tonnes. The largest coal production basin is in Cajamarca; the second largest, in Lima. Currently, Peru has 224 coal mines with mining rights for coal exploitation. On the imports side, Peru registered a total coal import of 922.46 million tonnes, showing an increase of 32.7% from 2006. This increase is explained by big coal imports by international companies such as Corporación Aceros Arequipa (400% growth), Corporación Cementos Lima (121% growth), Cemento Andino (12% growth), and Enersur (28% growth). Enersur is the largest importer, with a 46% share of total imports.

ELECTRICITY

The installed electricity capacity in Peru increased by 5.5% in 2007—from 6658 megawatts (MW) in December 2006 to 7027 MW in December 2007 (MINEM 2009a). Installed capacity was almost equally divided between hydropower, with 46%, and thermal power (natural gas, fuel oil, coal and biomass), with 54%. The increase in the installed capacity of hydropower (17.6 MW) resulted from the installation of electricity generation sets by regional companies. The largest hydroelectric facility is the Mantaro Complex, which contains two hydro-electric plants, with 900 MW of installed capacity each; together they generate over one-third of Peru's total electricity supply.

Peru's total electricity generation was 30 025 gigawatt-hours (GWh) in 2007, an increase of 9.7% over 2006. Of the increase, 65% came from hydropower plants, and 35% from thermal power plants. Total sales of electricity in 2007 totalled 26 909 GWh; 54% was traded in the regulated market and 46% in open markets.

Peru has two main power transmission grids: the North Central Interconnected System and the Southern Interconnected System; together these form the National Interconnected Electrical System (SEIN). Additionally, Peru has a small power transmission grid: the Isolated Systems (Sistemas Aislados or SA). In 2007, 98% of the total electricity generated in the economy was delivered through the SEIN; the remaining 2% was delivered through SA.

RENEWABLES

Renewable energy in Peru is provided by biomass, solar and hydro. Hydro and biomass (as bagasse) are developed for electricity generation, while other biomass (including firewood, sugarcane bagasse, vegetable coal, dung and yareta) and solar energy are used for heating. In 2007, total electricity generation from renewable sources was 20 141 GWh, with hydro representing 97% and the remainder by others (principally bagasse) (MINEM 2008c).

In 2007, the total estimated domestic production of firewood was 5.74 million tonnes (2065 ktoe), an increase of 7.9% over production in 2006. Most firewood is used in the residential sector for heating and cooking. The production of dung and yareta (with the residential sector being the largest consumer) reached 733 000 tonnes (263.8 ktoe), an increase of 7.9% from 2006.

Biomass is used for electricity generation and heating in the industrial sector. Sugarcane bagasse is the principal energy source for both purposes. Total domestic production of sugarcane bagasse was 2.5 million tonnes (373 ktoe), an increase of 12% from 2006.

Finally, Peru has small-scale solar energy developments through the installation of solar water heaters and photovoltaic panels. In 2007, total generation of solar energy was 82 GWh (or 7046 tonnes of oil equivalent), with the residential and commercial sectors being the largest consumers (98.8%).

FINAL ENERGY CONSUMPTION

Total final energy consumption (TFEC) in Peru has grown at an average of 1.2% per year over the past seven years. In 2007, TFEC amounted to 10 030 ktoe, an increase of 5.6% from 2006. The industrial sector consumed 41%, the transport sector 37.7% and other sectors 21.3%. Petroleum products dominated end-use consumption, accounting for 65.4% of demand in 2007. However, consumption of such products decreased by 2.4% between 2006 and 2007. Significant increases in the consumption of natural gas (60.3%) and coal (54.2%) were recorded in 2007 (EDMC 2009). The increase in natural gas consumption was driven by the industrial and metallurgical sectors.

Peru consumed around 3.14 bcm of natural gas in 2007. The power generation sector was the principal consumer (1.89 bcm). Other large consumers included the industrial and transport sector (0.59 bcm) and petroleum operations (0.52 bcm). Peru has the potential to produce much more gas than it currently does as domestic gas demand and gas export markets grow. Specifically, the power generation and industrial sectors are expected to be major gas consumers in the future.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

Since the 1990s, energy development in Peru has changed from being a state-controlled sector riddled with financial deficits and supply shortages to a competitive private sector model that now meets about 85% of the economy's energy needs (Wise 2006). Peru's economy has become more market-oriented since energy reforms approved in the 1990s. The mining, electricity, hydrocarbons and telecommunications industries have all been partially privatised. The first institutional development was the modernisation of the Ministry of Energy and Mines (MINEM) in 1993; MINEM, along with the Ministry of Economy and Finance, was elevated to super-ministry status. The second development was the creation of an autonomous oversight entity, Organismo Supervisor de la Inversión en Energía (Osinerg), to regulate gas transport and distribution rates, and to uphold contract compliance, safety standards, and quality control (in 2004 Osinerg became Osinergmin (Organismo Supervisor de la Inversión en Energía y Minas)). Finally, the state oil company, Petroperu, was partly privatised in 1993. In the same year, state company Perupetro was created by law. Perupetro is responsible for promoting investment in hydrocarbon exploration and exploitation. Several laws have affirmed that domestic and foreign

investment are subject to the same terms and have permitted foreign companies to participate in almost all economic sectors.

In Peru, the organisation responsible for the formulation and evaluation of energy-mining policies is MINEM, which has two sub-ministries: the Vice-Ministry of Mines and the Vice-Ministry of Energy. MINEM also has responsibility for environment issues in relation to mining and energy activities.

ENERGY SECTOR STRUCTURE

POWER SECTOR

With the privatisation of Peru's transmission electricity sector in June 2002, the government awarded Red de Energía del Perú (REP), a consortium consisting of the Colombian companies Empresa de Energía de Bogotá (EBB), ISA Peru, and ISA subsidiary Transelca, a 30-year concession to own and operate Peru's two main transmission companies, Empresa de Transmisión Centro Norte (Etecen) and Empresa de Transmisión del Sur (Etesur). EBB is the largest shareholder of REP, with a 40% stake. ISA Peru and Transelca each hold 30%. To regulate the operation of the market, the Peruvian Government created Osinergmin.

The Electricity Concessions Law, which allows for the privatisation of the electricity sector with regard to power generation, transmission, and distribution, was established in late 1992 to help promote competition and efficiency within the sector. The state utility company ElectroLima and much of the state utility company ElectroPerú were privatised soon after the law was implemented. The law of 1992 was modified by Law No. 26876 in 1997, which promotes competition in the electricity sector by prohibiting the control of more than 15% of electricity generation, transmission, or distribution by any one firm. Even with the passage of these laws, the Peruvian Government still retains a significant position within the electricity sector. The government can block acquisitions to ensure that private companies do not gain excessive market power. The private sector, including foreign companies, today controls about 65% of generating capacity and 72% of the distribution system. The government retains ownership of key hydro-electric plants.

Although Peru has an open electricity market, there are still barriers to the market's efficient operation. In July 2006, the government therefore 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; the modification of functions held by the Comité de Operación Económica del Sistema with the purpose of forming an independent operator for the electricity system; and an adjustment of the legal framework corresponding to the formation of transmission prices.

NUCLEAR

Although Peru does not currently use nuclear energy, the government has been studying the possibility of installing nuclear technology for electricity generation and for medical purposes. On 26 June 2006, the governments of Peru and the Russian Federation signed a bilateral agreement for the use of nuclear energy for peaceful purposes. As a result of this bilateral agreement, a

supreme decree was published on 21 August 2009 in the official gazette *El Peruano* (Supreme Decree No. 057–2009-RE), to validate this ratification and disclose it in the Peruvian Parliament (El Peruano 2009).

ENERGY SECURITY

Increasing energy imports combined with diminishing domestic resources have prompted rising concerns over energy supply security in Peru. Therefore, the government is promoting the use of natural gas to reduce oil import dependency. A new fuel mix that includes natural gas as an integral element is being developed in accordance with the National Plan for the Energy Matrix Transformation (Plan Nacional de Transformación de la Matriz Energética).

Peru is also interested in adding ethanol and biodiesel to its energy matrix, driven by the desire to create jobs, attract new investments, increase exports, and mitigate climate change. Some of the challenges facing the biofuels industry in Peru include lack of strong policy and incentives for promoting the sector's development as well as the need for substantial research and development (R&D) investments. In addition, the government has begun to promote biofuels production. In the Costa and Selva regions of Peru, soil and climatic conditions are suitable for crops that provide the volumes of adequate raw material needed to produce both anhydrous ethanol and biodiesel. To support the development of biofuel in Peru, in 2003 the government adopted Law No. 28054: Law for Promotion of the Biofuels Market (Ley de Promoción del Mercado de Biocombustibles). The goal of this law is to diversify the fuel market, stimulate farming and agriculture, promote sustainable development, and stimulate the creation of new jobs. The Peruvian Government introduced a B2 (2% biodiesel with 98% petroleum diesel) mandate in January 2009, and to extend it to B5 (5% biodiesel with 95% petroleum diesel) in 2011 and E7.8 (7.8% ethanol with 92.2% gasoline) in 2010 (APEC 2008).

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 Program (PAE). PAE was created in 1994 after an energy shortage in Peru, and MINEM implemented this program to start a strong energy savings campaign during the last decade and it is still continuing. (MINEM 2009b). After reaping positive results from PAE, MINEM signed, with the Inter-American Development Bank (IADB), a technical cooperation agreement called Convenio de Cooperación Técnica No Reembolsable ATN/JF-7040-PE, which was approved on 22 February 2000 and completed on 6 March 2009.

In 2000, the government passed the Law for the Promotion of Efficient Use of Energy (Ley de Promoción del Uso Eficiente de la Energía), Law No. 27345. In the framework of Law No. 27345 and its Supreme Decree No. 053–2007-EM of 2007, the Peruvian Government designed important ministerial resolutions such as 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 non-efficient lamps (incandescent lamps) with compact fluorescent lamps and acquiring equipment with energy efficiency labels.

As a result of this policy, the government recently compiled a Referential Plan for the Efficient Use of Energy 2009–2018, which is the principal instrument to achieve the energy efficiency goals through the action plans proposed for each sector. The Peruvian Government has established the goal of 15% of final energy consumption by means of energy-saving action plans among the residential, industrial (production and services), public and transport sectors until 2018. To achieve this goal, all action plans would be implemented in each sector as proposed by the Referential Plan (MINEM 2009c).

In addition, in line with the requirements of Supreme Decree No. 053–2007-EM of October 2007, MINEM is working on implementing energy efficiency standards and labelling for a wide range of end-use appliances; developing and implementing a comprehensive market

transformation strategy based on mandatory energy efficiency labelling and minimum energy performance standards; developing testing infrastructure and procedures; and raising consumer awareness.

CLIMATE CHANGE

Peru, as one of the economies most vulnerable to climate change, needs to have an effective strategy for climate change. 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), Version 8, for the mitigation and adaptation of 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 (GHG) emissions by means of the use of renewable energies and energy efficiency programs in production sectors. During the Conference of Parties 14 (COP14), Peru agreed to reduce its emissions by 47% (0.06 gigatonnes of CO_2-e) over 10 years through reforestation management.

At the beginning of 2008, the region of Tumbes in north-west Peru established a committee to discuss strategy and reach consensus on how to deal with climate change impacts. The initiative came as Peru faced a number of environmental challenges, including exposure to the negative impacts of climate change, the El Niño phenomenon, the retreat of glaciers in the Andes and increasing temperatures along the Peruvian coast. In a joint meeting, the Ministry of the Environment, the Office for Poverty Mitigation, the regional government of Tumbes and leaders of civil society organisations established the office of the Regional Platform on Climate Change (RPCC) (El Peruano 2008). The RPCC is tasked with building a contingency strategy to address the negative impacts of climate change.

NOTABLE ENERGY DEVELOPMENTS

PETROLEUM SECTOR

EXPLORATION AND PRODUCTION

In 2007, 24 new contracts for exploration and exploitation of hydrocarbons were let, making a total of 84 contracts (19 for exploration and 65 for exploitation). As a result, investments in both activities reached about USD 1447 million, representing an increase of 110% over 2006. Investment in exploitation was USD 1134 million; in exploration activities, USD 313 million.

In 2006, Barrett Resources announced that it would spend USD 1 billion to develop Block 67, located in Peru's Amazon region. The project could begin production by 2010, eventually reaching 100 000 B/D of crude oil. In early 2008, Barrett Resources was purchased by Perenco, which has continued to develop the project. At the time, Perenco was awarded a contract for a feasibility study of a pipeline between Block 67 and the existing Norperuano pipeline system.

In 2008, Petro-Tech announced that it had made a major discovery in the offshore Z-6 Block. The company stated that production there could begin as early as 2010. Also, BPZ Resources discovered crude oil in the Z-1 Block, specifically in the oil well Corvina, with 4.5 thousand barrels per day of crude oil production and 1.13 million cubic metres per day in proven reserves.

In late 2009, the Peruvian Government confirmed discoveries of a light crude oil field in Block 64, as well as of a natural gas field in Lot 58. According to the reports of the Brazilian oil company Petrobras a natural gas field in Peru's Cusco province was discovered, containing probable reserves between 1.0 trillion cubic feet and 1.5 trillion cubic feet.

Investments in the hydrocarbon sector are estimated at USD 3500 million in 2010, of which 50% is to be dedicated to exploration and exploitation. In addition, investments worth USD 5500 million are expected for 2011.

REFINING

In 1998, the World Bank proposed new quality specifications for fuels in Latin America and the Caribbean, to decrease their negative environmental impact and to harmonise their consumption within the region. As a result, Peru began a project to modernise the Talara refinery (Petroperu 2009). In 2001 and 2002, two important studies were undertaken by Foster Wheeler; the market study and the preliminary environmental impact study were published in November 2002. The Peruvian oil company Petroperu finished a feasibility study in 2004, and the project's implementation was approved in 2007. In 2008, the bidding and prequalification processes for front-end engineering design and engineering, and procurement and construction began. At the end of 2009, the long project management process concluded with the public release of the commercial evaluation results and the granting of the bid award.

With this project, Petroperu aims to produce diesel and gasoline with a maximum sulphur content of 50 parts per million. According to the company, the project will generate more added value to the operation of the Talara refinery, by increasing the production of mid-distillates, as well as the processing of light and heavy crude oils. The project consists of the revamping of the existing units, desulphurisation of diesel and gasoline, bottom conversion, and the increase of the average octane of gasoline. In addition, the refinery intends to produce enough sulphuric acid and to generate enough electricity to meet its own needs (Petroperu 2009).

NATURAL GAS

The huge reserves of natural gas discovered in Camisea and the reserves discovered less than 20 kilometres away in the Pagoreni field together make up an estimated 11 trillion cubic feet of proven and probable reserves. The Camisea gas project alone is expected to deliver 250–729 million standard cubic feet of natural gas per day and 70 000 B/D of condensate by 2015. The enhancement of natural gas reserves from these fields is expected to make Peru a regional gas exporter, with potential customers in Mexico and the western United States. This potential was a major factor in the PERU LNG consortium's decision to implement the project for the exploitation of liquefied natural gas (LNG).

In addition, Peru has been developing a compressed natural gas project. Cálidda, a natural gas company, is building a natural gas compression plant called City Gate. In 2008, Petroperu and Socma Americana S.A. signed a memorandum of understanding for mutual benefit with the purpose of developing gas pipelines to supply natural gas to fuel stations and industrial and household customers. The pipeline was designed to bring natural gas to places where no gas pipeline exists. It consists of compressors pumping natural gas under pressure into special containers. The first stage of the project started in July 2008 and was completed in October 2008. The second stage (construction plant) was concluded in December 2008.

In addition, it is expected that Peru will create natural gas pipeline interconnections with surrounding economies such as Brazil, Uruguay, Paraguay, Argentina, Chile and Bolivia.

LIQUEFIED NATURAL GAS

The Peru LNG Project, amassing USD 1 billion in loans and guarantees as the largest foreign investment in Peru's history, has been finalised. The Peru LNG Project consists of the construction of a liquefied natural gas plant, a marine loading terminal and a pipeline 408 kilometres (252 miles) long. The project will connect to the natural gas pipeline that runs from Peru's Camisea gas fields. The project sponsors are Hunt Oil Company (United Kingdom), SK Corporation (South Korea) and Repsol YPF, S.A. (Spain). Hunt Oil Company leads the Peru LNG consortium, which broke ground in January 2006 on an LNG export terminal at Pampa Melchorita. The Peru LNG facility will have an operating capacity of 4.2 million tonnes per year, and the first exports are expected in 2010 (Pluspetrol 2009). The initial investment to build the plant was between USD 1600 million and USD 2000 million. Repsol YPF, which joined the LNG Company, reached an agreement to buy all the production from the LNG plant.

Repsol YPF also bought a 20% stake in the LNG project so that it could participate in the exploration and production of the Camisea field. In October 2007, Techint was awarded a contract to build the project's natural gas pipeline. In late 2007, the IADB approved a USD 400 million loan package for the pipeline project. At the same time, Repsol YPF had already purchased rights to the entire output of the facility as mentioned above. In late 2007, the company concluded a contract with Comisión Federal de Electricidad, Mexico's state-owned electricity company, to supply LNG at the Manzanillo LNG re-gasification terminal, in the state of Colima, on Mexico's Pacific coast. According to industrial accounts, contract volumes start at 700 000 tonnes per year in 2011, rising to 3.8 million tonnes per year in 2015. The remaining output from the Peru LNG Project would be available for spot sales or additional term contracts.

POWER SECTOR

Peru has several expansion projects for the North Central Interconnected System (SICN and the Isolated Systems under consideration, including new power generation expansion projects and transmission expansion projects. According to long-term projections made by MINEM, installed power capacity under a conservative scenario will be 1200 MW; under an optimistic scenario, 2500 MW. The long-term vision for transmission expansion is to take progressive step developments; for example, by linking grids in SEIN regions. The projects under consideration include: Proyecto de Reforzamiento Centro – Norte Medio (Línea Chimbote y Línea Longitudinal de la Sierra), Proyecto de Transmisión Chilca–Lima, Proyecto de Reforzamiento de la Transmisión Centro–Sur (Línea Cotaruse – Machu Picchu and Estación convertidora CA/CC/CA 'back to back').

According to the Electricity Referential Plan (PRE) 2008–2017, investments needed to expand both generation and transmission could be around USD 5384 million (in the mid-term, 2009–17) and USD 38 140 million (in the long term, 2018–27) (MINEM 2009a). In the mid-term, new installed capacity by non-conventional renewable energy is contemplated for geothermal and wind energy. An installed geothermal capacity of 125 MW will be targeted for the end of 2017 and is to be located in the southern region of the economy. For wind energy, wind farms in central Peru are being considered; the total installed capacity between 2009 and 2017 is projected to be 450 MW. In the long term, 5454 MW of additional installed capacity is projected, primarily from the construction of hydro-electric power plants in central Peru.

RENEWABLE ENERGY

SOLAR ENERGY

Within the new energy efficiency policies endorsed in Peru, solar energy projects are being contemplated. These include the replacement of electric heaters (*termas*) with solar water heaters in rural areas. According to the Peruvian Government, the average energy savings from consumption could be 1163 terajoules per year from 2009 to 2018. Investments are projected to be USD 20 million per year during the first four years of its implementation.

Additionally, the IADB, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (German Technical Cooperation) and GVEP International (Global Village Energy Partnership) support the implementation of new solar projects in Peru (GTZ 2009). In November 2009, an incentive of USD 180 000 was given to Emprenda y Vivencia of Grupo Peruano A.C.P. for it to develop solar energy projects for electricity generation and to supply it in regions that have no electricity. The project, called Proyecto Sol Rural, will first focus on providing photovoltaic solar panels in the rural region of Piura at low prices, financing them in some cases. The goal of the first stage is to provide electricity to around 1000 rural homes in the region.

WIND ENERGY

Peru started the construction of a wind farm in September 2008. This was the first major alternative energy project in Peru. A 240 MW wind farm, called the San Andrés Wind Park (Parque Eólico San Andrés) is being built by the company Iberoperuana Inversiones S.A.C. (RED 2008). According to the company, the construction of the wind park is expected to be

completed in 2010, and the aim is to generate 22 MW by the end of 2012. The company will invest around USD 240 million to get the project up and running. When the wind farm is in full operation, it will have the capacity to generate electricity to 80 000 homes in Peru's southern desert region of Paracas. In addition, Iberoperuana Inversiones was licensed to pursue 15 alternative energy projects in Peru, which promises to ensure that Peru will be one of the renewable energy leaders in South America.

BIOFUELS

Biofuels are not used currently in Peru, but adding ethanol and biodiesel to the energy matrix has been one of its energy goals. New biofuel projects are under development. As of March 2008, two ethanol plants, each with 100 million litres per year of total capacity, were under construction in Sullana, Piura. Two more plants, also in the northern region, are planned, with a total capacity of 200 million litres per year. The primary feedstock for ethanol production in Peru is sugarcane. Sugar mills are located along the coast and have a total milling capacity of 37 000 tonnes of cane per day, with sugarcane being produced year-round.

There is one operating biodiesel plant in Callao, Lima. The plant, operated by Pure Biofuels Corporation, has a capacity of 127 million litres per year, and is currently under expansion. In 2007, Pure Biofuels acquired Interpacific Oil, S.A.C.'s biodiesel production business—Peru's largest and longest-running biodiesel processor. Interpacific currently produces 27 million litres per year of biodiesel and has been producing commercial quantities since 2002. Likewise, two plants are under construction: Industrias del Espino (42.5 million litres per year of total capacity) near Tocache, San Martín, and Herco (85 million litres per year of total capacity) near Lurín, Lima. The main feedstock for biodiesel production is palm oil. Its production is concentrated in the provinces of Ucayali, San Martín, and Loreto. Peru is also considering jatropha as feedstock, with several plantations in different locations in San Martín and Amazonas.

INTERNATIONAL COOPERATION

Peru engages in international energy cooperation in different regions around the world. It is a member of international organisations such as the Asia–Pacific Economic Cooperation (APEC), the Latin American Energy Organisation, the Organisation for Economic Co-operation and Development, the United Nations, the World Bank, the IADB, the Food and Agriculture Organization, the International Fund for Agricultural Development, the Inter-American Institute for Cooperation on Agriculture, the Economic Commission for Latin America and the Caribbean, and others. Also, it participates in several international meetings where bilateral and multilateral agreements are signed.

In 2008, the Peruvian Government hosted the 16th APEC Economic Leaders' Meeting. Peru became a member of APEC on 15 November 1998.

Peru engages in international energy cooperation with the United States, Canada and Mexico. In 2008, the Peruvian and US governments signed a memorandum of understanding to advance cooperation on renewable and clean energy sources. The memorandum provides the framework for further bilateral cooperation to promote energy security through greater use of cleaner and renewable energies, by means of several activities. In addition, the governments of Canada and Peru signed a memorandum of understanding that extends the Peru–Canada Mineral Resources Reform Project (PERCAN) for three more years, with an additional contribution of USD 4.1 million being made through the Canadian International Development Agency (Government of Canada 2008).

With the European Union, Peru has bilateral agreements with Germany through GTZ, which has been working on sustainable development projects and poverty reduction since 1975. Currently, GTZ is working on democracy, water, and rural development projects (GTZ 2009).

Peru's participation in international forums is necessary to maintain quality standards. Currently, Indecopi is developing cooperation and sustainable aid programs with international organisations such as APEC, the OECD, the International Competition Network, the World Bank and the United Nations Conference on Trade and Development. Furthermore, Peru has

established the Peruvian Agency of International Cooperation (APCI by its Spanish acronym), whose aim is the efficient and clear management of international technical cooperation, taking into account development priorities (APCI 2009).

USEFUL LINKS

Instituto Nacional de Estadística e Informática—www.inie.gob.pe

Ministerio de Economía y Finanzas—www.mef.gob.pe

Ministerio de Energía y Minas—www.minem.gob.pe

Perú Ahorra Energía—www.siee.minem.gob.pe

Presidencia de la República del Perú—www.peru.gob.pe

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THE PHILIPPINES

INTRODUCTION

The Philippines is located along the western rim of the Pacific Ocean and covers 300 000 square kilometres of land, spread out over an archipelago of 7107 islands and islets. The total population in 2007 was 88.7 million; more than half of which was concentrated in Luzon, the largest of the three major island groups in the Philippines. Between 2000 and 2007, the economy's GDP grew at an annual average rate of around 5% to USD 249.76 billion (USD (2000) at PPP) in 2007. GDP per capita likewise improved, reaching USD 2815 (USD (2000) at PPP) in 2007 from USD 2678 (USD (2000) at PPP) in 2006.

The Philippines' indigenous energy reserves are relatively small, with only about 30 million barrels of crude oil, 1639 billion cubic feet of natural gas and 440 thousand tonnes of coal, mainly lignite. However, the Philippines has extensive geothermal resources that could make the economy the world's largest producer and user of geothermal energy for power generation. The Philippines is also endowed with a significant hydropower resource, while other renewable energy resources (solar, wind, biomass and ocean) are theoretically estimated to have a power generation potential of more than 250 000 MW.

Table 35 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (sq. km)	300 000	Oil (million barrels)—proven	30
Population (million)	88.72	Gas (billion cubic feet)—proven	1 639
GDP (USD (2000) billion at PPP)	249.76	Coal (thousand tonnes)—proven	440
GDP (USD (2000) per capita at PPP)	2 815		

a Philippine Department of Energy, www.doe.gov.ph.

Source: Energy Data and Modelling Centre, Institute of Energy Economics, Japan (IEEJ).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, the total primary energy supply amounted to 39 263 kilotonnes of oil equivalent (ktoe) of which 43.4% (17 058 ktoe) was imported while the remainder (22 162 ktoe) was supplied through domestic production of indigenous resources. Geothermal and other renewable energy accounted for 42.1% of the total primary energy supply, while oil and coal, which are largely imported, contributed 34.2% and 16.0%, respectively.

OIL, GAS AND COAL

Indigenous crude oil production in 2007 was 827 ktoe, which accounted for only 6.7% of the economy's crude oil requirement. The amount of oil supplied (including imports) in 2007 (13 425 ktoe) barely increased from that supplied in 2006 (13 420 ktoe). The downstream oil industry has experienced steady growth since the implementation of the Downstream Oil Industry Deregulation Act (RA 8479) in 1998. In the first half of 2007, 627 new players were engaged in different activities in the downstream oil industry, a 2.9% increase from 2005. Over the same period, total investment by new players reached PHP 31.69 billion, up from the 2006 level of PHP 30.74 billion.

Currently, the economy's gas production is enough to meet its domestic requirements. Gas production increased from 2532 ktoe in 2006 to 3033 ktoe in 2007. Most of the gas is produced from Malampaya gas field, which also produces 5.15 million barrels per year of condensate. Coal supply increased from 5316 ktoe in 2006 to 6292 ktoe in 2007, of which almost two-thirds was sourced through imports.

RENEWABLE ENERGY

Among the renewable energy resources, geothermal contributed the most to the economy's indigenous energy supply in 2007, accounting for around 9356 ktoe (21.5%) of total primary energy supply. The untapped geothermal resource is estimated to have a potential of about 2600 megawatts (MW). In February 2007, the Philippine National Oil Company – Energy Development Corporation's first merchant power plant, the 49.37 MW Northern Negros Geothermal Power Plant, started its commercial operation, providing additional power capacity for the Visayas grid and brought the economy's geothermal generating capacity to 2677.4 MW.

In August 2008, the NorthWind Power Development Corporation completed the commissioning of Phase 2 of the Bangui Bay Wind Power project, consisting of five 1.65 MW wind turbine generators. To date, the project has increased the economy's wind power capacity to 33 MW.

The 1 MW grid-connected centralised solar photovoltaic power plant in Cagayan de Oro City remains as one of the largest in the region. Local coconut methyl ester (CME) and bioethanol total sales reached 279.27 thousand barrels (MB) and 21.28 MB in 2007, respectively.

ELECTRICITY GENERATION

The economy's power generation grew by 4.6% in 2007, from 56 784 gigawatt-hours in 2006 to 59 612 gigawatt-hours in 2007. The bulk of the economy's power requirements were supplied by natural gas and coal-fired power plants. Natural gas–fired power plants were the biggest source, increasing their share from 29% in 2006 to 32% in 2007, while coal-fired power plants were the second-biggest source, posting a 28% share. Other power generation sources were geothermal (17.1%) hydropower (14.4%) and sources in the 'other' category (0.1%).

Table 36 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	22 162	Industry sector	6 098	Total	59 612
Net imports and other	17 058	Transport sector	8 199	Thermal	40 775
Total PES	39 263	Other sectors	9 132	Hydro	8 563
Coal	6 292	Total FEC	23 429	Nuclear	–
Oil	13 425	Coal	1 419	Other	10 274
Gas	3 033	Oil	12 109		
Other	16 513	Gas	77		
		Electricity and other	9 823		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

In 2007, total final energy consumption in the Philippines was 23 429 ktoe, an increase of 4.4% from 2006 (22 438 ktoe). The transport sector remained as the largest energy consumer, accounting for 35% of this total; followed by the industry sector, 27.2%; and other sectors, 37.8%. By energy source, petroleum products contributed most to consumption, (51.7%), followed by 'other' sources (24.3%), electricity (17.6%), and coal (6.1%).

The 2007–14 Philippine Energy Plan (the 2007 PEP update) estimates that between 2007 and 2014 the economy's final energy demand will grow by 3.3% per year. Petroleum, used mainly in the transport sector, will make up the bulk of the final energy demand, with an average share of 39%, followed closely by biomass (38%), electricity (15%), coal (3%) and natural gas (2%) (DOE 2007).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The principal government agency charged with monitoring the energy sector, including oil, is the Department of Energy (DOE), which is responsible for issuing exploration and production licences and ensuring compliance with relevant regulations.

The development of the energy sector in the Philippines is based on the economy's two-tiered energy agenda of realising energy self-sufficiency and an efficient and globally competitive energy sector. The Philippine Energy Plan was updated in 2007, and approved by the government and the Congress in early 2008. The updated plan (PEP 2007 update) supports the Medium-Term Philippine Development Plan 2004–2010 and the 2005–2010 Medium-Term Public Investment Program.

The update outlines two major priorities. The first is to attain a 60% energy self-sufficiency level from 2010 and maintain this until 2014 (self-sufficiency was 57% in 2007). To achieve this target, the government is aiming to increase oil and gas resources by 20%, increase indigenous coal production to meet local demand and aggressively increase renewable energy (RE) capacity. Furthermore, the use of alternative fuels will be increased and energy efficiency and conservation programs will be strengthened. The second priority is to promote a globally competitive energy sector through reforms in the power sector and downstream oil and gas industries.

MARKET REFORMS

The economy's continuing reforms in the power sector and the downstream oil and gas industries are expected to result in a more efficient and globally competitive energy sector. The government is continuously undertaking a transparent privatisation process of its generation and transmission assets to enhance the investment climate for greater private sector participation. The government's continuing efforts to advance the privatisation of the National Power Corporation's (NPC) generation assets and the transfer of the National Transmission Corporation's (TransCo) transmission assets to private owners, notwithstanding several setbacks, demonstrate its firm resolve to implement reforms in the power industry.

As part of the Electric Power Industry Reform Act (EPIRA), many initiatives have been pursued and will continue to be pursued, such as the commercial operation of the wholesale electricity spot market (WESM), privatisation of the NPC's generating assets; privatisation of TransCo's transmission assets and of its concession; implementation of retail competition and open access; administration of a universal charge for missionary electrification [5] and an environmental charge for the preservation of the environment; and loan relief for electric cooperatives.

The WESM began commercial operation in Luzon in June 2006, signalling an important phase in promoting open access in accordance with the EPIRA. By November 2007, 14 power generators and 23 customers have applied as participants in the WESM.

To counter the impact of increases in the price of electricity, stemming from a number of factors, particularly rising fuel prices, some measures were enhanced, such as: energy conservation and demand-side management; the NPC's internal efficiency measures; economic

[5] 'Missionary electrification' refers to the provision of basic electricity services in unviable and far-flung areas with the ultimate aim of improving the economic condition of these areas.

dispatch; time-of-use pricing; implementation of the WESM; and working towards open access to provide economic price signals, power of choice, and market-based and retail competition.

As of December 2008, the government had successfully put out for bids more than 70% of generating capacity in the Luzon and Visayas grids (the level required under the EPIRA, and subject to the determination of the Energy Regulatory Commission) bringing the Philippines closer to open access and retail competition. This included the successful bidding for the Tiwi-Makban package in July, the Panay-Bohol plant package in November and the Amlan plant in December 2008. The privatisation of its transmission assets is the economy's biggest privatisation effort thus far. The TransCo concession was awarded to the National Grid Corporation of the Philippines (NGCP). The TransCo Franchise Law (RA 9511) was enacted on 1 December 2008, and became effective on 20 December 2008.

The government has achieved the target of 99.39% barangay (village) electrification as of December 2009 and will continue to energise remaining barangays to achieve the target 100 percent barangay electrification by 2010.

The Downstream Oil Industry Deregulation Act of 1998 (RA 8479) was passed to liberalise and deregulate the economy's downstream oil industry to ensure a truly competitive market under a regime of fair prices, a level playing field and an adequate and continuous supply of environmentally clean and high-quality petroleum products. DOE ensures the reasonableness of domestic prices through international price monitoring of crudes (such as Dubai, Brent and West Texas Intermediate) and petroleum products (Mean of Platts Singapore). Corresponding adjustments in domestic prices are estimated considering the movements in these international benchmarks and in the foreign exchange.

To counter the effects of intermittent increases in the price of oil to the economy, DOE ensures consumer protection and healthy competition among industry players. The various oil players have also offered price discounts for diesel sold at the pump economy-wide for the public transport sector.

UPSTREAM ENERGY DEVELOPMENT

OIL AND GAS

The government is actively promoting intensive upstream exploration and development through the Philippine Energy Contracting Round (PECR). 12 areas were evaluated in 2009 to become part of the 2010 PECR. The economy now has 33 active service contracts (SCs) and one geophysical survey & exploration contract (GSEC) due for conversion into a service contract.

One well was drilled in offshore Sulu Sea in 2009. The Dabakan-1 well was drilled by ExxonMobil Exploration and Production Philippines BV (EMEPP) under SC 56. The well registered a total depth of 5298 metres Measured Depth below Kelly (MDKB)/4844 metres True Vertical Depth below Kelly (TVDKB) and encountered significant hydrocarbon. Galoc Production Company (GPC) completed Extended Production Testing (EPT) of the Galoc oil field under SC No. 14C (Galoc Block).

In 2009, 3704 line-kilometres of offshore and onshore 2D seismic data was collected under four SCs, while 1754 square-kilometres of 3D seismic data was acquired under three SCs.

Total oil production in 2009 was 2 920 388 barrels. Of this total, Galoc oilfield accounted for 2 736,323 barrels, Nido oilfield 83 342 barrels, Matinloc 67 594 barrels and North Matinloc 33 129 barrels. Production from Malampaya gas field was 138 029 million cubic feet while condensate production was 5 456 583 barrels.

COAL

The Philippines has around 13 coal basins that contain significant coal deposits. Total coal resource potentials in these areas are estimated at 2.3 billion tonnes. In December 2009, the economy had 60 active coal operating contracts (COCs) with development, production and exploration commitments. In 2009, 18 new COCs to explore and develop coal resources were

issued in the provinces of Sorsogon, Zamboanga Sibugay, Zamboanga Del Norte, Cebu, Agusan Del Norte, Agusan Del Sur, Davao Oriental, Sultan Kudarat, Sarangani and South Cotabato and Surigao Del Sur. The economy's coal operating contractors produced 5.1 million tonnes in 2009.

NUCLEAR POWER

As a net energy importer, the Philippines is looking into the prospect of developing a nuclear energy program to support its development needs, and has considered it as a long-term option. In collaboration with the Department of Science and Technology (DOST), DOE is undertaking a review of scientific and technical options to revive the economy's nuclear energy program. With nuclear energy viewed as one of the cheapest options for ensuring electricity supply, the joint DOE–DOST initiative will prioritise capability-building activities to develop the required local expertise. For example, a vital component of a science-based approach to the nuclear option would be to ensure the training of young nuclear scientists and technical experts in various aspects of nuclear power through internships with, and scholarship grants from, economies with advanced nuclear technology. DOE will also look into all possible measures to address public acceptance and stakeholder involvement.

In January 2008, an International Atomic Energy Agency mission visited the economy to help in assessing the options of rehabilitating the mothballed Bataan Nuclear Power Plant in Morong, Bataan, or constructing a new plant. The mission recommended an extensive review and evaluation of the plant, particularly of its structure and facilities. At the Association of Southeast Asian Nations (ASEAN) level, consideration of nuclear energy as a potential area of regional cooperation is making moderate progress.

TRANSPORT

Among the economic sectors, transport remains the most oil intensive, comprising almost three-quarters of total oil demand. In order to secure oil supply and mitigate GHG emissions, the government promotes the utilisation of alternative fuels in the sector, which was given the necessary push with the passage of the Biofuels Act. The law was promulgated on 12 January 2007 (RA 9367) and provides the impetus for the full development and utilisation of biofuels in the economy. The importance of biofuels was highlighted during the 24th ASEAN Ministers on Energy Meeting held in Vientiane, Lao People's Democratic Republic, in July 2006. Emphasis was given to the need for closer cooperation and exchange of experiences among ASEAN economies in promoting the development, production and utilisation of biofuels, including the relevant fiscal incentives, funding facilities and regulatory infrastructures. Similarly, the East Asia–ASEAN Declaration on Energy Security, in 2007, acknowledged the significance of biofuels as one of the measures in realising the common goals of regional energy security.

The government implemented a mandatory blending of 1% biodiesel in all diesel-fed vehicles from May 2007, increasing to 2% by 2009. The 1% mandated blend would correspond to a total of 64.5 million litres (ML) of diesel fuel displacement in 2008, while the 2% biodiesel blend is expected to displace a total of 133.7 ML of diesel fuel and reach 160.7 ML by 2014. Meanwhile, an economy-wide mandatory blending of 5% bioethanol in all gasoline-fed vehicles started in 2009 and will increase to 10% by 2011. The implementation of the 5% mandatory blend of bioethanol in 2009 would displace a total of 208.1 ML of gasoline fuel, while the 10% blend would result in the displacement of a total of 460.6 ML in 2011 and reach 536.3 ML by 2014 (DOE 2007).

The introduction of E10 (10% bioethanol blend) to the market was initiated by new industry players such as Seaoil and, later, Flying V, which put it in at least four of its stations in Metro Manila. Philipinas Shell also launched Shell Super Unleaded E10 in 31 gasoline stations in Metro Manila at a price PHP 0.5 less than that of its regular unleaded gasoline at the pumps. Currently, E10 is available in 105 Seaoil stations, 55 Shell stations, and 14 Petron stations.

There are two existing bioethanol plants in the Philippines: Leyte Agri Corp. (in operation since July 2008) and San Carlos Bioenergy, Inc. (in operation since 2009). As of September 2008, DOE had endorsed eight bioethanol projects for incentives under the existing Investments

Priorities Plan, and one project under the Philippine Economic Zone Authority. The projects, involving an investment of PHP 28 billion, will have a total annual capacity of about 505 ML.

To regulate the economy's fast-growing auto-LPG industry and to protect consumers, the DOE issued DC No. 2007–02–0002, "Providing for the Rules and Regulations Governing the Business of Supplying, Hauling, Storage, Marketing and Distribution of LPG for Automotive Use" in February 2007. Demand for LPG in the transport sector is growing because it is cheaper than conventional fuels. The number of stations dispensing LPG increased rapidly (from an initial nine to more than 80), and is continuing to increase. Correspondingly, the number of garage-based dispensing stations has already reached 35.

In March–April 2008 the "Libreng Sakay" (free ride) program, was launched. The program raised commuter awareness on CNG use in public transport. Around 7000 commuters on the Batangas–Cubao and Santa Cruz, Laguna–Cubao routes have benefited from the program. Commercial operation of the Natural Gas Vehicle Program for Public Transport (NGVPPT) Pilot Phase began in April 2008. By the end of 2008, 24 CNG buses were commercially operating along the Laguna/Batangas–Cubao route. The retail price of CNG during the seven-year NGVPPT Pilot Phase is PHP 14.52/diesel litre equivalent. The Philippines' first compressed natural gas (CNG) daughter stations began in October 2007.

A major breakthrough in the Libreng Sakay program was the PHP 1.0 billion investment commitment of Ford Philippines for the building of a flexible fuel engine plant in Santa Rosa, Laguna. This was followed by the commercial launch of the first Ford Flexi-Fuel Vehicle (FFV) model in April 2006, which boosted the economy's bid to become the ASEAN Centre of Excellence for Flexible Fuel Technology. The FFV can run on regular gasoline or a blend of 85% ethanol and 15% gasoline (E85).

ENERGY EFFICIENCY

DOE launched the National Energy Efficiency and Conservation Program (NEECP) as part of the SWITCH movement, which was launched by President Arroyo in July 2008. SWITCH aims to persuade people to switch from a lifestyle of expenditure and waste to a lifestyle of conservation and efficiency. It also aims to promote a shift from petroleum-based fuels to alternative fuels such as biodiesel and bioethanol.

The NEECP outlines the following goals to be achieved by 2014:

- to cushion the impact of increases in the prices of petroleum products and electricity through the implementation of energy efficiency and conservation measures
- to promote cost avoidance/savings on fuel and electricity without sacrificing productivity
- to help protect the environment
- to generate cumulative energy savings for the planning period 2007–14 of 9.1 million barrels of fuel oil equivalent (MMBFOE), which is equal to a deferred megawatt capacity of 210.56 MW and greenhouse gas (GHG) emissions of 2.92 million tonnes of carbon dioxide equivalent at the end of the planning period.

The NEECP consists of nine components across six sectors (NEECP 2009):

- Component 1: Information, Education and Communication Campaign
- Component 2: Standard and Labelling for Household Appliances
- Component 3: Government Energy Management Program
- Component 4: Energy Management Services/Energy Audits
- Component 5: Voluntary Agreement Program
- Component 6: Recognition Award Program

- Component 7: Fuel Economy Run Program (currently part of the Information, Education and Communication Campaign, but necessary to establish/generate significant data for the Vehicle Labelling Program in the future)
- Component 8: Locally Funded Projects that promote Energy Efficiency Conservation
  - Fuel Conservation and Efficiency in Road Transport
  - Power Conservation and Demand Management (Power Patrol)
  - Philippine Energy Efficiency Project—a USD 31 million ADB loan to the Philippine Government to promote energy efficiency conservation
- Component 9: Foreign Assisted/Technical Assistance. This includes the Philippine Industrial Energy Efficiency Project for the Philippines. This United Nations Industrial Development Organization assisted project has the objectives of showing optimisation system models in industrial manufacturing facilities and establishing a Philippine Energy Management Standard in line with ISO 5001.

In 2007, the government's energy conservation efforts generated energy savings of about 880.8 ktoe and avoided 2.1 million tonnes of carbon dioxide equivalent (CO_2-e) emissions. The savings include those resulting from the energy management activities conducted by DOE, such as the 'spot check' program of government agencies, the continuing energy standards and labelling program, and energy audits of various commercial and industrial establishments.

The quantification of savings derived from the various energy efficiency measures and activities undertaken by end-use consumers is the subject of an ongoing study by the government, which seeks to formulate a more effective monitoring mechanism of energy savings.

The continued implementation of the government's energy efficiency and conservation program is expected to yield estimated savings of 7.5 MMBFOE (1.08 Mtoe) in 2010 and up to 9.1 MMBFOE (1.31 Mtoe) by 2014.

For the energy labelling and efficiency standards program, DOE will look into a minimum 15% increase in the average efficiency ratings of new appliance models within the planning period (2007–14). This program is also expected to contribute most to energy savings (6.7 MMBFOE (0.97 Mtoe) in 2010 and 8.1 MMBFOE (1.17 Mtoe) in 2014). To realise this target, the government will:

- pursue the standardisation of technical specification requirements in the procurement of energy efficient lighting systems and other electrical equipment and devices in government offices (for example, the use of 32-watt instead of 40-watt CFLs (compact fluorescent lamps) and the use of energy-efficient LCD computer monitors)
- formulate a benchmark in government buildings (in kilowatt-hours per square metre, subject to the age of building, usage/function, height/number of floors and floor area, among others), which will serve as a reference in managing energy consumption
- promote a market-based application under the Demand Reduction Program in the absence of utility-based demand-side management
- strengthen product testing and research through the establishment of a lighting testing facility to determine and recommend more efficient lighting designs for office buildings and street lighting
- draw up an inventory of legitimate and accredited testing laboratories to encourage the private sector to set up independent and competent testing laboratories
- review and formulate policies and guidelines on the disposal of mercury-containing lamp wastes (DOE 2007).

RENEWABLE ENERGY

To further promote the development, utilisation and commercialisation of renewable energy resources, the Renewable Energy Act of 2008 was enacted in December 2008 (RA9513). This Act facilitates the energy sector's transition to a sustainable system with RE as an increasingly prominent, viable and competitive fuel option. The shift from fossil fuel sources to renewable forms of energy is a key strategy in ensuring the success of this transition. Moreover, current initiatives in the pursuit of this policy are directed towards creating a market-based environment that is conducive to private sector investment and participation and encourages technology transfer and research and development.

The economy's total estimated potential of untapped geothermal resource is about 2600 MW. Over the next 10 years, development of proven reserve areas will make available a maximum 1200 MW of this estimated potential. About 610 MW of potential capacity can be generated from resources in service contract areas belonging to the Energy Development Corporation.

In addition to developing existing programs in geothermal energy development, the government will pursue optimisation of geothermal energy using the cascading scheme of development through the project Resource Assessment of Low-Enthalpy Geothermal Resources in the Philippines. The project, which started in 2007, will last five years. The project aims to promote and accelerate the development of small and low enthalpy geothermal resources in the Philippines by conducting detailed geo-scientific investigations and socioeconomic and environmental baseline studies.

The economy's total installed capacity from hydropower reached 3291 MW in 2008, which represents 62% of the total RE capacity. To further develop hydropower as the mainstay of the economy's power generating options, the government is currently pursuing greater private sector participation in the development of hydropower resources. The government has identified 41 hydropower projects with a total potential generating capacity of 1025.1 MW, composed of 10 large hydropower projects and 31 mini hydropower projects. In addition, the completion of four mini hydropower projects under construction will provide an estimated additional 4.6 MW to the economy's existing hydropower capacity by 2010.

To promote broad use of other RE sources, about 707 MW of generating capacities from biomass, wind and solar energy sources were identified for possible development. About 551 MW will come from wind power projects and 156 MW from biomass and solar.

CLIMATE CHANGE

To ensure compliance of energy projects to environmental regulations and standards, DOE actively participates in Multipartite Monitoring Team activities that include regular monitoring of air and water quality. Under the framework of the Philippine Environmental Impact Statement System, DOE provides technical support and advice to the Environmental Impact Assessment Review Committee in the evaluation of energy projects. In August 2007, DOE was also tasked to chair the Presidential Task Force on Climate Change (PTFCC) and take the lead in the Philippine's campaign to mitigate the impact of climate change. Under DOE leadership, PTFCC submitted and presented to the President the economy's climate change response framework and action plan entitled "Climate Change: Philippines Response". PTFCC signed a Memorandum of Agreement (MOA) on Watershed Reforestation to plant 10 000 hectares of open and low-lying areas in the 11 watersheds of the National Power Corporation. Similarly, a MOA was also forged with the Department of Education to institutionalise the Curriculum Development of Climate Change Education at the primary and secondary school levels.

In October 2009, RA 9729 or the Philippine Climate Change Act of 2009 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.

INTERNATIONAL COOPERATION

Pursuing collaborative activities with other economies through bilateral, regional and multilateral agreements is vital if the Philippines is to achieve the goals set out in its energy policies, such as greater energy self-sufficiency, energy security and sustainability.

In 2007, DOE and the United States Geological Survey signed a memorandum of understanding on scientific and technical cooperation in the earth sciences. The agreement provides the framework for the two economies to exchange scientific and technical knowledge of the energy sector. One of the activities under this agreement is a joint assessment of coal-bed methane and coal resources in the coal fields in the Philippines.

The Philippines is also actively participating in regional energy cooperation and initiatives through ASEAN, APEC, the Asia Cooperation Dialogue, the Asia–Europe Meeting and the East Asia Summit (EAS). Following the signing of the Cebu Declaration on East Asian Energy Security by the heads of government of ASEAN member economies and of ASEAN's dialogue partners during the second EAS held in 2007 in Cebu, the leaders endorsed the establishment of a working group to study possible areas of cooperation among EAS members to enhance energy security. Following this directive, the EAS Energy Cooperation Task Force was established with three identified areas of cooperation: biofuels for transport and other uses; market integration; and, energy efficiency. The Philippines was designated as the lead economy for the working group on biofuels.

During the thirty-sixth APEC Energy Working Group (EWG) meetings hosted by the Philippines in December 2008 in Manila, member economies noted the landmark RE Law which provides both fiscal and non-fiscal incentives to local and foreign private investors in developing RE resources. During the meeting, the Philippines also affirmed its commitment to revive active participation in the different energy working groups for both ASEAN and APEC.

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

The Philippines introduced the Renewable Energy Act of 2008 in December 2008. Details are contained in the 'Policy overview' section.

OIL AND GAS SECTOR

One new SC was awarded as a result of 2006 PECR in 2009. SC 71 was granted to Pitkin Petroleum Limited, covering the Mindoro-Cuyo platform. Likewise, one well was drilled in 2009 in the offshore Sulu Sea. The Dabakan-1 well was drilled by ExxonMobil Exploration and Production Philippines BV (EMEPP) under SC 56.

COAL SECTOR

In 2009, 18 new coal operating contracts to explore and develop coal resources were issued in the provinces of Sorsogon, Zamboanga Sibugay, Zamboanga Del Norte, Cebu, Agusan Del Norte, Agusan Del Sur, Davao Oriental, Sultan Kudarat, Sarangani & South Cotabato and Surigao Del Sur.

LOW-CARBON ENERGY PROJECTS

Potential additional capacity of 699.4 MW could be generated from geothermal resources by 2014. The Nasulo Geothermal Power Project in Palinpinon, Negros Oriental, and the Mindanao III project in Mount Apo, North Cotabato, are already committed and expected to be available by 2011.

The economy is the top wind producer in South-East Asia, with 25 MW wind turbines located in Bangui, llocos Norte. The additional 8 MW commissioned in August 2008 brought the economy's installed wind power capacity to 33 MW (DOE 2008). Energy Logics Philippines Inc.

will develop 100 MW wind power plants in Morong (Bataan), Subic (Zambales) and Pasuquin (Ilocos Norte). The economy's leading geothermal energy developer—EDC—has begun to move into other RE sources: it has applied to DOE for a production sharing contract (PSC) for a wind power development at Nagsurot, Burgos (Ilocos Norte). UPC Asia has applied for a PSC for wind power developments at Burgos and Pagudpud, both in Ilocos Norte. Moreover, 23 wind sites in different regions, with a total potential capacity of 556.5 MW, were being promoted during the planning period.

The 25 MW per year initial capacity of the Sunpower solar wafer fabrication plant was raised to 50 MW in 2005 and 108 MW in 2006. It is planned to gradually increase its capacity to 400 MW by 2010. The plant, which started operating in 2004, was the first large-scale solar cell facility in South-East Asia. It is located in Santa Rosa, Laguna, where it manufactures high-efficiency photovoltaic cells.

A total of 183.9 MW rice hull or bagasse-fuelled cogeneration projects have been lined up through to 2014. Investment by the private sector provides an indication of the potential for biomass energy development in the economy.

DOE has announced that with the support of the Asian Development Bank (ADB) and the World Bank, the economy will receive co-financing of USD 250 million from the Clean Technology Fund (CTF) to help it mitigate the effects of climate change. The CTF will be important in leveraging resources needed for reducing GHG emissions and accelerating implementation of projects and programs. Donor economies, including Australia, France, Germany, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States, pledged over USD 6.1 billion in 2008 for the Clean Technology Fund and the Strategic Climate Fund. The Clean Technology Fund is part of a broad global initiative to help developing economies meet the cost of actions needed to combat climate change. The Clean Technology Fund will issue concessional loans to support the deployment of low-carbon energy technologies as well as energy-efficiency measures for industry, commercial buildings and municipalities. Activities supported by the fund will get co-financing from ADB's regular operations, and this is expected to mobilise additional financing from both the state and private sectors (DOE 2009a).

NUCLEAR POWER

At the Ministerial Conference on Nuclear Energy in the 21st Century, held in Beijing, China, from 20–22 April 2009, it was said that the government of the Philippines was considering the option of nuclear energy as a long-term energy option and that it was studying the feasibility of rehabilitating the mothballed Bataan Nuclear Power Plant. The head of the International Atomic Energy Agency (IAEA) assured the Philippines of IAEA's continued assistance, especially in the area of human resource capability building in the various facets of nuclear science and engineering. Dr ElBaradei also committed the IAEA's support in the establishment of an independent nuclear regulatory body in the Philippines and in the government's information drive to educate the public on facts about nuclear energy.

ENERGY EFFICIENCY

In January 2009, DOE and Chevron Geothermal Philippines Holdings, Inc. (CGPHI) signed a pledge of commitment to support the NEECP. Under the commitment, CGPHI will implement the NEECP in all its buildings and facilities, including its geothermal facilities in Tiwi and Makban, as part of its energy management program. DOE will provide CGPHI with the necessary support services, including technical energy management assistance such as capacity building training seminars on energy auditing procedures, the use of auditing instruments, best practices in energy efficiency and conservation measures and energy consumption monitoring (DOE 2009b).

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/

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/

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APERC (Asia Pacific Energy Research Centre) (2009). *APEC Energy Overview 2008*.

DOE (Department of Energy) (2006). *The Philippine Energy Plan 2006–2014* (2006 PEP Update), DOE.

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EDMC (Energy Data and Modelling Center) (2009). APEC energy database. EDMC, Institute of Energy Economics, Japan. www.ieej.or.jp/egeda/database/database-top.html

THE RUSSIAN FEDERATION

INTRODUCTION

Covering more than 17 million square kilometres, the Russian Federation is the largest economy in the world in terms of land area. It is located in eastern Europe and northern Asia, and is bordered by the Arctic Ocean, Central Europe and the North Pacific Ocean. Its terrain is characterised 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. Russia has a vast natural resource base that includes major deposits of coal, natural gas, oil and other minerals. Despite its land area advantage, it is unfavourably located in relation to the major sea lanes of the world. It also lacks an optimal climate for agriculture, as most of its area is either too cold or too dry.

The overall population density is low (fewer than nine people per square kilometre) and the northern and eastern regions are very sparsely populated. Urban population accounts for 73% of the total. From 1990 to January 2007, the permanent population declined from 147.7 million to 142.2 million.

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 ruble in the aftermath of the 1998 financial crisis and its positive impact on the economy's competitiveness. Soaring world prices of oil and natural gas also drove the recovery.

The Russian Oil Stabilisation Fund was established in January 2004 to reduce the vulnerability of the state budget to the volatility of world oil prices (a stabilisation function) and to decrease the impact of oil-related foreign exchange inflows on the money supply and inflation (a 'sterilisation' 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 207 billion). Russia's economy is continuing to develop strongly, achieving 8.1% growth in 2007 and an average growth rate of 6.6% since 2000. GDP in 2007 was estimated at USD 1744 billion (USD (2000) at PPP). The unemployment rate in 2007 was 6.1%, while inflation stayed high at 11.9%.

Table 37 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	17 075 200	Oil (billion barrels)—proven	80.4
Population (million)	142.1	Gas (billion cubic metres)—proven	43.3
GDP (USD (2000) billion at PPP)	1 744.3	Coal (billion tonnes)—proven	157.0
GDP (USD (2000) per capita at PPP)	12 275		

Sources: Energy Data and Modelling Centre, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html); *BP Statistical Review of World Energy 2009*.

In terms of proven reserves, Russia holds a quarter of the world's gas, 7% of oil reserves and 17% of coal reserves. Even more resources remain undiscovered. However, the formidable obstacles of climate, terrain and distance have hindered exploitation of these natural resources. The economic potential of hydropower is estimated at 852 terawatt-hours (TWh) per year, but only 20% of this has been developed. Economic reserves of uranium ore comprise about 14% of the world total. Russia is the second-largest primary energy producer (behind the United States), the third-largest energy consumer (behind the United States and China), the largest exporter of energy (some 45% of total energy produced is exported), the largest exporter of natural gas, and the second-largest oil exporter. Energy sector output accounts for almost 30% of Russia's GDP,

and is very important not only to economic development but to the very survival of most of the population during harsh winters.

In 2007, exports of crude oil, petroleum products and natural gas accounted for two-thirds of the economy's total exports and approximately 9% of GDP. Russia holds leading positions in each of the world's energy markets: 45% of uranium enrichment, 25% of natural gas trading, 15% of reactor construction, 15% of spent nuclear fuel conversion, 12% of crude oil and petroleum products trading, and 12% of coal trading (MERF 2009:9). Net exports of energy in 2007 reached 545 million tonnes of oil equivalent (Mtoe), consisting of 29% of coal, 29% of natural gas and 75% of oil extracted, and maintaining Russia as the top energy exporter in the world.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Russia's total primary energy supply in 2007 was 669.9 Mtoe, comprising natural gas (55%), crude oil and petroleum products (21%), coal (15%) and other sources, including nuclear and hydro (9%). Exports go overwhelmingly to Western and Eastern Europe (including the Commonwealth of Independent States), which account for more than 92% of Russia's total energy exports. In an attempt to secure its future export flows, Russia is currently diversifying energy export routes towards regional markets in the Asia–Pacific, aiming to deliver coal, electricity, oil and natural gas to such Asia–Pacific Economic Cooperation (APEC) economies as China, Japan and the Republic of Korea in East Asia, as well as the North American Free Trade Agreement economies in North America.

Russia produced 490.3 million tonnes of crude oil and gas condensate in 2007. The oil heartland province of West Siberia accounted for about two-thirds of total production. Refiners consumed 229 million tonnes of crude oil as feedstock, producing 35.1 million tonnes of gasoline, 66.4 million tonnes of diesel oil and 62.5 million tonnes of fuel oil. Oil exports reached 259 million tonnes of crude oil and 111 million tonnes of petroleum products. Prospective oil provinces are in the Timano–Pechora and East Siberia onshore regions and offshore in the North Arctic and Far East seas, as well as on the North Caspian shelf.

Natural gas production reached 651 billion cubic metres (bcm) in 2007. Net exports accounted for 191 bcm or 29% of production, down from the previous year by 1.5% due to a milder winter in Europe. Nearly all natural gas exports were destined for Western and Central Europe, including Turkey, with small amounts piped to the Transcaucasian states—Armenia, Azerbaijan and Georgia. Huge but undeveloped resources of natural gas are located in remote regions, where a lack of infrastructure prevents the start-up of upstream operations.

Russia produced 314 million tonnes of coal in 2007. Coal exports reached 91.5 million tonnes, or 30% of production, despite the fact that the main coal-producing areas (Kuznetsky and Kansko–Achinsky basins) are landlocked in the Asiatic part of Russia, some 4000 to 6000 kilometres from the nearest coal shipping terminal for the Atlantic or 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.

Russia produced 1015 TWh of electricity in 2007, of which 66% was from thermal power plants, 18% from hydropower and 16% from nuclear energy.

FINAL ENERGY CONSUMPTION

In 2007, total final energy consumption in Russia was 443 Mtoe, an increase of 1.4% from the previous year. By sector, industry accounted for 36%, transport for 22% and other sectors for 42%. By energy source, coal accounted for 5%, petroleum products 24%, natural gas 30% and electricity, heat and others 41%. Russia has the highest final energy intensity among APEC economies. Because of Russia's extremely cold climate, the most important energy use is for space heating (about 40% of total final energy consumption). The traditional energy-intensive

industrial structure has been one of the major drivers of economic development. Measures to improve energy efficiency in existing industries and to increase the share of less energy-intensive services are considered to be major issues in Russian energy policy. According to experts' estimates, Russia has a huge untapped technical potential for energy savings, ranging from one-third to almost half of total primary energy consumption.

Table 38 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	1 222 366	Industry sector	157 450	Total	1 015 333
Net imports and other	–545 215	Transport sector	99 209	Thermal	673 823
Total PES	669 942	Other sectors	186 723	Hydro	178 982
Coal	102 153	Total FEC	443 382	Nuclear	160 039
Oil	138 562	Coal	23 720	Wind	n.a.
Gas	366 067	Oil	106 833	Solar	n.a.
Others	63 161	Gas	131 172	Biofuels	n.a.
		Electricity and others	181 657	Others	2 489

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

In May 2008, the new Ministry of Energy was established, taking parts of government control from the former Ministry of Industry and Energy. Major objectives for the new ministry are the development and monitoring of Russian energy policy and the regulation framework along the energy supply chain.

ENERGY STRATEGY TO 2030

One of the milestones in Russia's energy sector development was the adoption of the *Energy Strategy of Russia to 2020*, which was approved by the federal government in August 2003. The document identifies the economy's long-term energy policy and mechanisms for the realisation of the policy. A revised version of the strategy, with an extended timeframe to 2030, was adopted by the government in November 2009.

The strategic target of Russia's external power policy is the effective utilisation of the economy's energy potential for the maximum possible integration into the world energy market, strengthening Russia's position in the market and maximising benefits from energy resources for its economy. Measures to secure domestic energy consumption, energy export obligations, and efficiency improvements along the whole energy supply chain are to be implemented to ensure:

- a high degree of energy security for Russia and its regions
- fully fledged Russian participation in the construction of the 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, while the share of foreign direct investment to energy-related industries should increase to 12% from the current 4%)
- decreased economic dependence on the oil and gas sector (the share of energy in GDP should be reduced from 30% to 18%)
- reduced economic energy intensity.

To facilitate international cooperation on energy security, Russia, as the world's largest supplier of energy resources, has adopted the following strategic initiatives:

- modernisation and development of energy infrastructure, including construction of the main trunk oil and gas pipeline systems to enhance the economy's energy export capacity
- development of a closed nuclear fuel cycle and expansion of nuclear power generation
- development of new hydrocarbon provinces in remote areas and offshore
- accelerated energy exports to the Asia–Pacific regional international market.

The most important instrumental tools of the *Russian Energy Strategy up to 2030* are the development of energy market infrastructure and institutions, such as fair pricing, transparent trading principles, and sufficient energy transportation infrastructure. The policy will be implemented through:

- legislative support for transparent and non-discriminatory access for all market participants to energy infrastructure (pipelines, power and thermal grids), toughening of antimonopoly regulation to suppress cartel and technological monopolisation, and the creation of an integrated monitoring system for energy markets
- stimulation of private companies' participation in energy trade by means of commodity exchange, the creation of a regulatory framework for development of the energy 'derivatives' trade (futures, options etc.) in rubles through stock exchanges, and the use of that market to price Russian energy resources
- liquidation of cross-subsidies and reduction of state regulation of natural monopolies' prices, while maintaining socially significant categories for citizens' maximum permissible share of energy expenses
- steady liberalisation of domestic energy markets (gas, electricity, heat), encouraging long-term energy delivery contracts.

The share of renewable energies is expected to increase from the current 32% to 38% in 2030, to equal 100 TWh of electricity production.

The total cost of implementing the strategy was assessed at USD 2.4–2.8 trillion.

MARKET REFORMS

Since 2000, Russia has begun to restructure its power and nuclear industry, liberalise power and electricity markets, create a more favourable fiscal environment for oil and gas industry development, and realise giant infrastructure projects. The infrastructure projects, including new oil and gas export trunk lines to European and Asian markets, provide a basis for a solid Russian contribution to improved global energy security, and for the development of the international infrastructure for reliable maintenance of the nuclear fuel cycle under strict International Atomic Energy Agency (IAEA) supervision.

INDUSTRY RESTRUCTURING

Oil and gas

Currently, the oil industry in Russia consists of 10 large companies producing more than 90% of the crude oil, some 300 small-scale enterprises, and operators of three production sharing agreements, which produce less than 0.5%. The Federal Antimonopoly Supervision Agency has an element of control over oil and gas prices through its role in controlling the market share of sellers, but is not responsible for the regulation of prices. The refining sector consists of 27 large and more than 50 small refineries. After the merger of crude oil and petroleum products pipeline companies Transneft and Transnefteprodukt, the state controls 75% of the combined company's shares. Private oil pipelines already 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 also operate in the European part of the north-west and in Siberia.

The federal government remains the key shareholder in the economy's gas monopoly, Gazprom (extractor of 85% of the natural gas in Russia and owner of the Russia-wide gas pipeline system), holding more than 50% of its shares. Independent companies produce the other 15% and supply some 25% of domestic consumers.

International oil companies such as ConocoPhillips, ExxonMobil, Royal Dutch Shell, BP, CNPC (China National Petroleum Corporation) and Total hold up to 10 billion barrels of oil and natural gas reserves in Russia through their stake in state and private companies, and produce at least 14% of the economy's crude oil and 7% of its natural gas. Foreign investments accounted for 23% of more than USD 200 billion in cumulative investments in the Russian energy sector from January 2000 to September 2009.

Coal

The Russian coal sector was restructured and fully privatised in the 1990s, and foreign participation in the sector is practically absent. There are no subsidies to the coal industry, in which industrial development is based two-thirds on equity and one-third on loans. There are no restrictions on coal export, but the geographical size of Russia's vast economy requires the haulage of coal over long distances. Coal is the single largest commodity transported by Russia's railway network, accounting for over 27% of total rail freight.

Power

Russia started restructuring the power industry in 2000. The first step was the development of the reform concept. Federal laws and federal government decrees identified the main principles for the future functioning of the power industry under competitive conditions. All thermal generation and regional power distribution companies were privatised before July 2008. From July 2008, binding regulation has separated generation and transmission assets in Russia. Generation assets are consolidated into interregional companies of two types: seven wholesale generation companies (WGCs) and fourteen territorial generation companies (TGCs). Six thermal WGCs are constructed according to extraterritorial principles, with one holding hydropower plants (RusHydro), while 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. To prevent possible monopoly abuse, each WGC consists of power plants sited in different regions of the Russian Federation. The assets of six out of seven WGCs are thermal power plants, while state-owned holding company RusHydro manages 53 hydropower plants, including the largest in Russia, the Sayano–Shushenskaya plant (6.4 GW).

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 of the Russian Federation is in charge of monitoring the transportation market, where the threshold is less than 20% of transmission line capacity per actor. The wholesale power market infrastructure includes the following organisations:

- Non-profit Partnership Council for Organising Efficient System of Trading at Wholesale and Retail Electricity and Capacity Market (NP ATS)
- the system operator—Central Dispatch Administration of the Unified Energy System
- Federal Grid Company of the Unified Energy System.

The NP ATS was established in November 2001 pursuant to a Russian Federation Government resolution in July 2001. The main purposes of NP ATS are to organise trade and arrange financial payments in the wholesale electricity and power market, to increase the efficiency of power generation and consumption, and to protect the interests of both buyers and suppliers. NP ATS provides infrastructure services (which are related to the organisation of trade) to the wholesale power market, thus ensuring the execution and closing of transactions and the fulfilment of mutual obligations.

The system operator exercises technological control within the power grids and renders dispatching services to wholesale market participants. The Federal Grid Company owns and operates the transmission lines, provides consistency of technological management and is responsible for reliable power transmission services.

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 related infrastructure. In February 2007, a new Law on Nuclear Industry was adopted, providing a legal framework for the 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 power company was established. The new corporation—JSC Atomenergoprom (AEP)—includes uranium production, engineering, design, reactor construction, power generation and research institutes. AEP currently holds 17% of the world's nuclear fuel supply, 40% of the world's enriched uranium supply, 23 GW of existing Russian nuclear power plants, five reactors under construction in Russia, and five reactors under construction in four Asian and European economies. The company provides the full production cycle of nuclear power engineering, from uranium production to nuclear power plant construction and energy generation. AEP makes up 16% of the world's market for new nuclear power plant construction, and includes such large companies as Tenex (40% of the world's uranium enrichment services market), TVEL (17% of the world's nuclear fuel market), and Atomredmetzoloto (9% share of the world market in uranium mining).

MARKET LIBERALISATION

Russia has been gradually moving from state-regulated energy pricing to a free market for natural gas and electricity (coal and petroleum prices are already fully liberalised). During the transition period, the federal government will keep control over tariff-setting policy for natural monopoly services. The Federal Tariff Service is authorised to set maximum allowable regional tariffs for natural gas, electricity and centralised heat. The *Russian Energy Strategy up to 2030*, adopted in August 2009, will end in full liberalisation of domestic energy markets, while at least 20% should be traded at commodity exchanges. In December 2006, the government approved the decision to liberalise natural gas and electricity prices simultaneously in 2011, thus ensuring the smooth development of natural gas and the restructuring of the power industry for the next five years. The decision to synchronise price liberalisation was important for both industries, as the power industry's share of total domestic natural gas consumption is more than 40%, while gas provides an overwhelming 70% of the thermal power plants' fuel mix.

The oil market in Russia has been deregulated since the 1990s, however petroleum market remains oligopolistic, and non-transparent. Most crude oil in the domestic market is traded on a term basis, in which prices are linked to international benchmarks. The spot crude oil market is active for only a few days in the second half of each month, using commodity exchange platforms. Petroleum is traded in irregular tenders, which allows producers to control the market. The vertically-integrated oil company's domination prevents small and independent business to enter the markets. Regional petroleum storages play an important role in establishing fuel markets. The government make a strong message to the oil companies in 2009 by enforcing regulation on compulsory 10 percent petroleum products trading at domestic market by means of commodity exchanges or e-trading.

Access to Gazprom's gas transportation system by independent producers, as well as the wholesale gas price system, is regulated by a special federal government decree. In August 2006, tariff regulation for new pipelines came into force, which is important for enhanced access by independent companies to Gazprom's natural gas pipeline system.

The gradual transition to European prices in domestic markets is scheduled to be completed by 2011, while the share of domestic supplies will be gradually increased, based on transparent free trading pricing mechanisms. In July 2007, new regulations for natural gas sales in Russia were

introduced, including a schedule for set contracted industrial gas prices to 2011, in order to reach the European price level under the net-back pricing mechanism. Upper limits were set for tariff growth: 15% in 2007, 25% in 2008, 14% in each half of 2009 and 2010, and 40% in 2010. Regulated prices for the residential sector should be eliminated by 2015, as the pace of tariff increase for residential consumers will be slower than that for industry. However, while independent gas producers provide some 15% of natural gas production in Russia, they do not fall under current price regulation and enjoy free contract prices.

The first free trades for next-month deliveries of natural gas began in November 2006, and in 2008 the sessions were extended for 1-month, 10-day and 1-day ahead trading. The share of natural gas free trading increased from 2% of domestic consumption in 2007 to 8% in 2008, and average prices exceeded the regulated tariff by 30% in 2008 (approximately USD 73 to USD 90 per thousand cubic metres) for gas delivered to the Moscow region. However, in 2009 long-term contracts overwhelmingly prevailed, as the domestic spot market crashed due to low demand.

Coal trading is organised similarly to the oil and petroleum product markets. Although price control by government has been removed, many coal producers struggle to compete with regulated low natural gas prices.

The free electricity trade 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 regulated contracts to be concluded between the buyers and sellers of electricity and electric power. The day-ahead market covers all power produced and consumed, except that covered by regulated contracts. Under the current pricing methods within the market mechanism, there are no opportunities for arbitrage between the purchase and sale of electricity at regulated prices and the closing of transactions at unregulated prices. In April 2007, the federal government specified a schedule for further reductions of electricity traded under regulated contracts:

Second half of 2007—90% First half of 2008—85%
Second half of 2008—75% First half of 2009—70%
Second half of 2009—50% First half of 2010—40%
Second half of 2010—20% (*of total consumption*).

After January 2011, regulated tariffs will be eliminated (excluding tariffs for residential supply) and all electricity will be sold at competitive prices. At the same time, the average tariff growth for 2008 was projected to increase by 17%, for 2009 by 26%, for 2010 by 22%, and for 2011 by 18%. A timetable was set to complete the transition to Russia-wide electricity wholesale market trading in 2011. A total of 224 generation companies and 150 distribution companies and large consumers had joined the electricity wholesale trading system by November 2009.

UPSTREAM ENERGY DEVELOPMENT

AMENDMENTS TO THE SUBSOIL LAW

Two major amendments to the Subsoil Law were adopted in December 2007. First, the term for offshore exploration licences was extended from 5 to 10 years. Second, 31 natural gas fields in Yakutia, West Siberia, and the Barents, Kara and Okhotsk seas were announced as 'strategic fields'. Gas fields with 'strategic' status are inaccessible to foreign companies unless they establish joint project with Russian state companies. In March 2009, regulations for cost compensation were adopted for deposits discovered under the exploration licences, the further development of which is prohibited due to their strategic status. Under the current regulations, strategic status is applied to oil fields with reserves larger than 70 million tonnes (Mt) and gas fields with reserves larger than 50 bcm.

INCENTIVES FOR OIL INDUSTRY DEVELOPMENT IN NEW REGIONS

From January 2009, tax holidays from mineral extraction tax for oil extraction 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 existing tax reductions for East Siberian oil, this will

allow the creation of favourable conditions for the development of the new capital-expensive projects in remote areas that lack energy infrastructure.

Even more promising proposals include a filing to the regulator to extend tax holidays for offshore projects in the Black Sea and the Sea of Okhotsk. However, the amendments would be backdated to 1 January 2009, to provide a level playing field for all offshore projects in Russia.

On 1 January 2010, zero export duty was introduced on crude oil extracted at East Siberian oilfields, to maintain a stable market for the newly established eastward route of the Russian crude to the Asia–Pacific Rim (see 'Notable energy developments' section).

EAST GAS PROGRAM

In September 2007, the federal government approved the East Gas Program, which is to develop natural gas fields and build extensive trunk gas pipeline systems in eastern Siberia and the Russian Far East up to 2030. The program also includes export pipelines to the East Asian economies. Gazprom coordinates the program and is responsible for preparing long-term sales contracts for natural gas deliveries to the Asia–Pacific Rim. Under the program, pipeline construction from Khabarovsk to Vladivostok was started to provide a second outlet for Russian Far Eastern natural gas to regional domestic and international markets.

POWER MARKETS

POWER INDUSTRY

The guiding document for the power industry, the *General Scheme for the Development of the Power Industry up to year 2020*, was approved by the federal government in February 2008. The basic assumptions of the document are consistent with the *Energy Strategy of Russia to 2020*. This very important document provides guidelines on the industry's development after its privatisation and restructuring are finalised.

NUCLEAR INDUSTRY

In October 2006, the government approved the Federal Program for Development of the Nuclear Industry until the year 2015. The program includes the reorganisation of the industry and state-owned facilities. Under the program, it is expected that 10 GW of nuclear electricity generation capacity will be commissioned and the construction of another 10 reactors will be started by 2015. In 2006, Rosatom announced a target for a share of nuclear energy in electricity production of 23% by 2020 and 25% by 2030. Rosatom's long-term strategy up to 2050 involves moving to inherently safe nuclear plants using fast reactors with a closed fuel cycle and MOX (mixed oxide) fuel. Starting from 2020–25, fast neutron reactors will play an increasing role in Russia; the nuclear sector has capacity expansion plans to 90 GW by 2050 under an optimistic scenario.

International nuclear centres

The Russian Federation holds important stakes in the international nuclear fuel market. All of the Russian, CIS 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' nuclear fuel requirements, 23% of Western Europe's, and 16% of the Asia–Pacific region's.

According to the *Global Nuclear Infrastructure Initiative* announced by Russia in early 2006, Russia will 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. Uranium enrichment, reprocessing and storage of used nuclear fuel are the most important roles of the centres, along with standardisation, uniform safeguard practices, training and certification, and research and development.

In 2007, the International Uranium Enrichment Centre (IUEC) was established in Angarsk, Siberia, as a joint venture between Russia and Kazakhstan, but open to other interested parties. The objective of the IUEC is to provide low-enriched uranium (LEU) to those economies

interested in nuclear energy development and ready to comply with IAEA 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. The program for the IUEC expansion at Angarsk to 2015 was developed. The program includes three phases:

- Phase 1—use part of the existing capacity in cooperation with Kazatomprom and under IAEA supervision
- Phase 2—expand capacity with funding from new partners
- Phase 3—full internationalisation with involvement of many customer economies under IAEA auspices.

Russia has also announced that guaranteed reserves of 160 tonnes of low-enriched uranium hexafluoride (equivalent to full core loads for two 1000 MW reactors) will be created at the IUEC as a fuel bank available under IAEA control. The first phase of the capacity enhancement is scheduled for 2011, when 1 million separative work units (SWUs) should be commissioned. A target of 5 million SWUs is expected to be achieved in 2017 under the project. Experts from AREVA confirm that the Siberian nuclear processing site is ahead of world class capacities in public information facilities. The site has a 'real-time' onsite environmental information system, while similar information systems in France are operating offline.[6]

In November 2009, the IAEA Board of Governors adopted a resolution supporting a Russian Federation Government initiative to establish and maintain in Russia a stock of LEU and to carry LEU supplies for IAEA member states. This was a breakthrough in the establishment of an international system guaranteeing reliable nuclear power 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 will be transferred under contract from the IUEC to the IAEA when an appropriate supply request arrives from the IAEA.

ENERGY EFFICIENCY

Energy efficiency is of primary importance for Russia because the Russian economy is the least energy-efficient of the APEC economies. An energy-efficiency goal of a minimum 40% reduction in energy intensity in the Russian economy by 2020 was established in 2008. The energy-saving potential in Russia is huge, as institutional and technological factors account for up to 40% of final energy demand (MERF 2009:16). In November 2009, a new federal law, 'On Energy Conservation and Increase of Energy Efficiency', was adopted, effective from 1 January 2010. In addition, a number of draft laws amending existing laws and technical regulations are currently being developed to supplement the new law. Their purpose is to create opportunities for energy conservation, enhanced utilisation of renewable energy and energy-efficiency improvements. The resulting cornerstone legal framework introduces specific measures, including:

- mandatory energy-efficiency labelling and compulsory inventory of energy resources consumed
- monitoring of energy-efficiency standards for new buildings and industrial facilities (including mandatory energy passports)
- enhancement of energy auditing and monitoring of implementation measures in all sectors of the economy
- requirements for the most energy-intensive consumers to conduct energy-saving research, and to approve energy-saving and energy-efficiency improvement programs

[6] Angarsk electric–chemical combine website, 1 September 2009 http://www.aecc.ru/?mod=ml&mid=&id=5039 (in Russian)

- installation of compulsory meters to encourage conservation of electricity and heat, as well as to reduce budget expenditures on energy use
- restrictions on the use of incandescent light bulbs and their complete phasing out by 2014
- introduction of incentives and tax benefits for heavy industry to replace highly energy-inefficient technologies with advanced and more energy-efficient technologies
- creation of a single and unified interagency information and analytical network on energy efficiency.

In addition to the new law, the government is currently finalising the draft of the federal *On Energy Saving and Energy Efficiency Improvement up to year 2020* program. The program will promote the use of renewable energy resources; the enhancement and coordination of federal, regional and municipal energy-efficiency and energy-saving programs; the establishment of systems for information dissemination, public awareness and the promotion of education initiatives; and the introduction of financial mechanisms for the promotion of efficient use of energy and heat resources. The new program is expected to be approved and come into effect in early 2010. According to some estimates, total energy savings of up to 700 Mtoe and greenhouse gas (GHG) emission reductions of 2.2 billion tonnes could be achieved by 2020. Budget spending for the program will reach USD 28 billion from the federal budget and USD 32 billion from regional budgets, and will total an estimated USD 350 billion in the 10 years to 2020.

TRANSPORTATION

Russia's original schedule for fuel standards implementation was delayed by two years. The government amended the schedule a week before the deadline for the introduction of the Euro-3 standard was reached in July 2009. The transition from current Euro-2 to Euro-3 standards will be shifted to January 2011, while Euro-4 standards will be implemented from January 2015. However, Euro-4 standards for new imported cars are to be introduced from January 2010, with a two-year transition period for locally produced cars.

ENVIRONMENT POLICY

Russia's President signed a bill ratifying the economy's adoption of the Kyoto Protocol in November 2004. That decision reconfirmed Russia's strong commitment to address climate change and to work with the international community on dealing with this global problem. Ratification by the Russian Federation satisfied the '55%' clause and brought the protocol into force, effective from 16 February 2005.

Russia is considered to be the world's largest potential host for Kyoto Protocol 'joint implementation' projects. In May 2007, Russia adopted procedures for approval and verification of Russia-based joint implementation GHG reduction projects. Responsibilities were assigned for organisation and procedures for setting up and keeping the Russian Registry of Carbon Units, thus paving the way to practical implementation of GHG mitigation projects in Russia. At the Conference of Parties 15 (COP15) in December 2009, Russia pledged to reduce its GHG emissions by 25% below 1990 levels by 2020, a figure comparable to the targets of the European Union member states.

One major concern for world energy development is nuclear safety. Russia adopted the concept of the 'closed' fuel cycle, which includes spent nuclear fuel processing and mandatory return of fissionable nuclear materials to the fuel cycle. To provide the legal framework for managing spent nuclear fuel and radioactive wastes, the Environment Protection Law and the Nuclear Energy Utilisation Law were amended in June 2001. However, as promised by the government in 2007, expired contracts for depleted uranium hexafluoride enrichment/conversion will not be extended, and no new contracts will be concluded from 2010.

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

During 2009, Russia introduced the *Russian Energy Strategy up to 2030* and incentives for oil industry development in new regions. In addition, the introduction of new fuel standards was delayed by two years to 2011. Further details of these policies are in the 'Policy overview' section.

ABANDONMENT OF THE ENERGY CHARTER TREATY

On 20 August 2009, the Russian Federation officially informed the depository that it did not intend to become a contracting party to the Energy Charter Treaty and the Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA). In accordance with Article 45(3)(a) of the Energy Charter Treaty, such notification results in Russia's termination of its provisional application of the treaty and the PEEREA after 60 days from the date on which the notification is received by the depository. Therefore, the last day of Russia's provisional application of the Energy Charter Treaty and the PEEREA was 18 October 2009.[7] As a result, the Russian Federation will stay as a member and become, together with Australia, Iceland, and Norway, an 'ordinary' ECT signatory—an economy that has signed but not ratified the ECT.

ENERGY RESERVES AND RESOURCES CLASSIFICATION

The 'New Classification of Oil and Gas Fuel Reserves and Resources' was accepted in 2005. In addition to the previous categorisation of reserves and resources by the level of geological knowledge, the classification is based on grouping oil and gas reserves and resources by economic appraisal of their efficiency. The main economic criterion for identifying groups of oil and gas reserves and resources is the net present value, at a discount of 10%, that would result from the exploitation of a field or formation. The new classification came into force from January 2009.

THE RUSSIA–UKRAINE GAS DISPUTE

The Russia–Ukraine gas crisis of 2009 will probably have far-reaching policy consequences. Unfortunately, the two sides allowed the dispute to escalate from disagreements about debts, prices and transit tariffs to the point where supplies to Europe were cut off, and then allowed that situation to continue for two weeks in the middle of winter. The Russia–Ukraine gas dispute was a pricing dispute between Russia and Ukraine that occurred when Russian gas company Gazprom refused to conclude a supply contract for 2009 unless Ukrainian gas company Naftohaz paid its accumulated debts for previous gas supplies. The dispute began in 2008 with a series of failed negotiations, and on 1 January Russia cut off gas supplies to Ukraine. On 7 January, the dispute turned into a crisis when all Russian gas flows through Ukraine were halted for 13 days, completely cutting off supplies to south-eastern Europe. On 18 January, the dispute was resolved when a new contract, covering the next 10 years, was negotiated. Gas flows to Europe restarted on the morning of 20 January and were fully restored within two days. European economies can do little in the short to medium term to diversify supply away from Russian gas, but diversification of delivery routes away from Ukraine could potentially be achieved within a few years through projects such as the South Stream and North Stream pipeline systems (Pirani et al. 2009).

SERIOUS INCIDENT AT RUSSIA'S LARGEST HYDROPOWER PLANT

On 17 August 2009, an accident at the 31-year-old Sayano–Shushenskaya Hydro Power Plant in East Siberia killed 75 workers. Two of the plant's 10 turbines were destroyed and two were damaged[8]. A government commission investigation found that it was 'irresponsible and

[7] Energy Charter FAQ, www.encharter.org/index.php?id=18
[8] About restoration of the Sayano-Shushenskaya Hydro Power Plant (in Russian), www.rushydro.ru/press/sshges

criminal' to compromise on safety. Mr Kutyin, the head of the Rostekhnadzor industrial safety watchdog, said a range of factors were responsible for the accident. One was poor maintenance, which caused turbine 2 to vibrate excessively and then explode when it was forced to generate more power. RusHydro's largest power plant (6.4 GW capacity, roughly one-quarter of the company's total) will stay out of business for at least one year, and full rehabilitation will take more than five years.[9]

TENEX INCREASES MARKET PRESENCE

The brand name Tenex of the state-owned company Techsnabexport is well known in the international nuclear fuel market. The intergovernmental agreement between the Russian Federation and the United States on the use of highly enriched uranium (HEU) retrieved from nuclear arms (the HEU–LEU Agreement, or the Megatons to Megawatts Program) has been in force since 1993 under Tenex management. Since the first LEU shipment on 31 May 1995, the United States has received around 11 049 tonnes, or 76% of the HEU–LEU Agreement total volume, which earned Russia USD 8.8 billion (AEP 2009). Additionally, the so-called natural LEU component, priced at approximately USD 2.8 billion, has been returned to the Russian Federation. In 2009, Tenex resumed direct commercial shipments of uranium products to US, European Union and Asia–Pacific region power companies. By the end of 2009, the uranium products export order portfolio had reached more than USD 15 billion.

In 2009, collaboration under the contract between Tenex and CNEIC (China Nuclear Energy Industry Corporation) continued, with the fourth stage of an enrichment plant being built in China using state-of-the-art Russian centrifuge technology.

In May 2009, a memorandum of understanding was signed in Tokyo between Tenex and Toshiba Power Systems of Japan, a subsidiary of Toshiba Corporation. The memorandum complements the overall framework agreement on commercial cooperation between JSC Atomenergoprom and Toshiba Corporation and provides for cooperation in the production and supply of nuclear fuel cycle products and services, particularly of enriched uranium.

Two facilities were commissioned in Krasnoyarsk and Irkutsk to enhance closed fuel cycle capacities—conversion of the depleted uranium hexafluoride (DUHF) to the uranium oxides, and DUHF into safer uranium tetrafluoride. This is a move to improve security of DUHF storage, and a step approach to implementing the closed nuclear fuel cycle concept.

In December 2009, Kazakhstan agreed to Ukraine's participation in the International Uranium Enrichment Centre, and Armenia began the process of joining IUEC in the near future.

UPSTREAM ENERGY DEVELOPMENT

EAST SIBERIA – PACIFIC OCEAN OIL TRUNK PIPELINE

In April 2009, welding was completed on Phase 1 of the East Siberia – Pacific Ocean (ESPO) oil pipeline, which stretches 2694 kilometres from East Siberia to the Amur region and has a capacity of 50 Mt per year. The first commercial quantities of oil arrived at the Kozmino Oil Export Terminal on the Pacific coast in November, and were delivered by rail to Skovorodino station on the Trans-Siberian railway in the Amur region. International deliveries of East Siberian crude oil began on 28 December via the first Aframax-sized cargo vessel, *Moskovsky Universitet*, to Hong Kong, China. Total investments for Phase 1 are estimated at USD 14 billion, but the route tariff for crude deliveries from the East Siberian deposits to the Kozmino terminal is set at USD 7.3 per barrel. Phase 2 of ESPO will start in 2010 and should be finalised in 2014. Phase 2 will extend the pipeline from Skovorodino to Kozmino, thus avoiding rail deliveries of 30 Mt per year over 2100 kilometres.

In May, construction of a 64-kilometre spur to China was started. The Amur River crossing is being constructed using horizontal drilling—the best environmental protection technology

[9] Investigation report (in Russian), www.rushydro.ru/file/main/global/press/news/8526.html/Act6.pdf

currently available. The Chinese section is 992 kilometres long and will be finalised before the end of 2010.

The extension of ESPO to Kozmino will allow 15 Mt of VSTO[10] blend to be delivered directly to Asia–Pacific buyers. Another 15 Mt will go through the dedicated spur to PetroChina refineries in the Heilongjiang and Liaoning provinces of China. VSTO blend may offer the best chance of establishing a Russian benchmark, if a spot market for the grade develops.

SAKHALIN ISLAND OIL AND GAS DEVELOPMENT

The Sakhalin-1 offshore DeKastri export terminal has shipped 12 Mt per year of Sakhalin-1 'Sokol' sweet crude since September 2006. The consortium members market the crude individually, and it is sold on a delivered basis. In October 2005, natural gas production began to meet the needs of domestic customers in the Khabarovsk Krai. Domestic gas sales are expected to plateau at 2.8 bcm per year.

Sakhalin-2 marks 10 years of Vitiaz brand shipping. Since an oil export terminal was commissioned at the south of the island, next to the liquefied natural gas (LNG) export terminal, operations have been continuous. Deliveries started from the Sakhalin LNG terminal in February 2009. The *Energy Frontier* carried 67 000 tonnes of LNG to Tokyo on 4 April. Sakhalin-2 is the first LNG export facility in Russia, and most of its output will be destined for the East Asian market. Russia currently has a 6%–8% share of the LNG import market in Japan.

In August 2009, gas pipeline construction from Khabarovsk to Vladivostok began. The goal is to deliver natural gas from Sakhalin to Vladivostok before the first APEC Leaders summit in the northern autumn of 2012.

NEW COAL EXPORT TERMINAL ON THE PACIFIC COAST

A new export coal terminal started operations in Vanino Harbour on the Pacific coast of the Russian Far East in February 2009. The throughput of the new facility, which is intended to handle mostly coking coals from West Siberia and Yakutia, is 12 million tonnes per year.

ATLANTIC MARKET INFRASTRUCTURE EXPANSION

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 Ust-Luga port on the Baltic Sea.

In December 2009, Denmark, Sweden, Finland and Russia decided to construct the North Stream gas pipeline. The decision of the other actor, Germany, was expected before the end of 2009. The agreement was an important step that will allow construction of the pipeline to begin by the spring of 2010.

GAZPROM INVITES INVESTORS TO YAMAL

Gazprom began a promotional campaign for Yamal regional development by inviting the 14 largest oil companies to Salekhard in September 2009. The region currently possesses 12 trillion cubic metres of natural gas resources, with a potential of up to 50 trillion cubic metres. The program to produce 360 bcm per year in this area is under development, with the first gas scheduled to be delivered to Russia's unified gas supply system in 2012.

[10] VSTO is the Russian acronym for the ESPO (short for Vostochnaya Sibir – Tikhii Okean) and supposed to be a brand name used for East Siberian oil (Oil and Gas Journal, www.ogj.com).

USEFUL LINKS

OFFICIAL BODIES OF THE RUSSIAN FEDERATION

Current structure of the Government of the Russian Federation	http://government.ru
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 the 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 OF THE RUSSIAN FEDERATION

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	transnefteprodukt.ru

STATE ENERGY POLICY-RELATED RESEARCH CENTRES OF THE RUSSIAN FEDERATION

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
Institute of Economic Researches of the FEB of RAS	www.ecrin.ru
Centre for Energy Policy	www.cenef.ru

IMPORTANT ENERGY-RELATED MEDIA OF THE RUSSIAN FEDERATION

Official newspaper, *Rossiyskaya Gazeta*	www.rg.ru
Central Dispatching Unit of the Fuel and Energy Complex	www.riatec.ru
Neftegaz	www.neftegaz.ru
Oil & Gas Vertical	www.ngv.ru
RusEnergy	www.rusenergy.com
Russian Energy and Industry	www.eprussia.ru
World Energy	www.worldenergy.ru
Oil of Russia	www.oilru.com

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Pirani S, Stern J and Yafimava K (2009). *The Russo-Ukrainian gas dispute of January 2009: a comprehensive assessment*. Oxford Institute for Energy Studies, February, NG 27, www.oxfordenergy.org/pdfs/NG27.pdf

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 2007, Singapore had a total land area of 704 square kilometres and a population of 4.59 million, of which 1.01 million were non-residents. Despite its small land area and population, Singapore is one of the most highly industrialised and urbanised economies in South-East Asia.

Singapore is a highly developed and vibrant free-market economy. In 2007, its gross domestic product (GDP) grew by 7.8% from 2006 to reach USD 192.84 billion in 2007, and a per capita GDP of USD 42 026 (both in USD (2000) at PPP).

The service producing industry accounted for the largest share of value added in Singapore's 2007 GDP, at 63.4%, followed by the goods producing industry, at 31.3%. Financial and business services accounted for 36.7% of the service producing industry's share, followed by wholesale and retail at 25.5%. Manufacturing accounted for 83% of value added in the goods producing industry; it is Singapore's single largest economic subsector, accounting for 26% of GDP.

In 2007, Singapore's exports were worth USD 450.6 billion, made up of domestic exports (52.1%) and re-exports (the remainder). Main domestic exports comprised electronics (30.4%); petroleum and products (26.9%); chemicals and chemical products (19.2%); machinery and equipment (10.3%); and other manufactured goods, crude materials, and food, beverage and tobacco (the remainder). Most of Singapore's manufacturing output is destined for export.

Strategically located, Singapore has become one of the world's busiest shipping ports, an important petroleum hub, a major supplier of oil and gas equipment in South-East Asia, and an emerging leader in the biomedical industry.

Table 39 Key data and economic profile, 2007

Key data		Energy reserves[a]	
Area (sq. km)	704	Oil	–
Population (million)	4.59	Gas	–
GDP (USD (2000) billion at PPP)	192.84	Coal	–
GDP (USD (2000) per capita at PPP)	42 026		

a Proven reserves at the end of 2008; taken from *BP Statistical Review of World Energy 2009*.

Source: Energy Data and Modelling Centre, Institute of Energy Economics, Japan (IEEJ) (www.ieej.or.jp/egeda/database/database-top.html).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Singapore's total primary energy supply was 23 701 kilotonnes of oil equivalent (ktoe). Singapore relies on imports to meet most of its domestic energy needs. In 2007, the economy imported 51 246 ktoe of crude oil and 60 479 ktoe of petroleum products. Crude oil refined in Singapore's oil refineries produced 48 198 ktoe of petroleum products in 2007, of which 74.9% was for exports and international bunkers; the balance was for domestic consumption.

Natural gas supply grew by 5.5% in 2006–07, to 5960 ktoe (a lower rate of increase than the 7.9% in 2005–06). Oil supply declined by 1.45% in 2006–07 to 17 637 ktoe; by comparison, oil supply increased by 1.91% in 2005–06.

In 2007, 41 134 gigawatt-hours (GWh) of electricity was generated, a 4.3% increase over the 39 442 GWh generated in 2006. Peak demand for electricity was 5624 megawatts (MW) in 2006 and 5946 MW in 2007. Singapore's power generation is based entirely on thermal power plants—combined cycle gas turbines (52%), steam turbines (42%), open cycle gas turbines (3%), and incineration and other types of power plants (2%). Singapore has four large incinerators, with a total incinerating capacity of 2.5 million tonnes of solid waste per year. The Tuas South Incinerator Plant, with a licensed capacity of 132 MW, is one of the world's largest.

The fuel mix for power generation consists of natural gas (78.9%), fuel oil (17.6%) and other fuels—synthetic gas, diesel oil and waste—(3.5%). Power generation consumed 5849 ktoe of natural gas in 2007. Singapore's natural gas is piped from Indonesia and Malaysia.

Installed power generation capacity was 10 446 MW in 2007, an increase of 5% from the previous year. The power generation reserve margin was 43%, well in excess of Singapore's minimum reserve margin for system security (30%).

Table 40 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	104	Industry sector	8 251	Total	41 134
Net imports and other	55 143	Transport sector	5 417	Thermal	41 583
Total PES	23 701	Other sectors	2 155	Hydro	–
Coal	0	Total FEC	15 824	Nuclear	–
Oil	17 637	Coal	–	Geothermal	–
Gas	5 960	Oil	12 527	Other	551
Other	104	Gas	110		
		Electricity and other	3 186		

Source: Energy Data and Modelling Centre, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

Singapore's total final energy consumption (TFEC) was 15 824 ktoe in 2007, an increase of 3.8% from 2006 (15 251 ktoe).

In 2007, petroleum products accounted for 79.2% of the economy's TFEC; electricity, 20.1%; and natural gas, 0.7%. The industry sector share of TFEC was 52.1%; the transport sector, 34.2%; and the residential and commercial sector, 13.6%.

Between 2006 and 2007, the industry sector had the highest increase in energy use (6.8%), followed by the transport sector (3.8%), and the residential and commercial sector (3.8%).

POLICY OVERVIEW

FISCAL REGIME AND INVESTMENT

Singapore's tax regime is well known for its attractive corporate and personal tax rate, tax relief measures, absence of capital gains tax, one-tier tax system, and extensive double tax treaties. Singapore follows a territorial basis of taxation; that is, companies and individuals are taxed mainly on Singapore-sourced income.

Singapore is keeping corporate rates competitive to continue to attract a good share of foreign investment. The current corporate tax rate is capped at 18%, and from 2010 corporate rates will be reduced to 17% to help maintain Singapore's competitiveness. Under Singapore's single-tier corporate tax system, tax paid by a company on its profit is not imputed to the company's stakeholders (that is, dividends are tax free). Singapore has no capital gains tax, operating expenses incurred in the production of income are generally tax deductible, and losses arising from carrying on a trade or profession are deductible and may be offset against income from other sources. Singapore has concluded more than 50 bilateral comprehensive tax treaties to help Singapore companies minimise their tax burden (Guide Me Singapore 2009).

In 2004, Singapore announced that new companies with fewer than 20 shareholders could be exempt from paying tax on the first SGD 100 000 of normal chargeable income in their first three years of assessment, beginning from the 2005 year of assessment. In addition, from the 2008 year of assessment, a 50% deduction was introduced on the next SGD 200 000 of normal chargeable income for such companies. The tax system also allows companies to claim deductions (capital allowances) for wear and tear on fixed assets bought and used in their businesses. Other forms of tax deductions and exemptions may apply (IRAS 2009, Lowtax Network 2009).

ENERGY POLICY FRAMEWORK

The interagency Energy Policy Group, chaired by the Permanent Secretary of the Ministry of Trade and Industry, has developed an energy policy framework that strives to maintain a balance between the policy objectives of economic competitiveness, energy security and environmental sustainability. To meet its energy policy objectives, Singapore focuses on five key strategies (MTI 2007).

- *Strategy 1: Promote competitive markets.* Promote competitive markets to keep energy affordable and ensure Singapore's economic competitiveness. Correction of any market failures will be made by using market-based instruments or imposing standards and regulations. Moreover, the private sector will be encouraged to innovate and achieve energy security and the environmental outcomes that Singapore is seeking.
- *Strategy 2: Diversify energy supplies.* Diversify energy supplies to protect against supply disruptions, price increases and other threats to the reliability of supply. In competitive markets, companies will have incentives to diversify, and reduce their commercial risks. The government's role is to create an open and flexible framework that allows diversification to take place.
- *Strategy 3: Improve energy efficiency.* Improve energy efficiency to be able to achieve all the objectives of the energy policy, while reducing business costs, pollution and CO_2 equivalent emissions. The government has set up the Energy Efficiency Programme Office (E^2PO) and developed a comprehensive energy efficiency plan called Energy Efficient Singapore (E^2Singapore).
- *Strategy 4: Build energy industry and invest in energy R&D.* Position Singapore's economy to turn energy challenges into opportunities to meet rising global and regional demand for energy. Singapore will increase its refining capacity, consolidating its status as Asia's premier oil hub, and expand its range of energy trading products to include liquefied natural gas (LNG), biofuels, and carbon emissions credits. Furthermore, Singapore will pursue growth opportunities in clean and renewable energy, including solar energy, biofuels, and fuel cells.
- *Strategy 5: Step up international cooperation.* Promote greater regional and international energy cooperation to further the economy's energy interests, particularly to enhance energy security. Singapore continues to be actively involved in various energy-related initiatives in major forums, including the Association of Southeast Asian Nations, the Asia–Pacific Economic Cooperation, and the East Asia Summit. Singapore also

participates actively in the United Nations Framework Convention on Climate Change, as well as in international discussions on climate change in other forums.

ENERGY SECURITY

Natural gas has become the major fuel used 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; it supplies 150 million standard cubic feet per day (MMscf/D) of natural gas from Malaysia. Senoko Power 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 325 MMscf/D of natural gas to customers. Large customers use about 98% of the gas supplied. 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 and to exit the gas transportation business. The third pipeline, from South Sumatra, Indonesia, started supplying gas to Singapore in September 2003. It supplies 350 MMscf/D of natural gas for power generation and industry use. The fourth pipeline from Malaysia, which commenced operation in 2007, supplies 110 MMscf/D and is also mainly for power generation. Keppel Gas Pte Ltd is the importer for the natural gas from the fourth pipeline. 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 for gas transportation.

With gas representing such a large share of electricity production, diversification of supply has become an important issue. This has been highlighted by a number of power outages since 2003, including a brief outage in 2006 that resulted from a disruption of the gas supply from Malaysia. Such risk has made more palatable the potential cost of previously shelved LNG importation plans.

Following a feasibility study in 2005, the Singapore Government decided in 2006 to import LNG and to build an LNG receiving terminal. The terminal is expected to be operational by 2013 with an initial capacity of 3 Mt per year. Meanwhile, Singapore has introduced controls on new piped natural gas imports to allow for the build-up of LNG demand until the capacity of 3 Mt per year is fully utilised.

ELECTRICITY AND GAS MARKET REFORMS

ELECTRICITY

Singapore first restructured the energy sector with the corporatisation of the electricity and gas industries as vertically integrated companies, starting in 1995. Notable milestones since mid-1995 have included corporatisation and industry structure reforms, 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 and Power Supply Ltd—would remain under Singapore Power Ltd, while the power generation companies Senoko Power Ltd and PowerSeraya Ltd would compete with one another and with other power generation companies in Singapore. The government also established an independent power system operator and liberalised the electricity retail market.

In April 2001, the Energy Market Authority (EMA) was formed to regulate the electricity and gas industries and promote competition in these industries. In 2003, the National Electricity Market of Singapore (NEMS) commenced operation. In the NEMS, generation companies compete to sell electricity at every half-hourly interval to the new wholesale electricity market.

Liberalisation of the retail market was implemented in phases with plans to open up the market to full retail contestability.

The final phase of retail market liberalisation (full retail contestability) is under review, which will involve 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 currently studying 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, Senoko Power and Tuas Power over the following 12 to 18 months. The sale was reportedly made with due consideration of amendments to the Gas Act by the Singapore Parliament and completion of a regulatory framework governing the competitive wholesale supply of gas and power. Divestment of the three gencos was considered the next step towards liberalisation of Singapore's electricity market.

The sale of PowerSeraya in December 2008 concluded Temasek's divestment of its three power generation companies marking the completion of 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

In January 2002, PowerGas Ltd divested its contestable business 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 transferred to Temasek Holdings. With this divestment, PowerGas Ltd became a gas transporter. Under the new gas industry framework, transportation of natural gas will be regulated. PowerGas Ltd is not allowed to participate in gas import, trading and retailing businesses. No other gas industry participant will be allowed to transport gas.

Singapore's new gas industry structure has been in place since September 2008. As part of the new gas market, the gas transportation business will be separated from the competitive businesses of gas import and retail. The Gas Network Code (GNC), which was developed in consultation with industry players, governs the use and operation of the gas pipeline network enabling open and non-discriminatory access to the onshore gas pipeline network. It outlines the terms and conditions common to the gas transporter (PowerGas Ltd) and industry players who engage the transporter to transport gas through the pipeline network.

The restructuring of the gas market is largely to support the liberalisation of the electricity industry by proving a competitive source of natural gas for electricity generation. Singapore expects greater competition in the gas and electricity sectors, and that the benefits of competition, such as lower prices and a wider choice of retailer, will be passed through to consumers.

The GNC, issued by the EMA in consultation with industry players, provides open and non-discriminatory access to Singapore's onshore pipelines. It outlines the terms and conditions common to the gas transporter (PowerGas) and industry players who engage the transporter to transport gas though the pipeline network. To ensure that the gas transporter is not in commercial conflict with common interests, PowerGas is banned from participation in those parts of the electricity and gas business that are open to competition.

Sembcorp Gas, which has diversified interests in gas transportation, import and retail businesses, will exit from the gas transportation business and transfer its gas pipelines to PowerGas via a statutory transfer under Section 98 of the Gas Act.

TRANSPORTATION

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.

In 2009, a multi-agency task force led by the Energy Market Authority and Land Transport Authority embarked on the electric vehicle (EV) test bed project to assess the benefits and applicability of EVs in Singapore. The project will involve interested industry players to test bed, identify and develop the EV industry in Singapore. Participating companies can register their EVs under the Transport Technology Innovation and Development Scheme, jointly administered by the Land Transport Authority and the Economic Development Board. The EV taskforce will roll out a small network of EV charging stations (EMA 2009b).

ENERGY EFFICIENCY

The plans and programs of the E²PO primarily target five sectors: power generation, industry, transport, buildings and households.

POWER GENERATION

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 2000–06 period. This efficiency improvement was driven mainly by the move from oil-based thermal plants to combined cycle gas turbines in the generation mix. The E²PO expects further generating efficiency improvements in the future, and is promoting cogeneration and trigeneration in Singapore.

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, the National Environmental Agency (NEA) co-funds up to 50% of the cost of appraisals for buildings and individual facilities.
- The Investment Tax Allowance Scheme—a program to encourage companies to invest in energy-efficient equipment. The Economic Development Board administers the Investment Allowance Scheme, which is a capital allowance on qualifying equipment costs that allows a deduction against chargeable income.
- Design for Efficiency Scheme (DfE)—a program to help companies incorporate efficiency considerations during the conceptual design phase of a new facility.
- The Grant for Energy Efficiency Technologies (GREET)—a scheme to help companies to offset part of the cost of implementing energy efficiency measures.

TRANSPORT

Singapore's land transport policies focus on encouraging greater use of public transport and more fuel-efficient vehicles, as well as reducing congestion on Singapore's roads. The NEA has implemented the Euro IV emissions standard for new diesel vehicles registered from 1 October 2006. The Euro IV compliant rating is applicable to green buses, taxis and commercial vehicles.

BUILDINGS

In Singapore, energy efficiency is one of the main considerations in the assessment of a building's environmental credentials. Since the introduction of the Ministry of National Development Research Fund for the Built Environment in 2006, agencies such as the Building and Construction Authority (BCA) and the NEA have encouraged the development and construction of energy-efficient buildings. Energy efficiency initiatives include:

- *EASe for buildings*. The EASe scheme is available to building owners and operators.

- *Energy Smart Building Labelling Programme*. In 2005, NEA and the Energy Sustainability Unit of the National University of Singapore launched the Energy Smart labelling system for offices, to recognise energy-efficient office buildings in Singapore. In 2007, the scheme was extended to include hotels.
- *Building control regulations*. The BCA has established the Envelope Thermal Transfer Value standard and minimum efficiency requirements for commercial air conditioners and a maximum lighting power budget.
- *Green Mark buildings*. The Green Mark scheme is a green building rating system launched by the BCA in 2005 to evaluate buildings based on their environmental impact performance. From 2008, all new and existing buildings with a gross floor area greater than 2000 m^2 that are undergoing major retrofitting work must meet the Green Mark Certified standard.
- *Green Mark Incentive Scheme*. The Green Mark Incentive Scheme was launched in 2006 to encourage building developers to achieve higher Green Mark ratings. New and retrofitted buildings with a gross floor area greater than 5000 m^2 that have achieved ratings of Green Mark Gold and above will be awarded monetary incentives.
- *Public Sector taking the lead*. The public sector is taking the lead in moving towards environmental sustainability for its buildings. It aims to demonstrate the associated environmental and economic benefits and to set an example for the private sector.

HOUSEHOLDS

Households account for about a fifth of the electricity consumed in Singapore. Energy efficiency improvement in the household sector is promoted by encouraging consumers to purchase energy-efficient appliances and adopt energy-efficient habits. Programs for households include:

- *Mandatory Energy Labelling Scheme*. From 2008, all household refrigerators and air-conditioners that are sold in Singapore must be energy labelled. The E^2PO will evaluate the introduction of minimum energy performance standards for other energy-intensive household appliances.
- *Reducing Standby Power Consumption*. The NEA will step up efforts to inform and encourage households to completely switch off appliances that are not in use.
- *Residential Envelope Transmittance Value standard*. From 2008, residential buildings with a gross floor area of 2000 m^2 must comply with the BCA Residential Envelope Transmittance Value standard.

RENEWABLE ENERGY

Singapore's modern, electricity-generating incineration plants make large-scale use of renewable energy, annually consuming 2.5 million tonnes of biomass and wastes.

A number of new biodiesel plants in Singapore are close to commencing operation. Biodiesel production output is expected to exceed 1 million tonnes per year in 2010, and reach 3 million tonnes by 2015. Most of the existing and planned facilities use palm oil, soya oil, and small amounts of used cooking oil. Jatropha oil will be added to the mix when sufficient supplies are available.

The government's main focus on renewable energy is solar power. Singapore expects to become the world's largest producer of photovoltaic technology. Among the investors in the technology is Norway's Renewable Energy Corporation ASA, which has invested EUR 3 billion in building a world-scale solar manufacturing complex in Singapore. The plant, with a capacity of 1.5 GW per year, will produce wafers, cells and modules. The project is expected to attract other solar activities to Singapore.

CLIMATE CHANGE

In April 2009, the Inter-Ministerial Committee on Sustainable Development launched the Sustainable Singapore blueprint, *A Lively and Liveable Singapore: Strategies for Sustainable Growth*. The blueprint was devised and created to bring about changes that would shape Singapore into a sustainable city-state; it contained strategies and initiatives needed for Singapore to achieve both economic growth and a good living environment over the next two decades.

A four-pronged strategy will be employed to achieve the vision for Singapore as a sustainable city. This includes boosting resource efficiency, enhancing the urban environment, building capacities, and fostering community action. The blueprint has a 20-year timeframe, with identified key goals for 2030 and intermediate goals for 2020. The blueprint's goal for the energy sector is to reduce energy intensity (consumption per dollar GDP) by 20% from 2005 levels by 2020 and by 35% from 2005 levels by 2030.

ENERGY TECHNOLOGY/R&D

R&D is one of the main pillars in Singapore's comprehensive Sustainable Development Blueprint for building a clean energy industry global hub where clean energy products are developed, made and exported. The clean energy push centres on solar energy. Resources are also being channelled towards biofuels, wind energy, tidal wave, energy efficiency, and carbon services. The government has provided initial funding support of SGD 350 million for the program. By 2015, the clean energy industry is expected to contribute SGD 1.7 billion to Singapore's GDP and create 7000 jobs (EDB 2007).

The Clean Energy Programme Office (CEPO), an interagency work group, was formed to synergise growth of the industry. The CEPO has launched several comprehensive programs, including two programs to support the solar industry in Singapore: the Solar Capability Scheme and the Clean Energy Research and Testbedding Program. Launched in 2008, the SGD 20 million Solar Capability Scheme seeks to encourage innovative designs and integration of solar panels into green energy buildings. Other CEPO programs are the SGD 50 million Clean Energy Research Programme, which supports R&D efforts in education and industry; the SGD 25 million National Research Foundation (Clean Energy) PhD Scholarships, which provides scholarships for research on clean energy at PhD level and which, with eligible companies, funds local scholarships for clean energy research and coursework at Masters and PhD levels; and Quickstart, a repayable grant program that seeks to nurture Singapore-based cleantech start-ups.

Singapore has the most comprehensive solar research centre in Asia, the Solar Energy Research Institute of Singapore (SERIS) at the University of Singapore. SERIS will invest SGD 130 million in solar energy research (SERIS 2009).

NOTABLE ENERGY DEVELOPMENTS

SUSTAINABLE DEVELOPMENT BLUEPRINT

Singapore released its Sustainable Development Blueprint in 2009. Details of the blueprint are contained in the 'Policy overview' section.

USEFUL LINKS

APEC Biofuels—www.biofuels.apec.org

Economic Development Board—www.edb.gov.sg/edb/sg

Energy Data and Modelling Center, Institute of Energy Economics, Japan. APEC energy database—www.ieej.or.jp/egeda/database/database-top.html

Energy Market Authority—www.ema.gov.sg

Ministry of the Environment and Water Resources—www.mewr.gov.sg

Ministry of National Development—www.mnd.gov.sg

Temasek Holdings—www.temasekholdings.com.sg

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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 36 188 square kilometres. Only one quarter of the land is arable, but the subtropical climate permits multi-cropping of rice and the growing of fruit and vegetables all year round.

In 2007, Chinese Taipei's GDP was USD 600.93 billion, and per capita income was USD 27 783 (USD (2000) at PPP). Rapid economic development over the past decade has driven a substantial change in the economic structure of Chinese Taipei, with the emphasis shifting from industrial production to the services sector. In 2007, the services sector contributed 71% to GDP, followed by the industrial sector (27.5%) and the agriculture sector (1.4%). There has been an increase in the population of Chinese Taipei, which is one of the most densely populated areas in the world, but the rate of increase has been relatively mild. The population of 22.87 million grew at a rate of 0.3% between 2006 and 2007. This was much slower than the average annual growth of 0.4% between 2000 and 2006.

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 gas reserves are around 8.4 billion cubic metres (EIA 2009). In 2007, installed electricity generation capacity totalled 45 881 MW.

Table 41 Key data and economic profile, 2007

Key data		Energy reserves[b]	
Area (sq. km)[a]	36 189	Oil (million barrels)—proven	–
Population (million)	22.87	Gas (billion cubic metres)	0.84
GDP (USD (2000) billion at PPP)	635.92	Coal (million tonnes)—recoverable	–
GDP (USD (2000) per capita at PPP)	27 783		

a Directorate-General of Budget, Accounting and Statistics, Executive Yuan, ROC (Taiwan). (http://eng.dgbas.gov.tw/public/data/dgbas03/bs2/yearbook_eng/y001.pdf)

b US Energy Information Administration. (http://www.eia.doe.gov/emeu/international/gasreserves.html)

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2007, Chinese Taipei's total primary energy supply was 114 529 kilotonnes of oil equivalent (ktoe), an increase of 4% from the previous year. By fuel, oil contributed the largest share (42%), followed by coal (35%), natural gas (10%) and other fuels (13%). Chinese Taipei has limited indigenous energy resources and therefore imports around 99% of its energy needs.

Chinese Taipei imports almost its entire crude oil requirement. The Middle East is its major supplier, accounting for 81% of total imports. West African economies are also important suppliers. In 2007, Chinese Taipei imported 49 million tonnes of crude oil. However, because the

refining capacity of the economy exceeds domestic demand, Chinese Taipei is a net exporter of petroleum products. Exports of petroleum products were around 10 million tonnes in 2007. To prevent supply disruption, Chinese Taipei's refiners are required by the Petroleum Administration Law to maintain stocks of more than 60 days of sales volumes.

The total refining capacity of 1.26 million barrels per day is operated by Chinese Petroleum Corporation (CPC) (57.1%) and Formosa Petrochemical Corporation (FPCC) (42.9%). CPC—the state-owned oil company—is the dominant player in all sectors of the economy's petroleum industry, including exploration, refining, storage, transportation and marketing. FPCC is a subsidiary of the private petrochemical firm Formosa Plastics Group. In August 2006, FPCC completed an upgrade of its refinery facility at Mailia, increasing refining capacity from 450 000 to 510 000 barrels per day. Although refining capacity exceeds domestic consumption of petroleum products, both CPC and FPCC are considering constructing new refineries or expanding existing plants. At the end of March 2007, there were 2653 gas stations in Chinese Taipei. CPC directly operates 657 gas stations, while 1996 gas stations are jointly operated or franchised (privately operated) (BOE 2008a:110–111).

As natural gas resources are also limited, domestic demand is met almost entirely by imports of liquefied natural gas (LNG), largely sourced from Indonesia and Malaysia. LNG imports in 2007 were 8.3 million tonnes, a 6.4% increase from 2006. CPC operates Chinese Taipei's only LNG receiving terminal at Yungan, Kaohsiung, with a handling capacity of 8.56 million tonnes a year. To meet increasing demand and the first-stage goal of supplying gas for use by Taiwan Power Company's (TPC's) Datan Power Station from 2008, CPC has started building its second terminal at Taichung Harbour, with a design capacity of 3 million tonnes a year. The terminal started partial operation with a handling capacity of 690 000 tonnes in 2008 and was completed at the end of 2009 (CPC 2009:23).

Table 42 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	14 249	Industry sector	43 759	Total	243 120
Net imports and other	100 280	Transport sector	14 250	Thermal	186 288
Total PES	114 529	Other sectors	11 492	Hydro	8 350
Coal	40 293	Total FEC	69 951	Nuclear	40 539
Oil	48 398	Coal	6 589	Other	7 943
Gas	11 886	Oil	42 926		
Other	13 952	Gas	2 051		
		Electricity and other	18 384		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

Coal is used for electricity generation as well as by the steel, cement and petrochemical industries. All coal requirements are imported, mainly from Australia (74.2%) and Canada (20.4%). In 2007, primary coal supply was 40.3 million tonnes of oil equivalent (Mtoe), which was 1.9% lower than in 2006. In order to secure a stable supply of coal, joint ventures to undertake exploration and development overseas are being pursued.

Chinese Taipei generated 243 120 GWh of electricity in 2007. TPC's thermal power and nuclear power contributed 46.1% (29.1% from coal, 5.0% from oil and 12.0% from LNG) and 16.7%, respectively; privately owned cogeneration 18.2%; independent power producers (IPPs) 15.5%; and wind power 0.1%. TPC dominates Chinese Taipei's electric power sector, and IPPs account for only 19.3% 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 Power Project are under construction (EDMC 2009).

FINAL ENERGY CONSUMPTION

Final energy consumption in Chinese Taipei was 69 951 ktoe in 2007, 6.8% higher than in 2006. The industrial sector consumed 62.5% of the total, followed by transportation (20.3%) and the other sectors, mainly residential and services (16.4%). By energy source, petroleum products accounted for 61.2% of total final energy consumption, followed by electricity (26.3%), coal (9.5%) and city gas (3%).

The industrial sector has been the primary energy consumer. Rising gasoline prices and a more convenient mass transportation system have moderated energy consumption in the transportation sector. Consumption in the sector was 14 250 ktoe in 2007, a 3.5% decrease from 2006 (14 768 ktoe). In 2007, consumption in the commercial and residential sectors declined by 18%.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

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 Electricity Law; regulating natural gas utilities, petroleum and liquefied petroleum gas 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 fundamental goal of Chinese Taipei's energy policy is to promote energy security, supported by the secure importation of oil, natural gas and coal, and the development of domestic energy resources, including nuclear, fossil fuels and new renewable energy. Two National Energy Conferences were convened in Taipei on 26 May 1998 and 20 June 2005 to formulate strategies and measures in response to the United Nations Framework Convention on Climate Change and to seek a balance between economic development, energy supply and environmental protection in Chinese Taipei.

In December 2005, the Bureau of Energy released an Energy Policy White Paper addressing worldwide trends, short- and long-term energy security challenges and the corresponding measures to be taken. Future energy policy will focus on:

- stabilising energy supply to increase energy independence
- increasing energy efficiency and reinforcing management of energy efficiency
- further promoting liberalisation of the energy market
- coordinating the development of the 3Es (energy, environment, economy)
- reinforcing research and development
- promoting education campaigns and expanding public participation.

The aims of Chinese Taipei's energy policy are to establish a liberalised, orderly, efficient and clean energy supply and demand system based on the environment, local characteristics, future prospects, public acceptability and practicability.

On 5 July 2008, the Bureau of Energy released Chinese Taipei's Sustainable Energy Policy. It addresses:

- policy objectives—to achieve a win–win–win solution for energy, environment and economy, and setting 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 strategic framework—divided into two parts: cleaner energy supply and rationalised energy demand
- follow-up work—government agencies to formulate concrete action plans which clearly set carbon reduction targets and build monitoring and follow-up mechanisms to review effectiveness and performance and establish quantitative objectives for each task to measure performance and facilitate implementation (BOE 2008b).

MARKET REFORMS

In late 2006, Chinese Taipei formulated a draft amendment to the Petroleum Administration Act in order to further liberalise the petroleum market. The government is now coordinating with the relevant agencies for its implementation. Key actions include the following:

- Petroleum prices will be determined by market mechanisms. The equation used to adjust gasoline and diesel prices, originally determined by CPC, was abolished in September 2000 after FPCC's petroleum products were released to the market. Following significant fluctuations in international petroleum prices in the second half of 2005, the Ministry of Economic Affairs (MOEA) authorised CPC to adopt a floating fuel pricing mechanism at the beginning of 2007.
- The petroleum market will be further liberalised through the following three actions. First, the draft of the 'Partial Article Revision on Petroleum Administration Act' was promulgated and executed by presidential decree on 16 January 2008, and further amendments were promulgated on 21 January 2009. The amendments were made to reflect changes in the social environment that had occurred over time and the need to ensure a secure supply of domestic petroleum. Second, the security reserve threshold for the petroleum import business was reduced from 50 000 kilolitres (kL) to 10 000 kL, while the reserve for the petroleum refinery will be maintained at 50 000 kL. This is expected to reduce the barriers to entry to the market. Third, the partial import tariff on petroleum products will be relaxed in line with global trends. The Ministry of Finance has accepted the World Trade Organization's suggestion to reduce the tax difference between petroleum products and crude oil (that is, tariffs on gasoline, kerosene, jet fuel and diesel should be reduced to 0%).
- There are 23 private and two state-run natural gas companies, administered by the MOEA according to the Act for Regulating Privately Owned Public Utilities and the Regulations Governing the Administration of Gas Utilities. To establish sound management of natural gas utilities and to incorporate the production and importation of natural gas into regulations, the draft of the Natural Gas Business Act has been completed and submitted to the Legislative Yuan for deliberation. The Act outlines the responsibilities of authorities and provisions for the operation of businesses, the safety of related facilities, disaster prevention, customers' rights and the establishment of a safety inspection system. Penalties for noncompliance are also addressed (BOE 2008d).

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 60 days of sales volumes (which is defined as the average domestic sales and private consumption over the past 12 months) required under the Petroleum Administration Law. The liquefied petroleum gas stockpile should be more than 25 days of supply. Using the Petroleum Fund to finance the storage of oil, the government is responsible for stockpiling 30 days of oil demand (BOE 2009a, Article 24).

In order to diversify the electricity generation mix, the government encourages the development of nuclear power. At the end of 2008, there were three nuclear power plants with

six units and a total installed capacity of 5144 MW; the first reactor has two units of 636 MW, the second two units of 985 MW and the third two units of 951 MW. The first unit of the fourth nuclear power plant (1350 MW) will be completed in 2011, and the second (1350 MW) will be completed in 2012. By 2012, there will be 7844 MW of installed nuclear generation capacity (TPC 2009).

UPSTREAM ENERGY DEVELOPMENT

For many years, CPC has engaged in cooperative exploration with governments and large international oil companies under the name of the Overseas Petroleum and Investment Corp. (OPIC), in operations throughout the Americas, the Asia–Pacific region and Africa. Following rising oil prices in recent years, CPC 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 2008, CPC engaged with international oil companies in cooperative exploration in 13 fields in eight economies.

On 26 December 2008, CPC signed exploration cooperation agreements with the China National Offshore Oil Corporation (CNOOC). Among other things, the agreements covered the renewal of an agreement on joint exploration in the Tainan Basin of the Taiwan Strait, a feasibility study of exploration in the Nanridao Basin off northern Taiwan, and the transfer of a 30% stake in CNOOC's onshore Block 9 in Kenya to CPC.

In the future, CPC's strategy is to increase overseas exploration and production by heightening the asset value of its existing overseas oil and gas fields and establishing core areas with high rates of growth, participating actively in bidding for open blocks, seeking opportunities to take over fields from large oil companies, and pursuing opportunities for mergers and acquisitions in new oil and gas fields to add to the company's reserves (CPC 2009:12).

ELECTRICITY MARKETS

The Chinese Taipei Government's aim is to have a total electricity supply that provides a reserve capacity of 15%–20% based on peak demand. During the 1990s, some of TPC's new power plants were unable to meet 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 under 8% between 1990 and 1996. Beginning in 1995, to stabilise the power supply, Chinese Taipei's electricity market was opened to 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 MOEA announced the Fourth Stage of Opening Electricity Market to IPPs in June 2006. IPP investors did not meet the bidding price offered by TPC for this stage. Fortunately, power demand is not expected to increase between 2011 and 2013. The MOEA will announce a fifth stage of opening the electricity market to IPPs if the reserve capacity falls below 16% in the future.

To comply with the schedule for privatising TPC and promoting the liberalisation of the domestic power market, the MOEA has completed a program of liberalising the electricity industry. Based on the program, a draft amendment to the Electricity Act has been revised and submitted to the Legislative Yuan for review. Once the legislative process to amend the Electricity Act is completed, the generation sector will be able to set up and invest in the integrated utility, transmission utility and distribution utility. In addition, generators will be able to sell power to consumers directly, which means that the market structure will no longer be a monopoly. A competitive mechanism will also be established to improve the performance of utilities. The objectives of the amendment include (BOE 2008c):

- promoting the liberalisation of the power industry
- encouraging the development of renewable energy
- identifying the cogeneration system

- removing the obstacles to installing power infrastructure
- strengthening the management of the power industry
- maintaining the stability and safety of power supply
- integrating the management of industry and industry-related associations
- relaxing the limitation of operations on TPC.

ENERGY EFFICIENCY

Chinese Taipei's energy-efficiency strategy will target both the supply and demand sides (BOE 2008e).

On the supply side, the strategy has two main aims:

- Increasing the proportion of low-carbon and high-efficiency electricity generation plants by increasing the ratio of efficient gas combined-cycle generation. In 2025, gas combined-cycle generation is expected to account for 25% of the power generation system.
- Introducing the world's best available technology for electricity generation by speeding up power plant replacement, setting plans to raise the overall efficiency of power plants and calling for the world's best practice power conversion efficiency standards for all new power plants.

On the demand side, the strategy has three main aims for the manufacturing sector:

- Establishing financial incentives and regulatory mechanisms by providing preferential loans and investment tax credits, accelerated depreciation, and other financial incentive measures; by establishing energy-saving performance measurement verification mechanisms; by promoting energy-saving performance guarantee projects; and by introducing energy services companies to provide technology, capital and human resources.
- Improving energy efficiency by promoting high-efficiency motor programs and boiler efficiency plans and by establishing specific energy consumption indicators.
- Establishing full-service energy-saving systems by establishing the MOEA Service Centre and in-house counselling services and by strengthening and deepening energy technology services.

On the demand side in the residential sector, the strategy has four main aims:

- Encouraging the service industry to sign a voluntary agreement for energy conservation and setting an energy-saving goal of 5%–10%.
- Enhancing the use of electrical appliances with high energy efficiency, expanding electrical products energy efficiency management, subsidising the purchase of energy-saving products, and promoting the use of high-efficiency and low standby power products.
- Promoting a revolution in lighting. By 2012, incandescent bulbs will be extensively replaced and LED lighting will be promoted.
- Promoting price discount programs. Residential customers and primary schools using less than the average daily kWh usage in the same period of the previous year will be given a discount.

In the transportation sector, the aims are to raise standard fuel efficiency for private vehicles (measured in passenger kilometres per litre) stepwise to 25% by 2015, and to promote the replacement of traditional traffic lights with LED lighting.

In the government sector, the intention is to promote negative growth in oil and electricity consumption within government agencies and schools, aiming for an accumulated saving of 7% in 2010.

RENEWABLE ENERGY

In response to high oil prices and the global trend towards reducing greenhouse gas emissions, promoting the development and use of renewable energy is considered a critical strategy internationally. In Chinese Taipei, 98% of energy supply is imported. Therefore, promoting renewable energy development can diversify the energy supply, increase the share of domestically produced energy and lead the development of local industry. This will help reach the goal of the three 'wins' of energy security, environmental protection and economic development. In order to promote the use of new renewable energy, the government has selected some major areas with viable market potential: solar energy, wind energy, geothermal energy, ocean energy, biomass, and energy from waste.

Chinese Taipei mainly emphasises wind power, solar photovoltaic and biofuels, and also promotes other renewable energies as auxiliary means. By December 2007, the total installed capacity of renewable electricity generation was 2843 MW, which can produce approximately 7.65 billion kWh of electricity annually (BOE 2008f).

CLIMATE CHANGE

The 2005 General Energy Conference identified the need for Chinese Taipei to commit itself to global efforts to mitigate climate change. In 2006, the MOEA conducted four projects: establishing the auditing, registry, verification and certification systems of the energy industry; building the capacity of the energy industry to reduce emissions and promoting a program of voluntary CO_2 emissions reductions; promoting an environmental accounting system for the energy sector; and promoting a greenhouse gases emissions management system. The main achievements of these and related activities include:

- the establishment of a domestic greenhouse gas emissions auditing tool
- the selection of 40 energy industry companies to participate in demonstration projects
- the provision of education and training to demonstration companies
- assistance for five demonstration companies to obtain international certification.

NOTABLE ENERGY DEVELOPMENTS

RENEWABLE ENERGY

In order to effectively promote renewable energy and respond to the requirements of the private sector for institutionalised incentive measures, Chinese Taipei promulgated the Renewable Energy Development Bill on 8 July 2009 (BOE 2009b). The essence of the Bill is based on fixed feed-in tariffs and grid-connecting obligations to secure the market for electricity generated from renewable energy. The subsidisation of photovoltaics, hydrogen energy and fuel cells was also proposed. Because of the differences between the non-renewable electricity generating costs of power utilities and renewable electricity feed-in tariffs, a fund will be established to subsidise utilities when they produce or purchase renewable electricity. It is hoped that electricity from renewable resources will be able to make up over 12% of the total electricity generation capacity.

THIRD NATIONAL ENERGY CONFERENCE

In view of global climate change and energy shortages, the policies of the Chinese Taipei Government focus on energy conservation and reducing carbon emissions. To achieve those aims, the Executive Yuan approved the Sustainable Energy Policy on 5 June 2008, and issued the Sustainable Energy Policy—Energy Carbon Reduction Action Program on 4 September 2008. However, because the action program spans only four years of policy planning, long-term and controversial energy issues, which require extensive discussion, are discussed through the National Energy Conference. Therefore, the Executive Yuan held the Third National Energy

Conference on 15–16 April 2009. The main topics included sustainable development and energy security; energy management and efficiency enhancement; energy prices and the opening of the market; and energy technology and industrial development (BOE 2009c).

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

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THAILAND

INTRODUCTION

Thailand is in South-east Asia and shares borders with Malaysia to the south and Myanmar, 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 66.98 million at the end of 2007. In 2007, Thailand's GDP was USD 413.83 billion, and GDP per capita was USD 6178 (USD (2000) at PPP).

Thailand is highly dependent on energy imports, particularly oil. In 2007, net energy imports accounted for 56% of energy supply in the economy; down significantly from 96% in 1980. According to statistics from the Department of Mineral Fuels/Energy Policy Planning Office of the Ministry of Energy, Thailand had proven onshore and offshore reserves of 183 million barrels of crude oil, 271 million barrels of condensate, and 12 003 billion cubic feet of natural gas. Total reserves of lignite, including remaining resources in areas currently in production and proven and probable reserves in undeveloped areas, were 2059 million tonnes.

Table 43 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	513 115	Oil (million barrels)[a]	183
Population (million)	66.98	Condensate (million barrels)[a]	271
GDP (USD (2000) billion at PPP)	413.83	Natural gas (billion cubic feet)[a]	12 003
GDP (USD (2000) per capita at PPP)	6 178	Coal (million tonnes)[b]	2 059

a Proven reserves
b Proven, probable and possible reserves
Sources Energy Data and Modelling Center, Institute of Energy Economics, Japan, 2009 (www.ieej.or.jp/egeda/database/database-top.html); Department of Mineral Fuels/Energy Policy Planning Office, Ministry of Energy, 31 December 2008.

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Total primary supply in 2007 was 87 933 kilotonnes of oil equivalent (ktoe). Oil accounted for 55% of total primary supply, while gas, coal and others accounted for 26%, 16% and 3%, respectively. Most of Thailand's proven coal reserves are lignite coal of low calorific value; therefore, imported coal is needed for both electricity generation and the industry sector. In 2007, coal supply was 14 234 ktoe, a 20.2% increase from the previous year, mainly due to increasing consumption in the industry sector. In the power sector, coal accounted for 20% of power generation. Total oil supply was 48 288 ktoe in 2007, a 1.38% increase from 47 631 ktoe in 2006.

In 2007, natural gas supply was 22 925 ktoe, a slight increase from 22 097 ktoe in 2006. Natural gas is mainly used for power generation, which accounted for almost 80% of 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 during recent years, more industries have switched from oil to natural gas. Based on the Power Development Plan 2007, natural gas demand for power generation is projected to increase by an average of 6% per year from 2007 to 2011. If industry and transport demand are included, natural gas demand will grow at an average of 10% per year.

Total supply of natural gas in July 2009 was 3670 million standard cubic feet per day (MMscf/D), up 1.6% from the same period in 2008. Of the total, 2944 MMscf/D (80%) was produced in Thailand and 727 MMscf/D (20%) was imported from Myanmar. It is expected that natural gas production will increase to about 5400 MMscf/D in 2012 and to about 7440 MMscf/D in 2021. PTT Exploration and Production Public Company Limited (PTTEP) is expected to be the arm of the government in petroleum resource development, particularly at the international level. Thai energy operators are encouraged to participate in joint venture energy projects overseas.

Oil demand is projected to increase at an average growth rate of 2.8% during the period 2007 to 2021. Oil will remain the major fuel in Thailand, including in the transport sector, despite the promotion of energy conservation and greater use of natural gas. Total domestic refining capacity is sufficient to meet demand in the long term. At present, about 80% of crude oil imports are from the Middle East. Because Thailand does not have much potential for new crude oil resources, to meet increasing future demand it will have to expand trading activities with global networks, accelerate alternative energy development (for example, natural gas and biofuels to reduce oil consumption), and encourage Thai operators to invest in joint venture energy project developments overseas (for example, in Oman and Iran).

In 2007, total electricity generation was 143 378 GWh, a 3.3% increase from 2006. Thermal generation, mostly from natural gas and coal, accounted for 84% of production and hydropower for 5.6%. Natural gas made up over 70% of the fuel used for power generation; the balance was derived from fuel oil, coal, diesel, and hydro and other renewable fuel sources. In addition to domestic capacity, power was purchased from Lao People's Democratic Republic and Malaysia.

Table 44 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	36 063	Industry sector	18 416	Total	143 378
Net imports and other	49 416	Transport sector	23 636	Thermal	120 702
Total PES	87 933	Other sectors	15 155	Hydro	8 114
Coal	14 234	Total FEC	57 206	Nuclear	–
Oil	48 288	Coal	6 918	Other	14 562
Gas	22 925	Oil	36 378		
Other	2 486	Gas	2 497		
		Electricity and other	11 413		

Source Energy Data and Modelling Center, Institute of Energy Economics, Japan, 2009 (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

Thailand's total final energy consumption in 2007 was 57 206 ktoe, a slight increase of 3.4% from the previous year. The transportation sector was the largest energy-consuming sector, accounting for 23 636 ktoe, or 41.3% of total final energy consumption. The second largest consumer of energy was the industry sector, which consumed 18 416 ktoe in 2007, a slight increase of about 4% from 2006. By fuel type, oil accounted for a 63.6% share (36 378 ktoe) of total energy consumption in 2007, followed by electricity and other (20%), coal (12%) and gas (4.4%).

The consumption of oil and gas was greater in 2007 than in 2006. Oil consumption increased slightly by 5.0% to reach 36 378 ktoe in 2007 (2006: 34 637 ktoe). Natural gas increased by 16.1% to reach 2497 ktoe in 2007 (2006: 2151 ktoe). From 2006 to 2007, coal consumption decreased by 8.6% to 6918 ktoe.

As a result of economic expansion, domestic electricity demand increased by 4.2% from the previous year. The demand growth resulted mainly from increased consumption in the industrial, residential and commercial sectors.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Energy is in charge of all energy activities. Organisations responsible for energy include:

- the Office of the Minister—responsible for coordination with the Cabinet, the parliament and the general public
- the Office of the Permanent Secretary—establishes strategies and translates policies of the ministry into action plans, and coordinates international energy cooperation
- the 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
- the Department of Energy Business—regulates energy quality and safety standards, environment and security, and improves the standards to protect consumers' interests
- the Department of Mineral Fuels—facilitates energy resource exploration and development
- the Energy Policy and Planning Office (EPPO)—recommends economy-wide energy policies and planning
- the Electricity Generating Authority of Thailand—the state generation enterprise
- the PTT Exploration and Production Public Company Limited and the Bangchak Petroleum Public Company Limited—two autonomous public companies
- the Energy Fund Administration Institute—a public organisation
- the Energy Regulatory Commission and the Nuclear Power Program Development Office—two independent organisations.

The Royal Thai Government implements policy in various areas to address Thailand's urgent problems and to achieve sustainable development. In the area of energy policy, the government seeks to build an 'Energy Sufficient Society'; achieve food and energy security; build a knowledge-based and creative society; alleviate poverty and income disparity; develop good governance, including rural development and decentralisation of administrative powers; promote Thailand's role in the international arena; and enhance economic linkages with other economies in the region to peacefully cooperate in energy and other sectors. Actions are based on five basic guiding principles:

1. *Establish sustainable energy security*: A target has been set to increase domestic crude oil production to 250 thousand barrels per day from the 2009 level of 225 thousand barrels per day by 2011. The supply of natural gas from the Malaysia–Thailand Joint Development Area will also be accelerated. Electricity production from renewable energy is also encouraged, particularly from small and very small-scale power projects, as well as the introduction of 'Adder' and other incentive measures. In Thailand's energy roadmap, nuclear energy will also be an option for about 1000 MW to 2020 and another 1000 MW in 2021.
2. *Expedite and promote alternative energy:* Through its current 15-year Renewable Energy Development Plan (REDP) 2008–2022, the government encourages the production and use of alternative energy, particularly biofuel—for example, gasohol (E10, E20 and E85) and biodiesel (B5)—biogas, biomass and municipal solid waste to enhance energy security while reducing environmental impacts. Thailand strongly promotes

community-scale alternative energy and continuously promotes research and development of all forms of renewable energy.

3. *Monitor energy prices and ensure appropriate levels, in line with the wider economic and investment situation:* The government supervises and maintains energy prices at appropriate, stable and affordable levels by setting an appropriate fuel price structure. Thailand attempts to manage energy prices through market mechanisms and the Oil Fund levy.
4. *Effectively save energy and promote energy efficiency:* Thailand has made energy saving discipline part of its culture and encouraged energy conservation in the household, industrial, services, commerce and transportation sectors through campaigns aiming to build energy-saving consciousness. The government provides incentives to encourage the private sector to opt for energy-saving appliances. There are four main energy saving initiatives: a revolving fund for energy efficiency and renewable energy, Energy Service Company (ESCO) venture capital funds, tax incentives for energy saving, and demand-side management (DSM) bidding. Other actions have included the establishment of standards for electrical appliances and energy conservation in buildings, and the encouragement of the development of mass public transportation and the railway system.
5. *Support energy development while simultaneously protecting the environment:* Thailand has a strong policy of protecting the environment from the impact of energy production and consumption, especially impacts from oil refineries and power plants, and from the transportation sector, particularly through Clean Development Mechanism projects. The government's intention is to reduce Thailand's CO_2 emissions by least 1 million tonnes per year.

The five energy policies define the main mission of the Ministry of Energy, which is to devote its efforts to creating energy security, supporting alternative energy development and maintaining the fairness and stability of energy prices. With the ultimate aim of ensuring the wellbeing of the Thai people, the Ministry has defined its primary objectives to help alleviate the current economic crisis and raise Thailand's energy self-reliance.

ENERGY SECURITY

To enhance Thailand's energy security, the government's policy is to intensify energy development for greater self-reliance, with a view to achieving sufficient and stable energy supply. The policy is to expedite exploration and development of energy resources at domestic and international levels; negotiate with neighbouring economies at the government level for the joint development of energy resources; develop an appropriate energy mix to reduce risks to supply, price volatility and production costs; encourage electricity production from potential renewable energy, particularly from small or very small-scale electricity generating projects; and investigate other alternative energy for electricity generation. The strategies to achieve the policy are:

1. Promote domestic production of crude oil and condensate and develop related infrastructure systems, aiming to be able to produce crude oil and condensate at more than 230 thousand barrels per day in 2009 and 250 thousand barrels per day in 2011
2. Procure natural gas from both domestic and foreign resources to meet demand and develop related infrastructure, aiming to maintain natural gas reserves that can be developed for domestic consumption for at least 30 years
3. Develop the electricity supply industry to meet demand and promote diversification of fuel types
4. Conduct feasibility studies on the development of other fuel options for power generation (for example, nuclear, clean coal and oil shale), to provide the general public with better knowledge and understanding of new energy options
5. Explore energy resources overseas, emphasising cooperation between the public sector and private Thai operators

6. Promote and strengthen the development of the energy industry as well as downstream industry, aiming to prepare for scaling up petrochemical development and developing a new biofuels industry
7. Devise a plan for energy emergency preparedness to address all types of energy crises, including a coordination system and an exercise in addressing an oil shortage.

ENERGY PRICES

Thailand's energy price policy direction is to supervise and maintain energy prices at appropriate, stable and affordable levels by setting an appropriate fuel price structure that supports the development of energy crops and reflects actual production costs; to manage prices through market mechanisms and the Oil Fund levy to promote the economical use of energy; and to encourage competition and investment in energy businesses, including improvements in service quality and safety. Strategies to achieve these aims are:

1. Supervision of energy prices to ensure stability and fairness, while reflecting actual production costs, through market mechanisms, aiming to attain fair and affordable domestic energy prices and energy costs that are no higher in Thailand than in neighbouring economies
2. Promotion of service quality and safety improvement in energy-related business, facilities, service stations and equipment
3. Encouragment of competition and investment in energy businesses, with the aim of creating good environments for investment, with transparent competition and internationally accepted standards.

Oil pricing is currently monitored through the market, which is transparent and fair. For electricity, Thailand's automatic adjustment mechanism will be revised to be more appropriate and fairer, allowing the pass-through of fuel costs and power purchase prices while taking operating efficiency into account. The price of fuel ethanol has been adjusted to be based on the Brazilian ethanol price. The price structure and subsidisation of cooking gas (LPG), which has long been subsidised by the government, are under review in order to better reflect costs and reduce LPG market distortion.

ENERGY EFFICIENCY AND CONSERVATION

Thailand's energy efficiency and conservation policy direction is to increase the energy conservation target stipulated in the Energy Conservation Program to 20%, focusing on increasing energy-saving in the industrial and transportation sectors. The government is drafting the Energy Conservation Program, Phase 4 (2012–2016) to address future crises caused by oil price volatility, climate change and world food shortages, consulting the public and concerned parties at all levels.

The government organises campaigns to promote energy saving and provide information about energy conservation, devises incentives and provides privileges to induce investment in energy saving. The aim is to reduce Thailand's energy intensity (energy consumption per unit of production) in the industrial sector by 20% compared with the base year (2006). The promotion is through four major measures: the Energy Credit and Revolving Fund; tax measures and cost-based and performance-based concessions; joint ventures via the use of the ESCO Fund; and DSM bidding.

The government promotes R&D on energy-saving systems and technologies, aiming to establish integrated resources planning for energy conservation R&D. Standards, rules and regulations are set for energy-saving equipment, materials and energy management; for example, minimum energy performance standards for 15 types of electrical appliance were announced by the end of 2009. The issuance of Ministerial Orders, particularly on the Building Energy Code and ISO: Energy, was expedited.

The creation of prototype networking is also promoted. For example, the government promotes the Thailand Energy Awards to small and medium enterprises active in energy saving.

TRANSPORT SECTOR

Government support to the transport sector has been mainly through infrastructure development as part of a long-term plan. However, it is inevitable that entrepreneurs in the sector will be affected by the current economic slowdown and highly volatile oil prices, particularly in the short term. Land transport alone accounts for 79% of total energy consumption in the transport sector, and, among the fuels used in land transport, diesel holds a large share of 52%. As a result, the more volatile fuel prices are, the greater the impact on goods transport operators (and eventually on commodity prices, which will affect consumers).

A project to promote energy efficiency in the transport sector has been initiated by EPPO and implemented through the Federation of Thai Industries, which acts as 'project owner'. The objective is to provide opportunities for goods transport operators to conduct feasibility studies on energy efficiency improvements in their businesses, to encourage operators who have already planned to improve energy efficiency to carry out their plans, and to foster their personnel's knowledge and understanding of energy efficiency, which will lead to energy-saving cooperation in individual organisations and in the sector as a whole. Implementation approaches are the Feasibility Study on Oil Consumption Reduction in the Goods Transport Business; Promotion and Demonstration of Energy Efficiency Improvement in the Transport Sector; and Promotion of Smart Driving for Energy Saving in the Transport Sector.

LOW-CARBON ENERGY

To deal with the impacts of climate change, the Ministry of Energy has launched an ambitious program to increase investments in renewable energy, such as wind, solar, biomass and other clean renewable energy sources.

The main policy direction for alternative and renewable energy development is to set the policy on alternative energy as an economy-wide agenda. The agenda encourages the production and use of alternative energy, particularly biomass and biofuels, such as gasohol (E10, E20 and E85) and biodiesel, solid waste and animal manure. The aims are to enhance energy security, reduce pollution and benefit farmers by encouraging the production and use of renewable energy at the community level under appropriate incentive measures; to encourage greater use of natural gas in the transportation sector by expanding the natural gas transportation system throughout Thailand; and to rigorously and continuously promote R&D on all forms of alternative energy. The specific strategies to achieve these aims are:

1. Promote the production and utilisation of biofuels, such as ethanol and biodiesel, to replace oil consumption
2. Promote the use of natural gas in the transportation, industrial, commercial and household sectors, with a target of increasing natural gas mother stations by a minimum of seven in 2009
3. Promote all forms of renewable energy (wind, solar, hydropower, biomass, biogas and energy from waste) with the implementation of a plan to:
   - promote power generation from renewable energy in all forms through incentives for example the current provision of 'Adder' or 'Feed-in Tariff', an additional price on top of the normal prices that power producers will receive when selling electricity to the power utilities
   - promote the conversion of plastic waste into crude oil, in a way similar to the 'Adder' provision.
4. Carry out R&D on alternative energy, renewable energy and other innovative energy technologies, with the aim of developing and integrating relevant agencies' alternative energy R&D to build their capacity to participate in the already approved 15-year Renewable Energy Development Plan (REDP) framework
5. Set alternative energy as an economy-wide agenda and determine incentive measures, with a target of having the National Alternative Energy Master Plan approved and implemented. The intention is to present the 15-year REDP to the National Energy

Policy Council and the Cabinet for approval as the master plan for promotion and support of alternative energy in all forms, and to develop an integrated plan of action for alternative energy development in line with the targets set out in the REDP

6. Establish and strengthen renewable energy networks by encouraging participation at the community, district and provincial levels to create energy security from the foundation, with a target to establish one prototype village/community-based energy source in each province.

These policies will promote the energy security of the kingdom by reducing energy imports and increasing energy resources, build a competitive energy market for sustainable economic growth, and help to reduce emissions of greenhouse gases in the long run.

15-YEAR RENEWABLE ENERGY DEVELOPMENT PLAN 2008–2022

The goal of 15-year REDP is to increase the share of alternative energy to 20% of Thailand's final energy demand in 2022, to utilise alternative energy as a major energy source replacing oil imports, to increase energy security, to promote integrated green energy utilisation in communities, to enhance the development of the domestic alternative energy technology industry, and to research, develop and encourage high-efficiency alternative energy technologies. The REDP operates in the short, medium and long terms:

- Short term (2008–2011)—Emphasis on promoting and supporting commercial alternative energy technologies and high-potential energy sources such as biofuels, co-generation from biomass and biogas
- Mid term (2012–2016)—Focus on the development of the alternative energy technology industry, encourage new alternative energy R&D to achieve economic viability (including new technologies for biofuels production) and develop a sustainable 'green city' model
- Long term (2017–2022)—Enhance the utilisation of new alternative energy technologies (such as hydrogen and bio hydrogenated systems), extend green city models throughout Thai communities and encourage exports of biofuels and alternative energy technology in the ASEAN region.

ENVIRONMENTAL PROTECTION

Thailand has demonstrated its regional leadership in energy and environmental protection in South-east Asia during the past 20 years. Thai greenhouse gas (GHG) emissions from the consumption and flaring of fossil fuels account for 1% of the world's emissions, making Thailand the world's twenty-second largest emitter. Thailand is the second-largest emitter in ASEAN, after Indonesia. The government believes that Thailand should act as a member of the world community to reduce emissions and to mitigate the impacts of climate change.

Thailand's current policy direction to reduce energy's environmental impact is to encourage energy procurement and consumption that protects the environment, with public participation. This is to be achieved by setting relevant standards and promoting more Clean Development Mechanism (CDM) projects to reduce social and environmental impacts and GHG emissions; monitoring the environmental impact of energy production, conversion and utilisation; establishing a target and plan to boost emissions management in the energy sector; promoting CDMs in the energy sector to reduce emissions (with a target to submit CDMs of 1 million tonnes of CO_2 per year for certification); enhancing Thailand's role as a leading exporter of carbon credits in Asia; controlling and monitoring volatile organic compound emissions from the petrochemical and refining industries; and creating low-cost 'appropriate technology' innovations that are environmentally friendly.

NOTABLE ENERGY DEVELOPMENTS

DEMAND-SIDE MANAGEMENT

DSM bidding offers the private sector financial support for investments to improve the energy efficiency of companies by replacing or retrofitting existing machines or equipment to reduce energy consumption. A subsidy is granted based on the actual energy saving in a year as a result of the investment (that is, the subsidy equals annual energy savings times the subsidy rate). EPPO lets companies request their own rates, as long as the rates are under the maximum rates set by EPPO, as shown in the table below.

Table 45 Demand-side management bidding

Energy type	Maximum subsidy rate
Electricity	THB 1/kWh
Heat from liquid and gas fuels (e.g. fuel oil, LPG, natural gas, etc.)	THB 75/MMBtu
Heat from solid fuels (e.g. coal, wood, sawdust, rice husks, bagasse and other agricultural waste)	THB 15/MMBtu

Proposals with the lowest weighted subsidy rate are granted the subsidy first. The weighted subsidy rate takes into account not only the proposal's requested subsidy rate but also the lifetime of the investment (that is, the time over which the investment will result in energy savings). Compared to other subsidy programs, the DSM bidding program results in higher energy savings given the same amount of funding. This results in a higher energy saving to subsidy ratio. Currently, 81 projects have been approved, resulting in approximate annual energy savings of 39.4 ktoe (1.16 million British thermal units of heat and 122.2 GWh of electricity). Requested subsidies total THB 160 million.

POWER SUPPLY MANAGEMENT

Thailand's electricity roadmap is based on the Power Development Plan 2007–2021 (PDP 2007). PDP 2007 aims to increase the generating capacity of the overall power system, at appropriate timing, including through the construction of power plants of various types and power purchases from neighbouring economies, to meet forecast increasing power demand in the next 10–15 years. PDP 2007 is developed in line with the base case of load forecast (March 2007) under two scenarios: a recommended plan involving existing and potential coal-fired plants; and an alternative plan involving LNG imports of 10 million tonnes per year and increased power purchases from foreign sources. The plan will be reviewed every six months to keep it aligned with changing demand and will maintain the reserve margin at no less than 15%. PDP 2007 aims to diversify fuel types in power generation, develop small and very small scale power producers using renewable energy as fuel, study the feasibility of nuclear power generation, and promote clean coal technology for coal-fired power generation. International cooperation in power development projects includes power purchases from Lao People's Democratic Republic, Myanmar, China, Cambodia and Malaysia.

In 2009, the government approved the second revision of PDP 2007 to adjust power generation targets and the reserve margin. The revision covers two phases:

- Short term (2009–2015)—to take into account current sluggish economic conditions; to lower the investment burden in generation and transmission projects that can be postponed, so that power tariffs will not be affected; and to clearly reschedule power purchases so that power producers can manage their operations accordingly.

- Long term (2016–2021)—to be reviewed when developing a new PDP after a new set of GDP forecasts is completed.

Thailand has cooperated on hydropower development with neighbouring economies, on a bilateral basis. Memorandums of understanding on power purchases have been signed with Lao People's Democratic Republic, China and Myanmar for total purchases of 11 500 MW. Imported power being supplied to Thailand's grid comes from Lao People's Democratic Republic (313 MW) and Malaysia (300 MW, high voltage direct current).

CLEAN COAL TECHNOLOGY

Due to the increasing demand for fuel for electricity generation and in the industrial sector, there are already substantial capacities of coal-fired power plants in the region and coal resources remain largely untapped. Thailand's energy plans call for rapid growth in the use of coal for power generation, creating an opportunity for Thailand to promote and increase the use of cleaner coal and clean coal technologies (CCTs), which could also benefit energy security. Despite growing environmental controls, more coal power projects are progressing, with an increasing preference for CCTs. Thailand needs to strengthen cooperative partnerships among government, the private sector and NGOs to promote and use clean coal and CCTs.

To protect Thailand's energy security in the long term, Thailand strongly promotes collaborative image-building for coal and CCTs in the light of global environmental concerns. The government promotes CCTs by conducting studies (for example, on upgraded brown coal, coal liquefaction and integrated coal gasification) and investigating the potential of carbon capture and storage technology, as well as by encouraging private sector investment and participation. Enhancing environmental planning and assessment for coal projects, harmonising emissions standards and applying minimum efficiency requirements for coal-fired power plants are also important.

To support future CCTs, the government plans to establish a coal laboratory and standards, and to develop strategy and action to harmonise local practices and to encourage coal utilisation, resources and facilities. Building an image of coal that is aligned with public understanding is also a key success factor.

NUCLEAR POWER DEVELOPMENT

According to the Power Development Plan (PDP) 2007–2021, Thailand's total installed electricity capacity will increase from 28 530 MW in 2007 to 52 028 MW by the end of the plan in 2021. Growing electricity demand, fluctuations in fossil fuel prices and concerns over climate change are all factors in favour of nuclear power. Every 1 kilowatt-hour of electricity produced in Thailand emits 0.5 kilograms of CO_2, so nuclear power would also help Thailand achieve its climate change goals.

Under the PDP, Thailand's first two 1000 MW nuclear power plants (about 5% of Thailand's total installed electricity capacity) are expected to start operations during 2020–21. The Electricity Generating Authority of Thailand (EGAT), a state-owned company, will be responsible as the owner and operator. Despite nuclear technology's productive capacity and low emissions, it nevertheless faces challenges due to its capital intensiveness, long time lag and sensitivity to public opinion.

Thailand is a party to the Nuclear Non-Proliferation Treaty, and does not intend to develop uranium enrichment or spent-fuel reprocessing. Thailand is also preparing to participate in the relevant International Atomic Energy Agency (IAEA) conventions, which is necessary for implementation of the nuclear power program.

The development of a nuclear power program is a long-term process that needs strong leadership from government, particularly in the area of public acceptance. It is not possible to develop such a program against the will of the people, who need a good understanding of why they should support it. Education, along with efficient and transparent use of nuclear energy, is the way to build public confidence.

Currently, Thailand is exploring civilian uses of nuclear energy, nuclear energy safety, capacity building, education, training and information sharing. In April 2007, the National Energy Policy Council appointed the Nuclear Power Infrastructure Preparation Committee, which has six subcommittees: Legal and Regulatory Systems and International Protocols; Nuclear Safety and Environmental Protection; Industrial and Commerce Infrastructure; Human Resources Development and Technology Transfer; Public Information, Participation and Acceptance; and Nuclear Power Utility Planning Work.

Thailand must develop nuclear energy in accordance with relevant international agreements and standards, particularly those administered by the IAEA and other international and regional nuclear cooperative institutions. By 2011, the Cabinet will make a decision on final approval for the construction of the first 1000 MW nuclear power plant, based on the results of the feasibility study and information conducted by EGAT.

THAILAND HYDROGEN ECONOMY DEVELOPMENT DIRECTION

Thailand is prepared for the global move towards the hydrogen economy and will seriously develop hydrogen energy use. The REDP has dictated that Thailand will use at least 100 thousand kilograms per day of this type of energy by 2017 and gradually increase the amount in the following years, especially in the transport and logistic sectors.

Thailand has begun to develop the production process to turn hydrogen into various usable fuels, including by direct burning and fuel-cell technology. The aim is to increase energy security, enhance technological development potential and encourage joint ventures. To achieve this, the government has established an action plan to push Thailand towards hydrogen use in the transportation, logistics and power generation sectors. The action plan contains three phases.

- Preparation Phase (present–2017): Thailand has to enact laws to facilitate the hydrogen economy, such as the Hydrogen Transportation Act, regulations and a safety regime. Supporting measures may include tax reductions, subsidies for hydrogen production plants (especially those with reduced GHG emissions), and encouragement for management to build public confidence in hydrogen energy (including through technology transfer and demonstrations).
- Hydrogen Economy Starting Phase (2017–2024): This is a market testing phase that introduces related technologies to the public. Necessary infrastructure also has to be tested to build capacity and to enhance efficiency (for example, fleet testing in various locations throughout Thailand, with the emphasis on reasonable investment). At the end of this phase, the installed capacity of hydrogen production lines will place Thailand as a leader in the commercial hydrogen energy sector.
- 2nd Phase of the Hydrogen Economy (2024 onwards): After the starting phase, the public should have enough confidence in the technologies and infrastructure. With growing domestic and international markets, this will be the time for close economic monitoring to further increase opportunities in the hydrogen market and to prepare for other economies' commitment to a full hydrogen economy.

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 Data and Modelling Center (EDMC), Institute of Energy Economics (IEEJ), Japan, APEC energy database—www.ieej.or.jp/egeda/database/database-top.html

Energy Policy and Planning Office (EPPO)—www.eppo.go.th

Prime Minister's Office—www.opm.go.th

Ministry of Energy (MoEN)—www.energy.go.th/en

UNITED STATES

INTRODUCTION

The United States (US) is the world's largest and most influential economy, with a GDP of USD 11.5 trillion (USD (2000) at PPP) in 2007 (EDMC 2009). The US is in North America between Canada and Mexico. It has a population of 301 million people (2007), and spans 9.8 million square kilometres (CIA 2009, EDMC 2009).

The US enjoyed a long economic expansion from 1991 through to 2000. Growth was particularly robust from 1995 to 2000, averaging 4.3% per year in real terms, and unemployment declined from 5.6% to 4%. A brief recession slowed growth to 1.1% in 2001, but growth then gradually recovered to 3.6% by 2004, before slowing to 2.1% in 2007. By the end of 2008, however, the US was caught at the centre of the global financial crisis, and real GDP grew only 0.4% in that year (BEA 2009). Economic growth appeared to have resumed in the third quarter of 2009, but by then unemployment had reached 10.2%, the highest level in over 25 years (BLS 2009).

The US is the largest producer, consumer and importer of energy in the world. It is also rich in energy resources. At the end of 2007, it had 30.5 billion barrels of proven oil reserves, 6730 billion cubic metres of natural gas reserves and 238 billion tonnes of coal reserves (BP 2009). According to the US Department of Energy's Energy Information Administration (EIA), total (net summer) electricity generating capacity across all sectors was 994.9 GW in 2007, of which 77% was thermal, 10% was nuclear, 10% was hydro (conventional and pumped storage), 1.7% was wind, and 1.4% was other renewable energy (biomass, geothermal, solar etc.) (EIA 2007). The economy consumed 5.3 tonnes of oil equivalent per capita in 2007, over three times the APEC average and far in excess of domestic energy production (EDMC 2009).

Table 46 Key data and economic profile, 2007

Key data		Proven energy reserves[b]	
Area (sq. km)[a]	9 826 675	Oil (billion barrels)[c]	30.5
Population (million)	301.3	Gas (billion cubic metres)	6 730
GDP (USD (2000) billion at PPP)	11 491	Coal (billion tonnes)	238
GDP (USD (2000) per capita at PPP)	38 138		

a CIA (2009).

b BP (2009).

c The US EIA reports significantly lower proved oil reserves – 21.3 billion barrels in 2007 (EIA 2009h).

Source: Energy and Data Modelling Center, Institute of Energy Economics, Japan (2009).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

In 2007, total primary energy supply in the US was nearly 2366 million tonnes of oil equivalent (Mtoe). By fuel type, 39% of supply came from crude oil and petroleum products, 23% from coal, 23% from natural gas and 15% from nuclear, hydro, geothermal and other fuels. The US imported about 30% of its net energy requirements in 2007 (EDMC 2009).

In 2007, oil was responsible for approximately 927 Mtoe of the US primary energy supply. Petroleum product supply grew by 1.5% per year during the 1990s, but domestic crude oil production levels declined by 2.3% per year as oil exploration and production companies turned

their attention to cheaper, less mature basins in Africa, Asia and the Middle East (EDMC 2009). While 42% of crude oil and products demand was met by net imports in 1990, the net import share had climbed to 60% by 2005, and declined only slightly to 58% in 2007. About half of net imported petroleum in 2007 came from OPEC economies. Neighbouring Canada and Mexico are the largest non-OPEC net suppliers (EIA 2009c). The US itself, however, remained the third-largest crude oil producer in the world (EIA 2009g). Of the states, Texas, Alaska and California are the largest oil producers, and more than half of domestic reserves are in those three states (EIA 2009h).

The US primary natural gas supply totalled 539 Mtoe in 2007, of which 16% was met by net imports, almost all from Canada (EDMC 2009, EIA 2009d). Consumption growth was assisted by a period of falling wellhead gas prices following their 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 2007 the total primary gas supply returned to 98% of the 2000 peak (EDMC 2009). The fast growth of gas use by power producers has been driven in part by the fuel's low emissions compared to other fossil fuels.

Table 47 Energy supply and consumption, 2007

Primary energy supply (ktoe)[a]		Final energy consumption (ktoe)		Power generation GWh)	
Indigenous production	1 673 923	Industry sector	289 529	Total	4 017 349
Net imports and other	713 940	Transport sector	661 509	Thermal	2 819 499
Total PES	2 365 588	Other sectors	660 316	Hydro	275 545
Coal	554 151	Total FEC	1 611 354	Nuclear	836 634
Oil	926 742	Coal	27 725	Others	85 671
Gas	538 591	Oil	875 868		
Others	346 104	Gas	320 949		
		Electricity and others	386 812		

a Excludes stock changes and international marine bunkers.

Source: EDMC (2009)

The US held about 3.6% of the world's natural gas reserves in 2007 (BP 2009). The US transports gas through an extensive pipeline network, with more than 492 384 kilometres of transmission pipeline and 6.1 billion cubic metres per day of transmission capacity (EIA 2007). Underground gas storage capacity in the US has grown only slightly since the mid-1970s, and total end-of-year storage volume stood at approximately 36% of annual consumption in 2007, compared to a peak of 40% in 1986 (EIA 2009e). Interest in liquefied natural gas (LNG) has grown in the US because of LNG's potential as a means to diversify overall energy supplies while fuelling relatively clean power generation, but proposals to construct new LNG receiving terminals on the east and west coasts have faced local public and regulatory opposition. Nevertheless, the EIA forecasts that net LNG imports to the US will grow from about 15 billion cubic metres in 2006 to 40 billion cubic metres in 2018 as pipeline imports from Canada decline. After 2018, increasing domestic production is forecast to reduce imports, an important departure from past EIA forecasts. Successful commercialisation of production from the economy's abundant shale gas resource is the main reason for the increased estimate of future production (EIA 2009f).

Primary energy supply of coal in the US totalled 554 Mtoe in 2007 (EDMC 2009). 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 2007, 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 2009b). 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 2009b, EPA 2008).

The US is the seventh largest coal exporter in the world, behind Australia, Indonesia, Russia, South Africa, China and Colombia (EIA 2009g). After 1998, US coal exports dropped sharply due to lower world coal prices. In 2002, total US coal exports fell to 35.9 million tonnes, their lowest level since 1961 (EIA 2003). Since then, however, coal exports have recovered gradually, reaching 53.7 million tonnes in 2007. Canada is the primary destination for steam coal exports, and Europe is the largest consumer of coking coal exports (EIA 2008).

The US produced 4.0 million gigawatt-hours of electricity in 2007; of that total, 70% came from thermal plants, 21% from nuclear power, 6.9% from hydropower and 2.1% from other sources (EDMC 2009).

The US generates more nuclear power than any other economy, but no new nuclear reactors have been ordered since 1977 (CRS 2007b). 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 2002, the average utilisation 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 2009b, NRC 2009a). 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 2009, the NRC had approved licence extensions for 52 nuclear reactor units and had applications for another 18 extensions under review, while 17 other units had informed the agency of their intention to seek extensions by 2013 (NRC 2009b).

Total renewable energy production in the US in 2007 was approximately 172 Mtoe, or 7% of total primary energy supply, according to the EIA. Production from non-hydro sources increased 8.1% from the previous year, and at an annual rate of 6.4% since 2002 (EIA 2009b). By consumption of renewable energy type, biomass as a whole represented 53% of the total, hydroelectric power 36%, geothermal 5.1%, wind 5.0% and solar/PV 1.2% (hydroelectric, wind and solar power converted using fossil-fuelled plant heat rates). Of these, biomass used for biofuels (approximately 26 Mtoe consumption, 29% annual growth for ethanol and biodiesel combined) and wind power (approximately 8.6 Mtoe, 29% annual growth) experienced particularly rapid expansion (EIA 2009b). 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 2007, total final energy consumption in the US was 1611 Mtoe, an increase of 1.6% from the previous year. By sector, transport consumed 41%, industry accounted for 18%, and the rest (including non-energy uses) consumed 41%. By fuel, petroleum accounted for 54% of final consumption, natural gas 20%, coal 2%, and electricity and other fuels 24% (EDMC 2009).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The production, distribution and use of energy in the US are governed by an elaborate energy policy constructed over the past century by legislative acts and administrative regulations at federal and state levels. Historic legislation includes the Federal Water Power Act of 1920, which created the regulatory agency now known as the Federal Energy Regulatory Commission (FERC); the Atomic Energy Act of 1946, which introduced the first legal guidelines for how the US would develop nuclear energy; and the Department of Energy Organization Act of 1977, which established the Department of Energy (DOE 1994, DOI n.d.). Key environmental policies,

such as the National Environmental Policy Act of 1969 and the Clean Air Act of 1977, also shape the ways energy is used (EPA 2008, 2009a). This section summarises a few major policy packages of recent years that capture the spirit of the current energy policy.

Since the 1970s, several major legislative packages have been introduced to define the 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 research, development and deployment of technologies to enhance the production and efficient utilisation of renewable, fossil and nuclear energy resources (US House 1992).

In 2005, a new comprehensive Energy Policy Act was introduced as the successor to the 1992 Act. This was followed shortly after by the Energy Independence and Security Act of 2007. Together, these recent legislative packages substantially define the current US federal energy policy. The American Recovery and Reinvestment Act of 2009 also merits discussion for having dramatically increased the funding of many federal energy programs, thereby illustrating the current administration's commitment to creating a clean energy economy. Details of this Act are contained in the 'Notable developments' section.

ENERGY POLICY ACT OF 2005

In August 2005, the Energy Policy Act of 2005 (EPAct) was passed by the US Congress and signed into law as a comprehensive piece of energy legislation (CRS 2006, US Congress 2005). The main focus areas of the 2005 EPAct include addressing the impact of high energy prices on consumers, ensuring protection of human health and the environment, improving energy conservation and efficiency, increasing domestic energy supplies, increasing the use of new renewable energy, improving energy infrastructure, furthering research and development, and strengthening international alliances to improve energy security and relationships. The content of each title is described in brief below, based on the final legislative text of the 2005 EPAct and a summary of the enacted provisions.

Energy Efficiency (34 sections)

Energy management and performance standards in federal infrastructure, procurement and lands; daylight saving time adjustments; voluntary commitments to reduce industrial energy intensity; funding for state energy programs; financial assistance and rebates for weatherisation and energy-efficient appliances; Energy Star program, energy labelling requirements and other energy conservation standards for products; public education programs; public housing provisions.

Renewable Energy (36 sections)

Assessment of resources; renewable energy production incentives; federal renewable energy purchase goals; use of solar photovoltaics in public buildings; rebates for homes and small businesses that install a renewable energy system; leasing conditions and production incentives for geothermal energy; licensing and incentives for hydroelectricity.

Oil and Gas (61 sections)

National Petroleum Reserve operational authority and procedures; natural gas import/export (including LNG), storage facilities, market manipulation and transparency; exclusion of injections for hydraulic fracturing from the Safe Drinking Water Act; incentives for deep-well natural gas production in the Gulf of Mexico; oil and gas royalties, including a royalties in-kind program and royalty relief for deepwater production and low-production wells; gas hydrate production incentives; enhanced oil recovery incentives; management of oil and gas leasing and infrastructure offshore and on federal lands; development of oil shales, tar sands and coal-derived fuels; Great Lakes oil and gas drilling ban; coal-bed methane regulation; refinery revitalisation.

Coal (20 sections)

Loan guarantees for clean coal technology facilities; coal and coke gasification demonstration projects; Illinois Basin coal-to-liquids funding; funding for projects to improve efficiency and reduce emissions of coal-fired electricity generation; amendments to existing federal coal leasing regulations and repeal of the approximate 65 hectare limit for coal leases.

Indian Energy (6 sections)

Establishment of the Office of Indian Energy Policy and Programs; consultation with Indian tribes; rural electrification; assistance in development of energy resources; authority for leases, business agreements and rights-of-way; energy efficiency in federally assisted housing programs.

Nuclear Matters (41 sections)

Extension to 2025 of and amendments to the Price–Anderson Act (limiting liability of nuclear operators); scholarships and fellowships for students in related fields of study; nuclear licensing and decommissioning; exclusion from antitrust review; waste disposal; demonstration of hydrogen production at existing nuclear facilities; loans to cover costs incurred by legal or regulatory project delays; project establishment, management and organisation for the Next Generation Nuclear Plant Project; nuclear facility and materials security.

Vehicles and Fuels (39 sections)

Use of alternative fuels for dual-fuel federal vehicles; flex-fuel and hybrid vehicle commercialisation initiative; domestic manufacture of hybrid and advanced diesel vehicles; appropriations for advanced vehicle pilot programs with state and local governments; fuel cell bus demonstrations and clean school bus programs; studies of railroad and aviation fuel efficiency and emissions; promotion of bicycling; engine idling reduction programs; dual-fuel vehicle incentive labelling requirement; funding for implementation and enforcement of fuel economy standards; update of testing procedures for fuel economy labelling; federal and state procurement of hydrogen fuel cell vehicles; grants and loans for projects to reduce emissions from diesel vehicles.

Hydrogen (16 sections)

Hydrogen fuel cell research and development (R&D) program and related matters; integration of solar and wind technologies and hydrogen production; technology transfer.

Research and Development (81 sections)

Energy-efficiency R&D, including the Next Generation Lighting Initiative, National Building Performance Initiative, Energy Efficiency Science Initiative and Advanced Energy Efficiency Technology Transfer Centers; distributed energy and electric energy systems R&D, including micro-cogeneration energy technology, distributed energy technology demonstrations, electric transmission and distribution programs, and improved efficiency at high power density facilities.

Renewable energy R&D programs, including wind, hydro, geothermal, solar energy, bioenergy, and renewable hydrogen production and infrastructure for vehicle propulsion; agricultural biomass R&D, including conversion technologies, production incentives for cellulosic biofuels, bioproduct marketing and certification grants for small businesses, regional bioeconomy development grants, preprocessing and harvesting demonstration grants, and public outreach.

Nuclear R&D, including advanced nuclear systems, hydrogen production, the advanced fuel cycle initiative, security of nuclear facilities, and university nuclear science engineering support.

Fossil energy R&D, including reducing emissions from fossil fuel use, fuel cells, carbon capture and sequestration (CCS), technologies for the production and use of coal, maximising production from low-volume oil and gas reservoirs, complex well technology, and methane hydrates.

Science R&D, including such topics as fusion energy, catalysis, hydrogen, solid state lighting, energy and water supplies, advanced scientific computing, rare isotope accelerators, systems biology, Spallation Neutron Source, energy research fellowships and scholarships.

Provisions for international cooperation, administration of programs and R&D on ultra-deepwater and unconventional natural gas and petroleum resources.

Department of Energy Management (11 sections)

Improved technology transfer; Technology Infrastructure Program; inclusion of small businesses and outreach to stakeholders; improved coordination and management of civilian research programs; prizes for achievement in grand challenges of science and technology; and university collaboration.

Personnel and Training (6 sections)

Educational programs in science and mathematics; National Center for Energy Management and Building Technologies; National Power Plant Operations Technology and Educational Center.

Electricity (48 sections)

Establishment of the Electric Reliability Organization; transmission infrastructure modernisation; transmission operation improvements, including native load service obligations; transmission rate reform and infrastructure upgrade investment; amendments to the Public Utilities Regulatory Policies Act, including requiring net metering or time-of-use metering upon customer request, cogeneration and customer power production purchase and sale requirements; repeal of the Public Utility Holding Company Act; provisions for electricity market transparency, prohibition of manipulation, and FERC review of major utility transactions; and study of economic dispatch.

Energy Policy Tax Incentives (43 sections)

Tax credits for investments in electricity infrastructure, including extension of the renewable electricity production tax credit, credits for investment in clean renewable energy bonds, advanced nuclear power production credit, clean coal investment credit, amortisation of transmission and pollution control equipment, and modification of nuclear decommissioning costs; tax credits for domestic fossil fuel production, including non-conventional source production and other tax benefits for refiners, natural gas gathering and distribution lines, and geological expenditures; conservation and energy-efficiency tax incentives, including deductions for energy-efficient commercial buildings, tax credits for construction of efficient homes, for purchase of efficient appliances, and for investments in distributed generation equipment; alternative motor vehicles and fuels incentives, including tax credits for purchase of such vehicles, for installation of alternative fuel stations, and for production and use of biodiesel and ethanol; expansion of research tax credits.

Ethanol and Motor Fuels (30 sections)

Requirements for renewable (ethanol) content in gasoline, elimination of oxygenate requirement for reformulated gasoline, data collection and provisions for public health and environmental impacts of fuels and fuel additives; grants and commercial loan guarantees for advanced biofuel technologies and waste-derived biofuels; advanced biofuels demonstration projects; inspection and compliance for underground storage tanks, including remediation for contamination by oxygenated fuel additives; controls on the proliferation of boutique fuels.

Climate Change (2 sections)

Creation of a Committee on Climate Change Technology to design a climate change technology policy and program, and elimination of barriers to technology deployment; projects to reduce greenhouse gas emissions in developing economies, including funding mechanisms and technology transfer.

Incentives for Innovative Technologies (4 sections)

Loan guarantees may be made for a wide range of eligible projects, including renewable energy systems, advanced fossil energy technologies, hydrogen fuel cells, advanced nuclear facilities, CCS, efficient electricity generation, transmission and distribution technologies, efficient end-use technologies, production facilities for efficient vehicles, pollution control equipment and refineries.

Studies (40 sections)

Funding for a wide range of energy-related studies, including petroleum inventory storage, telecommuting, energy-efficiency standards, gasoline prices, the Alaska natural gas pipeline, coal-bed methane, rapid electrical grid restoration, distributed generation, natural gas supply shortage, employment in the hydrogen economy, passive solar technologies, impact of offshore LNG receiving facilities, availability of skilled workers, renewable energy on federal lands, increased hydroelectric generation at existing facilities, federal leasing structures, a security review of international energy requirements, and a review of the 1992 Energy Policy Act.

ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

Signed into law in December 2007, the Energy Independence and Security Act of 2007 (CRS 2007a) revises the EPAct and includes new provisions intended 'to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and sequestration options, and to improve the energy performance of the Federal Government', among other issues.

The main provisions of the Act included mandates for:

- 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)—CAFE credit trading is permitted among vehicle manufacturers and interim standards are set, beginning with model year 2011. Commercial vehicle fuel economy must be studied.
- improved vehicle technologies, by providing grants to encourage the use of electric and hybrid vehicles and by offering loans and loan guarantees for manufacturing facilities that produce advanced vehicles and their components.
- 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—from 2016, new biofuel production towards the mandate 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 a number of safety valves to respond to high costs or limited availability.
- a 25%–30% decrease in the power consumption of general service lamps by 2012–14 and a 60% reduction by 2020, effectively phasing out most incandescent bulbs.
- new efficiency standards for residential and commercial appliances and buildings—Appliance standards apply to dehumidifiers, dishwashers, electric motors, external power supplies, freezers (including walk-in freezers), refrigerators, residential boilers and residential clothes washers.
- increased funding for residential building weatherisation programs, and a goal for newly built commercial buildings to achieve zero net energy use by 2025 and to retrofit all commercial buildings to that level by 2050.
- federal government building and other efficiency improvements—Specific mandates include a 30% reduction in federal government building energy use by 2015 (relative to 2003) and the elimination of fossil-fuel energy demand in new federal buildings by

2030. Overall, federal government petroleum use is to drop 20% and alternative fuel use is to rise 10% from a 2005 baseline by 2015.

- new funding for feasibility studies or R&D on a number of new energy systems, including biofuels and biofuel infrastructure, energy efficiency in data centres, green building strategies including school design, solar energy, geothermal energy, marine energy, energy storage, CCS, international energy programs, green jobs, energy transportation and infrastructure, small business energy programs, and the smart grid. Funding also includes prizes for the development of advanced lighting and hydrogen technologies.
- the creation of an energy efficiency and renewable energy worker training program and the issue of grants to foster the development of 'green jobs'.
- support for the modernisation of the electricity grid by creating a Smart Grid Task Force, supporting smart grid demonstrations, assigning responsibility for development of device and system standards, and introducing a grant program to support smart grid investments.

Funding for some provisions of the Act, including improving the fuel efficiency of automobiles, is provided by the repeal of certain 2005 EPAct oil and gas tax subsidies.

TRANSPORT

In 2008, the US Environmental Protection Agency (EPA) denied the state of California's request for permission to regulate the greenhouse gas (GHG) emissions of automobiles. Under the Obama administration, that decision was reversed, and California has been authorised to implement a regulation to control GHG emissions from motor vehicles. At the same time, the federal government proposed a plan to speed the introduction of new fuel efficiency standards. The Department of Transportation and the EPA are now jointly developing vehicle GHG emissions standards and fuel economy standards that will achieve the same effect as the California standard and thereby maintain a harmonised economy-wide standard. The proposed standard would 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).

CLIMATE CHANGE AND RENEWABLE ENERGY

GREENHOUSE GAS ENDANGERMENT FINDING

There are two ways that GHGs may be regulated at the federal level in the United States. 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, with climate legislation stalled in Congress, the EPA issued an endangerment finding. The finding allows the EPA to issue rules to limit GHG emissions, such as the proposed vehicle emissions standards (EPA 2009b).

STATE AND CITY-LEVEL CLIMATE CHANGE INITIATIVES

In the absence of federal commitments to reduce US GHG emissions, a number of regional, state and city-level initiatives have been formed and were active in 2008.

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 statewide GHG emissions cap equal to 1990 levels by 2020, with penalties for noncompliance (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 2012–2020 period (ARB 2008).

In 2007, California also strengthened a statewide renewable portfolio standard (RPS) requiring that, by 2010, 20% of electricity sales by retail sellers (excluding municipal utilities) come from 'eligible renewable energy resources', which include geothermal, solar, wind, biofuels and municipal solid waste. In 2008, the state's major utilities met 13% of their aggregate load using RPS-eligible renewables (CA PUC 2009).

Ten states in the north-eastern US are members of the Regional Greenhouse Gas Initiative (RGGI). This initiative has a narrower scope than the California plan, focusing on reducing carbon dioxide emissions from the power sector by 10% by 2018. The first permit auction for the cap-and-trade system was conducted in September 2008, and the first three-year compliance period began in January 2009 (RGGI 2009). Six New England states are also party to the New England Governors/Eastern Canadian Premiers Climate Change Action Plan, whose 11 members have resolved to reduce the region's GHG emissions to 10% below 1990 levels by 2020 (NEG/ECP 2008).

The Midwestern Greenhouse Gas Reduction Accord, signed in November 2007, with members including six US states and one Canadian province, aims to establish GHG reduction targets and the regulatory or market mechanisms that might be used to achieve them (MGA 2007). A host of other regional initiatives focused on climate change or clean energy have now also been formed across 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, 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).

NOTABLE ENERGY DEVELOPMENTS

POLICY UPDATES

In June 2009, the House of Representatives passed climate and energy legislation. The legislation requires 20% of electricity to come from renewable energy in 2020 and caps carbon emissions from major sources in that year at 17% below the 2005 level, and in 2050 at 80% below the 2005 level (CRS 2009b). However, corresponding legislation has not been passed by the Senate, so it is unclear whether or when economy-wide climate legislation will be enacted.

AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009

In February 2009, President Obama signed the American Recovery and Reinvestment Act (the Recovery Act), which provided a massive stimulus in response to the worst recession in at least 25 years. The Recovery Act provides USD 787 billion in tax cuts, funds for federal programs and contracts, grants and loans. Of that amount, USD 36.7 billion was directed to offices under the Department of Energy. This dramatically increased funding to energy programs that were authorised by previous legislation, such as the EPAct 2005 and the Energy

Independence and Security Act of 2007, but had received modest funding or even no funding prior to the stimulus. The allocation of these funds, by office, is shown below (CRS 2009a).

Table 48 Allocation of Recovery Act Funds

USD 36.7 billion (total)	Department of Energy
USD 16.8 billion	Energy Efficiency and Renewable Energy
USD 6.0 billion	Environmental Management
USD 4.5 billion	Electricity Delivery and Energy Reliability
USD 4.0 billion	Loan Guarantee Program
USD 4.3 billion	Fossil Energy
USD 1.6 billion	Science
USD 0.4 billion	Advanced Research Projects Agency—Energy (ARPA-E)

For the Office of Energy Efficiency and Renewable Energy, this is nearly eight times the 2009 congressional budget allocation. The Department of Energy expects to disburse 70% of the total sum by the end of 2010 (DOE 2009d). So far, projects that have been authorised include environmental remediation at nuclear facilities, industrial CCS, improvements to home energy efficiency, and advanced research projects. The EIA estimated that the provisions of the Recovery Act will 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 2009f).

INCENTIVE PROGRAMS

NEW RENEWABLE ENERGY POWER INCENTIVES

Although all forms of energy production in the US receive government incentives in some form, incentives for new renewable energy (NRE) power industries are noteworthy for their importance to the development of those industries. Apart from R&D, current incentives include both financial incentives (subsidies) and policy support.

The production of wind, geothermal, bioenergy and marine power is currently eligible for a Federal Renewable Energy Production Tax Credit (PTC) of USD 0.021 per kilowatt hour (inflation-adjusted for 2009), 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 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 2009).

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, with similar tax credits for residential small wind and geothermal systems as well. Several federal loan and loan guarantee programs also exist to encourage the development of renewable energy and other advanced energy facilities (DSIRE 2009).

Many state and local governments have in place financial measures that complement federal financial incentives for NRE investment. In addition to subsidies, state legislation has also

provided significant indirect incentives for NRE development through the establishment of policy frameworks such as renewable portfolio standards (RPS), which mandate that a certain share of electricity sales be sourced from renewable energy. Thirty-five states and the District of Columbia had enacted RPS legislation, with varying degrees of stringency, by the end of 2009. 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 2009).

ENERGY-EFFICIENCY INCENTIVES

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 2009). 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 2009a). 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 2009, US House 1992).

OFFSHORE DRILLING

The 1981 US moratorium on offshore oil and gas drilling was allowed to expire by the Congress in September 2008. This followed the Bush administration's repeal of the administration's corresponding ban in 2008, and thus opened the way for new offshore exploration. However, in February 2009, the new administration halted plans to begin lease negotiations to allow time for further study and public comment. It is not yet clear whether either Congress or the administration, after the studies are completed, will choose to block offshore development (DOI 2009).

LOW-CARBON ENERGY

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 has since been restructured. The FutureGen Alliance is now preparing a preliminary design and cost estimate for a commercial-scale plant. After the preliminary design is complete, the partners will together decide whether to move forward. If they do so, the Department of Energy may contribute more than USD 1 billion, which was made available through the Recovery Act (DOE 2009c).

WIND ENERGY BOOM CONTINUES

In 2008, US cumulative wind energy capacity reached 25 369 megawatts (MW). A record 8558 MW was installed in 2008, which represented 42% of all added electricity generating capacity and an investment of about USD 16.4 billion. As the industry has grown, so too has the performance of wind generators. Wind projects installed since 2004 have achieved an average capacity factor of greater than 35%. Although the credit crisis that emerged in 2008 posed an obstacle to continued rapid expansion in 2009, incentives provided by the Recovery Act and other federal and state policies are expected to foster strong growth of wind energy in the years ahead (DOE 2009a).

INTERNATIONAL COOPERATION

MAJOR ECONOMIES FORUM ON ENERGY AND CLIMATE

In September 2007, President Bush 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 have continued under President Obama as part of the Major Economies Forum on Energy and Climate. At a meeting in July 2009, the economies resolved to work together to reach an agreement at the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change, in Copenhagen in December 2009 (White House 2009).

ASIA–PACIFIC PARTNERSHIP ON CLEAN DEVELOPMENT AND CLIMATE

The Asia–Pacific Partnership on Clean Development and Climate (APP) is a voluntary public–private partnership among seven Asia–Pacific economies—the US, Australia, Canada, China, India, Japan and Korea. Ministers from the six partner economies held an inaugural meeting in January 2007 in Sydney, Australia. The aim of APP is to accelerate the development and deployment of clean energy technologies, focusing on expanding investment and trade in cleaner energy technologies, goods and services in key market sectors. Eight public–private sector taskforces cover the cleaner use of fossil energy; renewable energy and distributed generation; power generation and transmission; steel; aluminium; cement; coal mining; and efficiency improvement in buildings and appliances. In October 2009, the third ministerial meeting was held in Shanghai. The ministers pointed to the 175 projects that have been endorsed by APP and noted the benefits of international partnership in addressing climate change (APP 2009).

NUCLEAR ENERGY

The US 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 2007 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). GIF, established in 2001, is a US-led multilateral partnership fostering international cooperation in R&D for the next generation of nuclear energy systems. The 13 member states of GIF work together to address several remaining challenges to the increased use of nuclear energy, including management of fuels and wastes, reliability and cost, safety, and proliferation risks (GIF n.d.).

USEFUL LINKS

Database of State Incentives for Renewables and Efficiency—www.dsireusa.org

Department of Energy—www.energy.gov

Energy Information Administration—www.eia.doe.gov

Energy Star—www.energystar.gov

Environmental Protection Agency—www.epa.gov/energy

Federal Energy Regulatory Commission—www.ferc.gov

Fuel Economy—www.fueleconomy.gov

Nuclear Regulatory Commission—www.nrc.gov

American Recovery and Reinvestment Act of 2009—www.recovery.gov

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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 331 212 square kilometres, and a marine exclusive economic zone stretching 200 nautical miles from its 3260 kilometre coastline. In 2007, Viet Nam's population was 85.15 million. Market-oriented reforms since 1986 and rapid economic development have transformed the economy of Viet Nam. In 2007, Viet Nam had a GDP of USD 185 billion and an income per capita of USD 2172 (both in USD (2000) at PPP). GDP grew at an average annual rate of 7.7% from 2000 to 2007.

The government targets GDP growth of 7.5% in 2010, when it expects export growth to increase by 16% per year, total annual capital investment in the economy to reach around 40% of GDP, and population growth to be under 1.1%. However, due to the economic recession in 2008 and 2009, the government's targets for 2005–10 have been reassessed.

In January 2007, Viet Nam joined the World Trade Organization, taking the organisation'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 endowed with diverse fossil energy resources, such as oil, gas and coal, as well as renewable energy such as hydro, biomass, solar and geothermal. Viet Nam's proven energy reserves in 2007 consisted of 615 million tonnes (Mt) of oil, 600 billion cubic metres (bcm) of gas, 5883 Mt of coal, and 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 49 Key data and economic profile, 2007

Key data		Energy reserves	
Area (sq. km)	331 212	Oil (million tonnes)—proven[a]	615
Population (million)	85.15	Gas (billion cubic metres)—proven[a]	600
GDP (USD (2000) billion at PPP)	184.99	Coal (million tonnes)	5 883
GDP (USD (2000) per capita at PPP)	2 172		

a Data is for 2005.

Sources: Energy Data and Modelling Center, Institute of Energy Economics, Japan (http://ieej.or.jp/egeda/database/database-top.html); General Statistics Office, Viet Nam (www.gso.gov.vn).

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Viet Nam's total primary energy supply (TPES) in 2007 was 46 933 kilotonnes of oil equivalent (ktoe), an increase of 7.5% from 43 628 ktoe in 2006. By energy source, 31.0% of supply came from oil, 20.6% from coal, 12.0% from natural gas and 32.2% 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 2530 ktoe in 1990 to 16 207 ktoe in 2007. From 2000 to 2007, oil

production and exports grew at an average annual rate of more than 8%. Viet Nam has 14 producing oil fields: Bach Ho, Rong, Dai Hung, Rang Dong, Ruby, Emerald, Su Tu Den, Bunga Raya, Bunga Tulip, Ca Ngu Vang, Phuong Dong, Song Doc, Cendor and Bunga Kekwa fields (PVN 2009).

Most oil exploration and production occurs offshore in the Cuu Long and Nam Con Son basins. Viet Nam did not yet have its own refinery in 2007, and all crude oil production was exported. The economy imports most of its petroleum products, but the Dung Quat refinery in Quang Nam province (capacity 150 000 barrels per day) has been in operation since February 2009, providing around 6.5 Mt of petroleum products annually for domestic consumption (Vietnam News 2009).

Oil product imports increased from 4713 ktoe in 1995 to 14 834 ktoe in 2007 at an average annual growth rate of 10%. Oil is the most important energy source in Viet Nam, accounting for 31% of the economy's TPES in 2007, up from 29.3% in 2006.

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. Besides several large gas fields that have been discovered, such as in the Cuu Long and Nam Con Son basins offshore from the South East region, there are also the Malay – Tho Chu basin offshore in the South West region and the Song Hong Basin in the North region. Cuu Long basin is one of the more mature natural gas production areas and mostly produces associated gas from crude oil production.

A 160-kilometre pipeline from the Bach Ho field has been operating since 1995; associated gas is gathered and transported to shore to fuel power plants. Associated gas from the Bach Ho and Rang Dong oil fields has a capacity of 2 bcm per year and is capable of supplying 1.7 bcm of dry gas, 350 000 tonnes of liquefied petroleum gas and 130 000 tonnes of condensate for domestic use. The gas development complex at Lan Tay field in Block 06.1 of the Nam Con Son Basin has an output of 2.7 bcm per year and a gas pipeline 400 kilometres long with a maximum capacity of 7.5 bcm per year, phases 1 and 2 of which were completed in November 2002 and October 2008, respectively. In addition, a gas pipeline system from the PM3-CAA gas fields to Camau, supplying gas to a power plant – fertiliser manufacturing complex, was completed in 2007. Thus, from 2007, Viet Nam's total gas supply was 6.8 bcm per year, which was capable of supplying enough gas to the Camau complex and the Phu My power generation plant, both of which have a generating capacity of 6000 MW. The share of natural gas in TPES increased from 186 ktoe (2%) in 1995 to 5653 ktoe (12%) in 2007. The largest increase in gas use has come from power generation.

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 at a depth 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 use foreign investment to mine in the next 10 years. Viet Nam's coal production increased steadily from 4.6 Mt in 1990 to 39.8 Mt in 2007, matched by growth in exports and domestic demand. In 2007, Viet Nam exported 22.2 Mt, a record amount. Nearly 55.8% of coal production in 2007 was exported to China, Japan, Korea, Chinese Taipei, Thailand, France and other economies. Primary coal supply increased by 12% per year from 2000 to 2007, from 4372 ktoe to 9681 ktoe. In 2007, coal used for power generation accounted for 14% of total coal consumption.

Electricity generation increased at an average annual rate of 14.1% between 2000 and 2007, from 26.562 terawatt-hours (TWh) in 2000 to 66.805 TWh in 2007. 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 32% in 2007. The share of coal declined from 33% in 1995 to 17% in 2007. In the meantime, hydropower decreased from 72% of total generation to 34% in 2007 due to rapid expansion of natural gas use and foreign companies

becoming increasingly involved in the growing power market of Viet Nam. In 2007, the economy's installed generating capacity was 13 512 MW; of that total, 9844 MW (72.8%) was managed by Viet Nam Electric Power Group (Electricity of Viet Nam, or EVN) and 3668 MW (27.2%) was managed by others (Institute of Energy 2009).

Low-income households in rural areas rely primarily on biomass, which consists of wood and agricultural waste, as a source of energy for cooking. In Viet Nam, biomass accounted for less than 30% of TPES in 2007; the share of biomass has decreased significantly since 1995, when it was 70% of TPES.

Table 50 Energy supply and consumption, 2007

Primary energy supply (ktoe)		Final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	63 159	Industry sector	14 482	Total	66 805
Net imports and other	–18 659	Transport sector	8 115	Thermal	43 921
Total PES	46 933	Other sectors	17 852	Hydro	22 824
Coal	9 681	Total FEC	40 448	Nuclear	–
Oil	14 534	Coal	6 089	Other	52
Gas	5 653	Oil	17 713		
Other	17 064	Gas	542		
		Electricity	5 256		
		Other	14 848		

Source: Energy Data and Modelling Center, Institute of Energy Economics, Japan (www.ieej.or.jp/egeda/database/database-top.html).

FINAL ENERGY CONSUMPTION

In 2007, Viet Nam's total final energy consumption (TFEC) was 40 448 ktoe, up 5.5% from 2006. By fuel source, biomass contributed the largest share (36.7%), followed by oil products (33.9%), coal (15.1%), electricity (13.0%) and gas (1.3%). Between 2000 and 2007, consumption of electricity grew fastest at an annual growth rate of 14%.

Industry is one of the biggest energy consumers, accounting for 35.8% of final energy consumption in 2007, up from 32.6% in 2006. The steel, construction materials, pulp and paper and fertiliser manufacturing industries consumed the most energy. From 2000 to 2007, the annual average growth rate of energy consumption in industry was 13.5%.

Although transport's share of TFEC increased at an average annual rate of 12% between 2000 and 2007, between 2006 and 2007, the increase was negligible—from 20% in 2006 to 20.1% in 2007. Oil products (diesel, gasoline and fuel oil) are mainly used in transportation.

Other sectors (residential and commercial, including biomass) consumed 42.7% of Viet Nam's TFEC, down from 47.2% in 2006. In remote and rural areas, however, non-commercial biomass is still the main energy source for households.

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Industry and Trade (MOIT) was formed after the merger of the Ministry of Industry and the Ministry of Trade. MOIT is in charge of activities related to the energy sector and other industries, in accordance with Decree 189/2007/ND-CP issued by the Prime Minister on 27 December 2007.

MOIT is responsible for the state management of all energy industries, including electricity, new renewable energy, coal, and the oil and gas industries. It is in charge of the formulation of law, policies, development strategies, master plans and annual plans for those sectors, and submits them to the Prime Minister for issuance 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 Energy Department administers the Viet Nam Electric Power Group (EVN), the Viet Nam National Coal and Mineral Industries Group (Vinacomin) and the Viet Nam Oil and Gas Group (PVN).

Many other ministries also have responsibilities relating to energy. The Ministry of Planning and Investment sets the Socio-economic Development Strategy and Plan, coordinates the distribution of economy-wide capital investment among projects submitted by ministries and agencies, and distributes foreign direct investment. The Ministry of Finance has jurisdiction over tariffs and taxation related to energy activities. The Ministry of National Resources and Environment plays an important role in research and development in energy and environmental protection.

The National Energy Development Strategy for the period up to 2020, with an outlook to 2050, was approved by the Prime Minister on 27 December 2008 (Decision No. 1855/ QD-TTg). The strategy set up the following targets for energy development:

- Ensuring sufficient supply of energy to meet the demands of socioeconomic development, in which primary energy is expected to reach 47.5–47.9 Mtoe in 2010, 100–110 Mtoe in 2020 and 310–320 Mtoe in 2050
- Developing power plants and power networks, ensuring a sufficient supply of electricity for socioeconomic development, and ensuring the 99.7% reliability of electricity supply in 2010
- 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 45 days in 2010, 60 days in 2020 and 90 days in 2025
- Achieving a share of renewable energy in the total commercial primary energy supply of 3% in 2010, 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 (by 2010, 95% of rural households will have access to electricity)
- 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 (by 2050, nuclear electricity will account for about 15%–20% of total commercial energy consumption).

MARKET REFORM

POWER SECTOR

Prime Ministerial Decision 26/2006/QD-TTg (approved in January 2006) concerns the development of a competitive electricity market that attracts investment from foreign and domestic companies operating in the electricity sector. Under this legislation, Viet Nam's power market will be established and developed through three levels, each of which will be implemented in two steps:

- Level 1 (2005–2014): a competitive generation power market will replace the current monopoly and subsidised power
- Level 2 (2015–2022): the establishment of a competitive wholesale power market
- Level 3 (after 2022): the realisation of a competitive electricity retail market.

The other main aims of the legislation are to reinforce the effects of production and business activities within the electricity sector, to decrease upward pressure on electricity prices, to ensure the stable supply of reliable electricity and an increase in quality over time, and to ensure the robust development of the electricity sector.

As part of the reform of the electricity sector, EVN has been proceeding with plans to corporatise member enterprises since the early 2000s. So far, the restructuring and equitisation of the generating companies has been completed. However, under this process, big hydropower plants (including Hoa Binh, Tri An and Yaly) and nuclear power plants will remain under the management of EVN. According to the 2006–2010 development plan, EVN plans to equitise or restructure all provincial power companies and a number of key distribution companies, including by merging four existing power transmission companies.

Power Markets Road Map. The Road Map for Electricity Market Establishment and Development in Viet Nam, approved by the Prime Minister, envisages the corporate restructuring of EVN to establish the necessary conditions for initiating the first stage of the power market. The first phase establishes an internal pilot market for EVN-owned power plants and the power plants in which EVN holds a dominant share. The existing independent power producers (IPPs) and the three strategic multi-purpose power plants will not take part in the internal market. The IPPs will be dispatched according to the power purchasing agreement between EVN and the IPPs. During the first phase, the market rules and the regulatory, technical and commercial institutions and capacity required for operating the second phase of the proposed power market (that is, a single buyer based competitive generation market with the participation of non-EVN power plants) will be developed and pilot tested.

Pilot Competitive Generation Market. During the first and second phases of the proposed power market, the competition would only be among the sellers (that is, the power plants), with a sole buyer who would sell electricity to distribution companies and large consumers at regulated prices. The EVN internal power market started in 2007, and the competitive generation market started in 2009.

The *Master Plan for National Power Development of 2006–2015 with prospects to 2025* (MP-VI) was approved by the Prime Minister of Viet Nam in Decision No. 110/2007/QD-TTg of 18 July 2007. The plan contains a list of power plants to be put into commercial operation during the 2006–15 period:

- Son My thermal power plant (TPP) (2400 MW) in Binh Thuan province
- Nghi Son II TPP (1200 MW) in Thanh Hoa province
- Mon II combined cycle power plant (1200 MW)
- Kien Giang (1–3) TPP (4400 MW)
- Southern GTCC (1–3) (2250 MW)
- Soc Trang I coal TPP (1200 MW)
- O Mon II GTCC (750 MW).

COAL SECTOR

In August 2005, 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. 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 issued Decision No. 89/2008/QD-TTg, approving the Viet Nam Coal Development Strategy to 2015, with an outlook to 2025. One of the main aims is to speed up the corporatisation of coal production companies and the creation of a coal market with diversified ownership and business activities.

OIL AND GAS SECTORS

The Prime Minister approved a scheme to form the Viet Nam Oil and Gas Group (PVN) in August 2006 by reorganising the core business and its subsidiary units. PVN has multiple owners, but the government holds the dominant share. The aim is to bring in more modern technology and management personnel; do business in multiple branches (exploration, exploitation, production, processing and distribution of oil and gas); closely combine production and business activities with science, technology, research and training; act as a core for the Viet Nam oil and gas industry to develop sustainably, compete effectively and integrate into the international economy; and ensure energy security for the development of the economy.

The restructured PVN will comprise 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 organisations.

ENERGY SECURITY

Viet Nam is diversifying its consumption of energy by developing regional indigenous resources and expanding regional cooperation. Viet Nam hopes to minimise 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 long-term policy to assure the supply of energy.

The economy needs to overcome many challenges to assure 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 rapid demand growth. 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 increasing demand. Although the potential for oil and gas discoveries is high, the size of those reserves is relatively small. In addition, relatively large oil fields 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 company 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.

ELECTRICITY AND GAS MARKETS

Electricity of Viet Nam (EVN) is a state-owned utility founded in 1995 and now called Vietnam 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 to meet 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 2007, 25% (16 772 GWh) of the power supply system in Viet Nam was owned by companies other than EVN.

In accordance with the Strategy for Electricity Sector Development approved by the government in October 2004, Viet Nam is implementing a policy to gradually establish a competitive power pool, to diversify investment and trading methods, and to stimulate the participation of several economic sectors. The state maintains a monopoly of transmission and the operation of large-scale hydropower and nuclear power plants.

The Electricity Law, approved by the Viet Nam National Assembly, came into effect in July 2005. The law outlines the major principles for the establishment of the power market in Viet Nam. Decision No. 258/2005/QD-TTg, signed by the Prime Minister in October 2005, clearly stipulates the functions, duties and organisation of the Electricity Regulatory Authority of Viet Nam (ERAV). ERAV's main function 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 the area of exploration and production, PVN had signed 54 oil and gas contracts with its foreign counterparts by October 2006. Foreign companies active in the market mostly operate through production sharing contracts or joint operating contracts with PVN. The international players are companies such as JNOC, KNOC, Shell, Total, BP, Mobil, ConocoPhillips and Unocal (now Chevron).

ENERGY EFFICIENCY

In April 2006, the Prime Minister of Viet Nam signed Decision No. 79/2006/QD-TTg, approving the Viet Nam National Energy Efficiency Program (VNEEP) for the 2006–15 period (PMVN 2006). 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 popularise highly energy-efficient equipment by phasing out low-efficiency

equipment; promote EE&C in industry; promote EE&C in building; and promote EE&C in transportation.

MOIT is the focal coordinator on EE&C and is authorised to administer the implementation of the 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 (Ministerial Decision No. 919/QD-BCN). The main work of the office is to develop organisations and systems for improving energy efficiency and conservation on the government level, from the central government to local governments.

A National Steering Committee chaired by MOIT was established to monitor the VNEEP. The committee includes representatives from the Union of Vietnam Associations of Science and Technology and the ministries of Construction; Transport; Education and Training; Culture and Information (renamed as Culture, Sports and Tourism in August 2007); Science and Technology; Planning and Investment; Justice; and Finance.

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 capacity of less than 30 MW per site) is estimated to be about 4000 MW; total capacity of geothermal is estimated at 300–400 MW; and, power from biomass is about 800 MW. Wind, solar and biogas are relatively abundant, with a potential capacity of over 2000 MW (Institute of Energy 2009).

Key organisations studying or developing renewable energy are MOIT, EVN and the Institute of Energy. MOIT is responsible for establishing and monitoring the implementation of energy policies such as the National Energy Strategy and Power Development Master Plan; EVN, the Institute of Energy and some other organisations are responsible for studies and the implementation of such policies. The institute, in particular, takes positive action for renewable energy, such as establishing the Center for Renewable Energy and Clean Development Mechanisms in 2007 and conducting the Master Plan on Renewable Energy in Viet Nam (assigned by MOIT).

In Viet Nam, renewable energy plays an important role in rural development. About 73% of the economy's 85 million people live in rural areas, but about 6% of households in those regions have no access to electricity. The government has provided significant support and legislated a number of policies to promote rural electrification and renewable energy development, such as the Viet Nam Power Sector Development Strategy issued in October 2004 (Decision: No. 176/2004/QD-TTg); and the National Energy Strategy Development issued in 27 December 2007 (Decision No. 1855/ QD-TTg), which address 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 by researching and developing new forms of new renewable energy so as to meet the need for power, especially in the islands and remote areas.
- Development objectives include developing new and renewable energy, increasing its proportion from its currently inconsistent level to around 3% of total primary commercial energy, or 1.4 Mtoe by 2010, 9.02 Mtoe (8%) by 2025 and 35 Mtoe (11%) by 2050; and providing 90% of rural households with access to electricity by 2010 and 100% by 2020.
- Development strategies include engaging in R&D for the new and renewable power sector, and gradually increasing the proportion of new and renewable power; investing only in power plants with capacity of 100 MW or greater, in order to create favourable conditions for other enterprises to invest in power plants with smaller capacity; giving priority to hydropower development, especially to multi-purpose projects (water supply, flood control, drought control etc.), and encouraging several

forms of investment in small hydropower plants in order to develop this clean, renewable energy resource (13 000 MW to 15 000 MW of hydropower is expected to be developed by 2020); promoting rural electrification to contribute to industrialisation and the modernisation of agriculture and rural areas by developing management mechanisms to maintain and develop power resources in those areas, and enhancing control of electricity tariffs to ensure the application of the ceiling tariffs stipulated by the government; and encouraging diversification in investment and management of rural power networks on the basis of controlling selling prices in rural areas, in order to ensure that the ceiling tariffs set by the government are not exceeded.

In general, despite the high potential of renewable energy resources, their contribution in electricity production in Viet Nam is still negligible (about 1.5%–2.0% of total electricity produced in 2007). 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 5% or higher by 2025.

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, were established in April 2003.

In August 2004, the Prime Minister of Viet Nam signed Decision No. 153/2004/QD-TTg, issuing Viet Nam Agenda 21 to develop the economy in a sustainable manner on the basis of close, reasonable and harmonious coordination of economic and social development and environmental protection (PMVN 2004). According to the document, the energy industry is one of the key industries of the economy and also has the biggest impact on the environment through coal mining, oil and gas exploitation on the seabed and the release of waste from energy production and consumption.

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; 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.

INTERNATIONAL COOPERATION

In the oil and gas sector, the governments of Viet Nam and Malaysia have authorised PetroVietnam and PETRONAS to sign the Commercial Arrangement Agreement for Joint Development of Petroleum in resource areas overlapping the two economies. At the ASEAN Energy Ministerial Meeting in Bali, Indonesia, in 2001, Viet Nam joined the ASEAN economies in signing a memorandum of understanding to build the Trans-ASEAN Gas Pipeline project.

During the first ASEAN, China, Japan and Korea Energy Ministers Meeting (AMEM+3) in June 2004, held in Manila, Japan's Ministry of Economy, Trade and Industry offered to provide technical assistance to conduct feasibility studies on the possibility of oil stockpiling. The first

step of the master plan—the development of oil stockpiling—was completed in 2006; the next step, utilising funds from Japan International Cooperation Agency, was completed in 2008.

In the power sector, the governments of Viet Nam and Laos People's Democratic Republic have signed an agreement on energy cooperation. Under this accord, Viet Nam will import about 2000 MW of electricity from Laos. The governments of Viet Nam and Cambodia have also signed an agreement on energy cooperation, through which Viet Nam supplied 80–200 MW of electricity to Cambodia via a 220 kilovolts (kV) transmission line in 2008 and 2009. In the future, when Cambodia builds hydropower plants and starts participating in the regional electricity market, Viet Nam will buy electricity from Cambodia. Viet Nam joined the Inter-Governmental Agreement on Regional Power Trade in the Greater Mekong Sub-Region, which was signed by all six regional economies in November 2002.

At present, Viet Nam supplies electricity to Laos and Cambodia by medium voltage lines at some places in bordering provinces and buys electricity from China through 110 kV and 220 kV lines. In 2007, Viet Nam imported nearly 1800 GWh from China. Viet Nam will buy more electricity from China over the next few years, as power shortages are expected. In early 2005, to provide access to Chinese power, EVN built two 220 kV transmission lines—the Ha Khau (China) to Viet Tri (Viet Nam) line and the Van Son (China) to Soc Son (Viet Nam) line. The lines were completed step by step by 2009. With a total transmission capacity of more than 500 MW, the lines met a part of the rising demand for electricity in the 2007–09 period.

In the coal sector, Viet Nam and Japan have been cooperating to explore deep underground coal deposits in southern Quang Ninh Province and to investigate reserves in the Red River delta.

NOTABLE ENERGY DEVELOPMENTS

POWER SECTOR

Viet Nam's thermal power plants use gas, mainly using combined cycle technology. The power plants using natural gas are concentrated in the Eastern and Western zones of the Southern Region of Viet Nam. Total capacity of natural gas power plants will increase from 4.4 GW in 2005 to 6.5 GW in 2010, consuming about 5.5–6.2 bcm of natural gas. In 2020, total capacity is expected to be 11 GW, consuming about 12 bcm of natural gas.

According the Master Plan for the Development of the Power Sector of Viet Nam for the 2006–25 period (approved by the Prime Minister on 18 July 2007), the electricity sector needs a total investment of around USD 108.7 billion through 2025; around USD 72.4 billion of that amount will be invested in power generation and the rest in the electricity transmission and distribution network. The capital is sourced from EVN and other domestic state-owned companies, foreign direct investment, the budget and loans.

NUCLEAR POWER

In January 2006, the Prime Minister of Viet Nam signed Decision No. 01/2006/QD-TTg, approving a strategy to apply nuclear energy for peaceful purposes by 2020. Viet Nam aims to build and develop a nuclear technology industry and to actively contribute to socioeconomic development and strengthening the economy's nuclear scientific and technological capacity. According to the strategy, investment for the construction of the economy's first nuclear power plant project will be approved by 2010. By 2020, Viet Nam will complete construction and commissioning of the plant. In the meantime, the economy has been preparing the necessary infrastructure for the development of a long-term nuclear power program.

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. Construction of both plants will begin in 2014–15, and the first unit should be in operation in 2020.

The development of nuclear power will have many benefits for the economy, such as the diversification of energy sources, energy security, the protection of the environment, and the development of national science and technology.

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 accomplish the target of increasing access to reserves. The corporation plans to discover about 30–35 Mtoe a year from 2006 to 2010, to pump about 20 Mt of crude oil and to bring ashore 11 bcm of natural gas (in 2007, production of crude oil was 16 Mt and production of gas was 6.8 bcm).

PVN strives to attract more foreign investment in exploration and seeks greater opportunities to invest in foreign economies and increase the construction speed of key projects, such as the Dung Quat oil refinery, the Ca Mau gas–electricity–fertiliser complex, and the gas pipeline linking Phu My District in Ba Ria – Vung Tau province with Ho Chi Minh City. The corporation will work out mechanisms, policies and solutions to solve difficulties in the construction of oil and gas projects in Viet Nam. It will also pay greater attention to training its staff, both professionally and ethically, to further the achievements and progress made by PVN in surpassing its revenue targets for the past five years, helping to ensure energy security and contributing significantly to the state budget.

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 on 27 July 2007, providing detailed provisions on investment procedures and 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 500-kilometre pipeline from gas fields in Blocks B and 52 to O Mon, Can Tho Province. The pipeline capacity is to be 5 bcm per year; and the project is expected to be operational in 2010. Natural gas production is projected to jump from 6.9 bcm in 2005 to 16.5 bcm in 2020. Depending on how soon future discoveries are developed and brought on-stream, imports will probably play a major role in meeting the projected increase in gas demand after 2020. For long-term security of gas supply, the connection between Viet Nam and the Trans-ASEAN Gas Pipeline is within the framework of cooperation. Gas could be imported via this gas network.

DOWNSTREAM

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 economic 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. After the Dung Quat Refinery in central Viet Nam, two more refineries (each with a capacity of about 8–10 Mt of crude oil) in northern and southern Viet Nam will be put into operation in the 2010–20 period. After 2020, refineries will be continuously developed to meet local demand

for oil products. If local supplies of crude oil fail to meet requirements, it will be necessary to import crude oil. Under the development strategy, refineries will supply about 35% of oil product demand in 2010, increasing to 60%–70% in the 2015–20 period.

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 fertiliser and other products from ammonia.

The economy's first gas-fuelled fertiliser plant began operations in Phu My Industrial Park in 2005. The Phu My Fertiliser Plant has a designed capacity of 2200 tonnes of urea and 1350 tonnes of ammonia per day. A second fertiliser plant, with capacity of 0.8 Mt per year, is being built in Ca Mau Province and will be completed in 2010.

In the south-west part of the economy, PetroVietnam is developing the Ca Mau gas–power–fertiliser complex, which comprises a 332-kilometre gas pipeline from the offshore PM 3 field to Ca Mau (capacity 2 bcm per year), a 720 MW power plant, and a fertiliser production plant (capacity 800 000 tonnes per year). Construction of the Ca Mau complex started in 2005. The gas pipeline, finished in 2007, created a 1.5 bcm gas market for Block PM 3 of the Bunga Kekwa field and Block 46 of the Cai Nuoc field.

COAL SECTOR

Vinacomin has discovered a major coal deposit in the Red River delta of northern Viet Nam, estimated to contain up to 100 billion tonnes. The coal bed covers an area of 25 square kilometres and is about 1 kilometre below the surface, stretching from Khoai Chau District of Hung Yen Province to Thai Binh Province's Dong Hung District. According to Vinacomin, about 28 billion tonnes of sub-bituminous coal could be viably mined from the bed and used for electricity generation.

Viet Nam produced about 39.8 Mt of commercial coal in 2007, and Vinacomin plans to exploit more than 45 Mt in 2010. However, domestic demand for coal is forecast to increase sharply to 40 Mt by 2010 and to over 70 Mt by 2020. Coal consumption is expected to increase substantially as the economy builds more coal-fired power plants to meet electricity demand.

Vinacomin began construction of three key projects in 2006: two thermal power plants at Son Dong and Cam Pha, and the Dac Nong aluminium plant. The Son Dong power plant (installed capacity 220 MW) is fired by low-quality coal from the Dong Ri mine. Vinacoal provides 65% of fuel for the USD 600 million, 600 MW Cam Pha thermal power plant in the northern province of Quang Ninh. Vinacomin has focused on thermal power plants to provide a market for lower-quality coal products, which are otherwise difficult to market. The Dac Nong aluminium processing plant, with an investment of USD 544 million and an annual capacity of 1 Mt, and the other power plants began operation in 2009.

ENERGY EFFICIENCY

The United Nations Development Programme (UNDP) and the Viet Nam Ministry of Science and Technology have been implementing a project to raise the effectiveness of energy use at small and medium enterprises (SMEs). The project is funded by the Global Environmental Fund through the UNDP. Over the five years from 2006 to 2010, USD 29 million will be spent 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 includes 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 will help save about 136 000 tonnes of fuel oil and reduce CO_2 emissions by 962 000 tonnes by 2009.

The Promotion on Energy Efficiency and Conservation project on energy efficiency, funded by Japan, began in 2000 and is continuing in 2010. This project is jointly implemented by the

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

EVN will spend VND 3.1 trillion (about USD 194.7 million) to build 37 small-scale hydro-electric power stations in the northern provinces bordering China.

Of those, 10 to 13 stations with a maximum capacity of 5 MW each are being built from 2007 to 2010 in the border districts of Lai Chau, Lao Cai, Ha Giang and Lang Son provinces.

Some recent wind-power developments include 15 kW solar PV – wind power hybrid systems in one of the smaller villages, with 40 households. The project was implemented by the Institute of Energy with a grant from Tohoku Electric Company of Japan. Another is a 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 150 MW, include the Ly Son Island project (2 MW), the Phuong Mai wind farm in Binh Dinh Province (15 MW), a wind power project in Phuong Mai (84 MW), a wind farm in Phu Yen Province (15 MW), a wind farm in Binh Thuan province (30 MW), and the Con Dao Island project (2.5 MW).

USEFUL LINKS

Electricity of Vietnam—www.evn.com.vn

Ministry of Industry—www.industry.gov.vn

PetroVietnam—www.PetroVietnam.com.vn

United Nations Development Programme in Vietnam—www.undp.org.vn

Vietnam Economic Times—www.vneconomy.com.vn

Vietnam News Agency—http://vietnamnews.vnagency.com.vn

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