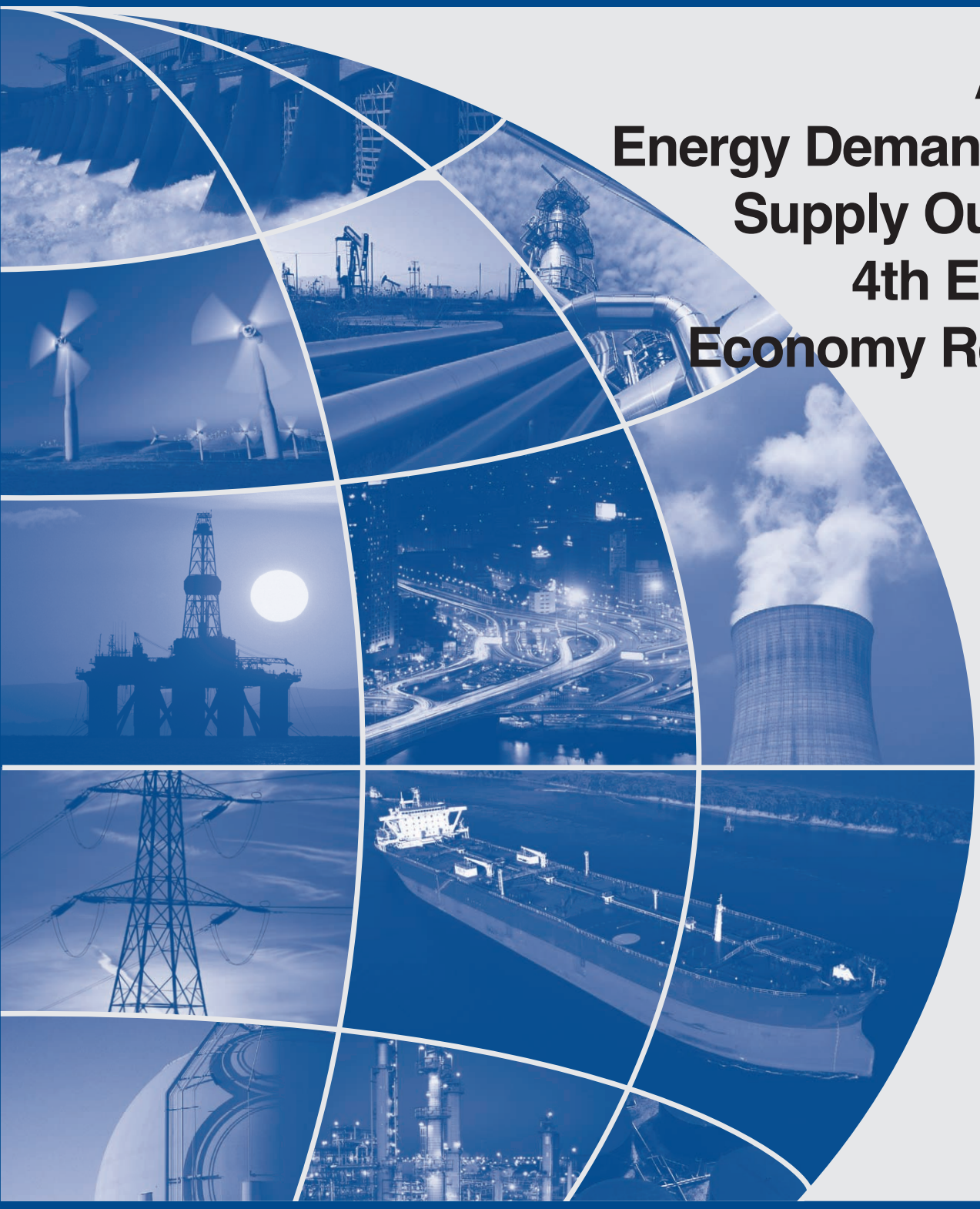

APEC Energy Demand and Supply Outlook 4th Edition Economy Review

APERC

Asia Pacific Energy Research Centre

APEC ENERGY DEMAND AND SUPPLY OUTLOOK

4TH EDITION

ECONOMY REVIEWS

ASIA PACIFIC ENERGY RESEARCH CENTRE

This report is posted on the website at
www.ieej.or.jp/aperc

2009

Published by

Asia Pacific Energy Research Centre
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November 2009

ACKNOWLEDGEMENTS

The development of the *APEC Energy Demand and Supply Outlook – 4th Edition* could not have been accomplished without the contributions of many individuals and organizations. We would like to thank all those whose efforts made this outlook possible, in particular those named below.

We wish to express our appreciation to the APERC Conference and Workshop participants who met with us and provided invaluable insights into the issues raised in the draft report.

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

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LIST OF ABBREVIATIONS

AUS	Australia
BD	Brunei Darussalam
CDA	Canada
CHL	Chile
CT	Chinese Taipei
HKC	Hong Kong, China
INA	Indonesia
JPN	Japan
MAS	Malaysia
MEX	Mexico
NZ	New Zealand
PE	Peru
PNG	Papua New Guinea
PRC	People's Republic of China
ROK	Republic of Korea
RP	the Republic of the Philippines
RUS	the Russian Federation
SIN	Singapore
THA	Thailand
US or USA	United States of America
VN	Viet Nam

ABARE	Australian Bureau of Agricultural and Resource Economics
APEC	Asia Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
ASEAN	Association of Southeast Asian Nations
bcm	billion cubic metres
CCGT	combined cycle gas turbine
CNG	compressed natural gas
CO_2	carbon dioxide
DOE	Department of Energy (USA)
DSM	demand-side management
EDMC	Energy Data and Modelling Center (Japan)
EIA	Energy Information Administration (USA)
EWG	Energy Working Group (APEC)
FEC	final energy consumption
FED	final energy demand
FDI	foreign direct investment
FPI	foreign portfolio investment
FSU	former Soviet Union
FT	Fischer-Tropsch technology
GDP	gross domestic product
GHG	greenhouse gases

g/kWh	grams per kilowatt-hour (used to measure the emissions caused by the generation of one unit of electricity)
GMS	Greater Mekong Subregion
GNP	gross national product
GTL	gas to liquids
GW	gigawatt
GWh	gigawatt-hour
GWP	gross world product
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producers
kgoe	kilogram of oil equivalent
ktoe	thousand tonnes of oil equivalent
LEAP	Long-term Energy Analysis Programme
LHV	lower heating value
LNG	liquefied natural gas
LPG	liquefied petroleum gas
mbd	million barrels per day
mcm	million cubic metres
MBTU	million British thermal units
MOU	memorandum of understanding
MSW	municipal solid waste
Mtoe	million tonnes of oil equivalent
MWp	megawatts peak
NAFTA	North American Free Trade Agreement
NGV	natural gas vehicle
NRE	new renewable energy
NYMEX	New York Mercantile Exchange
PPP	purchasing power parity
PV	photovoltaic
R&D	research and development
R/P	reserves-to-production ratio
SUVs	sports utility vehicles
tcf	trillion cubic feet
toe	tonnes of oil equivalent
TPED	total primary energy demand
TPES	total primary energy supply
TWh	terawatt hours
WTO	World Trade Organization

AUSTRALIA

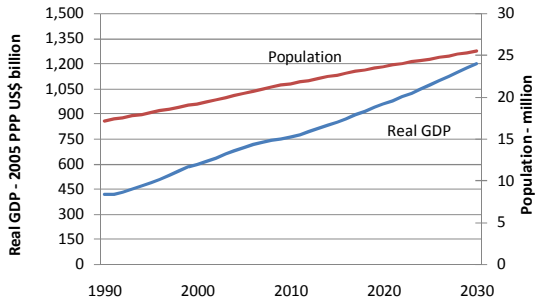
- *Australia will remain a major energy exporter in the APEC region, with coal and LNG exports reaching 254.9 Mtoe and 102.9 Mtoe respectively by 2030.*
- *Total primary energy demand is projected to grow at 1.6 percent a year, driven mainly by high demand for gas and oil from the expansion of energy-intensive industry, such as alumina refining, aluminium smelting and iron and steel making.*
- *The continued reliance on fossil fuels, especially coal in the electricity sector, means Australia's CO_2 emissions will increase; however, the projected emissions intensity of the total primary energy demand is trending downwards due to the government's clean energy initiatives.*

ECONOMY

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 made up of the mainland, the major island of Tasmania, and other small islands. Australia has no land boundaries with other economies; its ocean neighbours include Indonesia, East Timor, Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia, and New Zealand.

The Australian mainland is largely desert or semi-arid land. A temperate climate and moderately fertile soils are found in the south-east and south-west corners, while the far north is characterized by a tropical climate (warm all year) and a mix of rainforests, grasslands and desert.

Figure AUS1: GDP and population



Source: APERC analysis (2009)

In 2006, Australia's population was nearly 20.7 million people, mostly concentrated along the eastern and south-eastern coast, and some on the west coast. Across the total landmass the population density (three people per square kilometre) is one of the lowest in the world. Nearly 92 percent of the population live in urban areas; the average household is a family of no more than four.

Australia is rich in mineral resources and is a major world producer of bauxite, coal, gold, copper, nickel, zinc and iron ore – some concentrated in a particular region, others dispersed across its six states and two territories. The minerals sector is a substantial contributor to the Australian economy, with minerals production increasing over the past decade. Historically, mineral discoveries in Australia have been characterized by high-grade deposits and surface mineralization;[1] most of the surface mineralization has been discovered and future mining activities are expected to be more energy intensive.

Australia has developed a world-class minerals processing industry to complement its mining industry; the three major areas are alumina refining, aluminium smelting, and iron- and steel-making.

The economy is the largest alumina producer in the world: its seven refineries (with a total production nameplate capacity of 17.8 million tonnes) produce nearly 30 percent of the world's alumina. The Bayer refining process used is energy intensive – in 2006 the average energy input per tonne of Australian refined alumina was 12 GJ.[2] The industry is growing, although the current global economic crisis is expected to slow the start-up of planned expansions to four plants and construction of a new refinery (anticipated combined capacity increase of 8.8 million tonnes by 2013). The 2006 energy outlook report of the Australian Bureau of Agricultural and Resource Economics (ABARE) projected that further expansions and new projects would increase total production capacity to nearly 30 million tonnes by 2030.[3]

There are currently six aluminium smelters operating in Australia with a total production

1 Hogan (2003).
2 International Energy Agency (2008), p 41.
3 Cuevas-Cubria and Riwoe (2006), p 12.

nameplate capacity of 1.9 million tonnes. All are located close to or on the coastline, and over 80 percent of the product is exported. Since 1990, Australian aluminium smelters have been among the most energy efficient in the world, and continuous effort has been made to further improve that efficiency.[4] On average, Australian smelters consume about 14,800 kWh of electricity per tonne of aluminium produced.[5] Aluminium smelting is increasing in tandem with the alumina refining expansion but at a much slower pace; the total production capacity of aluminium smelters is expected to reach about 2.1 million tonnes by 2030.

Australian iron and steel production capacity was 7.9 million tonnes in 2006, with no expansion expected before 2030 in the current global economic climate. Other energy-intensive industries of note in the Australian economy include other non-ferrous metals processing, non-metallic mineral production, and chemical and associated production.

Australia has seven major crude oil refineries currently operating, with a total capacity of 745,500 barrels/day. Two of the refineries are on the eastern coast in the state of Queensland, two in New South Wales, two on the southern coast in Victoria, and one in Western Australia. Feedstock for the refineries primarily comes from oil produced in Australia's Bass Strait and from oil-producing countries throughout Southeast Asia. Australian refineries mostly produce gasoline and diesel fuel, plus some jet fuel, bitumen and liquid petroleum gas (LPG). The progressive introduction by the federal government of higher fuel quality standards since 2006 has forced most of the refineries to make costly facility upgrades. The industry is not expected to increase capacity in the next decade: a 2008 study of Australia's liquid fuels vulnerability assumed no new major additions before 2020.[6]

Agriculture in Australia is a highly commercialized, technology-based, export-orientated industry, with exports such as dairy products, grain and live cattle going mostly to Southeast Asia and the Middle East. Agriculture and the associated industries of food, beverages and tobacco, wood, and pulp and paper are important contributors to the economy.

Australia's harsh and wide-flung geography makes road transport a crucial element in the economy; Australia has three to four times more road per capita than Europe, and seven to nine times more than Asia. The rail network is slighter, although train networks are established within cities and between states. Air travel, domestic and international, has grown rapidly since the early 1990s, particularly with the emergence of budget airlines. Generally, while cars are the usual mode of travel between rural centres, and cars or train the mode between rural centres and state capitals, air transport is the most economic form of travel between state capitals. Most of Australia's automobile fleet, manufactured locally by the subsidiaries of foreign companies, is specifically designed for the Australian market (with larger engine capacities).

ENERGY RESOURCES

Australia has abundant coal reserves. In 2006, Australia's recoverable coal reserves stood around 78.5 billion tonnes, with an annual production level of about 374 million tonnes. Coal is the dominant primary energy source in Australia: in 2006, it accounted for 41 percent of primary energy consumption in the economy. Coal use is heavy in the electricity generation sector, where it accounts for nearly 76 percent of the generation mix.[7] Nearly 73 percent of coal produced in Australia is exported. The economy is the world's largest exporter of coal and the fourth largest producer behind China, the US and India. Over the past few years, the production and export of coal have grown steadily, at an average 5 percent annually.

Environmental issues, in particular climate change, are expected to have a strong influence on the future of Australian coal exports and domestic consumption. The industry is focused on the development and deployment of 'clean and green' coal conversion and storage technologies. In addition, the Australian government's efforts in promoting coal-to-liquids technology could play an important role in shaping future domestic coal consumption, especially in meeting the rising domestic demand for transport fuels.

Natural gas has become the fastest growing fossil fuel in terms of production and consumption in Australia. According to the *Oil and Gas Journal*, Australia had, as at the end of 2006, 860.8 billion cubic metres of proven natural gas reserves, an almost four-fold increase over the past two decades.[8] These are found in all states except New

4 International Energy Agency (2008), p 41.

5 Ibid.

6 ACIL Tasman (2008).

7 Cuevas-Cubria and Riwoe (2006).

8 Oil and Gas Journal (2006).

South Wales and Tasmania. The most abundant reserves are located offshore of the north-western coast in the Carnarvon Basin, also known as the North West Shelf. Other important basins include the Cooper-Eromanga Basin, in Central Australia, and the Bass and Gippsland Basins, located off the southern coast. In 2006, Australia's production of natural gas (including natural gas from coal seam methane projects) was about 45.8 billion cubic metres. About 65 percent of this production was consumed domestically, while the rest was exported in liquid form (LNG), almost entirely to Japan. Environmental concerns about energy use have provided a boost to natural gas use in Australia. Federal and state policy initiatives have encouraged the use of cleaner energy resources, including natural gas, which has a lower CO_2 emissions factor than coal or oil. Combined with its security of supply, natural gas will be the preferred choice for many Australian energy consumers. The electricity generation, manufacturing and mining sectors are all expected to significantly increase the share of natural gas in their energy mix in the medium and long term.

Australia also has significant reserves of coal seam gas (CSG). As at the end of 2006, the potential of CSG was estimated around 142.9 billion cubic metres and annual production was around 2.4 billion cubic metres[9]. CSG is only produced in Queensland and New South Wales where it accounts for around 90 percent and 100 percent of each state's total gas production, respectively. Production of CSG is expected to continue to grow with five CSG fired LNG projects planned in Queensland as well as significant CSG exploration in New South Wales.[10]

At the end of 2006, Australia's crude oil reserves stood at 1.59 billion barrels. Most of Australia's oil reserves are located in the Carnarvon Basin, the Gippsland Basin, the Bonaparte Basin, the Cooper-Eromanga Basin, and the Bass Basin. The 2006 figure for Australia's oil production was about 560,000 barrels per day, with consumption at about 925,000 barrels per day. 2006 oil imports were nearly 360,000 barrels per day (39 percent of the economy's oil needs). Australia's oil production has been declining since 2003 – this is due to natural depletion (especially in the Cooper-Eromanga Basin and the Gippsland Basin), lack of new exploration fields coming online, and higher exploration costs for unexplored resources located offshore (in deep water). Around 64 percent of Australia's consumption of crude oil and other refinery feedstocks were met by imports. There is some export of crude oil, particularly heavy crude from wells in the north-west.

Petroleum products are the main energy source for the transport and mining sectors in Australia. In 2006, they accounted for 35.5 percent of primary energy consumption in the economy – other major consumers are the industrial and agriculture sectors. In 2006, Australia was almost entirely self-sufficient in gasoline and jet kerosene (97 percent) while diesel self-sufficiency was 65 percent. Since 2000, demand for diesel and jet kerosene has risen steeply, while the growth in demand for gasoline has been moderate. Diesel demand was driven largely by a sharp increase in the number of vehicles using the fuel: between 2003 and 2007, registered diesel-powered motor vehicles increased by 35.5 percent, while gasoline-powered motor vehicles increased about 9.8 percent over the same period.[11] At the same time, the booming mining industry has also contributed significantly to the demand for diesel, used in mining machinery and off-road trucks. The advent of budget airlines in the domestic aviation sector has driven the high growth in demand for jet kerosene. Currently, three domestic budget airlines are operating in Australia, while more players were expected to being operating soon after the time of writing. Australia's automobile industry reports the main reason for the only moderate increase in gasoline demand is the shift in the Australian market from large, high-engine capacity vehicles to smaller, more fuel-efficient vehicles.[12]

Australia has enormous potential renewable energy resources, especially wind, solar, geothermal and hydro. However, these potential energy sources are currently under-utilized, mainly for economic reasons. In 2006, about 2.4 percent (around 4,821 GWh) of electricity generated in the economy came from renewable sources, excluding hydroelectricity. Australia has also made significant effort to develop a second-generation biofuel industry.

ENERGY POLICIES

Australia enjoys a high level of energy security characterized by low-priced, reliable energy supplies and a significant natural endowment of energy resources, including coal, natural gas, crude oil and a considerable potential for renewable

9 Cuevas-Cubria and Riwoe (2006).

10 ABARE (2009).

11 Australian Bureau of Statistics (2007).

12 Review of Australia's Automotive Industry (2008).

energy. Underpinning Australia's natural resources are extensive infrastructure and well functioning domestic and international energy markets.

Notwithstanding the current secure position, in 2009 the Australian Government released the *National Energy Security Assessment* (NESA) to assess the challenges that may affect current and future energy security. The NESA determined that Australia's energy security has declined compared with the assessment conducted as part of the 2004 Energy White Paper (EWP) process because of the need to address new challenges – mainly reducing carbon emissions [13]. The challenges that governments need to address to maintain or improve Australia's energy security identified in the NESA included 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 Ministerial Council on Energy (MCE) has responsibility for ensuring that Australian energy markets are operating efficiently, including in the transition to a lower carbon economy. To ensure this, the MCE has tasked the Australian Energy Market Commission (AEMC) to assess energy market frameworks, in light of climate change polices, with a final report released in September 2009 [14]. The recommendations in the AEMC's report will form a significant input to MCE's forward energy market reform agenda.

A key component of ongoing energy market reforms was the 1 July 2009 establishment of the Australian Energy Market Operator (AEMO) as a national operator for Australia's electricity and gas markets. AEMO now oversees Australian energy market governance in cooperation with the AEMC, as the rule making body, and the Australian Energy Regulator (AER), as the regulating body.

The Australian Government has a number of policies and programmes in place to capitalize on the economic and emissions reduction potential of improved energy efficiency within the industrial, transport and residential sectors. There are also a suite of policies and initiatives that have been introduced in 2009 to increase the role of renewable energy including the expansion of the Renewable Energy Target (late August 2009) which requires 20 percent (or around 45,000 GWh) of electricity generation to be sourced from renewable energy by 2020; and other measures to promote low carbon energy research, development, demonstration and deployment, such as the Global Carbon Capture and Storage Institute. However, because of the late passage of the Renewable Energy Target legislation, its impacts are not reflected in the projections in this Outlook.

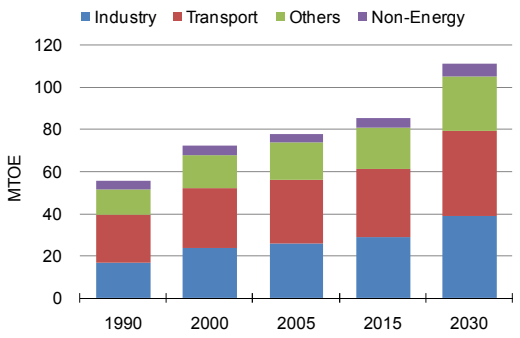
The Australian government is preparing a new EWP, which will focus on the provision of clean, adequate, reliable and affordable energy supplies by 2030. It will examine energy exploration, gas development, low-emission energy technologies, transport fuels, an integrated Australia-wide energy market, and capacity building and skills. Australia is also considering a scheme to curb carbon emissions, in line with its ratification of the Kyoto Protocol. The scheme, which would impose a price on carbon, is expected to make gas and renewable energy resources more competitive against coal. If passage of the legislation is successful, emissions trading will begin in Australia in mid-2011.

OUTLOOK

FINAL ENERGY DEMAND

Australia's total final energy demand over the 2005–2030 period is expected to rise at an average annual rate of 1.4 percent. This is based on a 'business as usual' scenario, which assumes GDP growth over the same period of nearly 2.2 percent. The main drivers of energy consumption in the economy are the transport and industry sectors. In 2030, the transport sector's total final energy demand is projected to reach 40.1 Mtoe, nearly 33 percent higher than in 2005. At the same time, the industrial sector's demand will rise to 38.9 Mtoe, about 51 percent more than in 2005.

Figure AUS2: Final energy demand



Source: APERC analysis (2009)

[13] Department of Resources, Energy and Tourism (2009).

[14] Australian Energy Market Commission (2009).

Industry

The industrial sector's final energy demand is projected to grow at an average annual rate of 1.7 percent over the outlook period. The energy-intensive industries (metals processing, mining, non-metallic mineral and chemical) will continue to drive energy demand. Natural gas and electricity, the major energy sources in the alumina refining and aluminium smelting processes, are projected to remain the largest industrial energy sources throughout the outlook period, growing at average annual rates of 2.1 percent and 1.4 percent respectively. Their combined consumption will account for about 65 percent of industrial energy use in 2030.

An interesting aspect is the increase in oil's share in this sector. From 2000 to 2005, oil's share in the industrial final energy demand was declining at an average annual rate of 0.8 percent. However, this trend is reversing and oil use is now projected to grow annually by 2.4 percent from 2005 to 2030. The growth in oil use is attributed to expected energy intensification in the mining industry – a sector that holds significant potential for Australia's economic growth. Coal's share in the industrial final energy demand is modest; coal use for industry is projected to grow at an average annual rate of 0.3 percent over the outlook period. The share of renewable energy is projected to remain at 10 percent over the forecast period. Biomass, largely used in co-generation in food, wood, paper and pulp processing, accounts for most of industry's renewable consumption.

Transport

The transport sector retains a high dependence on oil as the source of energy. Oil demand for transport is expected to increase at an average annual rate of 0.8 percent over the outlook period, to reach 35.6 Mtoe – this is based on growth in road and air transport. However, oil's dominant share of the transport final energy demand will reduce from 98 percent in 2005 to 89 percent in 2030. Ethanol and bio-diesel are expected to substitute for some of the fossil fuel use – together they are expected to contribute about 9 percent of the total transport final energy demand by 2030.

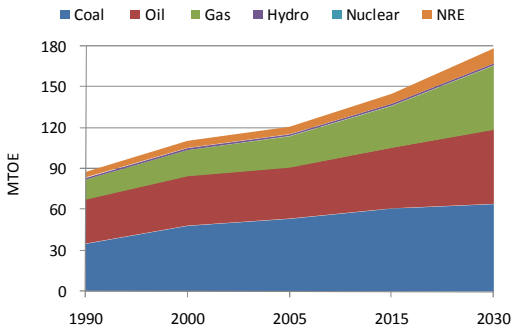
Other

The commercial, residential, and agriculture sectors will account for about 26.1 Mtoe (23.4 percent) of the final energy demand by 2030. Across all the 'other' sectors, consumption of electricity is projected to grow the fastest, at an average annual rate of 1.8 percent, followed by natural gas at 1.4 percent and oil at 0.9 percent.

PRIMARY ENERGY SUPPLY

Over the outlook period, Australia's primary energy supply is projected to grow at an average annual rate of about 1.6 percent. This reflects a declining pattern compared to growth in the previous 15 years: in the 1990s, the primary energy supply was growing at an average annual rate of 2.3 percent and this growth trend was maintained until the early 2000s. The reduction in primary energy supply over the longer term is attributed mainly to the continuous improvement of energy conversion technologies, government policies favouring clean and green energies, and high energy prices. In terms of the total primary energy supply required to create every dollar of GDP (the aggregate intensity), this is expected to decline by around 0.6 percent a year from 2005 to 2030. Fossil fuels still maintain their dominance in the primary energy mix; overall they account for nearly 93 percent of total primary energy supply in 2030, with coal at 36 percent, oil 31 percent and natural gas 26 percent. Fossil fuel's overall share is reduced slightly, as the renewable resources contribution increases.

Figure AUS3: Primary energy supply



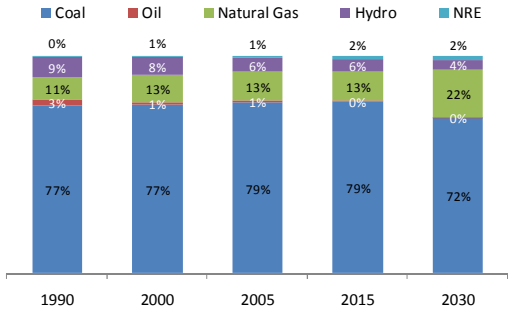
Source: APERC analysis (2009)

ELECTRICITY

Electricity generation is projected to increase from 245 TWh in 2005 to 367 TWh in 2030, growing at an average annual rate of 1.6 percent. The generation mix will continue to be dominated by coal, although this is declining from 79 percent in 2005 to 72 percent in 2030. Natural gas is its replacement, growing from 13 percent in 2005 to 22 percent in 2030. This shift is largely due to clean energy government policies. The share of renewable energy used for electricity generation is expected to increase from 1 percent in 2005 to 2 percent in 2030. This projection is based on

existing policies and does not include initiatives that were not enacted at the time of writing.

Figure AUS4: Electricity generation mix

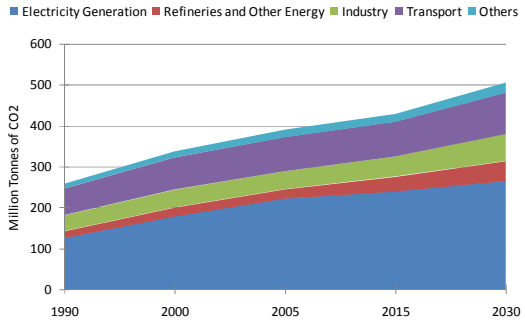


Source: APERC analysis (2009)

CO_2 EMISSIONS

Over the outlook period Australia's total annual CO_2 emissions from fuel combustion are projected to reach 506 million tonnes of CO_2 by 2030, which is 29 percent higher than the 2005 level. Electricity generation is expected to account for the largest share, producing 53 percent of the total annual CO_2 emissions (266 million tonnes of CO_2), followed by the transport sector at 20 percent (102 million tonnes of CO_2). At the same time, the CO_2 intensity of the total primary energy supply is projected to decline at an average annual rate of 0.5 percent (see table below). This trend is attributed to the Australian government's clean energy policies influencing fuel switching.

Figure AUS5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table AUS1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.6%	-0.9%	-0.3%	-0.5%
Change in Energy Intensity of GDP	-1.3%	-0.2%	-0.9%	-0.6%
Change in GDP	3.5%	2.0%	2.3%	2.2%
Total Change	2.8%	1.0%	1.1%	1.0%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Australia is well endowed with energy resources, especially coal and natural gas, and this provides considerable energy security to the economy. Nevertheless, in recent years Australia's oil self-sufficiency has been in decline, with a growing dependence on imported sources of oil and petroleum products. Given oil's status as the dominant source of energy for the economy over the outlook period, especially for transportation, issues of oil security become more pertinent. Improvements in energy efficiency in the transport sector could lower the economy's oil demand; however, minerals mining is expected to consume more energy in the future and this is expected to drive the overall oil demand higher.

The energy resources sector will continue to be a significant contributor to the Australian economy, with coal and natural gas remaining as the economy's most valuable exports. With the deployment of carbon capture and storage technologies, Australia's coal exports could be expected to expand further by 2030. The potential for growth in natural gas exports is well supported by the economy's extensive gas reserves, and expected strong long-term growth in the market for liquefied natural gas in the Asia Pacific region.

Environmental sustainability is becoming a major concern for the economy. In late 2007, the Australian Government ratified the Kyoto Protocol as an Annex 1 member and has committed itself to greenhouse gas emissions reduction. Australia's energy sector has high CO_2 intensity because of its dependence on coal in electricity generation. Government policy is directed towards increasing the use of energy resources with lower levels of CO_2 emission. The anticipated energy policy review (due late 2009/early 2010) is expected to provide a sound reconciliation to the challenges surrounding its energy sector while also strengthening its position as one of the main energy exporters in the Asia Pacific region.

REFERENCES

ABARE (2009) *Energy in Australia 2009*. Prepared for the Australian Government Department of Resources, Energy and Tourism. Canberra, Australia. http://www.abareconomics.com/publications_html/energy/energy_09/auEnergy09.pdf

ACIL Tasman (2008) *An Assessment of Australia's Liquid Fuel Vulnerability*. Melbourne, Australia. http://www.ret.gov.au/energy/Documents/Energy%20Security/Liquid%20Fuel%20Vulnerability%20Assessment.pdf

Australian Bureau of Statistics (2006) *Population Projections, Australia: 2004 to 2101*, cat. no. 3222.0, Canberra, Australia. http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3222.0Main+Features12004%20to%202101?OpenDocument

Australian Bureau of Statistics (2007) *Motor Vehicle Census – 31 March 2007: Cat no. 9309.0*. Canberra, Australia. http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/29DAD6FC17370C50CA257394000ECB08/$File/93090_31%20mar%202007.pdf

Australian Energy Market Commission (2009) *Review of Energy Market Frameworks in light of Climate Change Policies: Final Report,* September 2009, Sydney, Australia. http://www.aemc.gov.au/Media/docs/Review%20Final%20Report-9f02959f-0446-48ba-89a1-5882d58e11fd-0.PDF

Australian Government (2004) *Securing Australia's Energy Future* (Energy White Paper), Canberra, Australia.

Cuevas-Cubria, C and Riwoe, D (2006) *Australian Energy: National and State Projections to 2029–30*, ABARE Research Report 06.26. Prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra, Australia. http://www.abare.gov.au/publications_html/energy/energy_06/nrg_projections06.pdf

Department of Resources, Energy and Tourism (2009) *National Energy Security Assessment*. Canberra, Australia.

Hogan, L (2003) *Public Geological Surveys in Australia*, ABARE eReport 03.15. Prepared for the Australian Government Department of Industry, Tourism and Resources, Canberra, Australia. http://www.abare.gov.au/publications_html/energy/energy_03/er03_geologicalsurveys.pdf

International Energy Agency (2008) *Worldwide Trends in Energy Use and Efficiency: Key Insights from IEA Indicator Analysis*. Paris, France. http://www.iea.org/Textbase/Papers/2008/indicators_2008.pdf

Oil and Gas Journal (2006) "Worldwide refinery survey 2006" 18 Dec 2006. PennWell Editors, Houston, USA.

Review of Australia's Automotive Industry (2008) *Review of Australia's Automotive Industry 2008: Final Report* prepared for the Australian Government. Department of Innovation, Industry, Science and Research, Canberra, Australia.

BRUNEI DARUSSALAM

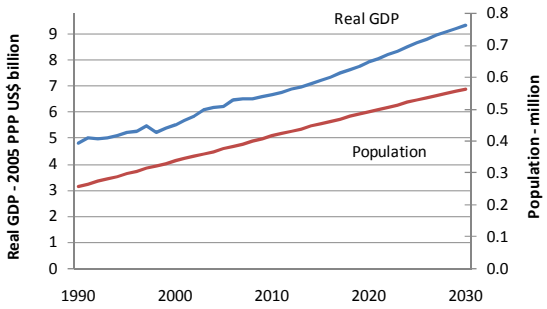
- *Brunei Darussalam's primary energy supply is projected to increase from 2.6 Mtoe in 2005 to 6.8 Mtoe in 2030.*
- *The planned start-up of the methanol plant at SPARK and the export-oriented oil refinery at Pulau Muara Besar in the first half of the forecast period will contribute to a significant increase in energy use.*
- *Development of energy-intensive industry is expected to significantly increase Brunei Darussalam's overall CO_2 emissions.*
- *Natural gas exports are expected to decline, unless large new reserves are found.*

ECONOMY

Brunei Darussalam is located on the northern coast of the island of Borneo. It borders the Malaysian state of Sarawak and the South China Sea.

The economy had a population of 381,371 in 2008, of which about 75,000 were foreign workers. The population grew by 1.8 percent in 2008; while average annual population growth was 2.1 percent from 2000 to 2007. This projection assumes average annual population growth at 0.9 percent over the forecast period from 2005 to 2030.

Figure BD1: GDP and population



Source: APERC analysis (2009)

In 2006, Brunei Darussalam achieved a nominal GDP of US$12.085 billion and a GDP per capita of US$31,850. Crude oil and natural gas production accounted for 54 percent of that GDP and 96.3 percent of exports.

There are also several other major economic activities. Manufacture of woven apparel and textiles, an industry developed primarily for export, has been in decline since 2003. In 2006, this industry's output was about half of what it was in 2002. On the other hand, the finance sector is growing in importance. The government has supported expansion of this sector since 2002 in an effort to develop Brunei Darussalam as an international offshore financial centre, and as a centre for Islamic banking. The construction sector has rebounded since the 1997 Asian economic crisis.

Agriculture, livestock, poultry, and fisheries, although relatively small in production and in overall contribution to GDP, are considered important to the economy, and are high priority sectors for expansion and modernization. Currently, however, most of Brunei Darussalam's food needs are imported, including staples such as rice, beef, fruit and milk. Brunei Darussalam produces less than 1,000 tonnes of rice a year, while rice imports were 31,240 tonnes in 2007.

Brunei Darussalam's existing oil refinery has an intake capacity of 10,000 barrels per day; refinery output has increased by 15 percent over the past 10 years. All output is consumed domestically. The main product is motor gasoline, followed by diesel oil and dual-purpose kerosene.

Brunei Darussalam is highly urbanized: the urban population makes up 78 percent of the total 2006 population. Almost all households are connected to grid electricity supply. In 2005, the economy had a road and motorway system of 3,650 kilometres. The government plans to extend the motorway system to meet anticipated growth in demand for road transport. Public transport, which consists of buses and taxis, is limited due to low demand. The bus fleet totalled 1,835 large buses in 2005. Passenger cars are the dominant mode of transport, with passenger car ownership per capita comparable to Korea.

The government of Brunei Darussalam seeks to maximize the economy's oil and gas resource potential, and to take advantage of its strategic location for trading. Plans underway include development of export-oriented industries including oil refining, petrochemicals, aluminium smelting, and associated downstream industries. The petrochemical industry would consist of a methanol plant and an ammonia and urea plant. These plants are to be located primarily at the Sungai Liang Industrial Park, named SPARK, a

world-class industrial complex in the Belait district; oil refining will be based on the island of Pulau Muara Besar (PMB) in the Brunei-Muara district.

The methanol plant, owned by the Brunei Methanol Co (BMC), 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 will be the primary feedstock for the plant.

TRC Synergy Bhd, through its associated company PetroBru (B) Sdn Bhd, received approval in late 2008 for its proposed export-oriented refinery project on Pulau Muara Besar. Construction of the refinery is expected to begin in the first half of 2010. Initial refinery capacity will be 200,000 barrels per day (bpd), with possible later expansion to 500,000 bpd. The refinery expects to refine imported crude from the Middle East.

Planned public sector development in the economy is outlined in the 9th National Development Plan (NDP) for 2007–2012.[15] This plan allocates BN$9.5 billion (around $US6.6 billion) for 826 programmes and projects to further strengthen the economy's human resources base, social services, infrastructure, and to support development of competitive industries. Priority industries are finance, hospitality, agriculture, halal products (which include food, pharmaceuticals and cosmetics), and software development.

Energy demand in Brunei Darussalam is primarily for petroleum products, including LPG, and electricity. Transport is the most important sector in terms of energy demand in Brunei Darussalam; it consumed 54 percent of the total final energy demand in 2006. Petroleum products are heavily subsidized.

The energy demand in all sectors of the economy was profoundly affected by the 1997 Asian economic crisis. The rapid growth of energy demand seen since 1971 ended abruptly that year. Since 1997, demand for fuels and electricity has moderated. However, this masks a considerable variation in demand growth for different fuels. For example, diesel fuel in transport regained pre-crisis growth rates by 2002, while growth in demand for aviation kerosene has remained flat.

ENERGY RESOURCES

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). Most of the existing oil and gas production is located at scattered sites about 70 km offshore. New discoveries are, however, being found further out, in water approaching 200m deep. There is also potential for additional discoveries onshore.

Most of Brunei Darussalam'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 move from primary recovery to secondary and tertiary 'enhanced oil recovery' (EOR).

An important milestone for Brunei Darussalam was the government's awarding of four new oil and gas blocks between 2003 and 2006: offshore Block J and Block K (2003), and onshore Block L and Block M (2006). These blocks are considered important for the economy to be able to maintain and extend oil and gas production in the future. Brunei Darussalam's proven oil reserve as at the end of 2007 was 1.2 billion barrels. Production in 2007 averaged 194,000 barrels a day, a decline of 12.1 percent from 2006. Proven gas reserves at the end of 2007 were 0.34 trillion cubic metres, while gas production was 12.3 billion cubic metres in 2007, a decline of 2.5 percent from 2006 production. At the current reserve-to-production ratios, the 2007 proven reserves of oil and gas are expected to deplete within 20 and 30 years, respectively.[16]

Brunei Darussalam's awards of Block J and Block K have been disputed by Malaysia due to overlapping sovereignty claims for the offshore area included in these two blocks. The two economies have been negotiating to resolve this conflict. 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 Darussalam expects to harness the hydroelectric potential of the Temburong River. This project could produce an estimated 300 GWh per year with capacity of around 80 MW. To assess the viability of large-scale photovoltaic power

[15] Brunei Economic Development Board (no date).

[16] BP (2009).

generation within the economy, the government has initiated a solar energy demonstration project known as Tenaga Suria Brunei (TSB). The TSB project is to be located at the Seria power station in Belait district. The photovoltaic system will have a nominal capacity of 1.2 MW, and will be connected to the grid in 2010.

Brunei Darussalam's electricity generation is currently almost entirely natural gas-fired. The current electricity system has three main grids that are operated by two utilities. The *National Development Plan for 2007–2012* proposes that all three of the economy's power grids are interconnected by 2012.[17]

ENERGY POLICIES

Brunei Darussalam introduced an Oil Conservation Policy in 1981 to rationalize its oil output, and as a result production gradually dropped to around 150,000 barrels per day in 1989. In November 1990, the government made the policy more flexible; this resulted in an increase of production to 219,000 barrels per day by 2006.

The government's long-term development plan, Brunei Vision 2035, states that the economy's major goal for the next three decades is economic diversification along with the 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"[18].

The government does not intend to remove fuel subsidies in the foreseeable future. It has, however, considerably increased the price of fuels for foreign-registered vehicles and vessels in the wake of increased smuggling of fuels to neighbouring economies. The government is concerned with the increasing cost of maintaining fuel subsidies, and in 2008 began a Subsidy Awareness Campaign.

Although there is no specific legislation concerning energy efficiency, the government is pursuing energy-saving measures in its own operations. In addition, the economy is promoting voluntary energy efficiency and conservation efforts, such as energy saving in buildings, through development of benchmarking for lighting and air conditioning, an energy code of practice, and an energy audit checklist.

[17] Brunei Economic Development Board (no date).

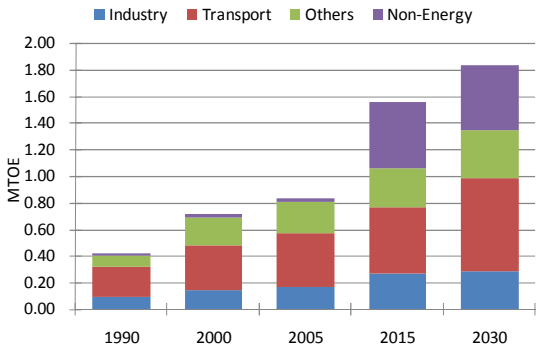
[18] Oxford Business Group (2008)

OUTLOOK

FINAL ENERGY DEMAND

The total final energy demand for Brunei Darussalam is projected to increase at an average annual rate of 3.2 percent over the forecast period. It will reach 1.84 Mtoe in 2030 compared to 0.83 Mtoe in 2005.

Figure BD2: Final energy demand



Source: APERC analysis (2009)

Industry

Changes in the final energy demand for the industry sector have two aspects: the expansion of the less-energy-intensive industry sector and the anticipated start of methanol production at SPARK in 2010. Other industries at SPARK are not considered in this analysis, since their definite time of entry has yet to be established.

The final energy demand for industry in Brunei Darussalam is projected to increase at an average annual rate of 2.1 percent, while energy demand outside of SPARK is projected to increase at an average annual rate of 0.8 percent. The final energy demand for industry is projected to reach 0.29 Mtoe in 2030 compared to 0.17 in 2005; this will be shared between oil (56 percent), gas (22 percent) and electricity (22 percent).

Transport

Transport is projected to continue to be the main energy-consuming sector. The final energy demand for transport is projected to increase at an average annual rate of 2.2 percent, from 0.41 Mtoe in 2005 to 0.69 Mtoe in 2030.

Other

The final energy demand of the 'other' sector, which includes residential, commercial and agriculture, is projected to increase at an average annual rate of 1.8 percent, from 0.23 Mtoe in 2005

to 0.36 Mtoe in 2030. This is shared between electricity (82 percent), natural gas (11 percent), and oil (7 percent).

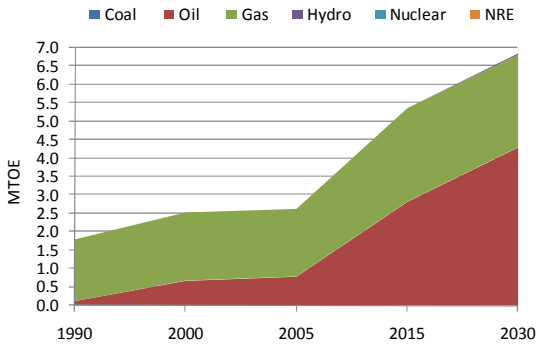
Non-energy

The methanol plant at SPARK will convert natural gas to methanol. This feedstock gas is counted as a non-energy use. For this reason, non-energy demand in Brunei will increase from negligible levels today to 0.47 Mtoe by 2030. This does not include the gas that the methanol plant will burn as fuel, which is counted as industrial use.

PRIMARY ENERGY SUPPLY

Brunei Darussalam's primary energy supply is expected to increase at an average annual rate of 3.9 percent over the forecast period to reach 6.83 Mtoe in 2030 compared to 2.62 Mtoe in 2005. Brunei Darussalam is assumed to be able to roughly maintain current levels of oil and gas production over the entire forecast horizon to 2030. This assumes a resolution of territorial disputes, allowing exploration and production to be maintained. This analysis also assumes that the Temburong River hydroelectric scheme is realized at the end of the outlook period.

Figure BD3: Primary energy supply



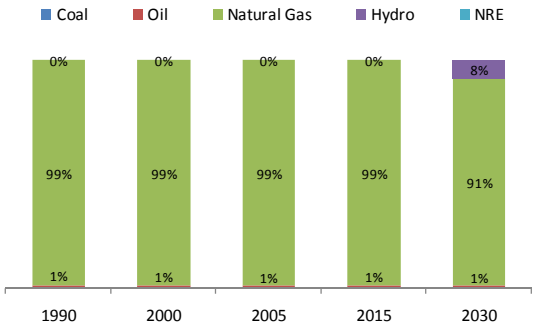
Source: APERC analysis (2009)

Brunei Darussalam is assumed to have an export-oriented refinery at Pulau Muara Besar by 2015; capacity is expected to be 200,000 barrels per day in 2015, increasing to 350,000 barrels per day in 2030. Net exports of petroleum products are projected to be 8.4 Mtoe in 2015, declining to 5.3 Mtoe in 2030. Exports of natural gas are projected to decline to 6.17 Mtoe in 2030 compared to 8.16 Mtoe in 2005.

ELECTRICITY

Brunei Darussalam is projected to continue its high level of reliance on natural gas for electricity generation. Conversion efficiency is expected to increase through the introduction of combined-cycle units. Electricity generation overall is forecast to reach 4.5 TWh in 2030 compared to 3.3 TWh in 2005, with Temburong hydropower contributing 368 GWh by that time.

Figure BD4: Electricity generation mix



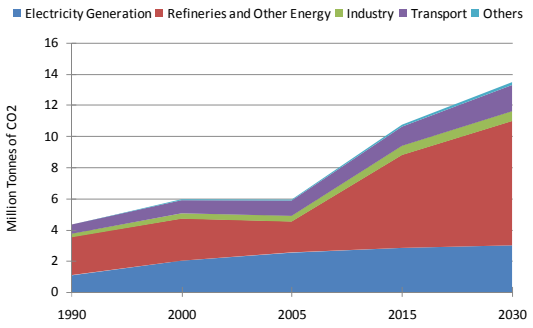
Source: APERC analysis (2009)

CO_2 EMISSIONS

Brunei Darussalam's total CO_2 emissions from fuel combustion is projected to reach 13.5 million tonnes of CO_2 by 2030; this compares to 4.4 million tonnes in 1990 and 6.0 million tonnes in 2005. In 2030, own use (that is, the use of energy in the conversion, transportation and processing of energy) accounts for the largest share of CO_2 emissions (8.0 million tonnes of CO_2), followed by electricity generation (3.0 million tonnes), transport (1.7 million tonnes), industry (0.6 million tonnes), and the 'other' sector (0.2 million tonnes).

Decomposition analysis of the combined factors that affect Brunei Darussalam's CO_2 emissions shows an increase in the energy intensity of GDP and economic growth are the drivers of increasing emissions. The CO_2-intensity of energy is expected to decline. Brunei Darussalam's CO_2 emissions are expected to grow at an average annual rate of 3.3 percent over the forecast period.

Figure BD5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table BD1: Analysis of reasons for change in CO_2 emissions from fuel combustion

	(Average Annual Percent Change)			
	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.3%	-1.3%	-0.1%	-0.6%
Change in Energy Intensity of GDP	0.8%	5.9%	-0.1%	2.3%
Change in GDP	1.7%	1.4%	1.7%	1.6%
Total Change	2.2%	6.0%	1.5%	3.3%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Producing oil and gas is Brunei Darussalam's major industry and major source of export earnings. A continuing challenge for the economy will be replacing the reserves of oil and gas being produced so as to avoid reserve depletion.

Brunei Darussalam's outlook in terms of achieving the 3Es (energy security, economic development and environmental protection) is mixed. Most of the economy's oil and gas production is currently exported. This oil and gas production could give energy-intensive industry in Brunei Darussalam a competitive advantage. Therefore, by following its current policy of developing energy-intensive industry, Brunei Darussalam can potentially achieve more value-added from its resources, while at the same time achieve a more diversified economy.

On the other hand, energy-intensive industry still leaves Brunei Darussalam's economy exposed to price risks in the world oil and gas markets. Therefore, Brunei Darussalam is wise to continue to promote less energy-intensive industries/sectors as well.

Energy-intensive industry will also result in increasing CO_2 emissions, although these same emissions would arguably have happened in some other economy if Brunei Darussalam simply exported its oil and gas. Brunei Darussalam can minimize its environmental impact and conserve its oil and gas resources by promoting energy efficiency in both its industries and domestic consumption.

REFERENCES

Alcoa (2008) "Alcoa and Brunei Economic Development Board Sign Agreement to extend feasibility studies to establish a modern aluminium industry in Brunei Darussalam; Youth and Small Business development program announced", *New York & Bandar Seri Begawan* http://www.alcoa.com/global/en/news/news_detail.asp?pageID=20080129005188en&newsYear=2008

ASEAN Centre for Energy (2003) "Brunei Darussalam, National Power Development Plan". http://www.aseanenergy.org/energy_sector/electricity/brunei/power_development_plan.htm

Begawan, B S (2009) "Brunei economy seen to contract 0.4% this year: Asian Development Bank (ADB) GDP growth forecast" Brunei Times, 1 April, http://www.bt.com.bn/en/home_news/2009/04/01/brunei_economy_seen_to_contract_0_4_this_year

BP (2009) Statistical Review of World Energy, June 2009. London, http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622.

Brunei Economic Development Board (no date) "Brunei's National Development Plan, 9th National Development Plan (2007–2012)", http://www.bedb.com.bn/why_ndp.htm

Brunei Times (2008) "Fuel price disparity a lure to smugglers", 18 June. http://www.bt.com.bn/en/opinion/2008/06/18/fuel_price_disparity_a_lure_for_smugglers

Chemicals Technology (2006) "Brunei Darussalam Methanol Plant, Brunei". http://www.chemicals-technology.com/projects/bruneimethanol/

Hadi, DP Mahmud (2008) "Petroleum Unit clarifies on second oil refinery unit", Brunei Times. Bandar Seri Begawan. http://www.bt.com.bn/en/home_news/2008/10/02/petroleum_unit_clarifies_on_second_oil_refinery_project

Hosni, Amin (2008) "Brunei to try solar power", Sultanate-News. 14 August http://www.sultanate.com/news_server/2008/14_aug_3.html

Incitec Pivot, Mitsubishi Corporation and West Side (2004) Brunei Ammonia/Urea Manufacturing Project, Bandar Seri Begawan.

IMF (2008) Brunei Darussalam: Statistical Appendix, IMF Country Report No. 08/165. International Monetary Fund, Washington DC, US.

Marubeni Power Systems Corporation (2005) "Marubeni awarded Brunei's first combined cycle power station". http://www.marubeni-mpsc.com/english/news/index.cgi?cid=0003#0003

OilGasArticles.com (2006) "Oil reserves and discoveries in Brunei" http://www.oilgasarticles.com/articles/177/1/Diversify-into-New-Areas-Attract-FDI--Brunei-to-Stabilize-its-Economy/Page1.html

Oxford Business Group (2008) *The Report: Brunei Darussalam 2008*, http://www.oxfordbusinessgroup.com/publication.asp?country=58

Rigzone E&P News (2008) "Total Makes Discovery in Block B Offshore Brunei". http://www.rigzone.com/news/article.asp?a_id=68695

The Department of Electrical Services of the Prime Minister's Office (2007) *DES supply side development challenges*, Bandar Seri Begawan.

The Energy Division of the Prime Minister's Office (2007) *Brunei Darussalam Energy in Brief, 2007*. Bandar Seri Begawan. http://www.energy.gov.bn

The Petroleum Unit of the Prime Minister's Office (no date) "Oil and Gas Activities & Opportunities – Upstream Activities, Concession Areas". http://www.petroleum-unit.gov.bn/oil_gas.htm

The Petroleum Unit of the Prime Minister's Office (2007) *Brunei Energy Outlook – Oil and Gas Perspective*. Bandar Seri Begawan. http://www.petroleum-unit.gov.bn

US Department of State, Bureau of East Asian and Pacific Affairs (2008) "Background Note: Brunei Darussalam". http://www.state.gov/r/pa/ei/bgn/2700.htm

Yusof, Mohammad Reduan Bin Haji Mohd, Petroleum Brunei (2005) *Country report for Brunei Darussalam*, 8th ASCOPE Conference, Manila, Philippines, December 2005.

CANADA

- *Canada's primary energy supply is projected to grow at an average annual rate of 1.1 percent to 2030.*
- *Canada will remain a net energy exporter through to 2030. Construction of an appropriate pipeline network and LNG terminals will be essential to support the supply of gas to the domestic and US markets.*
- *CO_2 emissions from energy consumption are projected to reach 666 million tonnes by 2030, a 22 percent increase on the 2005 level.*

ECONOMY

Canada is the second largest economy in the world, after Russia, in terms of land area. It is located in the northern part of North America, and has a widely varied climate, from temperate in the south to sub-arctic and arctic in the north. Canada's geography contributes to its high energy consumption (about four times the APEC average), [19] given the transportation required over vast distances, and the space and water heating needed to cope with severe cold weather (77 percent of 2006 residential energy demand was used for space and water heating).[20]

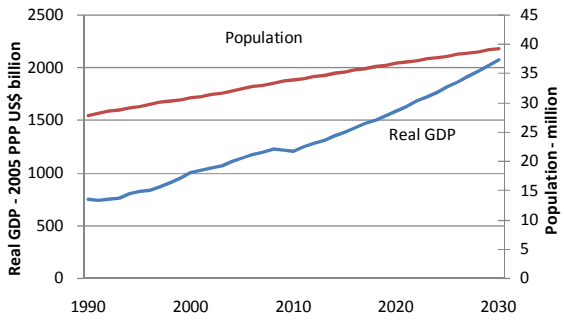
Canada was demonstrating solid economic growth before the onset of global recession in 2008. Between 1990 and 2005, GDP increased at 2.8 percent per year and in 2005 reached US$1,130 billion or US$34,972 per capita (in 2005 US$ at PPP). Although Canada's economy slowed down in 2008, the GDP is expected to recover, to grow at 2.4 percent on average over the outlook period.

The affluence of this economy translates into a high standard of living. Canada's car ownership is high for the APEC region: in 2005, there were 563 passenger vehicles per 1,000 people. According to the 2006 census, 80 percent of the employed labour force uses car, truck or van (as either driver or passenger) to commute, while only 11 percent rely on public transport.[21]

Canada is moving toward a knowledge-based economy: the service industry employs three quarters of Canadians and in 2008 generated 70 percent of GDP. Manufacturing makes up 14 percent of GDP; this includes major industries producing transportation equipment, food, chemical, fabricated metal product, and machinery. The oil and gas extraction industry currently provides three percent of GDP, with the contribution from oil sands expected to grow. Canada's economy is closely tied with the United States – in 2008, the US accounted for 76 percent of Canada's exports and 63 percent of imports.[22]

Canada has a population of 33 million, with approximately 80 percent in urban areas. The population is estimated to reach 39 million in 2030, growing at 0.8 percent per year on average. The death rate is expected to exceed births in the second quarter of this century, with population growth coming from net international migration. The economy's population is also projected to age, with people aged 65 and older outnumbering children under the age of 15 from 2015 on – this may have future labour force implications.[23]

Figure CDA1: GDP and population



Source: APERC analysis (2009)

ENERGY RESOURCES

Canada is richly endowed with natural resources: oil, natural gas, coal, and uranium in its western provinces and huge hydropower resources in Quebec, British Columbia, Newfoundland, Ontario, and Manitoba. In world production rankings, Canada is seventh for oil, third for natural gas, second for hydroelectricity, and first for uranium. [24] While conventional oil production is in continuous decline in the Western Canada Sedimentary Basin (WCSB), oil production from the east coast offshore deposits and the oil sands of northern Alberta offset the decrease. The oil sand reserves in particular are

19 APERC (2009), p 26.
20 Natural Resources Canada (2009A).
21 Statistics Canada (2008).
22 Statistics Canada (2009).
23 Statistics Canada (2007).
24 IEA (2008), pp 13–21; Natural Resources Canada (2007), p 1.

abundant; when included they make Canada the second largest economy in the world in terms of global proven crude oil reserves. [25] Oil sands production averaged 1.18 million barrels per day in 2007, and is expected to reach 3 million barrels per day by 2015.[26]

The US is Canada's major energy trading partner. Canada is the leading supplier of oil imports to the US and more than half of Canada's annual natural gas production was exported to the US in 2007. The two economies' electricity networks are also heavily integrated and there is active electricity trade (in 2007 50.1 TWh was exported to the US, while 19.6 TWh was imported).[27] This means the energy demand of the US has a significant effect on Canada's energy resource production.

Growing natural gas requirements in North America have prompted a major push in construction of LNG facilities in Canada – as of March 2009 there were seven receiving terminals and one liquefaction (export) plant proposed or in construction. While the existing pipeline capacity is considered adequate for current use, it is under pressure to expand (in part to connect to the new terminals).[28] This is expected to speed up the development of natural gas pipeline facilities.

Hydropower dominated electricity generation in 2005 (58 percent), followed by coal (18 percent) and nuclear power (15 percent). Although wind power generation currently accounts for less than 1 percent of Canada's electricity output, it is expected to grow because the federal and provincial governments have implemented policies that support wind energy development.

ENERGY POLICIES

Canada's abundant natural resources allow it to give high priority to safeguarding the environment when considering energy and energy security issues. The Canadian federal government has taken a number of actions to reduce greenhouse gas (GHG) emissions by 20 percent from 2006 levels, by the year 2020. The action plan is called *Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution.*[29] To this end, Canada has invested in a series of complementary programmes to promote energy efficiency, enhance renewable energy supplies, and develop cleaner technologies.

In addition, Canada is in process of strengthening energy-efficiency standards. The Energy Efficiency Act, which took effect in 1992, has been amended to expand its scope and increase effectiveness.[30] This includes provisions aimed at reducing standby power consumption, which is currently 10 percent of household electricity use in Canada.

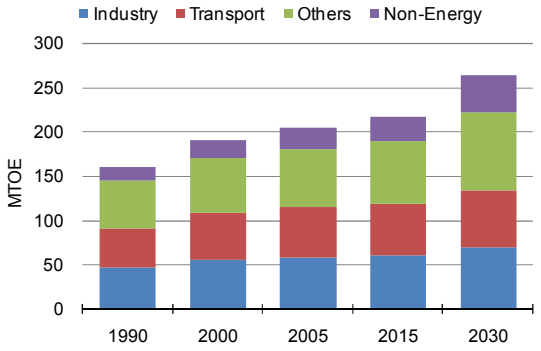
In the transport sector, the federal government has announced the introduction of the first mandatory fuel-efficiency standards under the Motor Vehicle Fuel Consumption Standards Act. These are to regulate the fuel consumption of new cars and light trucks, beginning with the 2011 model year.

OUTLOOK

FINAL ENERGY DEMAND

Canada's total final energy demand is projected to grow at 1.0 percent per annum over the outlook period, from 204 Mtoe in 2005 to 263 Mtoe in 2030. Its annual average growth rate is assumed to be slower (0.6 percent) in the near-term of the outlook period (2005–2015), mainly due to repercussions of the 2008 financial crisis and global recession. It is then expected to bounce back to 1.3 percent growth in the longer-term (2015–2030). The energy demands of the 'other' sector, which includes residential, commercial, and agricultural users, are projected to take the largest share (34.0 percent) in 2030, followed by industry (26.2 percent) and transport (24.5 percent). There will be only a small shift in the spread of demand across the sectors, with a small increase in the 'other' sector's share (up from 32.3 percent in 2005), and slight contractions in the share taken by the industry and transport sectors.

Figure CDA2: Final energy demand



Source: APERC analysis (2009)

[25] Government of Alberta (2008).

[26] National Energy Board (2006), p 13.

[27] EIA (2008), table 6.3.

[28] APERC (2009), pp 32–33.

[29] Government of Canada (2007).

[30] Natural Resources Canada (2009c).

Industry

Energy demand in the industry sector is projected to grow at an average annual rate of 0.7 percent through to 2030. The moderate pace is in accord with GDP growth. The expected energy intensity improvement (from 51 toe per US$ million GDP in 2005 to 33 toe per US$ million GDP) and slight structural change in favour of the service sector are also assumed to moderate energy consumption in this sector.

Transport

In the transport sector, the final energy demand is estimated to increase from 57 Mtoe in 2005 to 64 Mtoe in 2030. Petroleum products will remain the dominant fuel (around 91 percent) through to 2030, as the road transport sub-sector is expected to grow continuously. Most of the remaining share of the increased demand is for natural gas, largely used in the pipeline transport sub-sector. Although there have been federal programmes to encourage the use of ethanol as a transportation fuel, the share of alternative fuels will continue to be marginal.[31]

The average annual growth rate of the transport sector's energy demand between 2005 and 2030 is expected to slow to 0.5 percent, compared to earlier rates of increase – 1.9 percent between 1990 and 2000, and 1.2 percent between 2000 and 2005. Canada's economic slump and the federal government's implementation of the mandatory fuel efficiency standards are expected to dampen the sector's energy demand.

Other

Energy demand in the 'other' sector is projected to grow at 1.2 percent per year. Electricity will form the largest share of this demand (39 percent in 2030). Its projected average annual growth rate of 1.2 percent is mainly driven by anticipated GDP growth, which will translate into increased consumer spending on electric appliances and larger homes, and will facilitate more building construction. At the same time, energy efficiency improvements are expected to moderate energy use.

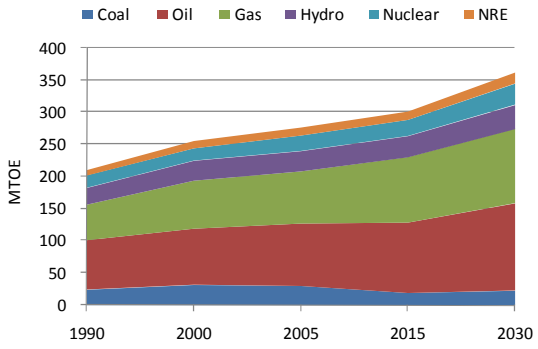
PRIMARY ENERGY SUPPLY

Canada's primary energy supply is projected to grow at an annual rate of 1.1 percent over the outlook period, from 274 Mtoe in 2005 to 356 Mtoe in 2030. Oil will maintain the largest share, with an average annual growth rate of 1.3 percent over the period. Most of the demand will be met by domestic production, mostly from oil sands.

The primary energy supply of natural gas is estimated to grow at an average annual rate of 1.4 percent. Canada is likely to remain a net exporter of natural gas over the outlook period due to advancements in the technology used for the extraction of unconventional gas. Increased production of tight gas and shale gas is expected to offset the decline in conventional gas production.[32] The use of natural gas for electricity generation is expected to rise, from 7.5 Mtoe in 2005 to 28.9 Mtoe in 2030.

Coal is likely to decline from 30.0 Mtoe in 2005 to 22.9 Mtoe in 2030, while nuclear and new renewable energy (NRE) use is projected to show robust increases. In the longer-term (2015–2030), the nuclear annual average growth rate is expected to reach 1.8 percent, while NRE will reach 1.9 percent. This reflects Canada's policy changes favouring energy sources with lower CO_2 emissions.

Figure CDA3: Primary energy supply



Source: APERC analysis (2009)

ELECTRICITY

Electricity demand is projected to grow annually at 1.2 percent on average over the outlook period. More than half of the increased demand is expected to come from the 'other' sector, with industry as the next highest source of rising demand.

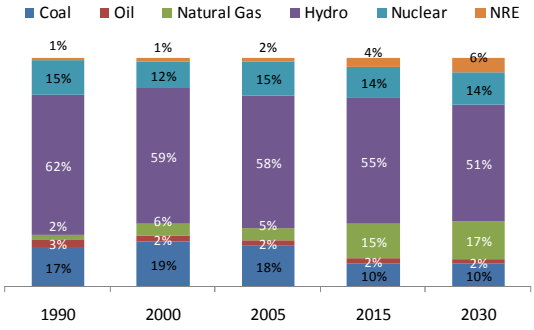
A critical change is expected in Canada's electricity generation mix. Natural gas generation is expected to increase from 34 TWh in 2005 to 146 TWh in 2030, at an average annual growth rate of 6.0 percent. In 2030 natural gas will provide 17 percent of electricity generation – a significant increase from 5 percent in 2005. New renewable energy (other than hydro) is projected to demonstrate the fastest average annual growth rate of 6.7 percent over the outlook period, increasing its share from 2 percent in 2005 to

[31] Natural Resources Canada (2009B).

[32] National Energy Board (2009).

6 percent in 2030. At the same time, the share of coal-fired generation is estimated to decrease towards 2030. The total amount of electricity generated from hydro will grow slightly (0.8 percent per year over the outlook period), so that its share in 2030 is down to 51 percent, from 58 percent in 2005.

Figure CDA4: Electricity generation mix

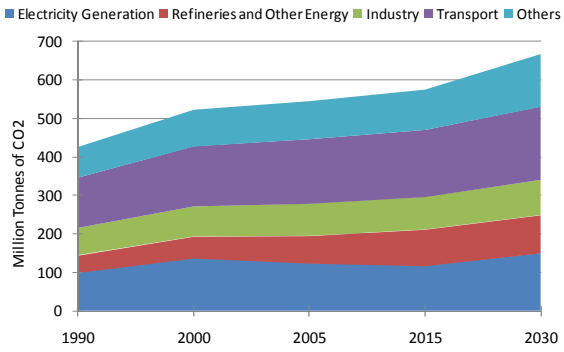


Source: APERC analysis (2009)

CO_2 EMISSIONS

Canada's CO_2 emissions are estimated to increase from 545 million tonnes of CO_2 in 2005 to 666 million tonnes of CO_2 by 2030. Petroleum products used in the transport sector will remain the major source of CO_2 emissions throughout the period. A decomposition analysis (see table) indicates that GDP growth is the major factor in the CO_2 emission increase.

Figure CDA5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table CDA1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.1%	-0.3%	-0.2%	-0.3%
Change in Energy Intensity of GDP	-1.0%	-1.2%	-1.5%	-1.4%
Change in GDP	2.8%	2.0%	2.7%	2.4%
Total Change	1.7%	0.5%	1.0%	0.8%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Considering Canada's geographical features, energy-intensive industries such as metal and chemical manufacturing industries, and high living standards, the economy faces a big challenge to meet its 2020 target of reducing GHG emissions by 20 percent from 2006 levels. Jurisdiction over energy and environmental matters are shared between the federal and provincial governments in Canada, and each province has a different strategy to reduce GHG emissions and protect the environment in accordance with the province's energy endowment. Coordination and cooperation among different provinces will improve the effectiveness of actions taken by each province.

Canada's overall energy productivity depends on the supply of natural gas. Natural gas is used in oil sands production, which is expected to meet the majority of Canada's future oil demand. To ensure security of supply, appropriate investment in pipelines and LNG terminals are essential to support the growing natural gas requirements.

REFERENCES

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre. Tokyo, Japan. http://www.ieej.or.jp/aperc/

Central Intelligence Agency, United States (2009) *The World Factbook: Canada.* https://www.cia.gov/library/publications/the-world-factbook/geos/ca.html

EIA (2008) *Electric Power Annual 2007*. United States Energy Information Administration. http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html

Global Wind Energy Council (2007) *Global Wind 2006 Report*. Brussels, Belgium. http://www.gwec.net/fileadmin/documents/Publications/gwec-2006_final_01.pdf

Government of Alberta (2008) *Oil Sands Facts*. http://environment.gov.ab.ca/info/faqs/faq5-oil_sands.asp

Government of Canada (2007) *Turning the Corner: An Action Plan to Reduce Greenhouse Gases and Air Pollution.* http://www.ecoaction.gc.ca/turning-virage/index-eng.cfm

IEA (2008) *Key World Energy Statistics 2008*. http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf

National Energy Board (2006) *Canada's Oil Sands: Opportunities and Challenges to 2015: An Update*. Alberta, Canada. http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprtntsndchllngs20152006/pprtntsndchllngs20152006-eng.pdf

National Energy Board (2007) *Canada's Energy Future – Reference Case and Scenarios to 2030*. http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2007/nrgyftr2007-eng.pdf

National Energy Board (2009) *2009 Reference Case Scenario: Canadian Energy Demand and Supply to 2020*. http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyftr/2009/rfrnccsscnr2009-eng.pdf

Natural Resources Canada (2006) *Canada's Energy Outlook: The Reference Case 2006*. Ottawa, Canada. http://www.nrcan-rncan.gc.ca/com/resoress/publications/peo/peo2006-eng.pdf

Natural Resources Canada (2007) *Mineral and Metal Commodity Reviews: Uranium*. http://www.nrcan.gc.ca/smm-mms/busi-indu/cmy-amc/content/2007/64.pdf

Natural Resources Canada (2009A) *Energy Efficiency Trends Analysis Tables*. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/analysis_ca.cfm

Natural Resources Canada (2009B) "Ethanol Expansion Program". http://oee.nrcan-rncan.gc.ca/transportation/fuels/ethanol/eep.cfm?attr=8

Natural Resources Canada (2009C) *Modernized Energy Efficiency Act Receives Royal Assent*. http://www.nrcan.gc.ca/media/newcom/2009/200942-eng.php

Statistics Canada (2007), *Canada's population future*. http://www41.statcan.gc.ca/2007/3867/ceb3867_001-eng.htm

Statistics Canada (2008) *Employed labour force by mode of transportation to work, 2006 Census*. http://www40.statcan.ca/l01/cst01/labor42a-eng.htm

Statistics Canada (2009) *Imports, exports and trade balance of goods on a balance-of-payments basis, by country or country grouping*. http://www40.statcan.gc.ca/l01/cst01/gblec02a-eng.htm

CHILE

- *After several years of robust economic expansion, Chile's GDP growth is projected to moderate to an average annual rate of 3.2 percent during the outlook period.*
- *Declining oil and gas production, and lack of exploration and exploitation of domestic energy resources, may weaken Chile's energy security.*
- *Increased diversification of the overall energy mix needs to be a priority for the economy's energy policy, if Chile is to achieve long-term energy security through the use of indigenous primary energy sources such as renewables.*

ECONOMY

Chile is one of three Latin American members of APEC. The economy lies in South America, with Peru to the north and Bolivia and Argentina to the east. The total land area of 756,950 square kilometres is divided into 15 regions. The climate varies greatly, covering at least seven major climatic subtypes, with average temperatures in central Chile ranging between summer peaks of 20 °C and winter lows of 8 °C.

Chile's population is projected to grow at an average annual rate of 0.8 percent over the outlook period, reaching over 20 million by 2030. This is a halving of the rate of population growth witnessed between 1990 and 2000, when the average annual growth rate was 1.6 percent.

In terms of economic size, Chile is rated sixth in Latin America, and 43rd in the world.[33] The economy showed accelerated growth between 1990 and 2005, with an annual average growth rate above 5 percent. In 2005, GDP per capita was US$12,248 (in PPP). During the outlook period this growth is expected to moderate, with an average annual growth rate of 3.2 percent projected – 2030 figures for GDP are estimated at US$438 billion (or US$22,241 per capita). This assumes continued expansion of the manufacturing industry, which has been a substantial contributor to Chile's GDP; the mining sub-sector, specifically copper, is also expected to continue to grow.

Chile's economy is based on four key areas: rich mineral resources, agriculture (which takes advantage of the wide variety of climatic conditions), rich fishing grounds, and industry. Chile has a market-oriented economy characterized by a high level of foreign trade. Chile's export markets are fairly balanced among Europe, South America, North America and Asia. Chile has 25 trade agreements in place,[34] and is an active participant in international organizations such as APEC, WTO, Mercosur, EFTA, CACM and Olade.

A significant aspect of Chile's recent economic development has been activity in the financial services sector. In 2007, the two major contributors to Chile's GDP were financial services (16.2 percent) and manufacturing (16.1 percent). The mining, construction, and transportation sectors contributed 7.2, 7.1 and 7.0 percent to the GDP, respectively.[35] In the case of mining, there is significant foreign private investment, principally in copper production. The copper industry in Chile is well developed and exports have provided economic stability.

The overall growth in production has driven increases in demand for energy within the economy, particularly for electricity, which had an average annual growth rate of 6 percent over the 10 years from 1997 to 2007.[36]

There are four major energy demand sectors in Chile: transportation, industry, mining and the commercial–residential–public grouping.[37] Transport is the most energy intensive, using 35 percent of the final energy demand in 2007. This is dominated by the roading sub-sector (68 percent of transport energy use); the rest is consumed by maritime, air, rail and electric transit (trolley buses and electric trains). Commercial, public and residential use consumes the next largest chunk, at 25 percent of Chile's final energy demand. The largest energy source in this sector is firewood, used mostly for cooking and heating – this equates to 47 percent of the energy demand of this sector, and creates environmental problems and issues related to sustainable resource management. The industry and mining sector share in 2007 was 37 percent of the final energy demand; this was driven by the copper and pulp and paper subsectors in particular. The major energy sources consumed for these uses are petroleum products, and biomass, as well as electricity.

33 World Bank (2009).

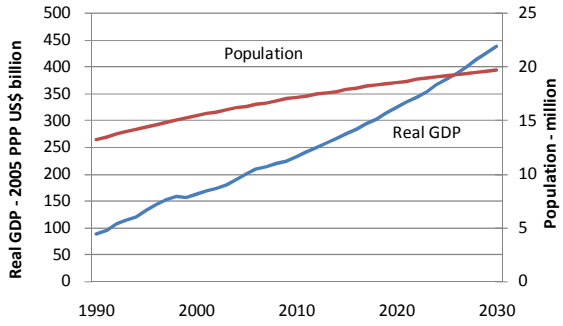
34 Ministerio de Relaciones Exteriores (2008), p 18.

35 Instituto Nacional de Estadística (2009), table 2.1.12-03, p 273, Producto Interno Bruto por año, según clase de actividad económica.

36 CNE (2008c), p 38.

37 CNE (2008c), p 37.

Figure CHL1: GDP and population



Source: APERC analysis (2009)

ENERGY RESOURCES

Chile has limited domestic energy resources. It is dependent on international energy markets, which means the economy is exposed to considerable risk in terms of security of supply and price fluctuations. However, Chile has domestic production of conventional energy resources, including crude oil, natural gas, coal, and renewable energy sources such as hydro, wind and biomass. Chile's indigenous energy sources are classified as coming from three major 'gross energy sinks': wood/biomass for heating and electricity generation (on average 50.2 percent of the economy's total energy production between 2005 and 2007); water for hydroelectricity generation (24.2 percent); and natural gas from the Magallanes region (21.4 percent).[38]

Chile's estimate of proven crude oil reserves in January 2009 was 150 million barrels.[39] Limited local production means dependency on imports is considerable, and growing – while Chile has capacity to refine 226,800 barrels per day (bpd) of crude oil, this meets only 75–85 percent of total demand.[40] The state-owned Empresa Nacional del Petróleo (ENAP) is the major oil producer and refiner in the economy. ENAP operates all three refineries in Chile, the largest of which is the 113,400 bpd Bio-Bio refinery, located south of Santiago, the capital.[41]

Chile's natural gas production comes from onshore and offshore facilities in the Magallanes region. Proved reserves of natural gas at the end of 2007 were 3,460 billion cubic feet (bcf) – or 19 years supply at 2005 demand levels.[42] Chile has a high demand for natural gas and its domestic production does not satisfy internal demand. The economy is a net importer of natural gas, with imports accounting for 54 percent of the economy's total natural gas supply. The main source is Argentina, and Chile has faced restrictions imposed by that economy from 2004.[43]

In response, Chile has begun to pursue other sources, such as liquefied natural gas (LNG) or piped supply from other economies. Two important LNG facilities in Chile are under construction. The first one, located in Quintero Bay, with a total installed capacity of 510 million standard cubic feet per day (mmscfd), started test operation at the end of July 2009 and will be commence full scale production during the second quarter of 2010. The second LNG facility is located in Mejillones, in northern Chile. It is projected to start operation in January 2010, with an installed capacity of 194 mmscfd. This project is a partnership between CODELCO and Suez Energy International.[44]

Chile's recoverable coal reserves were estimated at 700 million tonnes in 2008,[45] or 136 years of coal supply at 2005 demand levels. Domestic coal production is in two regions: Bio-Bio – Golfo de Arauco and Magallanes (Pecket and Isla Riesco).

In terms of electricity generation, Chile is well endowed with thermal and hydropower energy sources. Chile's total electricity generation was 60.1 TWh in 2007, with 62 percent of this coming from thermal sources (the rest almost all hydro).[46] Most of this was generated by public services (accounting for 93.7 percent of total electricity generation while the remainder was generated by own-producers), and distributed via four separate power grids — Sistema Interconectado Central, Sistema Interconectado del Norte Grande, Sistema Aysén and Sistema Magallanes. Chile has a small portion of its electricity generation based on new renewable energy sources, such as wind power (installed capacity 20.1 MW). The total electricity generation from wind power in 2007 was 8 GWh.[47]

The economy's biomass energy resources are largely based on wood. Wood accounts for around 19 percent of Chile's total energy domestic supply; this represents a considerable chunk of the economy's overall energy mix. A high volume of wood is used in the residential sector for heating and cooking (65 percent of the wood share of the economy's final

38 CNE (2008C), p 40; CNE (2007) table 3.

39 Oil & Gas Journal (2008B).

40 Oil & Gas Journal (2008A).

41 Empresa Nacional del Petróleo (2009B).

42 EIA (2009B).

43 For further discussion of Argentine gas export restrictions, see *The Economist* (2004).

44 Suez Energy International (2008).

45 CNE (2008C), p 106.

46 CNE (2007).

47 Instituto Nacional de Estadística (2008), tables 1.2 and 1.3.

energy consumption in 2007); the remainder was used in industry, in particular in the pulp and paper industry. Chile also has a modest potential supply of biogas from biomass treatment – from waste products such as poultry dung and urban solid residues. Recent studies show a potential of 1,280 million cubic metres per year of biogas (with average methane content of 65 percent), which could be used to produce 5 percent of Chile's 2005 electricity demand.[48]

Biofuels are just starting to emerge in the automotive sector. No other energy sources, such as nuclear, geothermal, and photovoltaic are being developed, but some investigation of their potential value to Chile's energy mix has begun.

ENERGY POLICIES

Chile's energy policy has several key objectives: greater security of supply, increasing diversification in terms of source, improving energy efficiency, environmental protection and sustainability, and social equity. Energy security has emerged as one of the main challenges facing Chile today.

In 2008, a bill was presented to the Chilean Parliament to create the Ministry of Energy; it has been through a lengthy process in the Congress during 2009 for its possible approbation. The aims of the new Ministry include the strengthening of policy development, techno-economic regulation and economy's revenues, as well as the energy efficiency of the economy. At the same time, the government also proposed the creation of the Chilean Energy Efficiency Agency (ACHEE), which is included in the bill presented. The creation of the Renewable Energy Centre (CER) was also proposed, however it won't be included in the bill. Under the new framework of the Ministry of Energy, previous institutions such as the Superintendent's Office of Electricity and Fuels will be integrated as a body of the ministry. The new ministry will centralize the functions of developing, proposing and evaluating public policies, including the definition of objectives, regulatory frameworks and strategies to be applied, as well as the development of public policy instruments.[49]

Chile has a range of government institutions working to achieve increased energy efficiency. The body directly responsible for developing and implementing energy efficiency policy and programmes is the National Energy Efficiency Programme (Programa País Eficiencia Energética, or PPEE). The PPEE was created to strengthen the economy's energy efficiency, energy security and energy supply. It aims to achieve positive economic, social and environmental impacts. PPEE's mission is to contribute to sustainable energy development in Chile by treating energy efficiency as an energy resource.

In this context, the Chilean government is working to launch the National Action Plan for Energy Efficiency 2010–2020; this action plan is one of the main products of the current energy efficiency policy being coordinated by the PPEE, which has the goal of consolidating Chile's initiatives on energy efficiency, realizing the energy saving potential for both public and private sectors.[50] PPEE is also working in other products such as the implementation programmes on energy efficiency in residential, commercial, industry, transport, mining and public sectors, and initiatives to promote the use of energy efficient technologies.[51]

The diversified energy mix the government is aiming for would be based on enhanced hydro electricity generation and on importing liquefied gas through public–private developments. Development based on new renewable energy sources could also provide the economy with alternatives to reduce its energy security risk. To support these changes, new legal frameworks have been established to remove barriers to commercial development. In the long-term, new renewable energy sources such as solar photovoltaic, geothermal, wind and biogas are expected to have an increased role in Chile's energy supply.[52]

The Chilean government is also analyzing the potential role of nuclear energy in the economy, which may possibly be incorporated into the energy mix after 2020, providing that major analytical studies could be presented beforehand. Work to explore nuclear energy options began in 2007 with the establishment of the Nucleo-Electricity Working Group – this group has begun studies into various aspects of development, including economics, environmental effects, health, regulatory framework, human resources and public opinion.[53]

OUTLOOK

FINAL ENERGY DEMAND

Under business-as-usual, Chile's final energy demand is projected to grow at 3.4 percent annually over the outlook period. The industry sector's share will remain the largest at 50.6 percent of the total

48 CNE & GTZ (2007), table 45, p 67.

49 APEC (2009).

50 CNE (2009C).

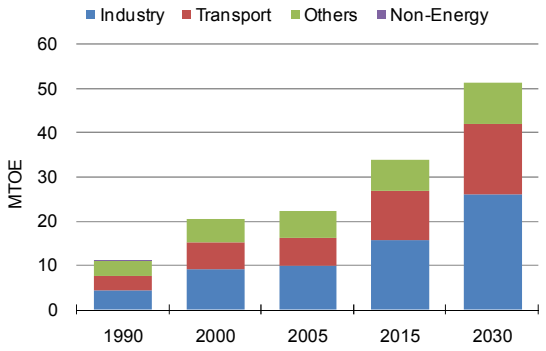
51 Further information on PPEE in www.ppee.cl

52 CNE (2008B).

53 CNE (2009B).

demand in 2030, followed by transport at 30.9 percent, and the 'other' sectors (residential, commercial, public and agricultural) at 18.3 percent.

Figure CHL2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 3.9 percent. This is considerably lower than the 7.5 percent annual growth between 1990 and 2000. Among the energy sources used in the industrial sector, natural gas is projected to provide the largest share (33 percent) throughout the outlook period. Total consumption of natural gas will reach 8.5 Mtoe in 2030. The second largest share will be electricity (29 percent), with its consumption reaching 7.6 Mtoe by 2030. The share of Chile's industrial energy demand met by petroleum products is projected to reduce, from 20 percent in 2005 to 16 percent in 2030 – a result of environmental regulations and energy-efficiency improvements in production processes; however, the total industrial consumption of petroleum products will maintain an average annual growth of 2.9 percent, reaching 4.2 Mtoe in 2030. Industrial use of new renewable energy sources such as biomass is expected to grow robustly, at an average annual rate of 5.9 percent. This will be driven by the use of wood as fuel in the pulp and paper industry as well as in the mining industry; the final biomass energy demand will reach 4.6 Mtoe in 2030.

Transport

Chile's transport energy demand is projected to increase at an average annual rate of 3.7 percent; total consumption in the sector is expected to reach 15.8 Mtoe in 2030, compared to 6.3 Mtoe in 2005. The main area of increase is expected to be in ultra low sulphur diesel demand, rather than gasoline; this is as a result of the introduction and high sales of vehicles with greater fuel efficiency and higher emission standards, particularly diesel-driven light vehicles. The government is also seeking to reduce the negative environmental effects of road transport, and improve fuel efficiency, through programmes to replace trucks that are more than 25 years old[54] and to change driver behaviour.

Other

The 'other' sector, which covers residential, commercial, public and agricultural uses, is expected to increase its total final energy demand by 1.9 percent annually throughout the outlook period, reaching 9.4 Mtoe in 2030.

Biomass, principally firewood, is projected to meet the largest share (47 percent) of this 'other' sector energy demand at the end of the outlook period. Continued high levels of firewood use are expected for heating and cooking in the residential and commercial subsectors, especially in southern Chile where it is readily available. The high firewood use is based on a lack of competitively priced alternatives, and a strong cultural tradition. The government is attempting to regulate wood use to improve its security, fuel efficiency and reduce environmental impacts – through National Commission of Energy initiatives to establish rules and requirements for its use.[55] Wood is also expected to remain in use for electricity generation in remote areas beyond the main electricity grid. Overall, electricity is the second largest segment in the 'other' sector energy demand (30 percent), reaching 2.8 Mtoe in 2030. One energy type is expected to level out in demand: use of petroleum products will decline by 0.3 percent per year in this sector, with consumption dropping from 1.2 Mtoe in 2005 to 1.1 Mtoe in 2030.

PRIMARY ENERGY SUPPLY

Chile's primary energy supply is projected to grow at an average annual rate of 3.3 percent; this is almost half the annual growth of 6.3 percent between 1990 and 2000. Among the fossil fuels, petroleum products will continue to increase, with an average annual growth rate of 2.7 percent, and a total demand of 22.9 Mtoe in 2030. The second largest chunk of the energy supply will be natural gas, with an average annual growth rate of 4.5 percent, reaching 21 Mtoe in 2030. Coal supply grows at an average annual rate of 3.9 percent, from 3.6 Mtoe in 2005 to 9.4 Mtoe in 2030. This increase in coal use is partly driven by the unreliability of natural gas imports from Argentina.

The transport sector is the major consumer of petroleum products – 65.9 percent at the end of 2030. Natural gas is largely consumed within

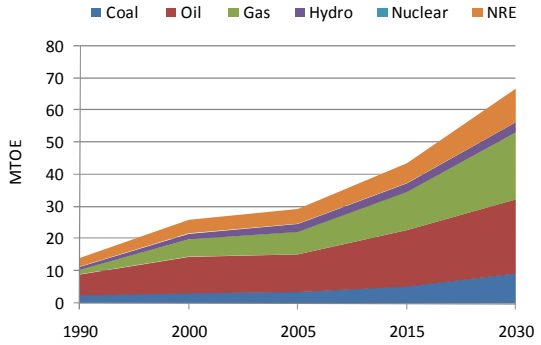
[54] CNE (2008A).

[55] CNE (2009A).

electricity generation and industry, with gas-fired electricity generation accounting for more than 52 percent of natural gas input for total electricity and heat generation in 2030 (10.9 Mtoe).

New renewable energy supply is projected to grow at an average annual rate of 3.3 percent to reach 10.4 Mtoe in 2030 – this forms the third largest share of Chile's primary energy supply. This is driven by demand in the residential and industry sectors, which will account for around 86 percent of the total in 2030. The residential use is mostly wood burnt for heating, with attendant negative public health and environmental consequences.

Figure CHL3: Primary energy supply



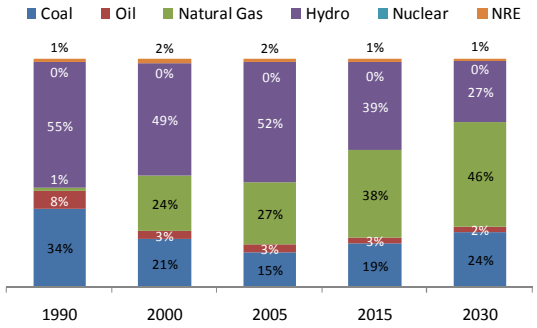
Source: APERC analysis (2009)

ELECTRICITY

Total electricity generation in Chile is projected to grow at 3.7 percent per year, reaching 135 TWh in 2030. Natural-gas-fired technology is the dominant source, supplying 46 percent of the total generated in 2030, followed by hydro plants at 27 percent. Natural-gas-fired generation will have the fastest growth rate (5.9 percent per year), followed by coal-fired generation (5.6 percent). The increase in use of coal for electricity generation is based on the projected unavailability of Argentinean natural gas, which permits its economic adoption through both lower comparative cost and construction times.

The installed capacity for electricity generation in Chile is expected to reach 35.1 GW in 2030. Thermal plants will form the majority of the installed capacity (78 percent); this follows planned new construction of natural-gas-fired plants, with a total installed natural gas generation capacity of 17.9 GW in 2030. For hydro, the installed capacity growth rate is projected at 1 percent per year, with a total installed capacity of 6 GW by 2030. Chile will face issues of water availability and plant location for hydroelectric generation in the outlook period, given an expected impact of climate change is the reduction of snowfall in mountain areas resulting in reduction of water levels in the central region, and the existing variability of the El Niño and La Niña phenomena.[56] At the same time, there is strong impetus behind proposals for the installation of plants based on new renewable energy sources in Chile; new renewable energy is expected to have a high average annual growth rate of 8.3 percent during the outlook period (possibly including wind farm and geothermal developments), reaching to 1.8 GW in 2030.

Figure CHL4: Electricity generation mix

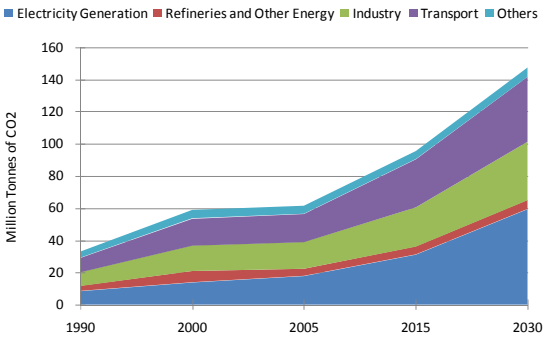


Source: APERC analysis (2009)

CO_2 EMISSIONS

Chile's total CO_2 emissions are projected to increase considerably over the outlook period, reaching 148 million tonnes of CO_2 in 2030, compared to 61 million tonnes in 2005 – an average annual increase of 3.6 percent. In 2030, emissions from the electricity generation sector are estimated to account for 39 percent of this (around 59 million tonnes), followed by transport (27 percent, 40 million tonnes), and the industry sectors (24 percent, 36 million tonnes), and the remaining (7 percent, 11 million tonnes) by "other" sector and refineries and other energy sectors in conjunction.

Figure CHL5: CO_2 emissions by sector



Source: APERC analysis (2009)

[56] CNE (2008c).

The decomposition analysis, reported in the following table, shows that economic growth (at 3.2 percent per year) underlies much of the projected CO_2 emissions increase. However, Chile is unusual among APEC economies in having a projected increase in CO_2 intensity of energy (that is, more CO_2 produced per unit of energy consumed) and also a rising level of energy intensity of GDP (that is, more energy used per unit of production). The projected rapid rise in oil use in electricity generation and transport accounts for much of these increases.

Table CHL1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.8%	0.5%	0.1%	0.2%
Change in Energy Intensity of GDP	-0.6%	0.8%	-0.3%	0.1%
Change in GDP	5.7%	3.2%	3.2%	3.2%
Total Change	4.3%	4.5%	2.9%	3.6%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

A fundamental challenge for Chile is to secure sufficient energy to fuel its rapid economic growth, despite limited domestic resources. Chile needs to do more to secure its energy supply if it is to meet the 3E goals of energy security, economic development and environmental protection. The current high level of dependency on energy imports leaves the economy vulnerable to supply changes, as well as to the price fluctuations of the international market.

Another key challenge is to balance the economy's energy requirements with the responsibility it has to protect the environment. Under this business-as-usual projection, Chile's CO_2 emissions from fuel combustion are expected to increase by over 240 percent between 2005 and 2030. Chile's continued high dependence on non-commercial firewood for energy is also likely to have negative environmental consequences.

Both challenges can be addressed through increased energy efficiency. Chile is already intensifying efforts in this area, with a focus on making improvements to fuel efficiency in its industrial, residential and transport sectors. This outlook suggests particular attention needs to be paid to improving energy efficiency in the transport sector, given the fast growth projected for oil consumption and because of the direct threat that transport emissions pose to the environment. This could include introduction of more efficient vehicles and promotion of alternative transport modes.

Diversification of the economy's overall energy mix will also be essential to address the challenges Chile faces. Potential low-carbon energy sources, such as biogas from waste products, need to be identified and encouraged.

Regional integration between the surrounding economies, such as Peru, Bolivia, and Argentina, could, in principle, greatly enhance the security of energy supply within the region. However, in order to achieve the goals of energy security through international cooperation, a more solid legal and institutional framework is needed to insure that unexpected energy shortages will be fairly shared by the participating economies.

REFERENCES

APEC (2009) *Peer Review on Energy Efficiency in Chile, Final Report*, 14 April 2009, Chile. www.cne.cl

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

Centro de Despacho Económico de Carga (CDEC) and Sistema Interconectado Central (SIC) (2008) *Estadísticas de Operación 1998–2007*. www.cdec-sic.cl

CNE (2007) *Balance Nacional de Energía 2007*. Comisión Nacional de Energía, Santiago, Chile. www.cne.cl

CNE (2008A) "Gobierno duplica presupuesto en materia energética para 2009", Comisión Nacional de Energía press release, October 2008. Santiago, Chile. www.cne.cl

CNE (2008B) *Ley de Energías Renovables No Convencionales; Ley 20.257*, Comisión Nacional de Energía, April 2008. Santiago, Chile. www.cne.cl

CNE (2008C) *Política Energética: Nuevos Lineamientos*. Comisión Nacional de Energía, Santiago, Chile. www.cne.cl

CNE (2009A) "Gobierno ingresa al Congreso proyecto de ley que establece exigencias para la leña y su uso", Comisión Nacional de Energía press release, 8 July 2009. Santiago, Chile. www.cne.cl

CNE (2009B) *Grupo Consultivo Nuclear*. Comisión Nacional de Energía, Santiago, Chile. www.cne.cl

CNE (2009C) "Ministerio de Energía constituye grupo de asesores en políticas de eficiencia energética", Comisión Nacional de Energía press release, 6 July 2009. Santiago, Chile. www.cne.cl

CNE & GTZ (2007) *Potencial de Biogás – Identificación y clasificación de distintos tipos de Biomasa disponibles en Chile para la generación de biogás*. Comisión Nacional de Energía and Deutsche Gesellschaft für Technische Zusammenarbeit, Santiago, Chile.

De Gregorio, J (2009) "Chile and the Global Recession of 2009", *Economic Policy Papers*, No. 30, March 2009, ISSN 0717-7151. Central Bank of Chile, Santiago, Chile.

EIA (2009A) "Chile Country Analysis Brief", Energy Information Administration, US Department of Energy. www.eia.doe.gov

EIA (2009B) *Chile Energy Profile,* Energy Information Administration, US Department of Energy. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=CI

Empresa Nacional del Petróleo (2009A) "Barco de GNL ingresó al Estrecho de Magallanes", press release, 24 June 2009. www.enap.cl

Empresa Nacional del Petróleo (2009B) *Memoria Anual 2008* (in Spanish). www.enap.cl

Instituto Nacional de Estadística (2008) *Energía Eléctrica: Informe Anual 2007*. 4 August 2008. Santiago, Chile. www.ine.cl

Instituto Nacional de Estadística (2009) *Compendio Estadístico 2008, Capítulo 2.1 Cuentas Nacionales y Balances*. Santiago, Chile. www.ine.cl

Ministerio de Relaciones Exteriores (2008) *Chilean International Economic Affairs - Figures 2008*, Dirección General de Relaciones Económicas Internacionales (DIRECON), Santiago, Chile. www.direcon.cl/documentos/Libro_Cifras_2008.pdf

OECD (2007) *Economic Survey of Chile 2007*, policy brief, November 2007. www.oecd.org

Oil & Gas Journal (2008A) *World Refining Survey 2008*, December 2008. PennWell Editors, Houston, USA.

Oil & Gas Journal (2008B) *Worldwide look at reserves and production*. 22 December 2008. PennWell Editors, Houston, USA.

Programa de Gestión y Economía Ambiental (Progea) y Universidad de Chile (2008) *Diseño de un modelo de proyección de demanda energética global nacional de largo plazo*, final report, 30 June 2008. Santiago, Chile.

Suez Energy International (2008) "SUEZ finalizes all conditions for LNG terminal in the North of Chile", press release, 11 February 2008, Brussels. www.suezenergyint.com

The Economist (2004) "What sort of neighbor is this? Chile suffers from Argentina's energy bungling", *The Economist*, 13 May 2004. www.economist.com

Universidad de Chile and Universidad Técnica Federico Santa María (2008) *Non-conventional renewables energies and energy efficiency potential contribution to the Chilean electric matrix 2008–2025*. Santiago, Chile.

World Bank (2009) *World Development Indicators database*. Accessed 24 April 2009, www.worldbank.org

CHINA

- *Rapid economic growth will drive an average annual growth rate of 2.4 percent in China's final energy demand over the outlook period.*
- *The total primary energy supply is projected to grow at 2.6 percent annually over the period; this includes average annual growth rates of 1.9 percent for coal, 3.1 percent for oil and about 7.7 percent for natural gas.*
- *China's oil import dependency will increase from 38 percent in 2005 to 72 percent in 2030.*
- *Nuclear energy production is expected to grow 11.9 percent between 2005 and 2030; this increase will be key to China reducing CO_2 emissions over the outlook period.*
- *Renewable energy is projected to grow significantly: 16.5 percent between 2005 and 2030.*

ECONOMY

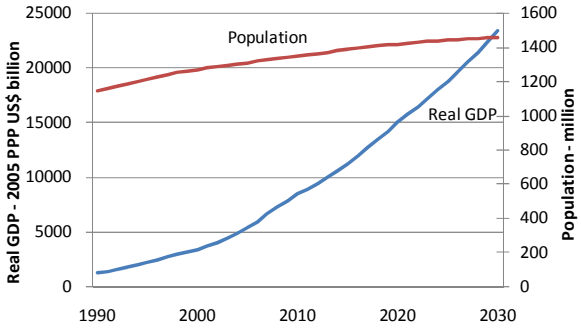
China's land area covers 9,596,961 square kilometres, making it the fourth largest economy in size in the world, after Russia, Canada, and the US. It features a range of landscape types, including mountains, deserts and river basins. The economy's population growth will be restrained during the outlook period, growing 0.4 percent per year compared with an average annual growth of 1.4 percent in the three decades from 1975. The total population is expected to increase to about 1.45 billion by 2030 – 20 percent of the world population.

China is the third largest economy in the world after the US and Japan with a nominal GDP of US$4.4 trillion in 2008. It has sustained high rates of economic growth since the early 1990s; the annual growth rates for 1991–2007 range between 7.6 and 14.2 percent.[57] However, in the late 1990s, growth slowed slightly, and energy consumption also levelled off during 1997–2000. Since 2001, as GDP growth sped up again, along with rates of industrialization, urbanization and motorization, China's energy consumption has grown rapidly.[58] The Chinese economy is expected to grow robustly over the outlook period, at an average annual rate of 6.1 percent – this is the fastest rate projected for all APEC economies.

In particular, China's oil demand increased in response to rising car ownership and industrial development, so that by 2005 it accounted for 19 percent of the economy's total energy demand.

Recent growth in China's energy demand has mainly been driven by rapid growth in industry; in 2006, industry as a whole accounted for 43.8 percent of final energy consumption.[59] While there is some investment in light manufacturing, the main area of growth has been in a comeback of heavy industry since 2001.[60] Within this sector, energy use is dominated by smelting of ferrous metals (29 percent of all industrial energy used in 2006), followed by non-metal mineral industry (21 percent).[61]

Figure PRC1: GDP and population



Source: APERC analysis (2009)

The transportation sector accounted for around 10.5 percent of final energy consumption in 2006; this increased at 9.1 percent annually from 2000 to 2005. This growth in demand is mainly driven by road transportation, which consumes 66.7 percent of this sector's energy use.[62] Passenger vehicle numbers, including civil and private, have grown at an average annual rate of 24 percent from 2000 to 2007.[63] While China is making significant investments in public transportation, including high-speed rail and urban mass transit rail systems, private vehicle ownership is still expected to rise sharply.[64]

The 'other' sector, which is mainly residential and commercial use, accounted for 37 percent of the economy's final energy demand in 2006. Residential

57 IMF (2009).
58 NBS (2008), Energy/6-2.
59 IEA (2008A), II.92.
60 APERC (2008), p 115.
61 IEA (2008A), II.92.
62 Ibid.
63 NBS (2008), Transport/15-26, 15-27.
64 IEA (2007), pp 378–379.

energy use dominates (75.8 percent of this sector's energy use in 2006), followed by agriculture and commercial, at about 10 percent each.[65]

Most of the rural areas in China now have electricity supply; the 2005 electrification figure was 99.4 percent of households.[66] Growth in residential energy demand, however, is mainly due to increasing urbanization. The urban population, concentrated in the Bohai Bay Rim, the Yangtze River Delta and the Pearl River Delta, has grown annually at 3.1 percent from 2000 to 2005, while the rural population has experienced negative population growth. [67] These increases in urbanization and the move toward nuclear families translate into a higher quality of life, and also to increases in total energy demand, as urban residents tend to be more dependent on electricity and commercial fuels than the rural population.[68]

Across the whole of China, heating and cooling is one of the top five residential uses of energy. However, the actual level of demand ranges widely across the economy's varying geography; for instance, in Guanzhou heating and cooling consumes 32 percent of household energy use, while in Shenyang it can be as low as 1 percent of total electric demand.[69]

ENERGY RESOURCES

China is rich in energy resources, particularly coal. In 2006, China 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 has recoverable coal reserves of some 114.5 billion tonnes, enough to last 44 years at 2007 demand levels; proven oil reserves of 2,100 million tonnes, which will last 5.6 years at 2008 demand levels; and proven natural gas reserves of 2,460 bcm, equivalent to 30 years demand at 2008 levels. [70] In addition, China is endowed with 400 GW of hydroelectric generation potential, more than any other economy in the world (2007 installed hydro capacity was 148 GW). There is also potential wind-based generation of 1000 GW, including 750 GW offshore and 250 GW shore-based. [71] Most of the economy's existing electricity generation is coal fired, with coal accounting for 79 percent of electricity production in 2005.

Much of the growth in domestic energy demand for crude oil is being met by imports. The expansion of domestic crude oil production and refinery capacity has not been sufficient to match the rapid increase in demand for diesel and gasoline. China's increased take from the global oil market has had significant impact internationally, tightening the overall balance between demand and supply. Chinese oil companies are also trying to boost overseas investment levels in order to ensure stable supplies.

In 2007, China's total investment in renewable energy was ranked second in the world at US$12 billion, after Germany, which invested US$14 billion. [72] Additions of 2.1 GW installed capacity increased the wind power total installed capacity to 4.2 GW in 2007. [73] In addition, China has been speeding up installation of solar photovoltaic power generation: in early 2007 the installed capacity was 20 MWp, which had risen to 200 MWp at the end of that year. China produced 1088 MWp of solar cells in 2007, exceeding production rates in Japan (920 MWp) and Europe (1062 MWp).[74]

ENERGY POLICIES

In a context of rising demand and constrained supply, China has made energy security the top priority in its energy policy objectives. The economy's "11th five-year plan" sets out a programme for the enhancement of energy security, with strong emphasis on energy efficiency. By 2010, China aims to improve energy intensity by 20 percent, compared with 2005 levels. A number of measures have been implemented to this end, including modernization of energy industries, with the closure of small coalmines, 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.[75]

In recognition of its vulnerability to international market changes, China has been trying to increase the security of its oil supply through intensifying its upstream investment activities in Kazakhstan, Venezuela, Sudan, Iraq, Iran and Peru. It also started developing a second cross-border oil pipeline project between China and Kazakhstan in 2008.[76]

65 IEA (2008A), II.92.

66 IEA (2006), p 570.

67 UN (2007).

68 APERC (2008), p 115–128.

69 APERC (2008), p 121.

70 2007 coal consumption from NBS (2008), p 246; all proved reserves and consumption other than coal from BP (2009).

71 Wu (2007).

72 The Climate Group (2008).

73 CEPY (2008), p 732.

74 IPPGC (2009).

75 NDRC (2007).

76 CIIC (2009).

The government has been steadily implementing energy sector reforms. Gains have been made in the management of energy, and law around energy saving has been noticeably strengthened. The new government elected by the 11th National People's Congress in 2008, has established a high-level coordinating body with the aim of strengthening decision-making in the energy area: the National Energy Committee is in charge of drawing up the economy's overall energy strategy, and deliberating on energy security issues.

One rapidly developing area is the use of combined heat and power (CHP) cogeneration. In northern China where demand for heat is great during winter, CHP offers good gains in energy efficiency, while also reducing air pollution and increasing overall power supply to communities – so allowing an increase in quality of life in a cold climate. Since energy reform policies were introduced in the 1970s, the installed capacity of heat and power cogeneration has grown quickly: from 10 GW in 1990, to 29.9 GW in 2000, and 69.8 GW in 2005 (annual average growth rates of 11.6 percent during 1990–2000, and 18.5 percent during 2001–2005). This expansion is seen to have made a considerable contribution to the economy and social development of China.[77]

The overall policy goals set by China for development of an efficient power sector are:[78]

- promoting the construction of highly efficient large-scale power plants, such as supercritical and extra supercritical coal-fired generation
- restricting the construction of small- and medium-sized conventional coal plants (300 MW and below) and closing inefficient small thermal power plants (China closed plants with total capacity of 23.36 GW in 2007)[79]
- promoting the construction of highly efficient combined heat and power plants to supply district heating in medium-sized and large cities
- promoting the construction of safely designed nuclear power plants.[80]

In 2008, the Chinese Ministry of Finance made a major budget allocation for energy saving and renewable energy, and it is expected this ministry's role in energy conservation promotion will increase greatly. Options being considered include: setting up a special fund to increase investment in energy conservation; adjusting the tax system to encourage energy conservation and promote the rational development and utilization of energy; improving government procurement policies to encourage government agencies to take the lead in energy saving; improving rates for use of resources and environment so that prices reflect real costs; and establishing a fund to support use of new renewable energy sources, to gradually reduce dependence on conventional sources of energy.[81]

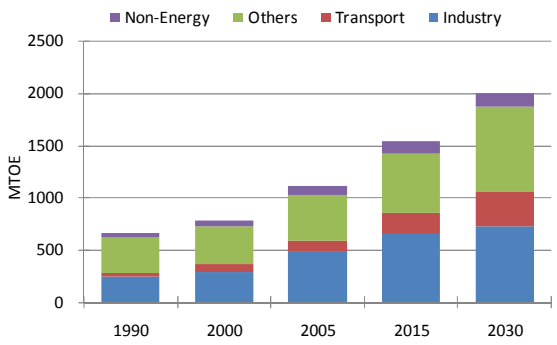
77 CTJ (2008).
78 NDRC-STD (2006).
79 CPIA (2008).
80 NDRC (2007).

OUTLOOK

FINAL ENERGY DEMAND

Over the forecast period, China's final energy demand is projected to grow at 2.4 percent per year, which is much slower than the average annual growth of 4.2 percent between 1985 and 2005. The 'other' sector will take up the largest share in 2030, at 40 percent, followed by the industry sector (36 percent) and transport (17 percent).

Figure PRC2: Final energy demand



Source: APERC analysis (2009)

Industry

China's industrial energy demand is projected to grow at an average annual rate of 1.7 percent until 2030; this is slower than its average annual growth of 2.6 percent between 1985 and 2005. More than two-thirds of the energy required in the industrial sector will be used by heavy industry, such as the processing of chemicals, metals, non-metallic minerals, mining and quarrying. Coal has been the major source of energy in China's industrial sector, although other energy sources such as oil and electricity have nibbled at its share. Over the forecast period, coal's share of the total industrial energy demand is expected to decline, reaching 46 percent by 2030, down from 59 percent in 2005. Coal is mainly used in the production of crude steel, cement, and chemicals.

81 APERC (2009), p 56.

The share of the total industrial energy demand met by petroleum products is projected to decrease to 6 percent in 2030, down from 8 percent in 2005. The industrial demand for natural gas is projected to grow quickly, at 6.1 percent per year, compared with 3.5 percent average annual growth between 1985 and 2005. Despite the relatively fast increase in demand, the natural gas share of the total industrial energy demand will reach only 7 percent in 2030, up from 3 percent in 2005.

The industrial demand for electricity is projected to grow the fastest, at an average annual rate of 2.8 percent over the outlook period. It is expected to follow coal as this sector's dominant energy source by 2030, accounting for 32 percent of China's industrial energy demand. Manufacturing is the major industrial electricity user.

Transport

Chinese transportation energy demand is expected to grow by 4.4 percent annually over the outlook period. Gasoline, the main fuel for passenger vehicles, will see a 4.0 percent increase over the period, while diesel use for trucks and farm vehicles is expected to grow by 4.5 percent. Continued income growth will boost levels of passenger vehicle ownership.

Other

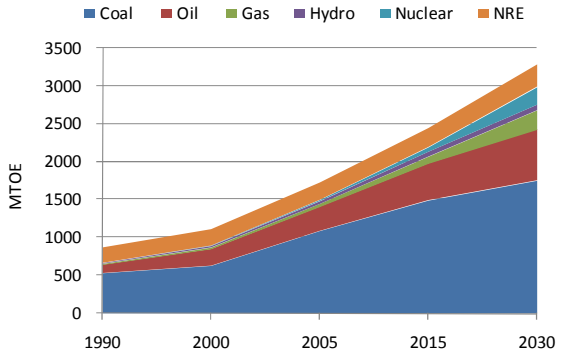
Energy demand in the 'other' sector, which includes residential, commercial, agricultural, and construction demand, is expected to grow at an average annual rate of 2.5 percent over the outlook period. Electricity and biomass are expected to continue to dominate the energy mix in this sector; electricity's share rises from 12 percent in 2005 to 26 percent in 2030, while biomass drops from 52 percent to 28 percent. This shift in the energy mix is based on increased urbanization and rising living standards.

PRIMARY ENERGY SUPPLY

China's total primary energy supply is projected to grow at an average annual rate of 2.6 percent – a slower pace than between 1985 and 2005, when the average annual growth was 2.9 percent.

Among the fossil fuels, natural gas will grow at the fastest pace (7.7 percent per year), followed by oil (3.1 percent) and coal (1.9 percent). Nuclear energy is expected to play a key role in reducing China's CO_2 emissions; it has a projected growth of 11.9 percent over the period, while new renewable energy has a projected growth of about 1.0 percent.

Figure PRC3: Primary energy supply



Source: APERC analysis (2009)

Coal demand will be largely driven by the electricity sector, which accounted for more than 50 percent of the total demand for this fuel in 2007.[82] China will continue to rely on coal to meet the rising demand for electricity, as the most cost-effective option it has; this is in the context of significant coal reserves and the expectation that China is likely to remain a net exporter of coal. The economy is projected to double its installed capacity of coal-fired electricity generation, from 381 GW in 2005 to 762 GW in 2030.

Growth in the industry and transportation sectors will boost demand for oil, with industry (including non-energy oil production) consuming 25 percent and transport using 52 percent of the total oil demand in 2030. As China's efforts to increase its oil supply will not match this rising demand, the economy's net oil import dependency is projected to increase from 38 percent in 2005 to 72 percent in 2030.

The natural gas share of the total primary energy supply will increase from 2 percent in 2005, to 4 percent in 2015, and 8 percent in 2030. China faces considerable difficulties importing and distributing natural gas, which has slowed its uptake of the fuel. Two major pipelines have begun operation or are under construction in the first decade of the twentieth century. The first West–East Gas Pipeline began operation in 2004. It brings natural gas from Kazakhstan to more than 70 cities and 3,000 large and medium-sized enterprises, supporting annual sales of 42 bcm; it is also the main gas source for the Bohai Sea, and Yangtze River Delta economic circles. Construction began in 2008 on the second West–East Gas Pipeline, which will run from Horgos in Xinjiang (where it connects to the Central Asia Gas Pipeline, bringing supply from Kazakhstan, Turkmenistan, and Uzbekistan), southeast to

[82] NBS (2008).

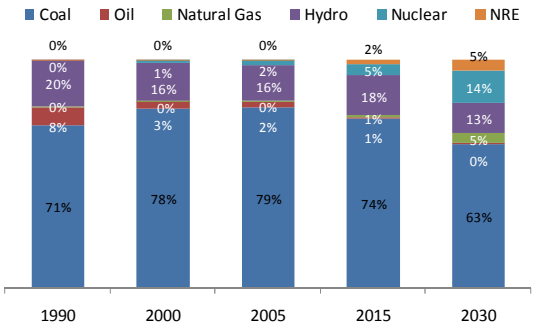
Guangzhou, and east to Shanghai. This 9,139 kilometre line will pass through 14 provinces and municipalities.[83] This second pipeline will deliver 30 bcm annually, a supply level expected to meet demand for 30 years.[84]

ELECTRICITY

Electricity demand in China will increase by 3.8 percent per year over the outlook period – this is more than twice as fast as it was increasing in the period to 2005. The economy's total electricity demand is expected to surpass that of the US sometime around 2025.

Throughout the outlook period, coal will maintain its dominant share in the electricity generation mix; it is projected to provide around 63 percent of generation in 2030. Generation based on natural gas will provide about 5 percent of the total generation mix. In coastal areas, gas-fired generation will replace coal-fired generation, as a result of reforms aimed at reducing emissions. Installed nuclear capacity is projected to increase substantially from 7 GW in 2005 to 70 GW in 2020, and further to 120 GW in 2030; however, the total nuclear share in the electricity generation mix will reach only 14 percent by 2030. Hydro will see a major expansion with the opening of the Three Gorges Dam project in 2009. By 2030, hydro capacity is expected to have reached 320 GW, up from 117 GW in 2005, and renewables-based capacity to reach 139 GW (mostly from wind), up from 3 GW in 2005.

Figure PRC4: Electricity generation mix



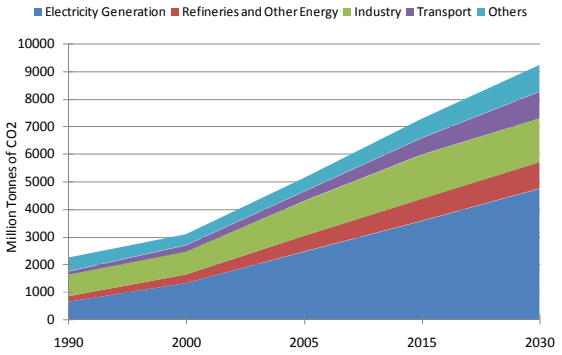
Source: APERC analysis (2009)

CO_2 EMISSIONS

Over the outlook period China's total CO_2 emissions are projected to increase from 5,131 million tonnes of CO_2 in 2005 to 9,225 million tonnes in 2030. Of the 2030 emissions, 51 percent will come from the electricity sector (about 4,741 million tonnes) and 17 percent from industry (1,600 million tonnes).

The decomposition analysis shown in the table below suggests that the growth in China's CO_2 emissions from fuel combustion will primarily be due to economic growth, moderated significantly by decreasing energy intensity. The decline in China's CO_2 intensity of energy by 0.3 percent during the outlook period is based on the commissioning of large capacity nuclear power plants and development of renewable energy resources.

Figure PRC5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table PRC1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.9%	-0.1%	-0.5%	-0.3%
Change in Energy Intensity of GDP	-4.9%	-3.7%	-2.8%	-3.2%
Change in GDP	10.1%	7.7%	5.0%	6.1%
Total Change	5.7%	3.6%	1.5%	2.3%

Source: APERC Analysis (2009)

CHALLENGES AND IMPLICATIONS

China is richly endowed with energy resources such as coal, oil, and hydro. However, the development of these energy sources is not sufficient to meet the economy's growing demand. On the electricity front, there is a need to create a regulatory framework that is attractive for investors, perhaps by means of rewarding investors who build more efficient and environmentally friendly plants.

China's new policy initiatives to promote energy efficiency are expected to reduce the economy's energy intensity significantly; however, the projected increases in living standards and continued economic growth, along with China's high reliance on coal, mean greenhouse gas emissions are still expected to climb significantly. With its large population and rapid economic growth, minimizing the significant environmental impact from the rapid projected

[83] CIIC (2008).

[84] CIIC (2009).

growth should be a top priority for the Chinese government, for without proper measures for fighting greenhouse gas emissions and pollution, China's economic development can create significant burden (on its citizens and the planet).

In terms of energy imports, net import dependency of oil is projected to increase from 38 percent in 2005 to 72 percent in 2030. The increasing energy imports, combined with depleting domestic resources, have raised concerns over energy supply security. While China is aggressively strengthening its relationships with resource-exporting countries, it must continue its effort if it wishes to avoid possible supply shocks and impediments to its high economic growth. Even without significant supply shocks, such high dependency on oil may impede economic growth due to unstable energy prices in China.

REFERENCES

APERC (2008) *Understanding Energy in China*. Asia Pacific Energy Research Centre, Institute of Energy Economics, Tokyo, Japan. http://www.ieej.or.jp/aperc/

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Institute of Energy Economics, Tokyo, Japan. http://www.ieej.or.jp/aperc/

BP (2009) *Statistical Review of World Energy June 2009*. London, England. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

CEPY (2008) *China Electric Power Yearbook*, Beijing, China. http://www.cepp.com.cn

CIIC (2008) "Kazakhstan starts work to send gas to China", China Internet Information Center (official portal of the Central People's Government of the People's Republic of China). http://www.china.org.cn/business/2008-07/10/content_15985103.htm

CIIC (2009) "China lays 2nd west-east natural gas pipeline", China Internet Information Center. http://www.china.org.cn/china/photos/2008-07/14/content_16004226.htm

The Climate Group (2008) *China's Clean Revolution*. http://www.theclimategroup.org/assets/resources/Chinas_Clean_Revolution.pdf

CPIA (2008) *China Power Industry Annual Development Report 2008*. China Power Industry Association, Beijing, China

CTJ (2008) "Energy of China", *China Technologic Journal*, October 2008. China energy magazine, Beijing, China.

EDMC (2007) *APEC Energy Database*. Energy Data and Modelling Center, Institute of Energy Economics, Tokyo, Japan (www.ieej.or.jp/apec).

IEA (2006) *World Energy Outlook*. International Energy Agency, Paris, France. http://www.iea.org/textbase/nppdf/free/2006/weo2006.pdf

IEA (2007) *World Energy Outlook: China and India Insights*, pp 378–379. International Energy Agency, Paris, France.

IEA (2008A) *Energy Balances of Non-OECD Countries*, International Energy Agency, Paris, France. http://www.iea.org/

IEA (2008B) *World Energy Outlook 2008*. International Energy Agency, Paris, France. http://www.iea.org/

IMF (2009) *Data and statistics IMF data mapper*. International Monetary Fund, Washington D.C., USA. http://www.imf.org/external/datamapper/index.php

IPPGC (2009) "Preface to the 3rd International Photovoltaic Power Generation Conference & Exhibition", 6–8 May 2009, Shanghai, China.

Liu, X (2009) "Overview of Energy Development in China", paper presented at APERC Annual Conference 2009, Tokyo, Japan.

NBS (2008) *China Statistical Yearbook (Electronic Version)*, National Bureau of Statistics, China. http://www.stats.gov.cn/tjsj/ndsj/2008/indexeh.htm

NDRC (2007) "11th Five Year Plan– Energy development", National Development and Reform Commission, issued in April 2007, Beijing, China.

NDRC-STD (2006) "Policy outline of China Energy Conservation Technology", National Development and Reform Commission – Science and Technology Department, issued in December 2006, Beijing, China.

UN (2007) "World Urbanization Prospects: 2007 Revision Database", United Nations. http://esa.un.org/unup/index.asp?panel=2

Wu Jingru (2007) "From 2005 to 2030, electricity demand forecasts and the development of strategic research", China Electric Power News Network. http://www.chinapower.com.cn

HONG KONG, CHINA

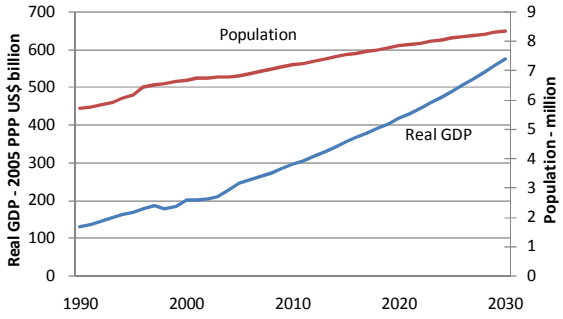
- *Hong Kong, China's primary energy supply is projected to grow at an average annual rate of 1 percent over the outlook period. Most of the increased demand is for oil for international air transport and local transport; in 2030 oil occupies a 40 percent share of the total primary energy supply.*
- *Hong Kong, China is expected to be increasingly dependent on imported energy from mainland China, with import levels doubling between 2005 and 2030.*
- *CO_2 emissions from fuel combustion are projected to reach 54 million tonnes of CO_2 by 2030, which is approximately a 28 percent increase on 2005 levels.*

ECONOMY

Hong Kong, China, is one of the special administrative regions of the People's Republic of China. It borders Guangdong to the north and is surrounded by the South China Sea to the east, west and south. Hong Kong, China is an international financial centre, and has a highly developed capitalist economy.

Hong Kong, China has been transforming itself into an almost entirely services-based economy. Its GDP is expected to grow at an average annual rate of 3.5 percent over the outlook period; this is a slowing down compared to average annual growth of 5.1 percent between 1985 and 2005. Besides the economy's traditional strengths in financial, logistics, property, tourism and services industries, Hong Kong, China's projected growth is based on an increase in knowledge-based and services industries, including fitness and beauty, theme parks, business consulting, and environmental industries. By 2030, it is expected that the services sector will contribute more than 95 percent of GDP. The population is expected to grow slowly at an average annual rate of 0.8 percent over the outlook period, reaching more than 8 million people in 2030.

Figure HKC1: GDP and population



Source: APERC analysis (2009)

Hong Kong, China's economy has a firm foundation in its strong financial services sector. It is expected to continue to shift towards higher-value-added services and a knowledge-based economy. To stay competitive and attain sustainable growth, Hong Kong, China needs to restructure and reposition itself to face the challenges posed by globalization and closer integration with mainland China. The Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) is an example of the opportunities the economy has under the 'One Country, Two Systems' relationship with mainland China.[85] The trade in goods liberalization of CEPA means that all products of Hong Kong, China origin enjoy tariff-free access to mainland China – on application by local manufacturers, and as long as the CEPA rules of origin are satisfied. And from January 2008, service suppliers in Hong Kong, China enjoy preferential treatment in 38 service areas in mainland China.

The government's strategy is to move up the value chain by: speeding up structural transformation to a high-value, knowledge-based, and skill-intensive economy; pursuing reforms in education and population policy to achieve the talent pool required; and leveraging on the immense business opportunities available in mainland China. There are four economic sectors where Hong Kong, China has a competitive advantage over mainland China: trade and logistics, tourism, financial services, and professional services and other producer services.

While road transport is highly visible in the city, the Hong Kong MTR rail system is also a significant part of the transportation sector, carrying about 3.5 million passengers every weekday in 2008, and its ridership has increased at about 5.8 percent annually from 2000 to 2008.[86] As a regional aviation hub as well as the gateway to the Pearl River Delta (PRD) area of mainland China, Hong Kong international airport has

[85] HKTID (2009).
[86] MTRC (2009).

significant throughput – it served around 80 airlines and 48.6 million passengers in 2008.[87] Hong Kong, China's energy use for international aviation is significant – petroleum products for international aviation accounted for about 76 percent of energy use in the whole transportation sector in 2006.[88] In the future, mainland China's increasing participation in global economic activities is expected to speed up the growth of passenger air travel between Hong Kong, China and mainland China. Globalization of economic activities has also increased the freight volume of air transport.

Energy use in Hong Kong, China's 'other' sector is heavily dominated by commercial and public services, which consume about 70 percent of all energy used in this sector (while the residential subsector consumes 29 percent).[89] Due to its tropical climate, air conditioning is a significant part of residential energy use, accounting for about 20 percent of residential demand in 2006. Relatively slow growth in residential energy use (an average annual increase of 1.72 percent from 1996 to 2006) appears to reflect market saturation. Similarly, growth in air conditioning use in the commercial sector has also grown only moderately, at an average annual rate of 2 percent over the same period.[90]

ENERGY RESOURCES

The absence of a domestic energy source has made Hong Kong, China a net importer of oil products (mostly from Singapore); it also imports natural gas – in 2007, 100 percent of this came from mainland China. Privately owned electric and gas utilities service the economy's daily requirements.

Towngas and liquefied petroleum gas (LPG) are the two main types of fuel gas used throughout Hong Kong, China. Towngas 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 (from October 2006) as the feedstock. LPG is supplied by oil companies and imported into Hong Kong, China through the five terminals on Tsing Yi Island.[91]

In 2008 the total installed electricity generating capacity serving Hong Kong, China was 12,644 MW, including capacity in Guangdong contracted to utilities in Hong Kong, China. All locally generated electricity is thermal fired. Electricity is supplied by CLP Power Hong Kong Limited (CLP Power) and The Hongkong Electric Company Limited (HEC). CLP Power supplies electricity from its Black Point (2,500 MW), Castle Peak (4,108 MW) and Penny's Bay (300 MW) power stations. Natural gas is the main fuel at Black Point, and coal the main fuel at Castle Peak. 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 about 70 percent of the electricity generated at the two 984 MW pressurized water reactors at the Guangdong Nuclear Power Station at Daya Bay to help meet the long-term demand for electricity in its supply area. It also has the right to use 50 percent of the 1,200 MW capacity of Phase 1 of the Guangzhou Pumped Storage Power Station at Conghua.[92]

Electricity for HEC is supplied from the coal- and gas-fired Lamma Power Station, which has a total installed capacity of 3,736 MW. Natural gas used at this station is mainly imported through submarine pipeline from Dapeng LNG terminal in Guangdong, China. At the Lamma site, HEC also operates the first commercial wind turbine in Hong Kong, which began operation in February 2006 as a pilot project. The rated capacity of the wind turbine is 800kW.[93]

ENERGY POLICIES

The Government of the Hong Kong Special Administrative Region (SAR) pursues 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 minimize the environmental impact 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

87 HKIA (2009).
88 IEA (2008) II–127.
89 Ibid, II–127.
90 HKEEO (2008).
91 APERC (2009), p 60.
92 Ibid, p 59.
93 HEC (2009).

through the Scheme of Control Agreements, most recently revised in 2008, to encourage energy efficiency, quality services, and renewable energy use.[94]

To help monitor the energy situation, Hong Kong, China has developed an energy end-use database. The database provides useful insight into the energy supply and demand situation, including energy consumption patterns and trends, and energy use characteristics of the individual sectors and subsectors. A basic data set is publicly available on the internet.[95]

In its latest 2008–2009 Policy Address, the government indicates it will continue to support environmental protection and promote sustainable development by taking vigorous measures to improve air quality.[96] For example, the Hong Kong, China government has reached a consensus with the Guangdong Provincial Government on jointly transforming the pan-Pearl River Delta (PRD) region into a 'green and quality living area' based on the principles of promoting environmental protection and sustainable development. To achieve this goal, Hong Kong, China and Guangdong will work together in the areas of post-2010 emission reduction arrangements, the optimization of the energy mix for electricity generation, the development and wider use of renewable energy, vehicle emissions reductions, enhanced conservation, and scientific research, as well as raising public awareness.

On 28 August 2008 a Memorandum of Understanding was signed between the Hong Kong SAR Government and National Energy Bureau of China. This ensures a long-term and stable supply of nuclear electricity, and the supply of natural gas from three different sources, namely offshore gas, piped gas, and liquefied natural gas (LNG), to be supplied through an LNG terminal to be built, as a joint venture, on a neighbouring mainland site.[97] At present, 28 percent of electricity generated by plants in Hong Kong, China is gas fired. The government enacted the legislation on the Mandatory Energy Efficiency Labelling Scheme in May 2008, which will enforce labelling of home appliances to ensure that appliances have met the government's specified requirements.[98] The government is also a leader in energy efficiency building codes, and has provided guidelines since July 2008 that include direction for reporting and reducing greenhouse gas emissions from buildings.[99]

Electricity supply in Hong Kong, China has been provided by two independent, vertically integrated power companies, each providing generation, transmission, distribution and retailing of electricity in two geographically separate areas. Natural gas will be the main energy source for electricity generation in the future. To improve air quality and address the challenges posed by global warming, the government of Hong Kong, China has said it will actively explore ways to gradually increase the use of 'cleaner' energy by, for example, increasing the proportion of natural gas for local electricity generation to 50 percent.[100] However, Hong Kong, China can import much more electricity from mainland China. This projection, therefore, estimates there will be limited new power plant development and that the gas-fired share of local electricity generation will remain at 35 percent in 2030.

Hong Kong, China's government has set a target of 1–2 percent of its total electricity supply to be based on renewable energy sources by 2012. Hong Kong, China does not have much wind farm potential, so most of these increases are expected to come from solar energy.[101]

Other action to promote energy efficiency and conservation, and to make substantial reductions in carbon dioxide emissions, includes the government's plans to implement a district cooling system at the Kai Tak Development – this will supply chilled water to buildings in the new development area for centralized air-conditioning.[102]

In the transportation area, almost all diesel taxis have now 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 electricity-driven models. Up to the end of December 2007, there were over 2,700 LPG light buses in operation, representing more than 40 percent of all public/private light buses in Hong Kong. The government has also taken a leading role in the use of green vehicles, and introduced petrol-electric hybrid vehicles in government fleets in 2005. The government

94 HKG, HECL and HEHL (2008).
95 http://www.emsd.gov.hk
96 HKG (2008A).
97 NEA of PRC and HKSAR (2008).
98 HKG (2008B).
99 HKEPD(2008).
100 APERC (2009), p 61.
101 Leung and Hui (2004).
102 EMSD (2009).

continues to identify possible ways to encourage vehicle owners to use cleaner alternative energy sources.[103]

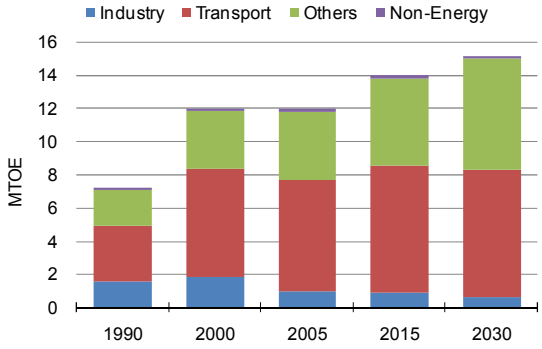
OUTLOOK

FINAL ENERGY DEMAND

In 2005, the total final energy demand in Hong Kong, China reached 12 Mtoe. The transport sector accounted for the largest share at 54 percent, followed by the 'other' sector (34 percent), which is mainly residential and commercial use, and the industrial sector (8 percent). The dominance of transport means the most important end-use energy source was petroleum, accounting for 66 percent of energy use. Electricity and others made up 29 percent of end-use consumption, while gas accounted for only 5 percent.

Over the outlook period, final energy demand is projected to grow at an average annual rate of 0.9 percent, which is low compared with the average annual rate of 5.2 percent between 1985 and 2005. In 2030, the transport sector is expected to still hold the largest share, at 51 percent, followed by the 'other' sector (44 percent), and industry (5 percent).

Figure HKC2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the industrial sector is projected to decline at an average annual rate of 1.7 percent until 2030; this is a drop from the average annual growth of 1 percent between 1985 and 2005. This decrease can perhaps be accounted for by the relocation to mainland China of many industries, especially energy- and labour-intensive ones. Petroleum products are the dominant energy source in Hong Kong, China's industrial production processes, and this consumption is projected to decline at 2.7 percent per year. Diesel accounts for almost all industrial oil consumption in the economy.

Transport

Transport energy demand is projected to rise slightly, from 6.7 Mtoe in 2005 to 7.7 Mtoe in 2030. Much of the growth will come from demand for jet kerosene for international air transport – representing more than 70 percent of the increase in transportation energy demand over the outlook period. The rest of the increase in the projected transportation energy demand will come from local road transport, which uses mainly oil.

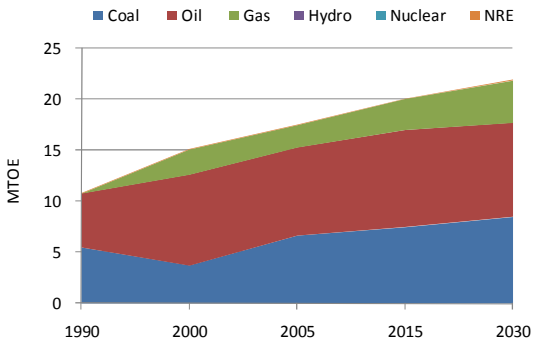
Other

Energy demand in the 'other' sector, which includes residential, commercial, agricultural, and construction demand, is primarily driven by the requirements for space cooling, water heating and cooking. Over the outlook period, the 'other' sector energy demand is expected to grow at an average annual rate of 1.9 percent; this is consistent with projected income growth and improving living standards in Hong Kong, China. Electricity will make up the largest share of the total 'other' sector energy consumption in 2030, accounting for 84 percent.

PRIMARY ENERGY SUPPLY

Hong Kong, China has no domestic energy reserves or petroleum refineries and therefore imports all of its primary energy needs. The total primary energy demand is projected to grow at an annual rate of 1 percent during the outlook period. The strong demand growth in transport means oil will continue to dominate the total primary energy supply, even though its share will decline from 48 percent in 2005 to 40 percent in 2030. Natural gas will increase its share, increasing from 12 percent in 2005 to 18 percent by 2030, at the fastest average annual rate of 2.6 percent. Coal will maintain its 37 percent share in 2030.

Figure HKC3: Primary energy supply



Source: APERC analysis (2009)

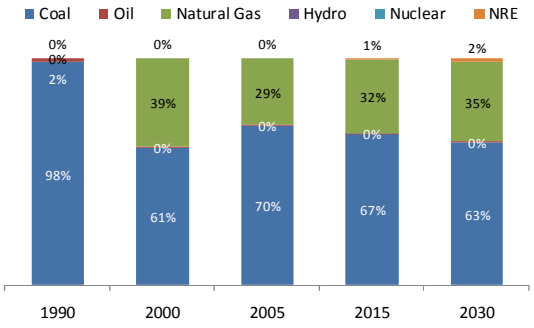
[103] APERC (2009), p 63.

ELECTRICITY

Hong Kong, China's electricity demand is projected to increase at an average annual rate of 2 percent, reaching 5.9 Mtoe in 2030. The economy's commitment to reducing GHG emissions means that additions to the total installed capacity are expected to be natural gas fired, rather than coal fired, and coal's share of the total electricity generation is expected to fall from 70 percent in 2005 to 63 percent in 2030.

Because of strong public opposition to nuclear power, and limited land for construction of a plant, nuclear power is not a viable option for Hong Kong, China over the outlook period. However, the importing of electricity from the Guangdong Daya Bay Nuclear Power Station will continue – this plant supplies around 22 percent of electricity demand in Hong Kong, China. When the power supply agreement with Daya Bay expires in 2013, Hong Kong, China will need to continue sourcing electricity supply from mainland China. Government policies aimed at slowing climate change have set a target for electricity generation from renewable sources: 1–2 percent of the total electricity supply is to be renewables based by 2012. Our projection is that the economy will achieve 1 percent electricity supply from renewable sources by 2015 and 2 percent in 2030.

Figure HKC4: Electricity generation mix



Note: this graph excludes imported electricity from China.

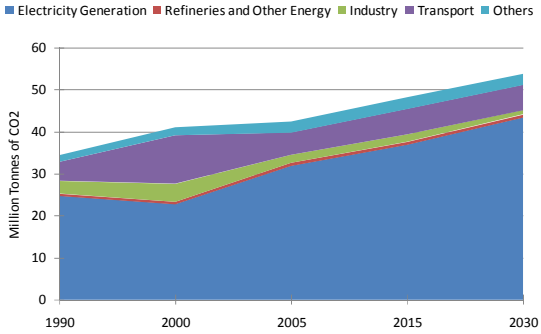
Source: APERC analysis (2009)

CO_2 EMISSIONS

Over the outlook period, Hong Kong, China's total CO_2 emissions from fuel combustion are projected to reach 54 million tonnes of CO_2, which is 29 percent higher than in 2005 and 59 percent higher than the 1990 level emissions.

The electricity generation sector is expected to account for the largest share, at 80 percent of total CO_2 emissions or 43.3 million tonnes of CO_2, followed by the transportation sector (11 percent, or 6.1 million tonnes of CO_2). The transport figures exclude emission from international aviation.

Figure HKC5: CO_2 emissions by sector



Source: APERC analysis (2009)

The decomposition analysis shown in this table indicates that the increases in Hong Kong, China's CO_2 emissions are mainly driven by GDP growth. However, significant and steady reduction in energy intensity is expected to offset much of the increase stemming from economic growth.

Table HKC1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-2.1%	-0.2%	0.1%	0.0%
Change in Energy Intensity of GDP	-6.6%	-2.8%	-2.5%	-2.6%
Change in GDP	10.9%	4.4%	3.3%	3.7%
Total Change	1.4%	1.3%	0.7%	1.0%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Overall, the economy of Hong Kong, China is expected to continue to grow healthily. However, such growth will be heavily dependent on its energy security, as Hong Kong, China depends on imports for most of its energy supply.

With its lack of capacity to refine oil or build many new power plants, the economy is heavily dependent on imported oil and electricity, especially to supply the large energy demands from international aviation and from the residential and commercial sectors. It is critical that Hong Kong, China improves its energy security, in particular to protect itself from fluctuations in the energy market. While the lack of indigenous resources means little can be done to improve security of supply of fossil fuels, electricity security could be greatly improved by ensuring the continuation of the contract with Guangdong Daya Bay Nuclear Power Station, which expires in 2013. Although

Hong Kong, China is almost entirely dependent on imported energy, the fact that much of this energy is imported from mainland China, with which it has close political and economic ties, should help to reduce security of supply risks.

In terms of reducing GHG emissions, the shift away from coal to gas for electricity generation will make a significant difference. However, the increasing energy demand, especially for electricity, will pose a challenge for reducing actual emissions totals. The economy could help reduce its GHG emissions by shifting to more imported electricity from nuclear or renewable energy sources, or by further increasing its energy efficiency at home. Government policies to increase vehicle fuel efficiency and implement district cooling schemes should be continued, to further reduce overall environmental impacts.

REFERENCES

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Institute of Energy Economics, Tokyo, Japan. http://www.ieej.or.jp/aperc/

EMSD (2009) *Agreement No. CE24/2009(EM) District Cooling System at the Kai Tak Development – Design and Construction*, Electrical and Mechanical Services Department. http://www.emsd.gov.hk/emsd/e_download/tenders/EOI_Invitation_CE242009EM.pdf

HEC (2009) The Hong Kong Electric Company Limited. http://www.heh.com/hehWeb/MajorGroupCompanies/TheHongKongElectricCompanyLimited/Generation/Index_en.htm

HKEEO (2008) *Hong Kong Energy End-use Data 2008*, September 2008, Hong Kong Energy Efficiency Office. http://www.emsd.gov.hk/emsd/eng/pee/edata.shtml

HKEPD (2008) *Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings of Commercial, Residential or Institutional Purposes in Hong Kong*, Hong Kong Environmental Protection Department. http://www.epd.gov.hk/epd/english/climate_change/files/CAGuidelines_Eng.pdf

HKG (2008A) *2008–2009 Policy Address*, Hong Kong Government. http://www.policyaddress.gov.hk/08-09/eng/policy.html

HKG (2008B) *Mandatory Energy Efficiency Labelling Scheme*, Hong Kong Government. http://www.gov.hk/en/residents/environment/energy/mandatorylabel.htm

HKG, HEC and HEH (2008) *The Scheme of Control Agreement*, Hong Kong Government, Hong Kong Electric Company Limited, and Hong Kong Electric Holdings Limited. http://www.heh.com/hehWeb/AboutUs/SchemeOfControlAgreement/Index_en.htm

HKIA (2009) "Our Business", Hong Kong International Airport. http://www.hongkongairport.com/eng/business/about-the-airport/welcome.html

HKTID (2009) *Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA)*, Hong Kong Trade and Industry Department. http://www.tid.gov.hk/english/cepa/cepa_overview.html

IEA (2008) *Energy Balances of Non-OECD Countries*, International Energy Agency, Paris, France.

K.M. Leung and W.W. Hui (2004) *Renewable Energy Development in Hong Kong*, Electrical and Mechanical Services Department, Hong Kong. http://www.emsd.gov.hk/emsd/e_download/wnew/conf_papers/drpt045.pdf

MTRC (2009) *Patronage Updated*, MTR Corporation. http://mtr.com.hk/eng/investrelation/patronage.php#search

NEA of PRC and HKSAR (2008) *Memorandum of Understanding*, National Energy Administration of People's Republic of China and Hong Kong Special Administrative Region. http://gia.info.gov.hk/general/200808/28/P200808280188_0188_44075.doc

INDONESIA

- *Indonesia's primary energy supply, including biomass, is projected to increase at an average annual rate of 2.6 percent, from 176.0 Mtoe in 2005 to 331.6 Mtoe in 2030.*
- *Indonesia is projected, on a business-as-usual basis, to continue to rely heavily on oil; crude oil and petroleum product imports are projected to increase from 12.2Mtoe in 2005 to 71.1 Mtoe in 2030.*
- *To reduce reliance on oil and address climate change, Indonesia will need to promote the use of gas in the domestic market, improve energy efficiency and intensify development of lower-carbon energy resources.*

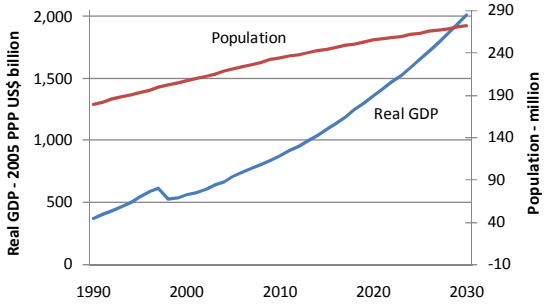
ECONOMY

Indonesia is a large archipelago located at the juncture between mainland Southeast Asia, the continent of Australia, the Pacific Ocean and the Indian Ocean. It consists of 17,508 large and small islands stretching across three time zones. There is considerable regional variance in population density, level of development, energy resources, energy supply infrastructure, and energy demand.

The economy had a population of 223 million in 2006. The population grew at an average annual rate of 1.3 percent between 2000 and 2006. Indonesia's population is projected to grow at an average annual rate of 0.8 percent over the outlook period.

The Indonesian economy has progressively become more industrialized. However, it is still largely agricultural. Around 57 percent of the population live in rural areas and are involved in agriculture-related activities.

Figure INA1: GDP and population



Source: APERC analysis (2009)

The Indonesian economy has recovered from the Asian financial crisis of 1997, which profoundly affected all sectors of the Indonesian economy. Since the mid 2000s, Indonesia has experienced robust economic growth, albeit at a significantly slower rate than before the crisis.

In 2005, Indonesia had a per capita GDP of US$3,209 (in 2005 US$ PPP). Between 2006 and 2008, Indonesia's average annual GDP growth was 6.2 percent. As a result of the global economic downturn, GDP growth is expected to decline to 4.5 percent in 2009. Over the outlook period to 2030, GDP is projected to increase at an average annual rate of 4.3 percent.

The manufacturing sector accounted for the largest share of Indonesia's 2006 GDP at 28 percent. Indonesia's transport equipment industry, in particular, is highly competitive in the manufacture of road transport vehicles and in shipbuilding. The various service sectors when combined accounted for 35 percent of GDP, the agriculture, livestock, forestry and fishery sector for 14 percent, while the remaining sectors make up the final 23 percent.

In 2006, Indonesia's energy-intensive industries were fertilizer[104] (production capacity of urea: 7.9 million tonnes, other fertilizers: 1.95 million tonnes); petrochemicals (aromatics and its derivatives: 6.74 million tonnes; polypropylene, ethylene, polyethylene, and methanol: a combined 2.59 million tonnes); cement [105] (44.9 million tonnes); non-metallic minerals; pulp (6.48 million tonnes) and paper [106] (10.4 million tonnes); and steel[107] (3.5 million tonnes). The capacity of the cement industry is expected to increase to 47.5 million tonnes in 2009.[108]

Indonesia's steel production capacity is relatively small compared with the economy's demand for steel at 6 million tonnes and the production capacity of the economy's downstream steel industry at 24.4 million tonnes in 2006.[109] However, capacity could increase by at least 3 million tonnes in the first half of the outlook period. [110] Similarly, Indonesia's ethylene

[104] US Embassy Jakarta (2008).
[105] Timuryono (2007).
[106] Bar (2008), Bulitinbisnis (2008).
[107] Indonesian Commercial Newsletter (2008B).
[108] Asia Pulse (2009).
[109] Indonesian Commercial Newsletter (2008B).
[110] ASEAN Affairs (2008A), Wulandri (2009).

production of 0.49 million tonnes in 2006 (capacity 0.55 million tonnes) was far short of ethylene demand at 0.9 million tonnes. The paper industry has been operating below capacity, at 81 percent of capacity in 2006. Energy-intensive industries are expected to expand over the outlook period, in line with economic growth.

The supply of gas to the fertilizer industry and non-metallic industries has been a challenge for Indonesia. For example, the expiry of the gas supply contract to ASEAN Aceh Fertilizer's (AAF) plant in Lhokseumawe, Aceh, led to the plant's closure in 2003. The AAF plant had a production capacity of 0.685 million tonnes.[111] Remaining fertilizer plants have been endeavouring to secure future gas supply because they are currently linked to suppliers with smaller gas reserves. Coal gasification and gas supply from imported LNG have been considered as alternative options to meet the future gas requirements of fertilizer plants.[112]

The island of Java is the most densely populated island of Indonesia; it is also the smallest of the five major islands. Java had a population of 130 million in 2006, more than half of the economy's total population. The island has energy-intensive industries including refineries and many of the economy's large manufacturing industries; it also hosts a large commercial and service sector, and features a high number of vehicles per population. This makes the island of Java a large energy demand centre; however, its energy resource base is relatively small. The island relies on supply of oil, coal and gas from other regions, and on foreign imports of oil.

Indonesia has large urban populations around its major cities, and the most populous and dense urban areas are in Java. Urban structure change, road development and population growth have led to an increase in long distance commuting and traffic congestion in the major cities of Indonesia. Public road transport, which relies primarily on large and small buses, is important all over Indonesia. However, an inadequate fleet, poor services provided by some operators, and lengthy walking distances often involved with the use of public transport result in private transport being the preferred choice.

Motorized road transport accounts for the largest share of oil use. In 2006, fuels used in road transport included gasoline (63 percent) and automotive diesel oil (37 percent). Government policy seeks to rapidly increase the use of gasoline/bioethanol blend and biodiesel fuels in transport.[113] Indonesia's inter-island sea transport and domestic air transport are expected to grow significantly over the outlook period, driven by economic growth.

Biomass is an important fuel in households and to a lesser extent in industry. Consumption of biomass in the residential sector is estimated at 43.6 Mtoe in 2006. Households are increasingly relying on commercial energy, primarily kerosene and LPG. In 2006, residential consumption of kerosene was 7.9 Mtoe, while LPG was 0.89 Mtoe.

In 2006, the state-owned electricity company (PLN) reported that it provided service to 54 percent of Indonesia's households.[114] PLN expects that 93 percent of households will be connected to grid electricity by 2020. The Ministry of Energy and Mineral Resources has reported that Indonesia's electrification ratio has increased to 65 percent in 2009.

ENERGY RESOURCES

Development of Indonesia's oil and gas resources has been a challenge for the economy, particularly in the years following the Asian financial crisis. In the mid 2000s, however, Indonesia was able to regain substantial investment in oil and gas exploration, with committed annual investments more than doubling in the period from 2004 to 2008. This trend is expected to continue.

With new oil and gas production capacity coming online over the outlook period and investment in exploration increasing, it appears likely that Indonesia will be able to maintain current its oil and gas production over the outlook period. Additions to proved reserves are likely given the number of basins that are unexplored.[115] At the same time, the cost of production could rise, as new discoveries will most likely be in frontier regions and deep water.

Indonesia's 2008 proven oil reserve was 4.0 billion barrels. Proven reserves of conventional gas were 112.5 Tcf, while proven coal reserves were 4.3 billion tonnes.[116] The economy's most productive oil and gas basins are located mostly in

[111] Indonesian Commercial Newsletter (2008A).

[112] Indonesian Commercial Newsletter (2008A).

[113] Republic of Indonesia (2008).

[114] Mulyantono (2007).

[115] ASEAN Affairs (2008B).

[116] BP (2009).

the western part of Indonesia; most of these are considered to be mature basins.

New gas production will come from the LNG project in Tangguh, Papua, which began LNG shipments in 2009. Large natural gas projects expected to come on-stream over the first half of the outlook period include the deep-water gas field in the Makassar Strait, the Abadi gas field in the Timor Sea, and the Sonoro–Matindok gas field in central Sulawesi. Most of the reserves developed for these projects are dedicated to LNG exports. Indonesia also expects to develop the large Natuna D-Alpha gas field in the Natuna Sea and other potential gas fields in Aceh, south Sumatra and in east Java.

Indonesia's crude oil and petroleum product imports are increasing. The trend coincides with rising domestic oil demand, declining crude production and limited refining capacity (1.15 million barrels per day in 2006).

Indonesia has considerable coal bed methane (CBM) resources, although the extent to which they can be commercialized over the outlook period remains uncertain. Indonesia's coal-bed methane (CBM) reserves were revised to 453.3 Tcf in 2008.[117] Work areas have been awarded for CBM development in east Kalimantan and south Sumatra, where the most promising basins are located. Indonesia is investigating the possibility of large-scale CBM development in east Kalimantan for delivery to Java. This will require the construction of a long-distance pipeline over land and undersea.

Indonesia's coal production increased from 40.1 million tonnes in 1995 to 212 million tonnes in 2007. This rapid increase of production was mainly driven by the international market – 158.6 million tonnes of coal was exported in 2007. The Indonesian Coal Mining Association (ICMA) expects coal production to increase to 421 million tonnes by 2025.[118] Indonesian coal producers have declared that they will voluntarily limit future annual coal exports to 185 million tonnes, in order to be able to meet increasing domestic coal demand.[119] Indonesia is currently one of the world's leading exporters of steam coal. Its coal is recognized for its low sulphur content.

In 2008, Indonesia has geothermal power generation potential of 27,000 MW, and hydropower potential of 75,670 MW[120]. However, about 35,000 MW of Indonesia's hydropower potential is located in the province of Papua, far from demand centres. In 2008, installed geothermal capacity was 1,042 MW, while hydropower was 4,200 MW in 2008.

There are hydropower developments underway and under consideration in north Sumatra and Aceh (443 MW), and in south Sulawesi (126 MW). Further development of large hydropower schemes in Java is considered unfeasible, due to longer spells of drought on the island. Geothermal development is expected to increase by at least 2,435 MW, in the first half of the outlook period.

Indonesia's electricity sector has been making substantial new investments in generation and transmission since 2006. The sector is catching up on delayed investments following the 1997 financial crisis. The electricity sector expansion plan is intended to end shortfalls of supply in all regions, with margin for growth, and to eliminate oil-based generation, except in the case of regions where there are no competitive alternatives.

The plan, which is executed by PLN, will involve the construction of a total of 36,440 MW of new generating capacity between 2006 and 2015.[121] APERC's projection of new generating capacity, which is based on generation needed to meet estimated demand, is considerably lower. However, APERC's demand projections may be conservative. New capacity would be predominantly coal-fired, with some new gas-fired and geothermal capacity as well.

ENERGY POLICIES

Indonesia's energy policy promotes the discovery of new hydrocarbon reserves. However, Indonesia is also keen to diversify its energy use in order to reduce the large share of oil in the economy's final energy demand, and to implement energy conservation measures. Its energy policy sets a goal for a 2025 primary energy demand that has an oil share of less than 20 percent. This would require the natural gas share to be more than 30 percent, coal share to be 33 percent, and renewable energy to constitute the balance.[122]

To achieve this goal, Indonesia expects to realize long-distance delivery of gas by pipeline to

[117] Yusgiantoro (2008).

[118] Suhala (2008).

[119] Suhala (2008).

[120] Ariati (2009).

[121] Ibrahim (2006), Republic of Indonesia (2006B), and PLN (2009).

[122] Republic of Indonesia (2006A).

demand centres, and to develop trunk lines within those demand centres.[123] In addition, Indonesia expects to build LNG-receiving terminals in demand centres in Java and Sumatra. At the same time, the government is undertaking a comprehensive geological survey of geothermal potential, in order to encourage investment by reducing some of the risks of geothermal development. Indonesia has also developed policies promoting biofuel use in road transport, which sets a 20 percent target for biodiesel replacement of automotive diesel use and a 15 percent target for bioethanol replacement of gasoline by 2025.

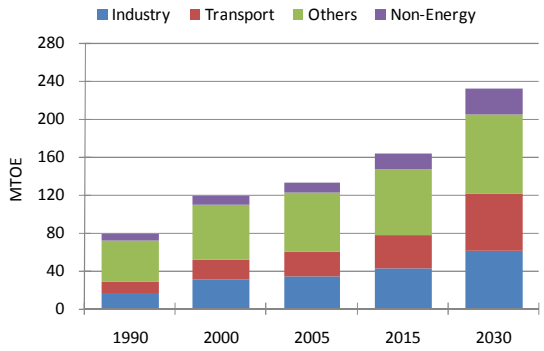
Fuel subsidies for electricity generation and industry have been removed. However, there remain significant subsidies on lower octane gasoline and diesel oil for transport, kerosene for households and certain classes of electricity for households and social use.

OUTLOOK

FINAL ENERGY DEMAND

Indonesia's final energy demand is projected to increase at an average annual rate of 2.2 percent over the forecast period, to reach 231.7 Mtoe in 2030 compared to 133.5 Mtoe in 2005. Demand is expected to increase more rapidly in the last 15 years of the period, at an average rate of 2.4 percent per year.

Figure INA2: Final energy demand



Source: APERC analysis (2009)

Industry

The final energy demand of Indonesia's industry sector is projected to increase at an average annual rate of 2.3 percent over the period, increasing from 34.4 Mtoe in 2005 to 61.2 Mtoe in 2030.

The composition of the final energy demand for Indonesian industry in 2030 is coal (31 percent), oil (25 percent), natural gas (17 percent), electricity (16 percent), and biomass (11 percent).

Transport

The final energy demand for the transport sector is projected to grow at an average annual rate of 3.4 percent over the period. Final demand for oil products is expected to increase from 25.7 Mtoe in 2005 to 59.8 Mtoe in 2030.

The projection assumes that 40 percent of gasoline used in 2030 will be a gasoline/bioethanol blend (E10) and 60 percent of automotive diesel will be biodiesel (B10).

Compressed natural gas (CNG) was introduced as a gasoline substitute in the capital Jakarta and two other large cities in Java in the mid 1980s. The number of CNG-based vehicles reached a peak of about 6,300 in 2000; however, the CNG-based vehicle stock declined to about 600 vehicles[124] by 2005, and sales of CNG was down to 5 ktoe in 2006.[125] Under this outlook's business-as-usual assumptions, expansion of CNG has not been considered.

Other

The final energy demand for the 'other' sector (which includes the residential, commercial and agriculture subsectors) is projected to grow at an average annual rate of 1.2 percent over the outlook period. Demand for electricity is projected to rise the most rapidly, at an average annual rate of 3.8 percent. Demand for petroleum products, including liquefied petroleum gas (LPG), is projected to increase at an average annual rate of 2.4 percent. The forecast anticipates a strong increase in use of fuels in agricultural activities. Biomass is assumed to continue to be an important source of fuel in the residential sector, although its use is increasing more slowly than in previous periods.

PRIMARY ENERGY SUPPLY

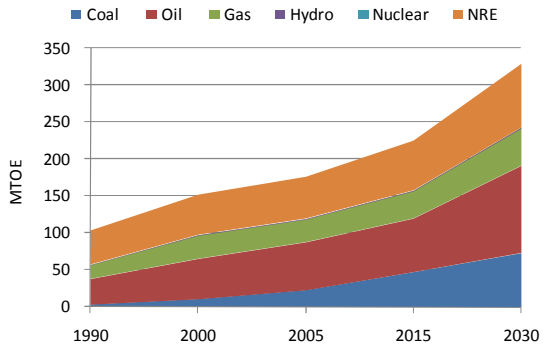
Indonesia's primary energy supply is expected to increase at an average annual rate of 2.6 percent over the forecast period, rising from 176.0 Mtoe in 2005 to 331.6 Mtoe in 2030.

[123] Republic of Indonesia (2005).

[124] Wibowo and Caryana (2006).

[125] EGEDA (2009).

Figure INA3: Primary energy demand



Source: APERC analysis (2009)

Indonesia is expected to be able to slightly increase its oil and gas production above 2005 levels in the first part of the outlook period, and thereafter will experience a gradual decline to 2030.

The projected average annual rate of growth for crude oil supply is 2.4 percent, and for natural gas supply is 2.1 percent. Indonesia is expected to be increasingly dependent on oil imports over the forecast period. Net crude oil imports will reach 61.4 Mtoe by 2030, while refinery product imports will reach 7.4 Mtoe.

Net gas available for export could decline to 15.3 Mtoe in 2030, down from 32.1 Mtoe in 2005. Coal production is projected to increase rapidly over the outlook period, with the supply of coal for domestic use expected to grow at an average annual rate of 4.7 percent. Total coal supply at 2030 is projected to be 73.2 Mtoe.

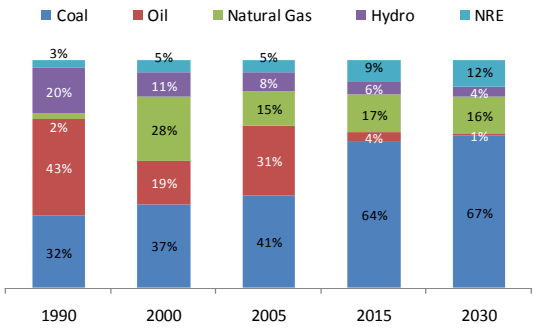
Although hydropower and other renewable energy resources, including geothermal and biofuels, are expected to contribute significantly to Indonesia's energy supply, their absolute role is relatively small in comparison to the growth of supply from fossil fuels. Most renewable energy use is expected to remain biomass.

ELECTRICITY

The electricity sector is expected to expand coal-fired generation capacity, and in the process to eliminate most use of oil for electricity generation. The share of electricity generated by oil-fired power plants will reduce from 31 percent in 2005 to 4 percent in 2015, and is then to further decline to 1 percent by 2030.

Electricity generated by coal-fired power plants is expected to increase rapidly to 64 percent of all electricity generated in 2015; the final figure for 2030 is 67 percent. The projection assumes that, in view of Indonesia's low load factor and elimination of oil from power generation, significant natural gas capacity will be required to supply peak and intermediate loads.

Figure INA4: Electricity generation mix



Source: APERC analysis (2009)

In previous periods the Indonesian electricity sector had been able to significantly reduce the share of oil used in electricity generation by introducing large gas-fired generation projects including combined cycle power plants. However, in the mid 2000s the economy had to revert to using a larger share of oil for electricity generation, due to inadequate supply of gas. This projection assumes there will be sufficient gas supply for planned gas-fired electricity generation throughout the outlook period. It also assumes that large-scale steam-generation plants will be based on subcritical steam technology rather than more efficient supercritical or ultra-supercritical steam technology. At the time of writing, no plans for the latter had been announced.

The projection assumes that the partially integrated power systems and isolated grids within the growing demand regions of Sumatra, Sulawesi, and Kalimantan will be interconnected and strengthened, and that the foreseeable transmission bottlenecks in the Java–Madura–Bali system will be eliminated. These changes will accommodate rapid growth of supply in the future.

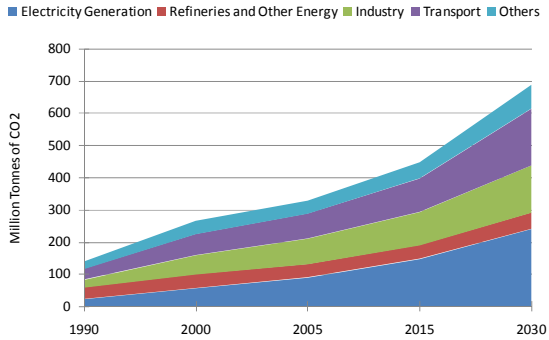
CO_2 EMISSIONS

Indonesia's CO_2 emissions from combustion of fossil fuel are projected to reach 688 million tonnes of CO_2 in 2030 compared to 328 million tonnes in 2005 and 140 million tonnes in 1990. Fossil fuel use for electricity generation accounts for the largest share of the CO_2 emissions in 2030 (35 percent or 240 million tonnes of CO_2).

The decomposition analysis shown in the following table suggests that economic growth is the most important factor in the increase of CO_2 emissions; there is also some impact from the

change in CO_2 intensity of energy, as a result of the increased use of coal. On the other hand, the energy intensity of Indonesia's GDP reduces over the outlook period as a result of both changes in Indonesia's economic structure toward less energy-intensive activities and improvements in energy efficiency. The overall average annual growth rate for Indonesia's CO_2 emissions is expected to be 3.0 percent over the outlook period.

Figure INA5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table INA1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	2.1%	0.6%	0.3%	0.5%
Change in Energy Intensity of GDP	-0.7%	-1.8%	-1.5%	-1.7%
Change in GDP	4.4%	4.4%	4.2%	4.3%
Total Change	5.8%	3.2%	2.9%	3.0%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

This projection suggests that under business-as-usual assumptions, Indonesia will not be meeting its own goals of reducing its dependence on oil and contributing to a solution to the climate change problem. Diversification away from oil is imperative for Indonesia given the likely cost, price volatility, and vulnerability to disruption of future imported oil supplies.

According to this projection, Indonesia will continue to have a high share of oil in its primary energy mix over the outlook period – 35 percent in 2030. This is significantly higher than the economy's current policy target, which is that oil will account for only 20 percent of the primary energy mix by 2025. A similar gap between projected and target figures is revealed by the 2009–2030 forecast made by the Ministry of Energy and Mineral Resources.[126] Also, according to our projections, Indonesia's CO_2 emissions from fossil fuel combustion could more than double between 2005 and 2030.

Natural gas, including CBM, should continue to be central to Indonesia's energy policy direction. Gas can be the basis for increased oil substitution and to meeting the anticipated increase in the economy's final energy demand with lower emissions. In particular, gas could substitute for coal in electricity generation and industrial applications. Indonesia is at a critical point in its management of gas reserves, and will need to allocate greater proportion of its reserves for domestic use if it is to meet its own policy objectives. It will also need to extend and strengthen its gas pipeline network and continue to promote gas exploration and development.

A particular challenge in regard to oil substitution and emissions is in the transport sector. Current policies focus primarily on increasing the share of biofuels used. Indonesia may want to consider policies that will promote greater use of natural gas and its derivatives for transport, such as compressed natural gas (CNG). In addition, a re-examination of the broad range of transport policies in light of Indonesia's energy challenges may be appropriate. These may include promotion of mass transit, promotion of transit-oriented land-use development, and higher energy efficiency standards for vehicles.

There is also significant potential for energy savings through efficiency improvements in other final demand sectors. A move away from general subsidies on fuel, while continuing to assist those who would otherwise face energy poverty, would be a key step toward promoting the more efficient use of energy, especially oil.

Finally, Indonesia has a range of options for reducing the carbon content of its energy supply that should be considered. These include increased development of its hydro, geothermal and wind resources, and more efficient thermal electricity generating plants.

REFERENCES

APERC (2007) *Urban transport energy use in the APEC region*. Asia Pacific Energy Research Centre, Tokyo, Japan. http://www.ieej.or.jp/aperc/

[126] Zed (2009).

APERC (2009) *Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. http://www.ieej.or.jp/aperc/

Ariati R, Ministry of Energy and Mineral Resources (2009) *Peran energy baru terbarukan (EBT) di Indonesia*, presentation to STTNAS, Jakarta 27 April 2009. http://www.ceen.unsw.edu.au

ASEAN Affairs (2008A) "China to build two steel plants in Indonesia", 21 July 2008. http://www.aseanaffairs.com/

ASEAN Affairs (2008B) "New oil, gas basins found in East Indonesia". http://www.aseanaffairs.com/

Asia Pulse (2009) "Indonesia's cement production capacity to increase by 2.5 million tonnes", May 2009. http://highbeam.com/

Bar, C – Center for International Forestry Research (2008) "Indonesia's pulp and paper industry: overview of risks and opportunities", presentation to Roundtable on Indonesia's Pulp and Paper Industry, 19 April 2008, New York, US. http://www.environmentalpaper.org/

BP (2008) *Statistical Review of World Energy*, June 2008. http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

Bulitinbisnis (2008) "Investasi USD2.4 terancam", 5 September 2007. http://bulitinbisnis.wordpress.com/

Data Consult (2007) "Indonesian pulp and paper industry: its outlook and prospect", March 2007, http://www.datacon.co.id/

EGEDA (2009) Database, Expert Group on Energy Data Analysis (EGEDA). Energy Data and Modelling Center (EDMC), The Institute of Energy Economics (IEEJ), Tokyo, Japan. http://www.ieej.or.jp/egeda/

ESDM, CDI-EMR (2008) *Handbook of Energy & Economic Statistics of Indonesia 2008*. Ministry of Energy and Mineral Resources, Centre for Data and Information on Energy and Mineral Resources, Jakarta, Indonesia.

ESDM (2009) "National electrification ratio increase by 1.5 percent per year", Ministry of Energy and Mineral Resources, 28 February 2009. http://www.esdm.go.id/

Hilmawan, E and Said, M (2009) "Energy efficiency standard and labelling policy in Indonesia", presentation to International cooperation for energy efficiency standard and labelling policy, 27 February 2009, Tokyo, Japan. http://eneken.ieej.or.jp/

Ibrahim, H D – Perusahaan Listrik Negara (PLN) (2006) "Launching and Discussion on: the Electrical Power Supply Business Plan (RUPTL)", presentation, 1 February 2006. Jakarta, Indonesia, http://www.akli.org/files/

Indonesian Commercial Newsletter (2007) "Essar licensed to build steel plant in Indonesia", April 2007, http://findarticles.com/

Indonesian Commercial Newsletter (2008A) "Market intelligence report on fertilizer industry in Indonesia", September 2008. http://www.datacon.co.id/Ferlilizer.html

Indonesian Commercial Newsletter (2008B) "Market intelligence report on steel industry in Indonesia", June 2008. http://www.datacon.co.id/Steel%20industry.html

Mediadata (2008) "Condition and investment prospects of steel industry in Indonesia", http://mediadata.co.id/

Ministry of Energy and Mineral Resources, Centre for Geological Resources (2008) "IAGI mapped 20 new basins", 28 August 2008. http://www.dim.esdm.go.id/

Mulyantono, T A – PLN (2007) "Challenges of investing in cleaner coal", presentation to Asian Clean Energy Forum – the Asia Energy Forum, 27 June 2007, Manila, Philippines. http://www.adb.org/

PLN (2009) *Siaran Pers* 9 February 2009. http://pln.co.id

Republic of Indonesia (2005) Ministerial Decree No. 1321/2005 regarding *National Earth Gas Transmission and Distribution Network Master Plan.* 30 May 2005. http://www.esdm.go.id/

Republic of Indonesia (2006A) Presidential Regulation No. 5/2006 regarding *National Energy Policy,* 25 January 2006. http://www.esdm.go.id/

Republic of Indonesia (2006B) Presidential Regulation No. 71/2006 regarding *Assignment of PT Perusahaan Listrik Negara to execute accelerated construction of power plants that utilize coal,* 5 July 2006. http://www.esdm.go.id/

Republic of Indonesia (2008) Ministerial Regulation No. 32/2008 regarding *Regulation on*

supply, use and commerce of biofuel as other fuel, 26 September 2008. http://www.esdm.go.id/

Suhala, S – Indonesian Coal Mining Association (2008) "Current Status and Future of Coal Mining Industry in Indonesia", presentation to Japan Coal Energy Centre and Ministry of Economy, Trade and Industry, Clean Coal Day Symposium (proceedings), Tokyo, Japan.

Timuryono, U – Indonesia Cement Association (2007) "Development of cement industry in Indonesia", presentation to FL Smidth 125 years anniversary seminar, 13 May 2007, Bali, Indonesia.

US Embassy, Jakarta (2008) *Petroleum Report Indonesia 2008*. Jakarta, Indonesia. http://jakarta.usembassy.gov/econ/petro2008-toc.html

Wibowo, E and Caryana, YK – Oil and Gas Technology Research and Development Center (LEMIGAS) (2006) "Compressed natural gas (CNG) utilization policy to improve urban air quality", presentation to The 4th Asian Petroleum Technology Symposium, 18–20 January, Siem Riap, Cambodia. http://www.pecj.or.jp/

Wulandari, F (2009) "Update 3 – Indonesia, South Korea's POSCO discuss steel project", 8 September 2009, Reuters http://www.reuters.com/articles/rbssSteel/idUSJAK

Yudhoyono (2009) "Statement by H.E. Dr. Susilo Bambang Yudhoyono, President of the Republic of Indonesia, for the Summit on Climate Change to be Held in New York on 22 September 2009", http://www.un.org/webcast/pdfs/climatechangesummit/indonesia.pdf

Yusgiantoro, P (2008) "Indonesia's CBM for the benefit of the GOI and investors: how would it progress?" Address by the Minister for Energy and Mineral Resources, Republic of Indonesia at the IndoCBM 2008 conference, Jakatra, 25-26 June 2008. http://iee-c.com/indocbm2008/

Zed, F – Data and Information Centre (Pusdatin), Ministry of Energy and Mineral Resources, Republic of Indonesia (2009) "Indonesia Energy Outlook 2009-2030", presentation to Asia Pacific Energy Research Centre (APERC), Tokyo, Japan.

JAPAN

- *Japan's GDP is expected to grow at an average annual rate of 1.2 percent between 2005 and 2030.*
- *Japan's final energy demand in 2030 will be 2.2 percent less than in 2005 (an average annual decrease of 0.1 percent).*
- *The economy's oil dependency will decrease over the outlook period, from 47 percent of the primary energy supply in 2005 to 36 percent in 2030. The share of the total energy mix provided by natural gas and nuclear will increase.*
- *CO_2 emissions from fossil fuel combustion in 2030 are projected to be about 7 percent lower than 2005 levels.*
- *In order to achieve energy security, economic development, and environmental protection (the 3Es), Japan will need to overcome acute technological and economic challenges.*

ECONOMY

Japan is an island economy in Eastern Asia. It is made up of several thousand islands, the largest of which are Honshu, Hokkaido, Kyushu and Shikoku. It has a total land area of approximately 377,800 square kilometres, most of which is mountainous and thickly forested.

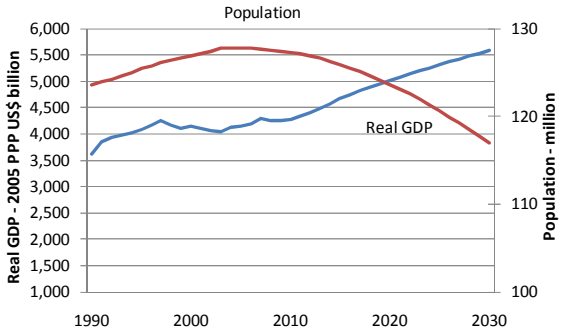
Japan is the world's second largest economy after the US. Japan's real GDP in 2006 was about US$4,196 billion (2005 US$ at PPP). Across the population of 128 million people, per capita income in 2006 was US$32,781. While Japan's economy remained resilient following the Asian financial crisis of 1997, it has been severely affected by the global economic recession that began in 2008.

Over the outlook period, the Japanese economy is expected to grow at an annual rate of 1.2 percent through to 2030. This reflects, in part, the current global recession. Japan's economy is projected to resume pre-recession growth rates from 2011.

Japan's population is expected to reduce over the outlook period, declining at an average rate of 0.4 percent per year; this compares with population growth of 0.4 percent between 1980 and 2005.

Despite a decreasing and aging population, the economy's overall labour productivity is expected to improve, as a result of technological development and other factors. Therefore, this outlook assumes stable growth, with an annual average growth rate of 1.2 percent between 2005 and 2030. During that time the Japanese industrial structure is expected, given the increasingly mature status of the society and economy, to become further oriented toward services, information and higher-value-added products.

Figure JPN1: GDP and population



Source: APERC analysis (2009)

Japan's electricity demand will continue to increase in the future, due to the economy's stronger emphasis on improved amenity and convenience, accompanied by a shift to higher process-assembled manufacturing in industries. Nuclear power is expected to become an important source of electricity – nine new reactors are to be constructed by 2030, as part of efforts to improve energy security and reduce CO_2 emissions.[127]

The economy's energy-saving programmes are expected to have a positive impact on total demand. New sources of energy such as NRE will be introduced gradually as they become economically and technically viable.

A significant feature of Japanese energy management is the formalized voluntary participation of industry in CO_2 emissions reduction. This is set out in the Keidanren (Japanese Business Federation) Voluntary Action Plan on Environment.[128] This plan is aimed at bringing average CO_2 emissions from industry and energy transformation sectors below 1990 levels by 2012. It sets out reduction targets for each industry category. The targets for reduction of energy

[127] Ministry of Economy, Trade and Industry (2008B).

[128] APERC (2006), p 39. See also Nippon Keidanren (1997).

consumption through voluntary action by industries are iron and steel (10 percent), chemicals (13 percent), pulp and paper (16 percent), and cement (3.8 percent).

ENERGY RESOURCES

In 2006, net imports of energy accounted for 82 percent of Japan's total primary energy supply. With limited indigenous energy sources, Japan imported almost 99 percent of the oil it used, 99 percent of coal and 96 percent of gas.

In that year, Japan was the world's third largest oil consumer after the US and China. The bulk of its imports (80 percent in 2006) came from economies in the Middle East, such as the United Arab Emirates (UAE), Saudi Arabia, Iran, Qatar and Kuwait. Japan's Middle East oil import dependency has been rising steadily from 68 percent in 1985 to 89 percent in 2006. This is due mainly to the decline in oil imports from Asian economies such as Indonesia and Malaysia as more of their production is used domestically.

Japan has only limited coal reserves – 359 million tonnes. It is the world's largest importer of steam coal for electricity generation, pulp and paper, and cement production, and of coking coal for steel production. The bulk of its imports (98 percent in 2006) come from Australia, Indonesia, China, Canada and Russia.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 40 billion cubic metres, located in Niigata, Chiba and Fukushima prefectures. Domestic demand is met almost entirely by imports of LNG. Japan's use of LNG dominates the world market – in 2004, LNG imports to Japan made up 57 percent of total world LNG trade.[129] Imports are mainly sourced from Indonesia, Australia, Malaysia, Qatar, and Brunei (84 percent in 2006).

ENERGY POLICIES

Japan's energy policy is based on market principles, but at the same time it seeks to ensure a stable supply and environmentally friendly production and consumption of energy. The aim is to achieve the '3E' goals – energy security, economic growth and environmental protection (against global warming etc.) – in an integrated manner.

The Basic Law on Energy Policy (2002) presents the core principles of Japan's energy policy.[130] These are "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.[131] It focuses on achieving these goals: construction of an international framework for energy conservation and countermeasures to global warming; establishment of the nuclear fuel cycle at an early stage; promotion of new energy sources for electric power suppliers; assurance of the stable supply of oil and other fuels; promotion of international cooperation in the energy and environmental fields; and development of an energy technology strategy.

In 2006, Japan launched the New National Energy Strategy in response to the current global energy situation.[132] This strategy contains a programme of action to 2030, which places considerable emphasis on achieving energy security. Its five targets are: further energy efficiency improvements of at least 30 percent; increasing the share of electric power derived from nuclear energy to more than 30–40 percent; reducing oil dependence in the transport sector to about 80 percent; raising Japanese investment in oil exploration and development projects and reducing overall oil dependence below 40 percent.

In 2007, the Japanese government announced Cool Earth 50, a cooperative initiative with major greenhouse gas emitters to reduce emissions by 50 percent by 2050 from current levels worldwide. The actions required to achieve these goals are set out in the Cool Earth Innovative Energy Technology Plan, which is made up of the Innovative Energy Technology Programme[133] and Technology Development Roadmap.[134]

OUTLOOK

FINAL ENERGY DEMAND

Japan's final energy demand is projected to decline by 0.1 percent per year over the outlook period to 2030; this compares to an average annual growth rate of 1.0 percent over the 15 years to 2005. Demand in the 'other' sector, which includes commercial and residential energy use, is projected to grow at the fastest rate (annual average of 0.5

129 APERC (2009), p 82.

130 Ministry of Economy, Trade and Industry (2008A), p 17.

131 Ministry of Economy, Trade and Industry (2008A), p 17.

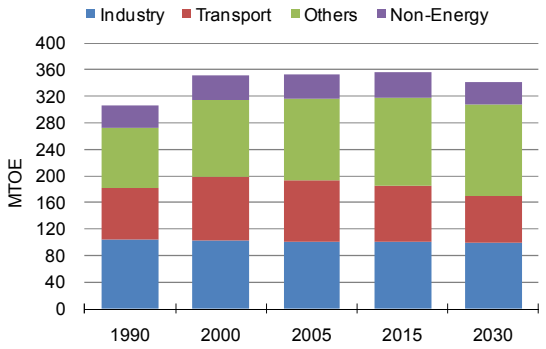
132 Ministry of Economy, Trade and Industry (2008A), p 18.

133 http://www.meti.go.jp/english/newtopics/data/pdf/031320CoolEarth.pdf

134 http://www.meti.go.jp/english/newtopics/data/pdf/CE_RoadMap.pdf

percent). At the same time, demand is projected to decline in the industry sector (by 0.09 percent a year), transport sector (1.0 percent) and non-energy sector (0.5 percent).

Figure JPN2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the Japanese industrial sector is projected to decline at an average annual rate of 0.09 percent over the outlook period. The rate of decline is much slower than the average annual rate of decline over the 15 years to 2005 (average annual decline of 0.27 percent). Energy consumption in the industrial sector is expected to keep on decreasing over the outlook period while energy efficiency is expected to improve. The reduction in demand is based on an expected shift in the industrial sector from energy-intensive to non-energy-intensive industries (with a focus on adding value), and sluggish growth in materials production. Energy efficiency is expected to improve within various industries; this is due to the Japanese business community's strong energy conservation initiatives, such as the Keidanren (Japanese Business Federation) Voluntary Action Plan on Environment.

Transport

The projected reduction in energy demand in the Japanese transport sector (average annual decline of 1.0 percent) compares to an average annual growth of 1.3 percent over the 15 years to 2005. This reflects a declining population and improvements in transport efficiency. While the demand for automobile transport constitutes about two-thirds of the total transportation demand, automobiles consume nearly 90 percent of the total energy consumed by the transport sector.

The reduction in total energy consumption by the transport sector, therefore, is mostly due to reduction of energy consumed by automobiles. Improved fuel efficiency for automobiles is currently promoted by the Top Runner standards. These are part of energy conservation law, which prescribes energy efficiency (Top Runner) standards for appliances and vehicles that are higher than the best performance value of each product currently on sale in the market.

Continued improvement in fuel efficiency of conventional vehicles is expected to be the most significant energy-saving and environmental protection measure in the automobile sector. Further, market penetration by hybrid vehicles is highly likely, as they do not require new infrastructure and government policy is reducing the price difference with conventional vehicles. The Japanese context does not support a major shift to biofuels (such as bioethanol and biodiesel) because of the limited land area available, which is already committed to food production; the highest likely uptake of ethanol blend in Japan by 2030 is 3 percent of the total transport fuel market.

Other

Japan's residential and commercial energy demand is expected to grow at an average annual rate of 0.5 percent, compared to 2.0 percent over the 15 years to 2005. The slowing of the rate of energy consumption in this 'other' sector is due to improvements to the energy efficiency of appliances (as a result of the implementation of Top Runner standards), an overall drop in population and number of households, and a slowdown in the increase in floor area used for business operation.

While electricity occupies the largest share of the total residential and commercial energy mix (where it is used to power the multitude of appliances added to households since 1990), the growth in electricity demand is projected to slow; an average annual growth rate of 1.1 percent is expected over the outlook period, compared to an average annual growth rate of 1.8 percent over the 15 years to 2005.

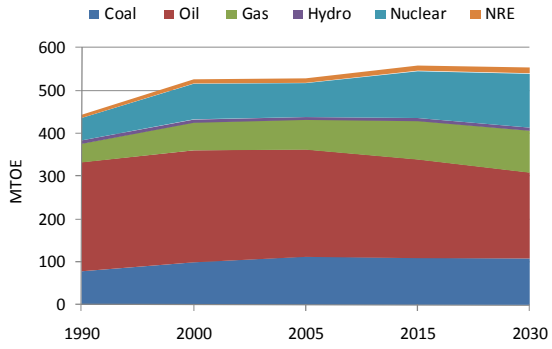
Demand for natural gas is also expected to grow in the residential and commercial subsectors, at an average annual rate of 0.8 percent – again this is significantly slower than the average annual growth rate of 4.3 percent over the 15 years to 2005. The rise in gas consumption is based on an expected increase in operation of restaurant kitchens as a result of the shift to a service-oriented society and the increased participation of women in the workforce, as well as increased use

of gas to power air conditioning due to high energy and economic efficiency.

PRIMARY ENERGY SUPPLY

Japan's primary energy supply is projected to grow at an average annual rate of 0.2 percent through to 2030. It is expected to generally level out until around 2020 and thereafter show a slight declining trend.

Figure JPN3: Primary energy supply



Source: APERC analysis (2009)

Japan's energy consumption divided by GDP (energy intensity) is expected to decrease by 24 percent over the outlook period. This economy-wide improvement in energy efficiency is a significant factor in the projected decrease in energy consumption from 2015 to the end of the outlook period. It is based on energy-saving measures adopted at industrial and consumer levels, and also on the overall shift in Japan to a higher-value-added, service-based economy. The overall population decline since 2005 will also contribute to the gradual decrease in energy consumption.

Japan's demand for oil is expected to decrease over the outlook period, declining at an average annual rate of 0.9 percent. This is due to continued improvements to fuel efficiency in the transport sector, and the move away from oil in the energy transformation sector. Japan's oil dependency is expected to decrease, from 47 percent of the primary energy supply in 2005 to 37 percent in 2030.

Japan's demand for coal is also expected to decrease over the outlook period, declining at an average annual rate of 0.1 percent. While the output of coal-fired electricity generation plants is projected to increase, this will be offset by improved generation efficiency. As a result, the amount of coal consumed for this purpose will level off through the outlook period. With decreasing final demand and improved efficiency in coke production, the overall demand for coal will slowly decrease.

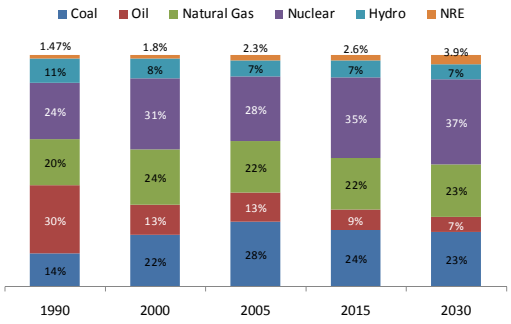
At the same time there will be a significant increase in the demand for natural gas, due to an expected rise in demand for residential and commercial gas supply and from increased electricity generation from LNG. LNG remains the only fossil fuel for which consumption is expected to increase during the outlook period.

The second fastest rate of growth will be that of new renewable energy (NRE), which is expected to have an annual average growth rate of 1.1 percent; however, the NRE share of the total primary energy supply will remain small, at around 2.5 percent of the whole. Nuclear will be the fastest growing energy source, at an average annual rate of 1.9 percent, followed by natural gas at 1.3 percent.

ELECTRICITY

Japan's electricity demand is expected to increase at an average annual rate of 0.8 percent over the outlook period to 2030. The fastest increase in demand is expected to come from the residential and commercial subsectors (at an average annual growth rate of 1.0 percent), followed by industry (0.4 percent).

Figure JPN4: Electricity generation mix



Source: APERC analysis (2009)

Against this backdrop of increasing electricity demand, nuclear is projected to increase its share in the electricity generation mix from 28 percent in 2005 to 37 percent in 2030. This is based on the construction of nine new reactors,[135] and follows the government's long term strategy of promoting nuclear power generation to reduce the economy's dependence on imported energy sources.

Thermal forms of electricity generation (coal, oil and natural gas) are also expected to increase in

[135] Ministry of Economy, Trade and Industry (2008B), p 28.

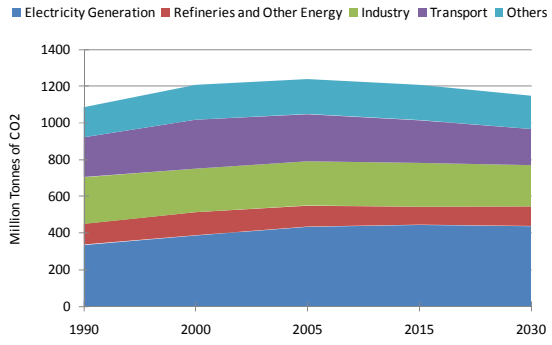
terms of total output, but their share of total electricity generation will gradually decrease – from 63 percent in 2005 to 52 percent in 2030 – as nuclear power generation increases. Coal's share of the total generation mix is expected to be around 23 percent in 2030, compared with 28 percent in 2005. Coal-fired electricity generation, while it has a high environmental impact in terms of global warming, offers the advantages of a stable supply and economical costs.

Natural gas is expected to increase its share in the electricity generation mix from 22 percent in 2005 to 23 percent in 2030. LNG-fired plants, which have smaller environmental impact than other thermal power plants, will continue to be used to supply both base and peak loads. Oil-fired electricity generation will continue to decline, with its share reducing from 13 percent in 2005 to 7 percent in 2030; it will be reserved for serving peak loads, but even this role will reduce as LNG-fired plant capacity becomes available to serve peak loads. Electricity generation from new renewable energy sources (hydro is excluded) is expected to demonstrate the fastest average annual growth rate of 3 percent, while its share in the total generation mix remains small at around 3.9 percent in 2030.

CO_2 EMISSIONS

Japan's CO_2 emissions from fossil fuel combustion are projected to decrease by about 7 percent, from 1,148 million tonnes of CO_2 in 2005 to 1,119 million tonnes of CO_2 in 2030. This is in line with the economy's falling energy demand, improving energy efficiency and decreased dependence on fossil fuels. Change in the transport sector is the biggest contributor to the reduction, accounting for 61 percent of the total decrease of CO_2 emissions over the outlook period.

Figure JPN5: CO_2 emissions by sector



Source: APERC analysis (2009)

Japan's economic growth over the outlook period is expected to contribute to an increase in CO_2 emissions at an average annual rate of 1.2 percent. However, this will be outweighed by improvements in energy efficiency (which will reduce emissions at an average annual rate of 1.2 percent). Reductions in the carbon content of energy sources (average annual reduction of 0.5 percent) will also contribute to overall decrease in Japan's CO_2 emissions.

Table JPN1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.3%	-0.8%	-0.3%	-0.5%
Change in Energy Intensity of GDP	0.2%	-0.7%	-1.2%	-1.0%
Change in GDP	0.9%	1.2%	1.2%	1.2%
Total Change	0.9%	-0.3%	-0.3%	-0.3%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Japan will have to take considerable care in managing its energy sourcing into the future. Its continued, even if declining, dependence on imported oil will require Japan to diversify its energy supply sources, to include unconventional resources.

The positive and negative features of coal (including its stable supply, lower cost and higher level of CO_2 emissions) require that while its abundance can be taken advantage of, this needs to be done in an environmentally sustainable manner, particularly through use of advanced technology such as carbon capture and storage (CCS).

Among the fossil fuels, demand for natural gas is expected to grow the fastest, despite relatively higher gas prices. This is due to the government's commitment to reduce CO_2 emissions, and the decision to substitute nuclear power for fossil fuels in the economy's overall energy mix. While the Japanese public may come to see nuclear energy as an indispensable option to combat global warming, this recovery of confidence might take time; in the interim, natural gas will fill the gap in Japan's long-term energy supply mix. This will require Japan to make every effort, such as coordination with other LNG-importing countries, to achieve a flexible LNG supply structure with lower prices.

Generally, Japan may need to engage in dialogue and cooperative endeavours with other exporting and importing economies to increase its energy security. These might include exchanges around policy development, energy conservation, environmental technology development,

diversification of energy sources, cooperation to increase supply capacity, and oil stockpiling.

If Japan is to actually achieve the integrated 3E goals (of energy security, economic development, and environmental protection) it will need to intensify its efforts to achieve the best energy mix. In particular the economy needs to further promote diversification of energy supply structures, energy conservation, and the decarbonisation of its energy supply. Energy efficiency must be improved in every sector, and greater support given to the development of new energy technologies and low carbon technologies such as CCS. If nuclear power is to play the key role set for it in Japan's energy policy, the government will have to increase efforts to improve public acceptance.

As background to these initiatives, Japan also needs to strengthen energy related administrative and policy infrastructure, including energy-efficiency standards, labelling, taxation, energy-oriented environmental education, and assistance for development of associated technologies.

Japan's eventual achievement of its Kyoto Protocol goals depends on the economy making the maximum effort at the domestic level to reduce its GHG emissions. This could include accelerating the development of revolutionary innovative clean energy technologies. Japan could also take an active role in implementation of international programmes based on the Kyoto mechanisms, such as clean development mechanisms (CDM) and joint implementation (JI).

Japan can provide a model of an economy acting to reduce CO_2 emissions while making sure its own economic development stays stable – through a balanced mix of fuel switching, energy-efficiency improvements, and innovative technology use. It has a world-leading role in developing and demonstrating energy-saving and clean energy technologies, and this could be strengthened further – through continued support for developing economies, by means of technological transfer of knowledge and experience in areas such as energy management, nuclear power, photovoltaic generation, and energy related standards and labelling systems.

REFERENCES

APERC (2006) *APEC Energy Demand and Supply Outlook 2006 – Economy Review*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

EDMC (2007A) "APEC Energy Database". Energy Data and Modeling Center, The Institute of Energy Economics, Tokyo, Japan. www.ieej.or.jp/apec

EDMC (2007B) *Handbook of Energy & Economic Statistics in Japan*. Energy Data and Modeling Center, The Institute of Energy Economics, Tokyo, Japan.

Ministry of Economy, Trade and Industry (2002) "Basic Law on Energy Policy 2002". http://law.e-gov.go.jp/htmldata/H14/H14HO071.html

Ministry of Economy, Trade and Industry (2007) "Basic Energy Plan", 2007 edition. In Japanese. http://www.enecho.meti.go.jp/topics/kihonkeikaku/index.htm

Ministry of Economy, Trade and Industry (2008A). *Energy in Japan*. Tokyo, Japan.

Ministry of Economy, Trade and Industry (2008B). *Japan's Energy Demand and Supply Outlook* (in Japanese). Tokyo, Japan.

Nippon Keidanren (1997) *Keidanren (Japanese Business Federation) Voluntary Action Plan on Environment*. http://www.keidanren.or.jp/english/policy/pol058/index.html

KOREA

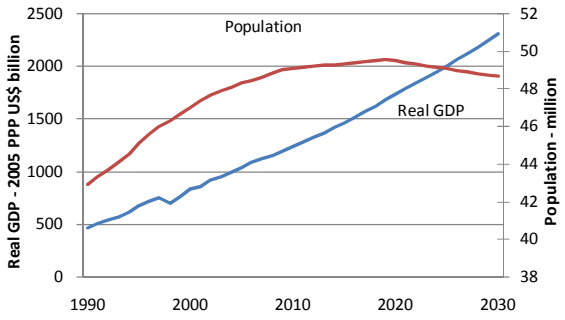
- *Korea's primary energy supply is projected to grow at an average annual rate of 1.6 percent, from 213 Mtoe in 2005to 313 Mtoe in 2030; the growth is driven primarily by expected high demand for natural gas from the industrial and 'other' sectors.*
- *Future energy demand growth will slow as a result of Korea's population growth tailing off, and continued structural change in the economy, toward industries that are less energy intensive.*
- *The shift in Korea's energy policy toward sustainable development is expected to facilitate replacement of oil with renewable and nuclear energies, improvements in energy efficiency, and optimal diversification of the economy's energy supply*

ECONOMY

Korea is located in Northeast Asia, on the southern half of the Korean Peninsula. The economy's geography is largely made up of hills and mountains, with wide coastal plains in the west and south. The climate is relatively moderate; there is more precipitation in summer than winter, and it gets bitterly cold in winter.

Korea has experienced dynamic and robust economic growth in the last few decades. Between 1990 and 2005, GDP increased at an average annual rate of 5.6 percent, reaching US$1,027 billion (2005 US$ at PPP) in 2005. While Korea's economy has lately demonstrated strength in industries that are less energy intensive, such as the production of semiconductors, computers and digital electronics, energy-intensive industries such as steel and petrochemicals are still major producers of export commodities (the steel and petrochemical subsectors together accounted for 40.7 percent of the industry sector's total energy consumption). Korea's GDP is expected to grow at an average annual rate of 3.3 percent over the outlook period.

Figure ROK1: GDP and population



Source: APERC analysis (2009)

In 2006, Korea had a population of 48 million, with approximately 21 percent living in the capital Seoul. Since the economy's population is projected to peak in 2018 and then decline, the overall projection for the period 2005 to 2030 is for no population growth.[136] In addition, Korea's population is ageing rapidly. In 2030, 24 percent of the population will be over the age of 65 – a substantial increase from 9 percent in 2005.[137] The effects these population changes will have on the size and composition of the labour force will have an impact on future economic growth.

ENERGY RESOURCES

Korea's indigenous energy resources are very limited – there are only 80 million tonnes of recoverable coal (anthracite) reserves and 0.93 billion cubic metres of recoverable natural gas reserves. The Donehae-1 gas field, which was discovered in 1998 and began commercial production of natural gas and crude oil in 2004, produces 1.4 million cubic metres and 1,000 barrels of crude oil per day.[138] Even with this contribution, domestic natural gas production provided less than 2 percent of the economy's total primary energy supply, and crude oil production less than 1 percent. The economy is heavily dependent on overseas energy resources: in 2007 Korea imported 84.5 percent of its total primary energy supply, if production of nuclear power is included. In world rankings, the economy is the second biggest importer of coal, fourth of oil, and ninth of natural gas.[139]

Korea's dependence on the Middle East region for its oil supply has remained around 80 percent in recent years, in spite of concerted efforts to diversify its energy import sources. In 2007, approximately 81 percent of the economy's crude oil imports came from Middle Eastern economies such as Saudi Arabia, Kuwait, Iran and the UAE.[140] The Korea National Oil Corporation (KNOC), the only state-owned upstream oil development company, has actively participated in a wide range of overseas exploration and production projects, with strong support from the Korean government. As of July

136 Korean Statistical Information Service (no date).
137 Ibid.
138 Korea National Oil Corporation (2007).
139 IEA (2008), pp 11–15.
140 Korea Energy Economics Institute (2008), table 10-3.

2008, KNOC was involved in 26 exploration projects, 3 development projects and 9 production projects in 16 economies worldwide.[141]

Sources for LNG imports are more diverse than for oil. The Korea Gas Corporation (KOGAS), which has exclusive control of Korea's natural gas industry from import through to wholesale trade, had LNG contracts with nine economies as of 2008 – five of these are APEC economies (Russia (Sakhalin), Malaysia, Indonesia, Brunei Darussalam, and Australia), while the others are Qatar, Oman, Yemen, and Egypt.[142] In 2007, Qatar provided 31.4 percent of imported LNG, followed by Malaysia (24.1 percent), Oman (18.7 percent), and Indonesia (14.7 percent). As of 2007, KOGAS was operating three LNG terminals, in Incheon, Pyeongtaek, and Tongyeong, with plans to construct a fourth terminal in Samcheok.

Korea's coal production fell significantly between 1990 and 2005, declining at an average annual rate of 11.5 percent. In addition to the contracting rate of production, the economy also lacks high-quality and bituminous coals. As a result, Korea is also reliant on coal imports, mainly from Australia, Canada and China.

Given these limited indigenous energy resources, nuclear is an essential input in Korea's electricity generation. Nuclear has retained a high share (around 40 percent) of the electricity generation mix over the last two decades, and this is expected to increase over the outlook period, in response to climate change and energy security pressures.

ENERGY POLICIES

Securing a stable energy supply for ongoing economic growth has been the major focus of Korea's energy policy. However, the long-term strategy announced by the government in August 2008 indicated a shift in its energy policy direction toward sustainable development, with consideration of energy security, economic development, and environmental protection (the '3Es').[143] The August 2008 strategy focuses on improving energy efficiency, increasing the supply of clean energy, advancing green energy technology, and providing accessible and affordable energy to all citizens. The major goals set out there are:

- Energy intensity will be reduced by 46 percent by 2030, from current 341 toe/million US$ to 185 toe/million US$.
- The share of fossil fuels in the primary energy supply will be reduced from the current 83 percent to 61 percent by 2030. Instead, the share of renewable energy and nuclear will be increased – renewables will be increased to 11 percent in 2030, from 2.4 percent in 2007, and nuclear will be increased to 27.8 percent from 14.9 percent. (The renewables growth involves increasing photovoltaic generation 44-fold, wind 37-fold, biofuels 19-fold, and geothermal 51-fold; this will be achieved by stimulating domestic demand and supporting technology developments for photovoltaics, wind and hydrogen fuel cells.)[144]
- Korea's green energy technologies will be advanced to a level comparable to that of the most advanced economies, through the government's investment in research and development.
- To ensure affordable energy supply is available to all citizens in Korea, the government will help low-income households acquire energy-efficient products.

This new direction reflects increasing concern within the economy about energy security, climate change and unstable energy prices.

In order to strengthen the economy's energy security, the government is aiming to reduce Korea's dependence on fossil fuels and also to raise its level of energy self-sufficiency. To this end, the government has supported upstream companies with crude oil and natural gas exploration and production projects, by means of financial assistance such as tax exemption and long-term low-interest loans. In addition, the government is seeking energy cooperation opportunities with oil and natural gas producing economies such as Russia and Asian economies.

OUTLOOK

FINAL ENERGY DEMAND

Korea's total final energy demand is projected to grow at an average annual rate of 1.6 percent over the outlook period. The industry sector and the 'other' sector (which includes residential, commercial, and agricultural users) are expected to account for a similar large share of this demand in 2030 – industry at 26.5 percent and 'other' at 26.3 percent. However, both sectors' shares are declining through the outlook period, as demand from the transport and non-energy sectors increases.

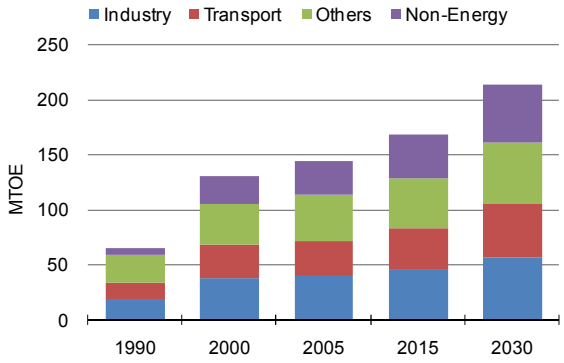
[141] Korea National Oil Corporation (2008).

[142] Korea Gas Corporation (2009).

[143] Ministry of Knowledge Economy (2008).

[144] Ibid.

Figure ROK2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the industry sector is projected to grow at an average annual rate of 1.4 percent, which is slower than the rate of growth of the total final energy demand. The limiting factors on this sector's energy demand are the anticipated slower rate of economic growth, and an anticipated shift away from energy-intensive industries.

Electricity is the dominant energy source for the industry sector, although demand for natural gas is projected to increase substantially – rising at the fastest average annual growth rate of 5.1 percent, from 4.2 Mtoe in 2005 to 14.3 Mtoe in 2030, which is 25 percent of the industrial sector's final energy demand.

Transport

The Korean transport sector's final energy demand is expected to increase at an average annual rate of 1.7 percent over the outlook period. Petroleum products used by the dominant road-transport subsector make up more than 96 percent of this demand over the period. However, the average annual growth rate has slowed significantly since the 1990–2005 period, when it was 5.2 percent. This is mainly because vehicle ownership is assumed to be levelling off as economic growth slows and as population growth begins to decline after 2018. Well-developed public transport systems such as subway and bus, especially in Seoul, will also marginally help to dampen the transport energy demand growth.

Other

Energy demand in the 'other' sector is projected to grow at a slower average annual rate of 1.2 percent. The increased demand is based on expected growth in high-value-added industries within the commercial subsector.

Electricity makes up the largest share of the 'other' sector demand throughout the outlook period – 45 percent in 2030. Electricity demand is expected to grow at an average annual growth rate of 2.2 percent, slowing down due to market saturation of electric appliances and the expected peaking of population growth.

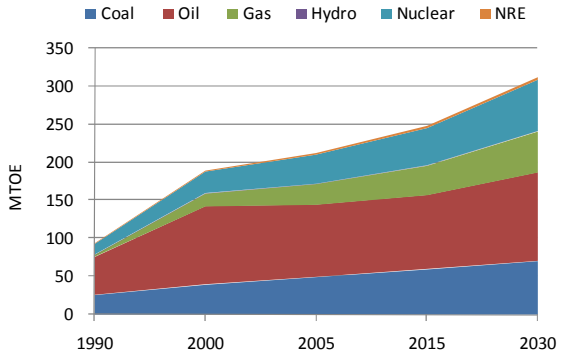
The energy source with the highest growth rate in the 'other' sector is natural gas, which is expected to increase at an average annual rate of 2.4 percent. This will be driven by increased city gas demand, although that itself is expected to slow down over the outlook period, compared with growth witnessed over the last two decades, as the expansion of the trunk pipeline network is almost complete.

PRIMARY ENERGY SUPPLY

Korea's primary energy supply is projected to grow at an average annual rate of 1.6 percent over the outlook period; this is much lower than the growth rate of 5.6 percent between 1990 and 2005. This is likely due to a shift away from energy-intensive industries, energy efficiency improvements, and limited population growth.

Oil is likely to remain the dominant energy source through to 2030 but its share will decrease gradually – from 45 percent in 2005 to 37 percent in 2030. At the same time natural gas is projected to increase its share, from 13 percent in 2005 to 17 percent in 2030; it will grow at the fastest average annual rate of 2.8 percent. Renewable energy is estimated to grow at an average annual rate of 1.5 percent over the outlook period, as a result of efforts to diversify energy resources to improve the economy's energy security.

Figure ROK3: Primary energy supply



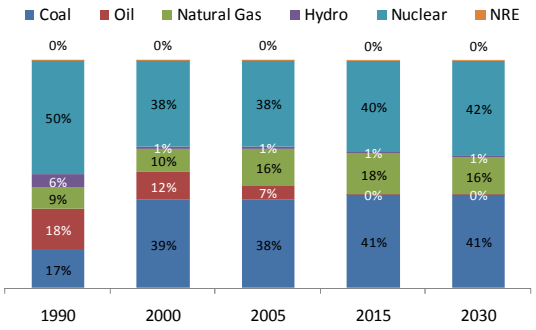
Source: APERC analysis (2009)

ELECTRICITY

Korea's electricity demand is projected to grow at an average annual rate of 1.9 percent over the outlook period; this is much lower than the 9.3 percent annual growth recorded between 1990 and 2005. More than half of this demand growth is expected to come from the 'other' sector, followed by industry.

The electricity generation mix is expected to change slightly if the government's 2008 long-term strategy is followed: the nuclear share will expand to 42 percent in 2030, while oil will account for less than 1 percent (a substantial decrease from 7 percent in 2005). At the same time, natural gas is projected to remain at 16 percent of the mix. Renewable energy is expected to grow the fastest, at an average annual rate of 7.1 percent, although its share will remain marginal.

Figure ROK4: Electricity generation mix



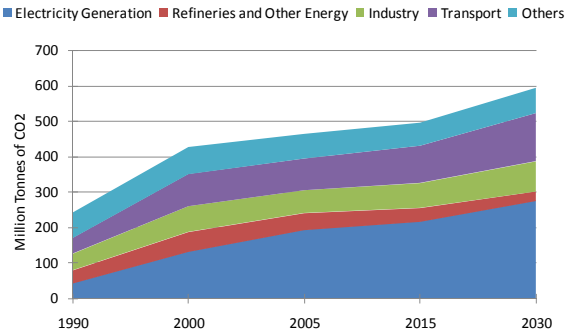
Source: APERC analysis (2009)

CO_2 EMISSIONS

Korea's CO_2 emissions are estimated to increase by 28 percent from the 2005 level, rising from 464 million tonnes of CO_2 in 2005 to 594 million tonnes of CO_2 by 2030. This increase is mainly attributable to persistent dependence on coal in electricity generation. Even though nuclear and natural gas are expected to increase their share in the electricity generation mix by 2030, coal will remain the second largest energy source after nuclear. After coal use for electricity generation, petroleum products used in the transport sector provide the second highest source of CO_2 emissions in 2030.

From the decomposition analysis shown in the following table, it can be seen that economic growth underlies Korea's CO_2 emissions increase through the outlook period.

Figure ROK5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table ROK1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-1.1%	-0.9%	-0.3%	-0.6%
Change in Energy Intensity of GDP	0.1%	-1.9%	-1.5%	-1.7%
Change in GDP	5.6%	3.6%	3.1%	3.3%
Total Change	4.4%	0.7%	1.2%	1.0%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Korea's energy policy shift towards sustainable development is expected to be maintained. However, the achievement of a cleaner energy supply for the economy is less certain. The expansion of nuclear power generation may not progress as planned, due to public opposition. Even though there is good understanding of the importance of nuclear power by the Korean public, acceptance of a new plant at a local level can still be a significant barrier. Delays in nuclear power plant construction will result in other energy sources being retained for electricity generation.

Furthermore, the government's target for increasing renewable energy's contribution to the primary energy supply (11 percent by 2030) is also insecure. There are challenging issues hindering development of renewable energy resources, including high upfront costs and shortage of available technology. In addition, the efforts made to shift electricity generation to renewable sources can be influenced by changes in the oil price situation and economic activity. Renewable energy tends to be overshadowed when the oil price is in a reasonable range or business conditions are sluggish. Strong and constant government support for the efforts to increase renewable energy use will be essential if the target is to be achieved.

Energy security will remain a critical issue for any economy such as Korea that relies on imports for most of its energy resources. Even with an expanded share of the primary energy supply coming from nuclear and renewable sources, the projected continuing emphasis on coal for electricity generation, oil for transport use and LNG in the residential sector will leave Korea importing the majority of its energy resources. It is therefore assumed that Korea will experience significant challenges in its efforts to better secure its energy supply.

REFERENCES

An, Tae-Hoon (2009) *Supply and demand trends and plans for natural gas in South Korea.* http://eneken.ieej.or.jp/data/2480.pdf

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. http://www.ieej.or.jp/aperc/

Central Intelligence Agency, United States (2009) *The World Factbook: Korea, South.* https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html

International Energy Agency (2008) *Key World Energy Statistics 2008*. http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf

Korea Energy Economics Institute (2008) *Energy Info: Korea.*

Korea Gas Corporation (2009) "KOGAS_PT, Jan 2009". http://www.kogas.or.kr/kogas_eng/05_public/07.jsp

Korea Gas Corporation (no date) http://www.kogas.or.kr/kogas_kr/00_main/main.jsp

Korea National Oil Corporation (no date). http://www.knoc.co.kr/

Korea National Statistical Office (no date). http://www.nso.go.kr/eng2006/emain/index.html

Korean Statistical Information Service (no date) *Population projections for Korea.* http://www.kosis.kr/eng/index.html

Ministry of Knowledge Economy, Korea (2008) "Korea Goes for 'Green Growth': Sustainable development in a low carbon society". Press release, 11 September 2008. http://www.mke.go.kr/language/eng/index.jsp

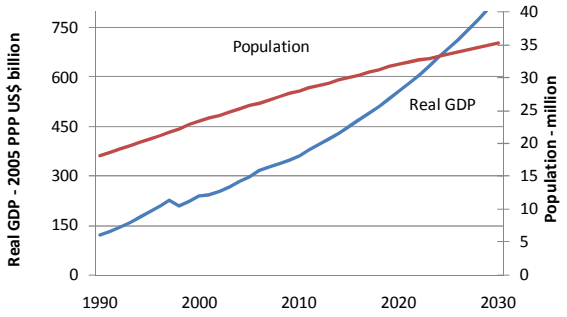
MALAYSIA

- *Malaysia's primary energy supply is projected to grow at 2.8 percent a year, from 65.9 Mtoe in 2005 to 130.5 Mtoe in 2030. The growth is driven mainly by the demand for coal and gas in the electricity generation sector and oil products in the transport sector.*
- *The rising demand for coal in the electricity generation sector and for oil in the transport and industry sectors will make Malaysia a net energy importer by 2030. Net imports of energy will reach 17.9 Mtoe in 2030; in 2005 the economy had net exports of 31.1 Mtoe.*
- *Malaysia is seeking to ensure its long-term energy security and minimize negative environmental impacts, by intensifying its energy-efficiency initiatives and enhancing development of viable alternative energy sources, such as solar and biofuels.*

ECONOMY

Malaysia is located in Southeast 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. Malaysia's equatorial climate has year-round average temperatures of 20–35°C and relative humidity of 80–90 percent; the timing of the rainy season on the peninsular coast varies. The total 2006 population of Malaysia was about 27 million, with nearly 66 percent living in urban areas.

Figure MAS1: GDP and population



Source: APERC analysis (2009)

Malaysia is one of Southeast Asia's successful economies. Its economic success to date has been principally based on manufacturing and resource extraction, although there are ongoing initiatives to expand services and higher-value-added activities. The economy's GDP has grown steadily at an average annual rate of 6.1 percent since 2000.

The manufacturing sector contributes the single largest share of the Malaysian GDP – in 2006 accounting for about 30.5 percent. The major energy-intensive segments of the manufacturing sector are iron and steel, cement, wood, food, glass, pulp and paper, ceramics and rubber industries. Natural gas and electricity are the main energy sources used, while coal has been used mainly by the cement, and iron and steel, producers.

Mining is another important economic activity, contributing a 9 percent share of the GDP in 2006. Currently, tin mining is the biggest mining industry in the economy. Other metallic minerals, such as iron ore, bauxite and gold, are also mined in Malaysia. The economy's mining industry has great growth potential, given Malaysia's relatively under-exploited mineral resources, especially in East Malaysia. Fuel oil and diesel have been the main fuels consumed by the mining industry.

The agriculture sector, which includes forestry and fishing, contributed about 8.7 percent to the Malaysian GDP in 2006. Agriculture is expected to grow strongly, based on increasing global demand for biofuels as alternatives to fossil fuels for transport use. Malaysia is one of the world's major producers of palm oil, which has huge potential for biofuel production, due to its price competitiveness, year-round supply and high yield. Energy demand in this industry is also expected to increase as a result of the aggressive implementation of food and other commodity production programmes in the economy. Diesel and fuel oil have been the main agricultural fuel types.

Passenger transportation in the economy is heavily dependent on road transport. The road transport network in Peninsular Malaysia extends over nearly 65,000 kilometres, including 1,470 kilometres of expressways. Commuting in urban and suburban areas and between cities is mainly by private car. In 2006, there were about 15.8 million registered vehicles, which is increasing at an average annual growth rate of 6.6 percent.[145] Rail transport, monorail and light rail transit systems also play significant roles in the Malaysian land transport system, especially in Kuala Lumpur, the economy's capital city. Road and rail transport are the main modes used for goods freighting. As the demand for passenger and goods transportation is continuously growing, the government is making concerted efforts

[145] Road Transport Department (2007).

to improve services: in the 2009 budget, the government allocated about US$ 10 billion to improving public transportation over the five years from 2009 to 2014. This includes increasing the capacity of existing rail services, building new rail tracks, and increasing the number of buses, as well as providing better infrastructure facilities. [146] Air transport is growing rapidly in Malaysia, especially in the domestic sector. This is driven by the introduction of budget airlines and expansion in the number of air routes and destinations.

The tropical climate requires year-round space cooling in Malaysian buildings. On average, space cooling accounts for nearly 40 percent of the total building energy requirement. Increased energy demand in the economy's residential and commercial sector is expected as a result of increasing urbanization; by 2030, 82 percent of the population is expected to be living in urban areas.[147]

ENERGY RESOURCES

Oil is one of the economy's main sources of energy; in 2006 the total oil supply was 26 Mtoe, or 39 percent of the economy's total energy supply. According to the Oil and Gas Journal, as of December 2006, Malaysia's oil reserves were about 3 billion barrels, with production at about 680,000 barrels. The production of oil in the economy has been regulated by the National Depletion Policy since 1980, which stipulates that annual production from a field may not exceed 3 percent of oil-originally-in-place (OOIP). Malaysia has five refineries with a total nameplate capacity of 483,000 barrels per day – this goes to both domestic consumption and export. In 2006, total refinery input was 26 Mtoe, with 71 percent coming from local crude and the remainder imported, mainly from the Middle East plus some from Africa and Asia. Currently, local refineries supply more than 80 percent of the demand for domestic petroleum products.

The advent of gas as an important component in Malaysia's energy mix may be traced to the National Depletion Policy and the Four-Fuel Diversification Policy. These policies have sought to reduce dependence on oil and increase gas use, with the aim of delaying the depleting of oil reserves and ensuring adequacy and security of energy supply. According to the Oil and Gas Journal, Malaysia's gas reserves stood at 2.1 trillion cubic metres in 2006.[148] With greater utilization of natural gas, especially in the electricity generation sector, the production of gas has grown significantly, to about 190 million cubic metres per day. Since 2006, natural gas has been the largest energy source for Malaysia, at 30.37 Mtoe or 44 percent of total primary energy supply. Malaysia has six natural gas processing plants on the peninsula, with a total daily capacity of 76 million cubic metres. The supply for these plants comes from locally extracted gas and imported gas from West Natuna, Indonesia and the Malaysia–Thailand Joint Development Area. Gas from the processing plants is supplied through a 2500-kilometre network, which links most cities in Peninsular Malaysia. In 2006, the electricity generation sector consumed about 62.5 percent of the gas piped through the system, while the non-energy sector, which includes industrial, petrochemical and other users, consumed about 31.2 percent; the balance of 6.3 percent was exported to Singapore. At the same time, natural gas sourced from East Malaysia has mainly been converted into liquefied natural gas (LNG) for export. The liquefaction process has been carried out at three LNG plants, namely MLNG Satu, Dua and Tiga in Bintulu, Sarawak, which have a combined capacity of 22.2 million tonnes per year. In 2006 nearly 91.9 percent of Malaysia's LNG was exported to Japan (57.7 percent), South Korea (24.7 percent) and Chinese Taipei (16.7 percent). The remaining 8.1 percent was consumed domestically.

Bituminous and sub-bituminous coals make up the bulk of coal reserves in Malaysia. The coal resource in Malaysia was 1,843 Mtoe in 2006, of which about 83 percent was in Sarawak, 16 percent in Sabah and 1 percent in Peninsular Malaysia. Although the coal resource in Malaysia is substantial, domestic coal production has not been aggressively pursued because most of these coal deposits are far inland where infrastructure is lacking and the extraction cost is high. Furthermore, a large portion of these deposits is suitable only for costly underground mining. In Peninsular Malaysia coal is used primarily for electricity generation, and by the iron and steel industry and cement manufacturers. At present, coal is imported from China, Australia, Indonesia and South Africa.

Renewable resources, especially hydropower and biomass, are abundant in the economy. Malaysia's hydropower potential is assessed at 29,000 MW; 85 percent of these potential sites are located in East Malaysia. Most of the hydropower sites in Peninsular Malaysia have already been developed due to the high energy demand there. At the end of 2006, Malaysia had a total installed hydro capacity of 1,976 MW and the capacity will increase further with the addition of the 2400 MW Bakun hydroelectric project by 2010. Malaysia has abundant biomass waste resources

146 Ministry of Finance (2008B).

147 Yuen et al (2006), chapter 9.

148 Oil and Gas Journal (2006).

coming mainly from its palm oil, wood and agro-industries. There is also a substantial amount of unexploited biomass waste resources in the form of logging wood residues, rice straw, palm tree trunks and other residues, which could further supplement future biomass-based electricity generation in the economy if necessary.

ENERGY POLICIES

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 utilization of energy and the elimination of wasteful and non-productive patterns of energy consumption; and ensuring factors pertaining to environmental protection are taken into consideration in the production and utilization of energy by minimizing the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

To prolong and preserve the economy's energy resources, particularly oil and gas resources, the National Depletion Policy was formulated. Under this policy, total annual production of crude oil should not exceed 3 percent of oil-originally-in-place, which currently limits oil production to about 680,000 barrels per day. To diversify the energy 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 the optimization of the energy mix of oil, gas, hydro and coal used in the generation of electricity. As a result, oil's domination of the electricity generation energy mix has been significantly reduced and replaced with gas and coal. Meanwhile, in 2002 the Four-Fuel Policy was expanded to incorporate 'renewable energy' as the fifth fuel after oil, gas, coal and hydro. Currently, nuclear energy has no share in Malaysia's energy mix. However, the economy is exploring nuclear potential as one option for its future electricity generation.

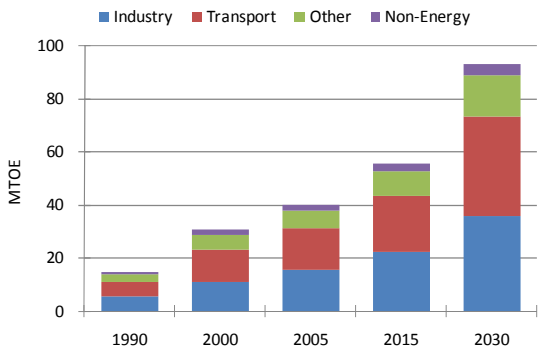
The Malaysia Plan is an important document published at five-yearly intervals by the government. The plan sets out goals and indicative targets for Malaysia in a range of fields, including energy. The current plan, *The Ninth Malaysia Plan 2006–2010*, lays out actions that need to be taken in developing a sustainable energy sector, with the focus on renewable energy and energy efficiency.[149] Malaysia signed the United Nations Framework Convention on Climate Change (UNFCC) in 1993 and ratified the Kyoto Protocol in 1994. Currently, there is no specific greenhouse gas emissions reduction target adopted by the economy. However, the Ninth Malaysia Plan does outline a strategy for addressing environmental and resource management issues in an integrated and holistic manner, to ensure developments are sustainable and resilient.

OUTLOOK

FINAL ENERGY DEMAND

Malaysia's final energy demand is projected to grow at an average annual rate of 3.4 percent, reaching 92.9 Mtoe in 2030 – more than double the 2005 level. The transport sector accounts for the largest portion, with a share of 37.3 Mtoe. This is followed by industry (35.9 Mtoe), 'other' sectors (15.4 Mtoe) and non-energy (4.3 Mtoe). Petroleum products will make up 56 percent of the total final energy demand in 2030, followed by electricity (23 percent), natural gas (15 percent), new renewable (4 percent) and coal (2 percent).

Figure MAS2: Final energy demand



Source: APERC analysis (2009)

Industry

The final energy demand for the industrial sector is expected to grow at an average annual rate of 3.4 percent, reaching about 35.9 Mtoe by 2030. Electricity and oil are projected to be the fastest growing energy sources in the industrial sector; demand for electricity will grow at an average annual rate of 5.1 percent, while oil grows at 3.4 percent. The industrial sector will continue to be the main contributor to the economy's GDP. While the industrial energy demand is expected to double over the outlook period, its intensity is reduced nearly

[149] Economic Planning Unit, the Prime Minister's Department (2004).

20 percent. This reflects the sector's shift towards a structure that is less energy intensive, as well as improvements in technical energy efficiency.

Transport

The transport sector accounts for the largest portion of Malaysia's final energy demand, with a share of 37.3 Mtoe. The sector's energy demand is projected to grow at an average annual rate of 3.6 percent. Petroleum products are expected to remain the dominant transport energy source; however, the share of petroleum products is projected to fall from 99 percent in 2005 to 94 percent in 2030. Bio-fuel use is expected to expand significantly over the outlook period, reaching 2.1 Mtoe in 2030 or 6 percent of the total transport final energy demand.

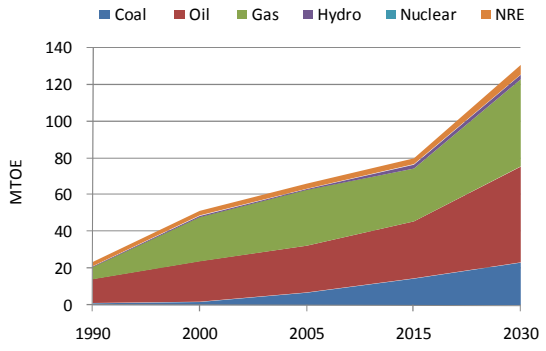
Other

The final energy demand for the 'other' sector, which includes commercial, residential, and agriculture uses, is projected to grow at an average annual rate of 3.8 percent. Electricity constitutes the largest portion of this, with a share of about 61 percent (9.4 Mtoe).

PRIMARY ENERGY SUPPLY

Malaysia's primary energy supply is projected to grow at an average annual rate of 3 percent, reaching 130.5 Mtoe in 2030. Oil is expected to account for 40 percent, natural gas 36 percent, coal 18 percent, hydro 2 percent and renewables 4 percent.

Figure MAS3: Primary energy supply



Source: APERC analysis (2009)

Hydro is the fastest growing primary energy source, growing at an average annual rate of 7.1 percent. The development of hydroelectric projects in East Malaysia will contribute to the rise in the share provided by hydro, from 0.4 Mtoe in 2005 to 2.5 Mtoe in 2030.

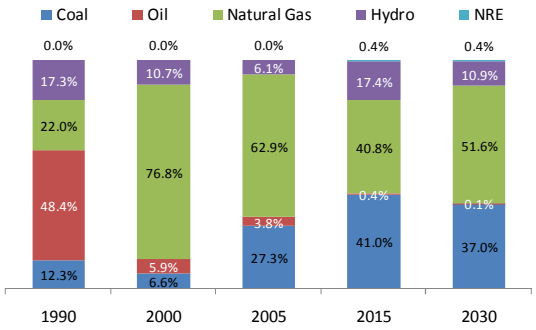
Coal will be the second fastest growing primary fossil fuel over the outlook period, rising at an average annual rate of 5 percent. The total primary supply of coal is projected to reach 23.3 Mtoe by 2030. The increase of coal is due to the diversification policy in the electricity generation sector, where coal is projected to replace some of the natural gas share in the energy mix. Electricity generation accounts for 91 percent of the total increase in primary coal consumption, and the industrial sector accounts for the balance.

At the same time, the consumption of natural gas is projected to rise only modestly over the outlook period, at an average annual rate of 1.8 percent, reaching 47.4 Mtoe by 2030. Oil in the primary supply is projected to increase to 52.3 Mtoe by 2030, at an average annual rate of 2.9 percent. Growing transport energy demand is the main driver for the growth in oil consumption.

ELECTRICITY

Electricity generation in Malaysia is projected to grow over the outlook period at an average annual rate of 4.7 percent, from 85 TWh in 2005 to 265 TWh in 2030. The key change in the electricity generation sector is the reduction of the natural gas share, which will be replaced by coal and hydro. The proportion of coal use in electricity generation is expected to grow from 27 percent in 2005 to 37 percent in 2030. A corresponding decrease is projected in the share of electricity generated from gas – from 63 percent in 2005 to 52 percent in 2030. Hydroelectric generation is projected to grow strongly over the outlook period, based on the development of large hydro projects in East Malaysia – it is expected to grow at an average annual rate of 7.1 percent, until it accounts for 11 percent of total electricity generation in 2030.

Figure MAS4: Electricity generation mix



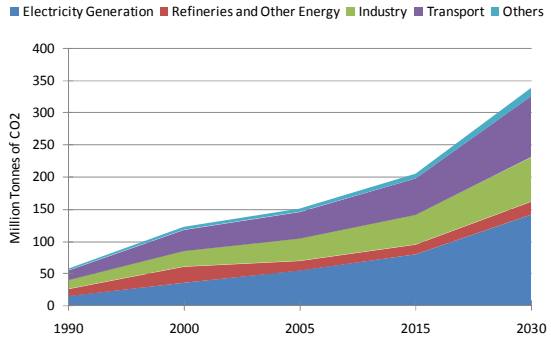
Source: APERC analysis (2009)

CO_2 EMISSIONS

Malaysia's CO_2 emissions from fuel combustion in the energy sector are projected to grow at an average annual rate of 3.3 percent over the outlook

period, reaching 339 million tonnes of CO_2 in 2030. The electricity sector will be the biggest contributor to the growth in CO_2 emissions (contributing 42 percent of the total 2030 emissions), followed by the transport sector (28 percent) and industry (20 percent). The CO_2 intensity of the total primary energy supply is projected to rise at an average annual rate of 0.5 percent over the outlook period.

Figure MAS5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table MAS1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.4%	1.2%	0.1%	0.5%
Change in Energy Intensity of GDP	0.9%	-2.2%	-0.9%	-1.4%
Change in GDP	6.2%	4.2%	4.3%	4.2%
Total Change	6.7%	3.1%	3.4%	3.3%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Malaysia has achieved remarkable success in its economic development agenda, which is strongly underpinned by its energy sector, especially its oil and gas production. Malaysia's oil and gas reserves are modest in size and are gradually depleting. While efforts to discover and exploit new reserves are going on and have yielded encouraging success, the economy must accept that economic domestic reserves may become fully depleted, with significant consequences on the economy. Under a 'business as usual scenario', our projection shows that Malaysia will be a net energy importer by 2030, with net imports totalling 17.9 Mtoe. The increased share of coal in electricity generation will result in a substantial increase in coal imports – net coal imports are projected to rise from 6.4 Mtoe in 2005 to 22.3 Mtoe in 2030.

In order to ensure long-term energy security, the economy must look for new, long-term solutions for its energy needs. This includes intensifying energy efficiency initiatives to ensure more productive and prudent use of the remaining reserves, while enhancing efforts to develop viable new renewable energy resources, such as solar, wind, and tidal. These efforts would also mitigate environmental ill-effects caused by the energy sector, especially from the projected 43 percent increase in greenhouse gas emissions over the outlook period.

REFERENCES

Economic Planning Unit, the Prime Minister's Department (2004) *The Ninth Malaysia Plan 2006–2010*.

Ministry of Energy, Water and Communications (2006) *National Energy Balance 2006*.

Ministry of Finance (2008A) *Malaysia Economic Report 2006/2007*.

Ministry of Finance (2008B) *Malaysia 2009 Budget Speech*, delivered by the Prime Minister on 28 August 2008.

Oil and Gas Journal (2006) "Worldwide Oil Reserves and Production 2006" 18 Dec 2006. PennWell Editors, Houston, USA.

PETRONAS (2007) *Annual Report 2007*.

Road Transport Department (2007) *Annual Report 2007*.

Yuen, B, Supian, A & Ho, C.S. (2006) *Urbanization and Sustainability in Asia.* Asian Development Bank.

MEXICO

- *Mexico's primary energy supply is expected to grow at an average annual rate of 1.7 percent over the outlook period. This will be driven mainly by consumption of oil products in the transport sector; the second largest energy demand is from industry.*
- *Declining crude oil production in mature basins could affect the economy's export revenues in the long-term. Domestic crude oil production is projected to grow at only 0.1 percent a year until 2030.*
- *The government has introduced major energy reforms, with the aims of increasing investment in the hydrocarbon sector and improving Mexico's energy security.*

ECONOMY

Mexico is located in southern North America, lying between the Pacific Ocean, the Caribbean Sea and the Gulf of Mexico. It shares land borders with the United States in the north and Guatemala and Belize in the south. The economy's land area is 1.96 million square kilometres, divided up into 32 states.

Mexico's population is expected to grow at an average annual rate of 0.8 percent over the outlook period – from 103 million in 2005 to 125 million in 2030. The population is increasingly urban, with the urban share expected to rise from 76 percent in 2005 to about 83 percent by 2030.[150]

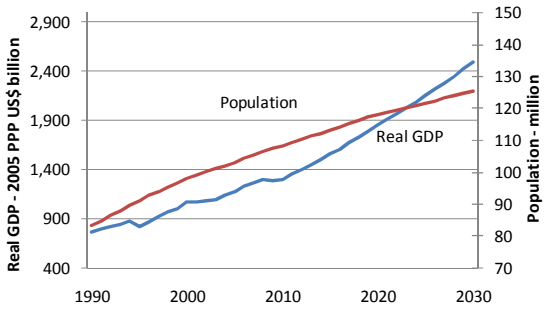
The climate is different north and south, with a temperate zone in the north (with cooler temperatures during winter) and a tropical zone in the south, which features fairly constant temperatures year round. Overall the economy has one of the most diverse weather systems in the world.

Mexico's economy is the fourteenth largest in the world, and the second largest in Latin America. Current macroeconomic policy has focused on achieving fiscal balance, including active public debt management to lengthen debt maturity and reduce exposure to exchange rate risk, and a monetary policy based on inflation targeting and a flexible exchange rate. Mexico's economy is expected to grow at an average annual rate of 3.1 percent over the outlook period.

For the first period of the analysis, during 2005 to 2015, the projections for growth in the Mexican economy are conservative, given the continued economic contraction around the world; an average annual growth rate of 2.9 percent is expected. However, for the second part of the outlook period (from 2015 to 2030), the Mexican economy is projected to grow at an annual average rate of 3.2 percent. The GDP in 2030 is expected to be US$19,800 per person. This will be driven by a dynamic industry sector (particularly the base metal industry, non-metallic minerals and chemical subsectors) as well as by growth in the service sector.

Most of the economy's GDP comes from its secondary and tertiary sectors. In the 2008 financial year, industry contributed 30.3 percent of GDP (including crude oil exports), with 63.3 percent coming from goods and services (including tourism and remittances sent home from Mexicans working abroad). The primary sector (agriculture, fishing, forestry and others) contributed 3.6 percent.

Figure MEX1: GDP and population



Source: APERC analysis (2009)

Crude oil exports contribute about 9 percent of Mexico's GDP. In 2008, crude oil export sales totalled US$43,324 million, an increase of 14.2 percent on the previous year. As oil prices have risen, crude oil export incomes have grown considerably. In 2004, crude oil exports sales totalled US$21,258 million – a more than two-fold increase in four years.

Remittances are a substantial and growing part of the economy – they have become the second largest source of foreign income after crude oil exports. From 1999 to 2007, remittances increased at an average annual rate of 20.4 percent. However, in 2008, remittance income contracted in the second

[150] United Nations (2005).

half of the year, and overall was down by 3.6 percent on the previous year.[151] The final 2008 remittances total was US$25,145 million, or around 2.3 percent of GDP.

In recent decades, Mexico has steadily reduced its energy intensity (ie improved overall energy efficiency); over the 1990–2000 period, the economy reduced the amount of energy required to produce each $US 1 million of its GDP by an average of 1.4 percent.

ENERGY RESOURCES

Primary energy resources in Mexico include crude oil, natural gas, coal, hydro, geothermal, nuclear, wind, biomass and solar. Their exploitation is largely state-owned. Petróleos Mexicanos (Pemex) explores for and produces crude oil and natural gas, while electricity generation, distribution and transmission is carried out by Comisión Federal de Electricidad (CFE) and Luz y Fuerza del Centro (LyFC).

In 2008, Mexico was ranked the sixth largest crude oil producer in the world, with total production of 2,792 thousand barrels per day (tbpd), and thirteenth largest natural gas producer, with 6,919 million cubic feet per day (mmcfpd).[152] Most of the crude oil produced in Mexico is heavy crude oil (63.2 percent); light crude (29.2 percent) and extra-light (7.5 percent) make up the remainder.

Crude oil and natural gas are produced from offshore and onshore fields. As at 1 January 2009, estimated proved hydrocarbon reserves totalled 14,308 million barrels crude oil equivalent (mmmbcoe). Crude oil made up 73 percent of this, condensates and plant liquids 10 percent and dry gas equivalent to liquid 17 percent. Natural gas proved reserves totalled 17,650 billion cubic feet (Bcf), made up of associated gas (65 percent) and non-associated gas (35 percent). The Cantarell field, considered a super-giant crude oil basin, is a major source of crude oil and natural gas. The Cantarell field is now declining in crude oil production, with a reduction of 50 percent from 2004, its highest level, to 2008 (2,079 tbpd down to 949 tbpd).[153] Production levels have been maintained in the short term through improvements made by Pemex to well performance, but continued decline is inevitable. The other basin with significant hydrocarbon reserves is located in the Chincontepec region. Between 2009 and 2017, crude oil production in this region is expected to reach 436 tbpd on average, with natural gas production of 546 mmcfpd.[154]

Coal, hydro, nuclear, geothermal and wind resources are all used for electricity generation. Mexico has around 1,200 million tonnes of recoverable coal reserves, mostly located in the north-eastern state of Coahuila. In 2008, Mexico's final coal production was 5.5 Mtoe, and imports contributed 2.7 Mtoe for total supply of 7.2 Mtoe; about 72 percent of total supply going to electricity generation and 20 percent to coking plants. In the same year, renewable resources (including hydro) made up 20 percent of total electricity generation by public providers (46,202 GWh); of this, 38,892 GWh came from hydroelectric plants.[155] Overall, hydro-based generation has increased at an average annual rate of 0.2 percent between 1997 and 2007. Modest expansions of installed hydro capacity are planned in Mexico, with another 1,374 MW expected by 2018.[156]

The economy is currently the world's fourth largest producer of geothermal energy, with a total generation of 7,056 GWh in 2008. This is based on four major geothermal fields, one of which, Cerro Prieto, is the second largest geothermal field in the world. Wind energy contributes only a marginal share (0.5 percent of the total renewable electricity generation); however, its potential is estimated at over 40 GW of installed capacity,[157] of which only 86 MW was installed by 2008. The regions with greatest wind potential are in the south-east and north-west, specifically the State of Oaxaca and the Yucatan and Baja California peninsulas.

Nuclear energy generation totalled 9,804 GWh in 2008. There are no anticipated increases in nuclear power generation in the outlook period; however, small expansions through technology modernization in existing nuclear plants are being contemplated.[158]

The National Electric System is made up of three main grids, with a total installed capacity of 51,029 MW in 2007. Expected increases in electricity demand in the north have prompted the planned interconnection of the SIN and Baja California grids in 2013; this may reduce the call for future investment in generation facilities, while also opening

151 Banco de México (2009B).

152 Petróleos Mexicanos (2009D).

153 Petróleos Mexicanos (2009D), p 20.

154 Petróleos Mexicanos (2009B).

155 Secretaría de Energía (2009).

156 CFE (2008B).

157 Secretaría de Energía & Deutsche Gesellschaft für Technische Zusammenarbeit GTZ GmbH (2006).

158 Secretaría de Energía (2008F), p 142.

opportunities for energy trading with electricity companies in the western United States.

ENERGY POLICIES

The Mexican federal government has developed an overall long-term policy vision called 'Visión 2030'. It is based on five pillars: 1) rule of law and public safety 2) economic competitiveness and generation of jobs 3) equality of opportunities 4) environmental sustainability and 5) effective democracy and responsible foreign affairs. Each pillar has numerous goals with detailed strategies. Visión 2030 represents an ambitious new programme based on collaboration at all levels of government. The main goal is that all Mexicans have 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.

The Energy Sector Program 2007–2012 was developed out of the Visión 2030 project; it 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, minimizing 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.[159]

Mexico began economic reforms in the 1980s, with the aim of liberalizing the economy and opening it to foreign trade and investment. It is now in the middle of significant structural change to its energy policy. 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: Regulation law of the Article 21 of the Mexican Constitution; Organic law of the Federal Public Administration; Law of the Energy Regulatory Commission; Organic Law of Pemex; Law of the National Hydrocarbon Commission; Law for the Efficient Use of Renewable Energies and the Financing of the Energy Transition; and Law for Sustainable Use of Energy.[160]

At the same time administrative efforts in energy conservation were strengthened through the transformation of the National Commission to Save Energy (CONAE by its Spanish acronym) into the National Commission for Energy Efficiency (CONUEE by its Spanish acronym). This aims to further promote energy efficiency and provide technical advice on the sustainable use of energy. Overall, the economy's efforts to improve its energy efficiency have sparked the sustained, programmatic development of federal agencies, which now are taking the lead in formulating and delivering programmes for various sections of the energy sector and society. The most effective is 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. There have been other effective measures such as the private, public and social partnership called FIDE (Trust Fund for Electricity Savings) that provides financing for energy audits and assessments, and facilitates the acquisition and installation of energy-efficient equipment. However, at the time of writing, energy efficiency programmes in the transformation sector (including crude oil refining and petrochemical industries) are not yet developed in Mexico, and there remain high levels of energy degradation and greenhouse gas (GHG) emissions. One advanced methodology to increase energy efficiency could be useful as optimization process methods or *exergy analysis*, which simultaneously considers the 3Es (energy, economy and ecology), so allowing identification and reduction of the energy degradation in transformation processes used in refining, petrochemical industries, and power plants.[161]

The Law for the Promotion and Development of Biofuels was approved by the Mexican Congress on 26 April 2007 and gazetted on 1 February 2008. This law does not set any specific targets; rather it is a 'first step' toward developing a biofuels industry in Mexico, outlining the regulatory responsibilities of different ministries within the federal administration. Biofuels for electricity generation, transport and rural residential have considerable potential in Mexico, so the use of this energy would allow the economy to foster sustainable development strategies as well as creating new jobs, combating poverty and increasing the renewable element of the energy mix. One estimate puts the potential for bioenergy use in the energy sector at 16 percent by 2030 – this is based on a high penetration scenario.[162]

[159] Secretaría de Energía (2007B).

[160] Further information on Secretaría de Energía website: www.energia.gob.mx

[161] Rivero R (2002).

[162] Islas et al (2007).

Another government initiative in line with the new energy policy is the construction of a new crude oil refinery with 300 tbpd of installed capacity, as announced in April 2009. The new refinery, which is scheduled to begin operations in 2015, will be built in the state of Hidalgo. Total investment for new refinery construction is estimated at US$12,198 million.[163] This will also cover the government's planned revamp of the Salamanca refinery, to help meet the economy's mounting refined products deficit. Petroleum product imports, particularly of gasoline, are expected to reduce by 2015 with the introduction of this additional installed capacity. However, the constant fuel demand in the transport sector and the lack of more efficient and effective installed refining capacity will mean Mexico is expected to continue being a net importer of fuels.

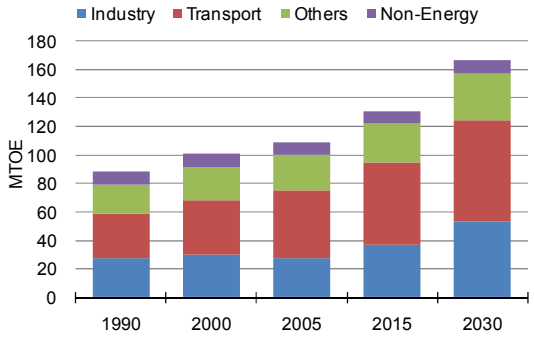
OUTLOOK

FINAL ENERGY DEMAND

Mexico's final energy demand is expected to grow at an annual average rate of 1.7 percent during the outlook period, reaching 166.8 Mtoe in 2030. The transport sector is expected to continue to dominate, reaching 42 percent of the total energy demand (70.9 Mtoe) in 2030. Industry has the second largest share in the final energy demand (32 percent), while the 'other' sector (including the residential, commercial, public and agricultural subsectors) will take 20 percent; the remaining 6 percent comes from the non-energy use sector. Of the energy sources used in the economy, electricity is expected to have the fastest average annual growth rate (3.4 percent), with a total final demand of 36.6 Mtoe in 2030. However, the largest energy source remains oil products, with a share of 54 percent in 2030.

Mexico's energy intensity is expected to steadily reduce during the outlook period, declining at an average annual rate of 1.3 percent. This will be achieved through the continuous promotion and improvement of energy efficiencies. However, the economy's overall growth means its energy demand will keep increasing, based on accelerating consumption of petroleum products in the transport sector and natural gas in the transformation sector.

Figure MEX2: Final energy demand



Source: APERC analysis (2009)

Industry

The energy demand of the Mexican industrial sector is projected to grow at an average annual rate of 2.7 percent during the outlook period. This is faster than the 0.7 percent annual average growth between 1990 and 2000. This growth projection is based on the reactivation of the Mexican chemical and petrochemical industry, as well as growth in the cement industry. Construction of new petrochemical plants as a result of Presidential initiatives is expected during the first half of the outlook period;[164] this follows several years without substantial investments and improvements in the chemical and petrochemical subsectors.

Electricity use in the industrial sector will increase at an average annual rate of 3.8 percent, reaching 23.6 Mtoe in 2030 – at 44 percent; this is the largest share of the industrial fuel demand. By contrast, demand for petroleum products is expected to grow more slowly, at an average annual rate of 1.8 percent, and in terms of the total industrial energy demand, petroleum products' share is expected to decrease from 21 percent in 2005 to 17 percent in 2030. This is a result of environmental regulations that discourage the use of fuel oil and coal. However, in the first half of the outlook period (2005–2015), there is an anticipated spike in demand for petroleum products, when an average annual growth rate of 4 percent is expected – this will be driven by petroleum coke (petcoke) consumption in the cement industry. Natural gas's share of the industrial energy demand is projected to reach 31 percent at the end of the outlook period; the increase from 10 Mtoe in 2005 to 16.8 Mtoe in 2030 is based on an average annual growth rate of 2.1 percent. Natural gas consumption is expected to increase during the first half of the period, driven by growth in the chemical and petrochemical subsectors.

[163] Petróleos Mexicanos (2009C).

[164] Secretaría de Energía (2008D), p 130.

In order to reduce the impact of increasing energy demand in the industrial sector, Mexico is carrying out programmes to improve energy efficiency in industrial facilities.

Transport

The energy demand in the road-transport subsector is expected to increase as a result of a 2009 change in vehicle import restrictions. This is when one clause of the North American Free Trade Agreement (NAFTA) comes into effect, allowing imports of used vehicles (more than 10 years old) from the US; the Mexican vehicle fleet is expected to increase substantially. The aviation subsector also has an increasing energy demand. Overall, the total transport energy demand will grow from 47.5 Mtoe in 2005 to 70.9 Mtoe to 2030, at an average annual rate of 1.6 percent – this makes transport the fastest growing sector in terms of its energy demand.

Gasoline is expected to make up the largest share of the Mexican transport energy demand, growing at an average annual rate of 1.1 percent. Biofuels are expected to contribute 9 percent of the transport energy demand by 2030, with 4.4 Mtoe of bioethanol and 2.3 Mtoe of biodiesel.

Other

The final energy demand of the 'other' sector in Mexico is driven by the residential and commercial subsectors. Overall, the 'other' sector demand is projected to grow at an average annual rate of 1.1 percent over the outlook period. Demand for natural gas is expected to grow fastest, at an average annual rate of 3.1 percent, increasing from 1.1 Mtoe in 2005 to 2.3 Mtoe in 2030. The rise in natural gas demand is linked to increased private sector investment in natural gas distribution, as well as more urban (new and existing) households shifting to natural gas from LPG. At the same time, the demand for petroleum products in this sector is expected to increase slightly with an annual average growth rate of 0.2 percent, from 11.4 Mtoe in 2005 to 12.1 Mtoe in 2030. However, its share will decline from 46 percent to 37 percent during the same period, driven by the replacement of LPG boilers with solar water heaters for residential and commercial use, through the Procalsol programme.[165]

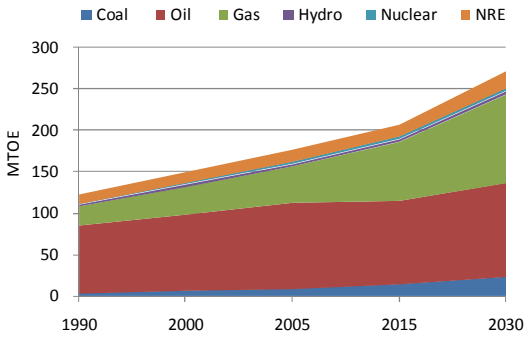
Electricity is expected to make up the largest share, at 39 percent in 2030; this is up from 26 percent in 2005. The 'other' sector's electricity demand will have an average annual rate of growth of 2.7 percent, and is expected to double over the outlook period, reaching 12.8 Mtoe in 2030. This increase is based on anticipated construction of large developments featuring new single-family houses.

PRIMARY ENERGY SUPPLY

Mexico is a net exporter of crude oil. Over the outlook period it is expected to maintain current levels of oil production (197 Mtoe in 2005 and 202 Mtoe in 2030), which will continue to dominate its primary energy supply. Oil's share of the economy's primary energy supply in 2030 is expected to be 63 percent, which is lower than in 2005, as some of oil's share will be taken up by the increasing supply of natural gas. Significant effort continues to be devoted to promoting increased oil production by the exploitation of current and mature deposits, as well as future exploration and possible exploitation of resources in deep-water basins in the Gulf of Mexico.

Natural gas domestic production is expected to grow at an average annual rate of 3.2 percent. Although Mexico has considerable natural gas reserves, imports will continue to be required. Based on a projection of domestic production of natural gas continuing at current levels, imports will need to rise to 25.8 Mtoe in 2030. Imports of liquefied natural gas (LNG) are also expected, with three LNG gas terminals projected to begin operation during the outlook period.

Figure MEX3: Primary energy supply



Source: APERC analysis (2009)

The domestic supply of coal is expected to increase at an average annual rate of 2.1 percent; this is driven largely by demand for electricity generation and also by demand from coking plants. Nuclear is expected to show a slow increase over the outlook period, based on the optimization of performance of Mexico's only nuclear plant – this will increase nuclear-based electricity generation from 2.8 Mtoe in 2005 to 3.3 Mtoe in 2030. The contribution of renewables to the primary energy supply is projected

[165] Secretaría de Energía (2007A).

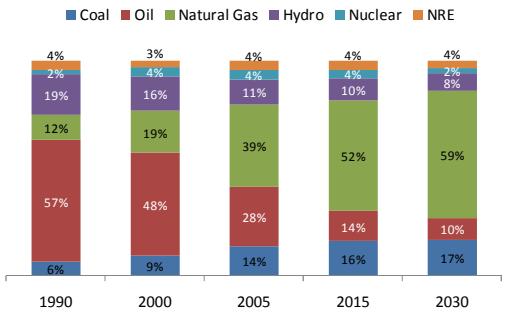
to grow at an average annual rate of 1.4 percent, as result of more geothermal and solar projects.

ELECTRICITY

Electricity demand is projected to grow at 3.1 percent a year over the outlook period, with total electricity generation reaching 517 TWh in 2030. Natural gas dominates the electricity generation mix; its share is expected to increase from 39 percent in 2005 to 59 percent in 2030. Electricity generation based on oil is expected to decline at an annual average rate of 1.1 percent over the outlook period (from 66 Mtoe in 2006 to 51 Mtoe in 2030), as a result of environmental regulations and the introduction of new technology, including combined cycle plants, and optimization of existing plants.

Use of coal for electricity generation will grow at an average annual rate of 3.9 percent, with total coal-fired generation increasing 2.6 times over the period (rising from 33 TWh in 2005 to 86 TWh in 2030). New coal power plants are expected to come online at the end of first period of analysis (2005–2015). Electricity generation based on new renewable energy sources (NRE) is expected to grow at an average annual rate of 2.3 percent, reaching 20 TWh in 2030. This growth is based on the installation of new wind farms and a small increase in geothermal capacity. Nuclear power generation will also increase slightly, through the optimization of the existing plant: the expected average annual growth rate is 0.7 percent, rising from 10.8 TWh in 2005 to 12.7 TWh in 2030.

Figure MEX4: Electricity generation mix



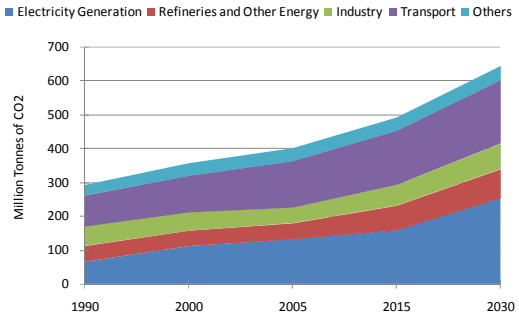
Source: APERC analysis (2009)

Hydroelectric generation is projected to increase at an average annual rate of 1.6 percent, reaching 41 TWh in 2030. Most of this increase is expected in the second half of the outlook period, when 9 TWh of new capacity is due to come online.

CO_2 EMISSIONS

Mexico's CO_2 emissions from fuel consumption are expected to increase by around 160 percent over the outlook period, reaching 644 million tonnes of CO_2 in 2030. Fossil fuel dominance in electricity generation and transport is a key factor in this increase. The highest share of CO_2 emissions comes from electricity generation (39.2 percent, or 253 million tonnes of CO_2), with transport next at 28.8 percent (186 million tonnes of CO_2).

Figure MEX5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table MEX1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.3%	0.5%	0.0%	0.2%
Change in Energy Intensity of GDP	-0.5%	-1.2%	-1.3%	-1.3%
Change in GDP	2.9%	2.9%	3.2%	3.1%
Total Change	2.1%	2.1%	1.8%	1.9%

Source: APERC analysis (2009)

The decomposition analysis shown in this table indicates that economic growth is the most important factor in Mexico's increased CO_2 emissions. While the economy's energy intensity of GDP is decreasing (through improvements in energy efficiency), the CO_2 intensity of energy is increasing slowly, at an average annual rate of 0.2 percent – due to greater use of coal in the transformation sector.

CHALLENGES AND IMPLICATIONS

Significant structural change in Mexico's energy policy has been achieved, which will reduce barriers to foreign and private investment in the oil sector. However, if future development of the economy's oil resources is to progress, the government will need to secure significant investment in new projects, within clear boundaries.

On the energy supply side, the high rates of natural decline in crude oil reserves and exploitation of mature basins mean that oil exports are expected

to decrease over the outlook period. Although Mexico has a high level of certified crude oil reserves, major investments are needed in order to maintain the economy's growth, which is currently heavily dependent on oil revenue.

There is great potential within Mexico for the exploitation of new renewable energy sources, and this is a priority in an economy with a strong focus on oil production and export. The Mexican government has been implementing stronger policies to foster exploitation of NRE resources, such as solar, bioenergy and wind, with the aim of improving the economy's energy efficiency and reducing GHG emissions. However, this analysis shows growth in this area will be slow, while CO_2 emissions are expected to increase rapidly. Mitigation and reduction of CO_2 emissions is a big challenge for Mexico, particularly given its dependency on natural gas and possibly coal for electricity generation and gasoline for transport.

These issues of energy security and environmental protection will need to be addressed in parallel, so that Mexico can achieve its long-term vision of raising its standard of living.

REFERENCES

APERC (2009) *APEC Energy Overview 2008*, Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

Banco de México (2009A) *Informe Anual 2008*, April 2009, Mexico. www.banxico.org.mx

Banco de México (2009B) *Las remesas familiares en 2008*, 27 January 2009, Mexico. www.banxico.org.mx

CFE (2008A) *Informe Anual 2007*. Comisión Federal de Electricidad, Mexico. www.cfe.gob.mx

CFE (2008B) *Programa de Inversiones del Sector Eléctrico (POISE) 2009–2018*. Comisión Federal de Electricidad, Mexico. www.cfe.gob.mx

EDMC (2009) APEC Energy Database. Energy Data and Modelling Center, Institute of Energy Economics, Japan. www.ieej.or.jp/apec

Islas J, Manzini F and Masera O (2007) "A prospective study of bioenergy use in Mexico", *Energy*, vol 32, 2007, pp 2306–2320. Elsevier Science.

Petróleos Mexicanos (2009A) "Hydrocarbon reserves as January 1st, 2009", 20 March 2009. www.pemex.com

Petróleos Mexicanos (2009B) "Proyecto Chicontepec". www.pemex.com

Petróleos Mexicanos (2009C) "Resultados finales de la evaluación técnica de la nueva Refinería", 23 March 2009. www.pemex.com

Petróleos Mexicanos (2009D) *Statistical Yearbook* Pemex *2009*. www.pemex.com

Presidencia de la República (2006) *Proyecto "Visión 2030"*, Estados Unidos Mexicanos. www.vision2030.gob.mx

Rivero R (2002) "Application of the exergy concept in the petroleum refining and petrochemical industry", *Energy Conversion and Management*, vol 43, issues 9–12, June–August 2002, pp 1199–1220. Elsevier Science.

Secretaría de Energía (2007A) Programa para la Promoción de Calentadores Solares en México (Procalsol) 2007–2012. Mexico. www.energia.gob.mx

Secretaría de Energía (2007b) Programa Sectorial de Energía 2007-2012. Mexico. www.energia.gob.mx

Secretaría de Energía (2008a) Balance Nacional de Energía 2007. Mexico. www.energia.gob.mx

Secretaría de Energía (2008b) Leyes y decretos de la Reforma Energética publicados en el Diario Oficial de la Federación (DOF). Mexico. www.energia.gob.mx/webSener/reforma/DOF.html

Secretaría de Energía (2008C) *Prospectiva del Mercado de Gas LP 2008–2017*. Mexico. www.energia.gob.mx

Secretaría de Energía (2008D) *Prospectiva del Mercado de Gas Natural 2008–2017*. Mexico. www.energia.gob.mx

Secretaría de Energía (2008E) *Prospectiva del Mercado de Petróleo Crudo 2008–2017*. Mexico. www.energia.gob.mx

Secretaría de Energía, (2008F) *Prospectiva de petrolíferos 2008-2017*. México www.energia.gob.mx

Secretaría de Energía (2008F) *Prospectiva del Sector Eléctrico 2008–2017*. Mexico. www.energia.gob.mx

Secretaría de Energía (2009) *Balance Nacional de Energía 2008*. Mexico. www.energia.gob.mx

Secretaría de Energía & Deutsche Gesellschaft für Technische Zusammenarbeit GTZ GmbH (2006) Renewable *Energies for Sustainable Development in Mexico*. Mexico. www.energia.gob.mx

United Nations (2005), "UN Common Database (UN Population Division estimates)" as reported on the Globalis Interactive World Map, Global Virtual University, http://globalis.gvu.unu.edu/indicator_detail.cfm?IndicatorID=30&Country=MX

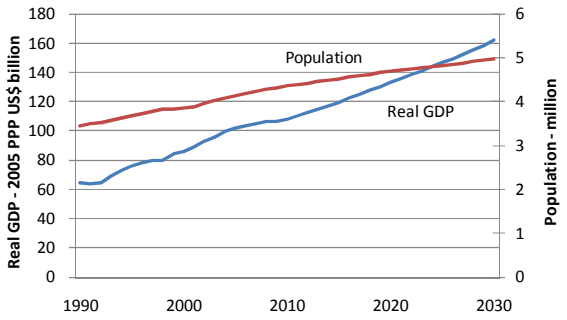
NEW ZEALAND

- *New Zealand's final energy demand will grow annually at 1.6 percent from 13.0 Mtoe in 2005 to 19.4 Mtoe in 2030, with the transport sector accounting for about 60 percent of the growth.*
- *Oil imports will rise from 5.8 Mtoe in 2005 to 8.8 Mtoe in 2030, leaving the New Zealand economy more exposed to fluctuations in oil prices.*
- *CO_2 emissions from fuel combustion are projected to reach 50 million tonnes of CO_2 by 2030 – about 50 percent higher than in 2005.*

ECONOMY

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 smaller 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, however, comparable only 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.

Figure NZ1: GDP and population



Source: APERC analysis (2009)

New Zealand is a mature economy, with a population that is expected to increase only modestly to about 5 million by 2030. Economic growth will be similarly modest, increasing by an average of about 1.8 percent per year in real dollars between 2005 and 2030.

New Zealand's per capita GDP of about US$25,000 puts it at the low end of the OECD economies. However, New Zealand generally rates high 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.

Most of New Zealand is hilly or mountainous. The climate is mostly cool and wet. Winters are generally not extreme, with snow and ice unusual except in the far south and at higher elevations. However, winter heating of buildings is still necessary and almost universal. Summer cooling of buildings is less common, and mostly limited to large commercial structures.

New Zealand's economy is heavily dependent on agriculture, including the raising of dairy cattle, sheep, and other grazing livestock, as well as the cultivation of fruits and vegetables. Other major export industries include tourism, fishing, coal mining, forestry, forest products processing, and food processing. The dairy processing industry is particularly energy intensive, as much of New Zealand's dairy exports must be dried or condensed. Another energy-intensive export industry is the aluminium smelter at Bluff, which accounts for about 12 percent of New Zealand's electricity consumption.[166] New Zealand has two plants that convert natural gas into methanol, mostly for export. These methanol plants are currently only partially utilized, and their future operation will depend upon the availability of gas and the spread between local gas prices and international methanol prices. There is also one integrated steel mill, one oil refinery, and one petrochemical plant that converts natural gas into urea (mostly for fertilizer), all of which serve mostly domestic markets.

Although Auckland and Wellington have small commuter rail systems, and all cities have local bus services, the automobile is the dominant mode of local passenger transportation. The automobile and air travel dominate the intercity passenger market, although there is some intercity bus service. Intercity rail service is limited to three routes, mostly served only once a day in each direction.

Domestic freight transport is also dominated by road transport, although the railways (re-acquired by the government in 2008) have a role, especially in moving container freight, coal, and other commodities. About half of New Zealand's

[166] Ministry of Economic Development (2006B), p 122.

automobile fleet is imported used from Japan. There is no domestic automobile manufacturing industry. Due to New Zealand's remote location, New Zealand is heavily dependent on overseas air and ship transport for both freight and tourism.

ENERGY RESOURCES

Although New Zealand has a modest oil and gas producing industry, New Zealand is 68 percent[167] dependent on imports of oil and oil products. New Zealand also produces a significant quantity of natural gas, which is used to generate electricity, used directly in homes and businesses, and also used in the methanol and urea plants mentioned above. However, only the North Island has a natural gas pipeline and distribution network. There are no facilities for importing natural gas on either island; all of New Zealand's gas is currently domestically produced.

New Zealand's gas and domestic oil come primarily from the Taranaki Basin, where there are several offshore fields. The largest of these fields, Maui, is believed to be nearing depletion, and there has been concern that New Zealand's gas supply could be inadequate in future years. Proposals have been made to build a liquefied natural gas (LNG) terminal to allow the importation of LNG. However, private investors have not been willing to finance such a major investment without government backing, and the government thus far has not been willing to provide the necessary support.

Despite the immediate concerns about gas supply, New Zealand's long-term prospects for finding more domestic gas, and oil as well, are excellent. The May 2009 version of the website of Crown Minerals, the agency that manages New Zealand's oil and gas resources, notes:

> "All of New Zealand's production so far has been from the Taranaki Basin, the country's most explored and commercially successful hydrocarbon province. However, the basin is only moderately explored compared with basins world-wide, and there is considerable scope for further commercial discoveries as demonstrated by recent exploration successes.
>
> The rest of New Zealand is severely under-explored, and most sedimentary basins have the potential for commercial hydrocarbon discoveries. Many untested structural closures are potentially larger than the giant Maui field in the Taranaki Basin."[168]

The last few years have indeed seen a series of small discoveries in the Taranaki Basin. In addition, Crown Minerals has identified seven other basins, each with good prospects, but there has been little exploration so far.

The lack of exploration is due to several factors. First, oil is the big prize that most exploration firms seek, and New Zealand's geology is widely viewed as gas-prone. Indeed, much of New Zealand's current 'oil' production is actually natural gas liquids. Second, New Zealand's gas infrastructure is underdeveloped. A modest discovery outside the Taranaki Basin would require construction of a gas pipeline system to reach the New Zealand market. A really major gas discovery would swamp the New Zealand market and require construction of an LNG export facility. Either way, the cost of the investment would reduce the value of the gas at the wellhead. Third, many of the best potential drilling sites are distant from shore, in deep water, and exposed to severe sea conditions, making drilling difficult and expensive.[169] However, each of these barriers is likely to be overcome as technology improves and oil prices rise.

With historically abundant hydro resources, New Zealand is heavily dependent on electricity. Many homes and businesses in New Zealand have electric space heating and electric water heating. About 55 percent of New Zealand's electricity is generated by hydro. However, the good sites for hydro plants have been largely developed, and there is strong environmental opposition to developing the remaining sites. While some small additional hydro projects may be possible, major new hydro projects are unlikely. New Zealand's heavy dependence on hydro for electricity generation leaves its electricity supplies subject to fluctuations in precipitation. Dry years in New Zealand have historically resulted in electricity supply crises.

New Zealand has only one coal-fired electricity generation plant, Huntly, commissioned in 1987.[170] While there is only one coal-fired plant, it accounts for about 7 percent of New Zealand's electricity production. Although New Zealand has significant domestic coal resources, there is strong opposition to new coal plants because of their greenhouse gas emissions. Although Huntly will probably continue to operate for some time under business-as-usual policies, it is unlikely that a new coal plant could be built in New Zealand without accompanying carbon capture and storage.

Gas accounts for about 26 percent of New Zealand's electricity production. While there is environmental opposition to new gas plants on the

[167] Ministry of Economic Development (2008), p 30.

[168] Ministry of Economic Development – Crown Minerals Group (2009).

[169] Samuelson (2008), pp 64–65.

[170] Ministry of Economic Development (2008), table G3a.

basis of their greenhouse gas emissions, the opposition is less strong than it would be for coal. Gas has the advantages of a relatively low capital cost, a short construction and approval cycle, and an ability to avoid transmission constraints (since gas plants can be built close to major markets and existing transmission infrastructure). For these reasons, gas generally tends to be the preferred option for electricity generation developers, assuming gas supplies are available.

Geothermal electricity currently accounts for about 9 percent of New Zealand's electricity production, and there is significant potential for more. It is important to note that geothermal energy is assumed to have a conversion efficiency of only 15 percent (according to New Zealand Ministry of Economic Development statistical standards) – meaning it takes roughly seven units of primary geothermal energy to produce one unit of electricity. The quite large figures reported for primary energy from new renewable energy (NRE) sources for New Zealand may therefore be deceptive, as only a small portion of this primary energy is converted to usable energy.

Wind power, which currently accounts for about 2 percent of New Zealand's electricity production, could also be expanded significantly. Unlike most economies, New Zealand's windy climate often allows wind farms to be developed without subsidy.

New Zealand has only one small oil product-fired generation plant, which serves as a reserve resource. Due to high costs and concerns about security of supply, oil is probably New Zealand's least preferred option for electricity generation.

ENERGY POLICIES

Although New Zealand ratified the Kyoto Protocol, its greenhouse gas emissions have been growing. In 2006 and 2007, the New Zealand government developed a New Zealand Energy Strategy; its major thrust was to aggressively promote energy efficiency and low-carbon energy. However, the government that developed it left office in late 2008, before most of the proposed policies could be implemented. The new government supports energy efficiency and low-carbon energy, but at the time of writing was still evaluating its policies. A moratorium on new fossil-fired generation plants imposed by the previous government has been lifted.

New Zealand has a relatively long tradition of promoting energy efficiency, having passed an Energy Efficiency and Conservation Act in 2000, which led to the 2001 National Energy Efficiency and Conservation Strategy (NEECS), as well as the establishment of the Energy Efficiency and Conservation Authority (EECA) to spearhead implementation of the strategy.

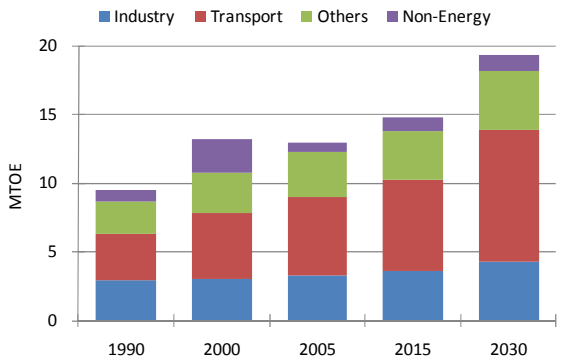
New Zealand's oil and gas exploration and production activities are largely in private ownership and open to competition. New Zealand generally welcomes investments in oil and gas exploration by foreign firms. Electricity generation and marketing is also largely open to competition, but three of the five major generators are state-owned firms, as is the transmission grid operator. The New Zealand Electricity Commission oversees the rules of the electricity market, and regulates transmission investment, but does not regulate electricity prices. The coal mining industry in New Zealand is dominated by a large state-owned firm, although there are private operators as well.

OUTLOOK

FINAL ENERGY DEMAND

Final energy demand is expected to grow at 1.6 percent per year over the outlook period, a bit slower than the 2.1 percent over the previous 15 years. The transport sector is projected to account for the largest share of the growth at 59 percent, followed by industrial and 'other' (residential, commercial, agriculture, construction), each at about 16 percent.

Figure NZ2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 1.1 percent until 2030, compared to 0.8 percent over the previous 15 years.

Electricity demand is projected to increase from 1.2 Mtoe in 2005 to 1.9 Mtoe in 2030; this is the fastest growth in industrial energy demand in absolute terms (0.14 Mtoe/year). Oil demand will

grow from 0.4 Mtoe to 0.6 Mtoe; this is the fastest growth in percentage terms (2.0 percent/year).

Transport

Over the outlook period, the transportation energy demand of New Zealand is projected to grow at an annual rate of 2.1 percent, reflecting continued growth in automobile-dependent suburbs. By 2030, transport will represent about half of New Zealand's final energy demand. Virtually all of this demand will be for oil products.

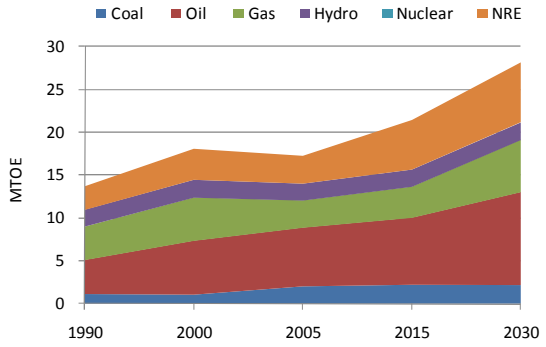
Other

Energy demand in the 'other' sector, which includes residential, commercial, agricultural and construction demand, is expected to grow at 1.1 percent per year over the outlook period. Electricity is expected to continue to dominate the energy mix in this sector, accounting for 65 percent of 'other' energy consumption in 2030.

PRIMARY ENERGY SUPPLY

New Zealand's primary energy supply in the 2005–2030 period is projected to grow at an annual rate of 2 percent, compared to 1 percent over the previous 15 years.

Figure NZ3: Primary energy supply



Source: APERC analysis (2009)

APERC's analysis of New Zealand's energy supply differs in one key respect from the conventional view (as reflected in, for example, the New Zealand government's *New Zealand's Energy Outlook to 2030*[171]). This is our view on the future of gas in New Zealand. The conventional wisdom holds that New Zealand is facing a tight market and perhaps shortages of gas, once the existing reserves, especially in the large Maui field, are depleted. Following this line of reasoning, New Zealand will eventually either need to scale back its use of gas, especially for electricity generation, or import gas in the form of LNG.

APERC's view is that additional gas supplies are likely to be found. As oil prices have risen since 2004, expenditures on exploration activity have more than tripled.[172] The result has been an increase in New Zealand's remaining gas reserves from 51,913 million cubic metres to 61,912 million cubic metres between January 2005 and January 2008.[173] At the historically high oil prices hypothesized in this report, this increased drilling activity is likely to be sustained. As noted above, New Zealand's geological prospects for finding more gas are excellent, and we believe new discoveries are likely to continue.

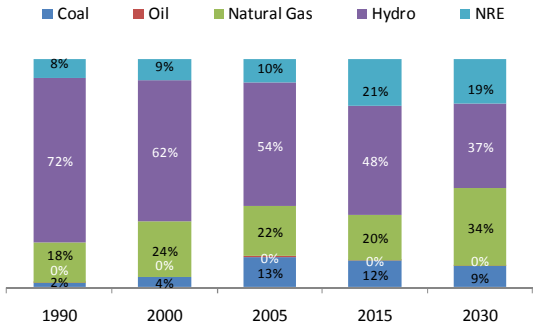
The availability of gas is likely to allow New Zealand to continue to generate electricity from gas, and to meet any gap between electricity demand growth and new and renewable energy generation with gas. It is also likely that New Zealand can continue to produce methanol for export from gas. Direct use of coal is little changed, due to the availability of gas.

The growth in transport demand leads to a significant increase in oil demand. Although New Zealand's oil production is likely to grow in response to higher oil prices and increased exploration activity, demand will grow by an even larger amount, causing oil imports to rise from 5.5 Mtoe in 2005 to 8.8 Mtoe in 2030.

ELECTRICITY

The availability of gas may make it possible to replace the Huntly coal-fired generation plant with a gas-fired plant, although this is not reflected in our projections. While this analysis assumes Huntly will continue to operate, it also assumes that new coal-fired generation in New Zealand is not likely to be built. Hence, there is no growth in the demand for coal for electricity generation.

Figure NZ4: Electricity generation mix



Source: APERC analysis (2009)

[171] Ministry of Economic Development (2006B), chapter 7.

[172] Ministry of Economic Development (2008), table H1.

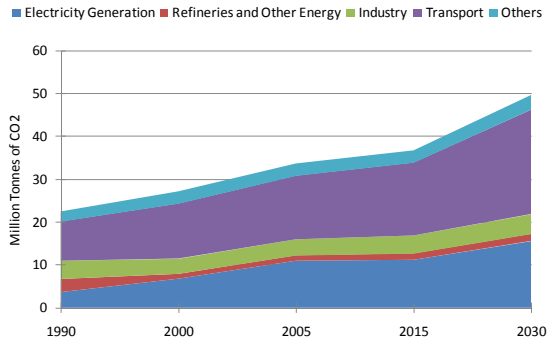
[173] For January 2008 reserves, see Ministry of Economic Development (2008), tables H3a and H3b. For January 2005 reserves, see Ministry of Economic Development (2006A), table H2.

Electricity production from hydro is likely to remain fairly constant, given the lack of suitable sites for new projects and the opposition to hydro development at the sites that are available. Other forms of renewable generation, including wind and geothermal, are, however, likely to nearly triple between 2005 and 2030, reflecting both available resources and existing supportive government policies.[174] However, gas-fired generation will still need to more than double, to fill the gap between projected electricity demand growth and projected renewable electricity supply growth.

CO_2 EMISSIONS

Over the outlook period, New Zealand's total CO_2 emissions from fuel combustion are projected to reach 50 million tonnes of CO_2, which is 48 percent higher than in 2005 and 121 percent higher than the 1990 level. By sector, transport is expected to account for the largest share (24 million tonnes of CO_2, or 49 percent of total CO_2 emissions), followed by electricity (16 million tonnes of CO_2, or 31 percent).

Figure NZ5: CO_2 emissions by sector



Source: APERC analysis (2009)

The decomposition analysis shown in the following table suggests that the growth in New Zealand's CO_2 emissions from fuel combustion will be primarily explained by GDP growth, rather than by change in CO_2 intensity of energy (fuel switching) or energy intensity of GDP (energy efficiency).

Table NZ1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	1.2%	-1.3%	0.2%	-0.4%
Change in Energy Intensity of GDP	-1.5%	0.5%	-0.2%	0.1%
Change in GDP	3.0%	1.7%	2.0%	1.9%
Total Change	2.7%	0.9%	2.0%	1.6%

Source: APERC analysis (2009)

[174] APERC's renewable electricity generating capacity projections are based on the "Medium Renewables" case in Electricity Commission (2008).

CHALLENGES AND IMPLICATIONS

Under our business-as-usual assumptions, New Zealand's energy demand and supply outlook does not accord well with the goals of energy security, economic development, and environmental protection (the '3Es').

- Rising oil imports will leave New Zealand vulnerable to any disruption in the oil market, as well as leaving New Zealand's economy exposed to fluctuations in oil prices.

- As noted above, New Zealand's greenhouse gas emissions will rise by about 50 percent between 2005 and 2030.

The one bright spot in this analysis, at least from an energy security and economic perspective, is the availability of gas. However, although we believe it is likely that New Zealand will be able to find more gas (perhaps considerably more), New Zealand is a small island economy that cannot base its energy planning on the assumption that this will definitely happen. If New Zealand based its energy planning on the assumption that lots of gas will be found, and these additional gas discoveries do not materialize, New Zealand could be left scrambling for alternative energy supplies, which would leave it even further from achieving the 3E goals.

Fortunately, New Zealand has many alternatives to 'business as usual'. Over the past few years, the New Zealand government has put a great deal of resources into studies, plans, and public consultation on a variety of proposed new polices to promote energy efficiency and low-carbon energy supply. New Zealand now has the opportunity to move ahead with implementing these proposals.

REFERENCES

Covec, Hale & Twomey, and Exergi Consulting (2006) *Heavy Industry Energy Demand*. Ministry of Economic Development, Wellington, New Zealand. http://www.med.govt.nz/energy/modelling/papers

Electricity Commission (2008) *2008 Statement of Opportunities*. Wellington, New Zealand. http://www.electricitycommission.govt.nz/opdev/transmis/soo/2008soo

Energy Efficiency and Conservation Authority (2007) *New Zealand Energy Efficiency and Conservation Strategy*. Wellington, New Zealand. http://www.eeca.govt.nz/node/2639

Ministry of Economic Development (2006A) *New Zealand Energy Data File* (Jan 2006 edition). Wellington, New Zealand. http://www.med.govt.nz/templates/MultipageDocumentTOC____15181.aspx

Ministry of Economic Development (2006B) *New Zealand's Energy Outlook to 2030*. Wellington, New Zealand. http://www.med.govt.nz/templates/StandardSummary____10186.aspx

Ministry of Economic Development (2007A) *Benefit–Cost Analysis of the New Zealand Energy Strategy*. Wellington, New Zealand. http://www.med.govt.nz/templates/MultipageDocumentTOC____31983.aspx

Ministry of Economic Development (2007B) *New Zealand Energy Strategy to 2050 – Powering* OurFuture. Wellington, New Zealand. http://www.med.govt.nz/templates/MultipageDocumentTOC____31948.aspx

Ministry of Economic Development (2008) *New Zealand Energy Data File (*Jun 2008 edition). Wellington, New Zealand. http://www.med.govt.nz/templates/MultipageDocumentTOC____36571.aspx

Ministry of Economic Development – Crown Minerals Group (2009) 'Petroleum Basins'. http://www.crownminerals.govt.nz/cms/petroleum/petroleum-basins

Samuelson, Ralph D (2008) *Oil: An Introduction for New Zealanders.* Ministry of Economic Development, Wellington, New Zealand. http://www.med.govt.nz/templates/StandardSummary____36.aspx

PAPUA NEW GUINEA

- *Papua New Guinea's total primary energy supply is projected to increase from 1.8 Mtoe in 2005 to 6.3 Mtoe in 2030. The growth in the primary energy supply includes significant increases in natural gas production in preparation for the start of LNG exports in 2014.*
- *Papua New Guinea may become a net oil importer before 2030 unless large new reserves of oil are found.*
- *Papua New Guinea may need to make greater use of renewable energy sources for electricity generation, as a long-term alternative to oil and natural gas.*

ECONOMY

Papua New Guinea is located in the south-western Pacific Ocean, just south of the equator. It is made up of over 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 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.

Papua New Guinea's population in 2007 was 6.25 million, with about 85 percent[175] living in rural areas; most of the rural population are dependent on subsistence farming. The population grew 2.7 percent in 2007[176]; it is expected to continue to grow at an average annual rate of 1.7 percent over the outlook period.

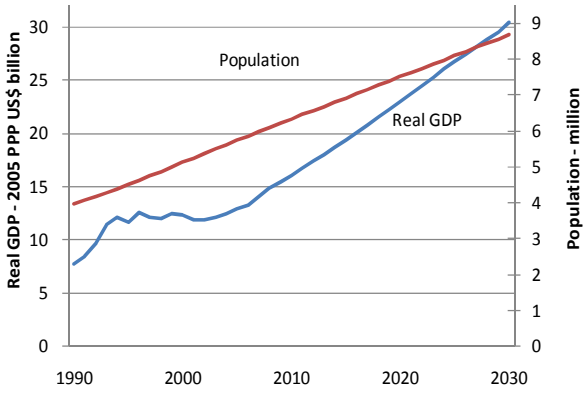
The economy of Papua New Guinea can be separated into subsistence non-market and market sectors. The market economy is dominated by large-scale resource projects, particularly mining, oil and gas. Agriculture currently accounts for 13 percent of GDP and supports more than 75 percent of the population.[177] The economy's primary cash crops are coffee, palm oil, cocoa, copra, tea, rubber and sugar. Some of the rural population is involved in smallholder cash cropping of coffee, cocoa and copra. Operations in Papua New Guinea's mining, timber, and fishing sectors are largely foreign owned.

Papua New Guinea is endowed with substantial mineral resources, including gold, copper, natural gas and oil.

Government revenues depend heavily on minerals and oil exports. Revenues from exports of minerals and oil accounted for 82 percent of GDP in 2006. Papua New Guinea's industry sector is made up of light industries and agricultural processing industries, which together accounted for 9 percent of GDP in 2006. Overall, the economy is highly dependent on imports of manufactured goods.

Papua New Guinea has achieved modest economic growth and government surpluses since 2003, after three years of decline. Economic growth was primarily the result of high commodity prices. The real GDP growth rate in 2006 was 3.7 percent, while GDP per capita was US$2,239 (in 2005 US$ PPP). GDP is expected to continue to expand at an average annual rate of 3.4 percent over the outlook period.

Figure PNG1: GDP and population



Source: APERC analysis (2009)

ENERGY RESOURCES

Papua New Guinea's proven hydrocarbon reserves consist primarily of natural gas (17.3 Tcf), followed by oil (0.660 billion barrels) and gas condensates (0.262 billion barrels). Inferred, mean-risk reserves may increase oil reserves by an additional one billion barrels, and natural gas by more than 10 Tcf.[178]

The Papuan Basin in the south-eastern part of the mainland is the most explored and developed oil and gas region – particularly the Papuan Fold Belt

[175] National Statistical Office of Papua New Guinea (2004).

[176] AusAID (2007).

[177] Department of State, United States (2009).

[178] Papua Petroleum Limited (2008).

and Papuan Foreland areas. There has also been exploration in the North New Guinea basin, and the Cape Vogel, New Ireland and Bougainville basins.

Papua New Guinea has significant hydroelectric potential. Its land area includes nine large hydrological drainage divisions (basins). The largest river basins are the Serpik (catchment area of 78,000 sq km), Fly (61,000 sq km), Purari (33,670 sq km), and Markham (12,000 sq km). There are other catchments of less than 5,000 sq km, in areas that are very steep. On the mainland, the mean annual rainfall ranges from less than 2,000 mm to 8,000 mm in some mountainous areas, while the island groups receive a mean annual rainfall of 3,000–7,000 mm. The gross theoretical hydropower potential for Papua New Guinea is 175 TWh per year.[179]

The Geothermal Energy Association estimates Papua New Guinea's geothermal potential at 21.92 TWh[180]; the association also categorizes Papua New Guinea as an economy that could, in theory, meet all its electricity needs from geothermal sources alone, well into the future.

ENERGY POLICIES

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 percent of taxable income, which is lower than the tax rate for income from petroleum projects established before 1 January 2001 (50 percent), and the rate for projects established after that date (45 percent). The new 30 percent 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 of 1 January 2003 to 31 December 2007.[181]

Papua New Guinea has arguably the most competitive terms for oil and gas investment in the region.[182] There is no capital gains tax, a full (100 percent) tax deduction is available for exploration expenditure, government participation is 22.5 percent, the effective royalty rate is 2 percent, and the government take is about 50 percent.

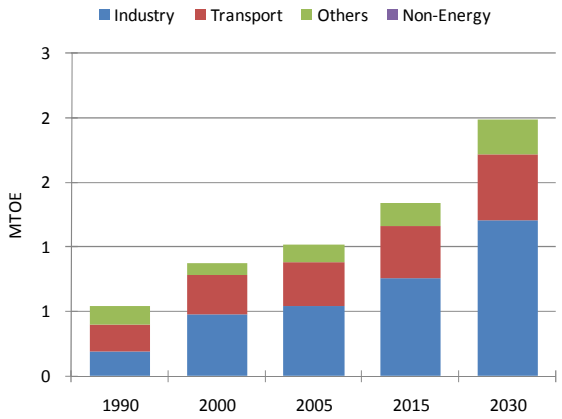
In its first petroleum-licensing round in 2007, Papua New Guinea offered 15 prospect blocks covering 12,000 ha in the Gulf of Papua.

OUTLOOK

FINAL ENERGY DEMAND

The final energy demand for Papua New Guinea is projected to increase at an average annual rate of 2.7 percent over the outlook period.

Figure PNG2: Final energy demand



Source: APERC analysis (2009)

This projection takes into account Papua New Guinea's LNG project, which is expected to begin production and exports of LNG in 2014; predicted volumes are 6.3 million tonnes of LNG per year from two trains, with additional annual production of 3.15 million tonnes from the third train, starting in 2017. The LNG plant is to be located near Port Moresby, with natural gas delivered by pipeline from the Juha and Angore production facilities, which are located at an elevation of 950m, and from the Hides production facilities, which lie between 1,700m and 2,800m. The gas pipeline from the production fields will descend from the mountains to the coast, and continue as a sub-sea gas pipeline parallel to the coastline, heading due east for 450 km[183] to the LNG plant.

The production of natural gas and LNG for export will significantly increase PNG's energy use. The main energy source is assumed to be natural gas, used directly to generate heat and as an input to electricity generation.

179 Encyclopedia of Earth (2008).

180 Gawell et al (1999).

181 Department of Petroleum and Energy (2003).

182 Papua Petroleum Limited (2008).

183 Esso Highlands Limited (2008).

Industry

This outlook assumes the Papua New Guinea industry sector will retain its current structure, which consists of light manufacturing and agricultural processing industries. However, the scale of production of these industries is expected to grow.

Final industrial energy demand is projected to increase at an average annual rate of 3.3 percent, from 0.54 Mtoe in 2005 to 1.21 Mtoe in 2030. In 2030 final energy demand of commercial energy in industry is projected to consist of petroleum products (61 percent) and electricity (39 percent); this includes a rise in industrial use of electricity, up from a 32 percent share in 2005.

Transport

The projected final energy demand in the transport sector is expected to increase at an average annual rate of 1.6 percent over the outlook period. The demand will be mostly for diesel oil, followed by aviation kerosene, and gasoline. Demand for diesel is projected to increase at an annual average rate of 2.2 percent, from 0.17 Mtoe in 2005 to 0.29 Mtoe in 2030. Demand for aviation kerosene is expected to increase at an average annual rate of 2.3 percent, from 0.08 Mtoe to 0.14 Mtoe.

Other

The final energy demand in the 'other' sector, which includes commercial and residential uses, is projected to increase at an average annual rate of 3.0 percent over the outlook period. The 'other' sector commercial energy demand is for electricity, kerosene and LPG. Demand for electricity is expected to increase most rapidly, at an average annual rate of 3.8 percent, from 0.07 Mtoe in 2005 to 0.17 Mtoe in 2030, while the demand for petroleum products including LPG is expected to increase at an average annual rate of 2.8 percent, from 0.05 Mtoe in 2005 to 0.10 Mtoe in 2030.

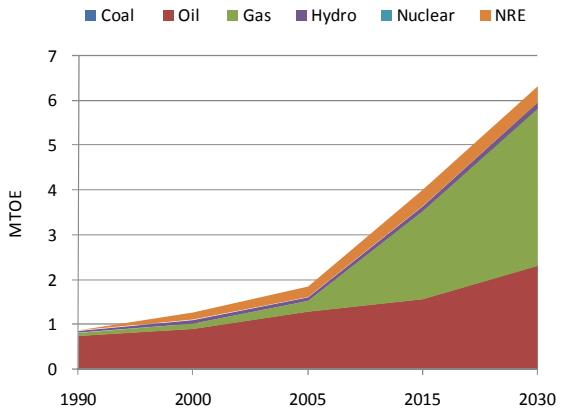
The projection for the 'other' sector includes only final demand for commercial energy, due to inadequate information about non-commercial energy use in Papua New Guinea. The economy's consumption of non-commercial biomass is projected to remain significant over the outlook period.

PRIMARY ENERGY SUPPLY

This outlook expects average annual oil production to increase from 2005 levels. This is based on the government's 2003 move to create advantageous tax rates for oil and gas exploration, and on the rapid development of natural gas production that will produce associated hydrocarbon liquids.

Papua New Guinea's primary energy supply is projected to increase at an average annual rate of 5.1 percent, from 1.8 Mtoe in 2005 to 6.3 Mtoe in 2030.

Figure PNG3: Primary energy supply



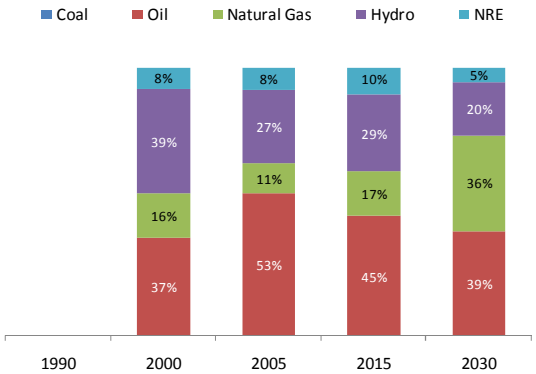
Source: APERC analysis (2009)

Natural gas production is expected to be able to meet both the demand for LNG production for export at full production capacity, and demand for electricity generation in the future.

ELECTRICITY

By 2015 Papua New Guinea is expected to add 74.3 MW of hydropower capacity to the 161.8 MW available in 2005;[184] a further 75 MW of hydropower is expected to come online by 2030. However, under this outlook's 'business as usual' assumptions, no further geothermal development is expected. The existing geothermal total capacity of 56 MW will be maintained throughout the outlook period.

Figure PNG4: Electricity generation mix



Source: APERC analysis (2009)

[184] Ururu and Makati (2005).

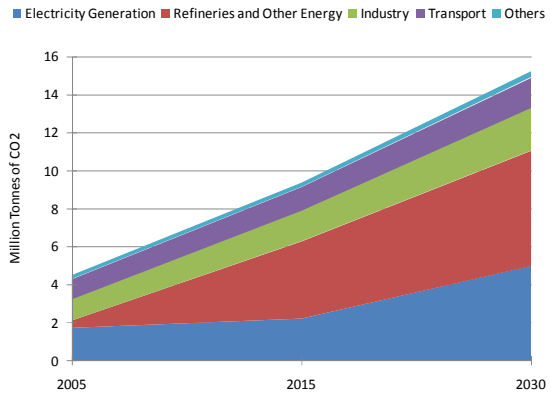
Greater use of natural gas in electricity generation is expected, as a result of natural gas supply becoming available in the Port Moresby area. Given this outlook's assumptions of business as usual, and that there are currently no definite plans for extensive utilization of renewable energy in electricity generation, it is expected that electricity generation will become increasingly fossil fuel based, although oil use will decline.

CO_2 EMISSIONS

Papua New Guinea's CO_2 emissions from the combustion of fuels are projected to reach 15.2 million tonnes in 2030, which is a 337 percent increase from the 1990 level of 4.5 million tonnes.

In 2030, 'own use in energy production' is projected to contribute the largest share of CO_2 emissions (6.1 million tonnes); followed by electricity generation (5.0 million tonnes); industry (2.3 million tonnes); transport (1.6 million tonnes); and the 'other' sector (0.3 million tonnes).

Figure PNG5: CO_2 emissions by sector



Source: APERC analysis (2009)

The decomposition analysis of factors that affect Papua New Guinea's CO_2 emissions, shown in the following table, indicates that economic growth is the most important factor behind Papua New Guinea's increasing CO_2 emissions. The growth in average energy intensity of the economy also contributes to increasing CO_2 emissions, but is projected to slow after 2015.

Table PNG1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.1%	-0.3%	0.2%	0.0%
Change in Energy Intensity of GDP	1.6%	3.9%	0.0%	1.6%
Change in GDP	3.6%	4.0%	3.0%	3.4%
Total Change	5.3%	7.8%	3.3%	5.1%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Given Papua New Guinea's efforts to attract investment in oil and gas exploration and production, and the expected significant condensate production in the near future, the economy may be able to maintain current levels of oil production through the outlook period. Our 'business as usual' projection, however, shows that unless large new oil reserves are found, production will decline and Papua New Guinea will become a net oil importer before 2030.

There remains great potential to replace oil in electricity generation. The options for Papua New Guinea are quite broad, particularly for greater use of geothermal and hydropower resources. Development of these resource bases have high upfront investment cost; however, they may well be more economic in the long run, compared to the readily available option of gas-fired electricity generation.

As Papua New Guinea's electricity system will become larger and more integrated in the future, other options for electricity generation may need to be investigated as an alternative to use of more expensive natural gas.[185] Future electricity generation could be based on a mix of geothermal and hydropower to meet base, intermediate and peak electricity demand. However, there would still be a requirement for oil-fired electricity generation on the small islands.

REFERENCES

APERC (2006) *APEC Energy Demand and Supply Outlook 2006*. Asia Pacific Energy Research Centre, Tokyo, Japan. http://www.ieej.or.jp/aperc

APERC (2008) *APEC Energy Overview 2007*. Asia Pacific Energy Research Centre, Tokyo, Japan. http://www.ieej.or.jp/aperc

AusAID (2007) *About Papua New Guinea.* Australian Agency for International Development, Australian Government. http://www.ausaid.gov.au/country/png/png_intro.cfm

Bank of Papua New Guinea (2009) *Quarterly Economic Bulletin, March 2009*. Port Moresby, Papua New Guinea. http://www.bankpng.gov.pg/index.php

Department of Petroleum and Energy, Papua New Guinea (2003) *Government introduces new incentives rates for petroleum production.* http://www.petroleum.gov.pg/

[185] Bank of Papua New Guinea (2009).

Department of State, United States (2009) *Background Note: Papua New Guinea*, March 2009, http://www.state.gov/r/pa/ei/bgn/2797.htm

Encyclopedia of Earth (2008) "Water profile of Papua New Guinea", *Encyclopedia of Earth*, December 2008. http://www.eoearth.org/article/Water_profile_of_Papua_New_Guinea

Esso Highlands Limited (2008) *PNG Liquefied Natural Gas 2008*. http://www.pnglpg.com

Gawell K, Reed M, and Wright PM (1999) *Preliminary report: Geothermal energy, the potential for clean power from the earth*. Geothermal Energy Association, Washington DC, USA. http://www.geo-energy.org

National Statistical Office of Papua New Guinea (2004) *National Accounts Statistics*. Port Moresby, Papua New Guinea. http://www.spc.int/prism/country/pg/Stats/Economic_Statistics/National%20Accounts/nat_act.htm

Papua Petroleum Limited (2008) *Oil & gas exploration and production – Why Papua New Guinea.* http://www.papuapetroleum.com/why-png/default.php

Ururu B and Makati L (2005) "PNG Power Ltd" presentation at the Pacific Power Association (PPA) and e7 (Montreal, Canada), Renewable Energy Workshop, November 14-25, Nadi, Fiji. http://www.e8.org/

PERU

- *Peru's economy has been one of the best performing in Latin America since 1990, and it is expected to continue to grow at an annual average rate of 4.2 percent over the outlook period.*
- *High levels of indigenous natural gas production to satisfy primary energy demand are expected, growing at an average annual rate of 9.2 percent, from 1.5 Mtoe in 2005 to 13.3 Mtoe in 2030.*
- *Diversification of Peru's energy mix will be possible as a result of development of significant natural gas resources in the Ucayali basin.*

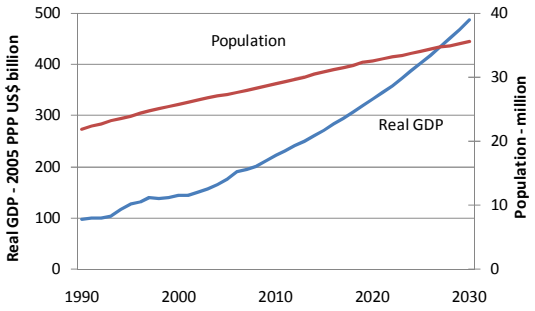
ECONOMY

Peru is one of two APEC economies in South America. It has a total land area of nearly 1.28 million square kilometres and shares borders with Chile, Ecuador, Colombia, Brazil and Bolivia. The population in 2008 was 29.15 million, with expected growth to around 36 million by 2030. Peru's population is increasingly urban, rising from 72 percent in 2005 to about 76 percent by 2030.[186] The climate is varied, with high average temperatures in the La Selva region and low average temperatures in the La Costa region.

Peru's economy has ranked among the best performers in Latin America, with strong growth since 1990. Between 2000 and 2005, Peru's GDP grew an average 4.2 percent per year.[187] The impact of such strong growth on employment and income levels has spread beyond the capital city Lima and resulted in significant reductions in poverty rates. This recent economic expansion has been driven by growth in construction, mining, private investment, exports, and domestic consumption. During 2008, Peru's economy continued to grow, reflecting a positive outlook for increased domestic consumption and public and private investment. In the long term, Peru's economy is expected to experience robust growth at an average annual rate of 4.2 percent over the outlook period, reaching US$487 billion by 2030 (2005 US$ at PPP). Peru's economy is well managed, and improved tax collection and growth are increasing revenues, with expenditure keeping pace. Private investment is rising and becoming more broad-based.

Positive economic growth has reduced poverty in Peru, with a reduction in total poverty from 48.6 percent (or 13.4 million poor people) in 2004 to 36.2 percent (or 10.5 million poor people) in 2008.[188] However, despite this significant progress, poverty rates are still high for an economy with income levels like Peru's (US$6,452 per capita in 2005). Although the Peruvian government aims to reduce poverty levels to below 10 percent of the population (or 3.2 million poor people) by 2015,[189] there is still widespread poverty in Peru, especially in rural areas. For example, in 2007, 13.7 percent or 3.86 million people in the economy were considered to be living in 'extreme poverty',[190] which indicates Peru's economic growth is not necessarily a universal success.

Figure PE1: GDP and population



Source: APERC analysis (2009)

Two sectors that have had strong growth in their energy demand between 1985 and 2007 are industry (average annual growth of 2.7 percent) and transport (2.6 percent).[191] Peru's industrial sector has a diverse energy demand, drawing from almost all of the economy's energy basket. The energy-intensive industry of mining and metallurgy is Peru's largest industry – the economy is the world's top producer of silver, second of zinc, third of copper and tin, fourth of lead, and sixth of gold. Mineral exports have consistently accounted for the most significant portion of Peru's export revenue, making up around 63 percent in 2008.[192] In the transport sector, diesel occupies the largest portion of the energy demand. Growth in its

186 INEI (2001).

187 INEI (2008B) and INEI (2001).

188 The World Bank (2009) and INEI (2008A).

189 El Comercio Newspaper (2008).

190 According to World Bank (2009) and INEI (2007).

191 Ministerio de Energía y Minas (2007E).

192 Ibid.

consumption has been driven by higher sales of new vehicles.[193]

ENERGY RESOURCES

Peru's energy resources include hydrocarbons (crude oil, natural gas, gas liquids and coal), hydro, biomass (firewood, bagasse, dung and yareta) and solar; however, some of these make only a small contribution to the total Peruvian energy mix. In 2007 Peru's total primary energy supply was 17.8 Mtoe, with 72 percent coming from domestic sources and the remaining 27 percent from imports (principally crude oil and coal).

In 2007, the economy had total proven hydrocarbon reserves of 458 Mtoe, with the largest share coming from natural gas (60 percent). Liquids (crude oil and natural gas liquids) contributed 32 percent, with coal contributing the remaining 8 percent.[194]

Peru's proven oil reserves (crude oil plus natural gas liquids) were estimated at 1,121 million barrels at the end of 2007, or about 27 years of domestic production at 2007 levels.[195] Crude oil is sourced from several basins, mostly in Block 1-AB (on the border with Ecuador) and Block 8 (in the north-eastern Amazon region). These two blocks account for almost two-thirds of Peru's total crude oil production. At the time of writing, exploration activities were due to intensify in onshore and offshore fields, and crude oil production is expected to start in the Amazon region from 2010, specifically in Block 67, as well as in the offshore Z-6 Block and Z-1 Block. There are seven crude oil refineries in Peru, with a total installed capacity of 197 thousand barrels per day.[196]

Proven natural gas reserves were estimated at 11.9 trillion cubic feet (tcf) in 2008; this is the fifth largest amount in South America. The most important natural gas source in Peru is the Ucayali basin in Block 88, where the Camisea River runs. The proven and probable natural gas reserves in this block are estimated at 11 tcf, with 482 million barrels of associated natural gas liquids (NGL). This is the site of the economy's most significant natural gas project, the Camisea project, which involves the construction of several facilities for the exploitation of Block 88 and transportation and distribution of natural gas and its liquids to the Lima and Callao regions.[197] The Camisea project currently provides natural gas for domestic consumption; exports to Mexico and the US will be possible when a planned liquefied natural gas (LNG) export terminal in Pampa Melchorita on the Pacific coast begins operation in 2010. The LNG facility will have an installed capacity of 4.4 million tonnes per year. Overall, the natural gas distribution network in Peru is expected to remain limited in scope, thus inhibiting the growth of domestic gas demand.

Proven coal reserves were estimated at around 50 million tonnes at the end of 2007 – this is 68 years of domestic consumption at 2005 levels. Almost 97 percent was anthracite coal, and the remainder bituminous coal. The largest reserves of mineral coal are in the regions of La Libertad, Ancash and Lima. Despite the extent of the resource, Peru's production does not satisfy domestic demand and coal imports are necessary – in 2007 nearly 90 percent of Peru's final energy demand for coal was imported, mostly from Colombia (88 percent) and Venezuela. In recognition of the economy's dependency on coal imports, Peru has been promoting development investment in its anthracite coal market.[198]

Hydro is the economy's second largest potential primary energy resource. In 2007, total proven reserves of hydro were estimated at 1.3 million GWh. According to the Peruvian government, this measure is of the mean energy production between 2007 and 2057 at hydroelectric power plants in operation, under construction and under proposal. Peru's total hydroelectric installed capacity at the end of 2007 was 3.23 GW, representing 46 percent of the economy's installed electricity capacity. Proposed new hydro plants are expected bring another 1.15 GW online by the end of 2015.[199]

While Peru has no nuclear energy development, there are small uranium reserves. The proven reserves of approximately 1,800 tonnes are located in the region of Puno. Those reserves were assessed between 1984 and 1986, with no further exploration. However, during 2007 there has been new interest shown by private companies in investing in uranium exploration such as the Macusani Project, in south-eastern Peru.[200]

193 Banco Central de Reserva de Perú (2009).

194 Ministerio de Energía y Minas (2007E).

195 Ministerio de Energía y Minas (2007D).

196 Ministerio de Energía y Minas (2007B).

197 See www.gtic-camisea.com.pe

198 See www.venaresources.com

199 Ministerio de Energía y Minas (2006).

200 See Macusani Project in www.macusaniyellowcake.com

The contribution of biomass energy to Peru's economy is significant. There is high consumption of non-commercial firewood for residential and commercial use, particularly in northern areas. In jungle regions in particular this resource is abundant and consumption is not currently restricted. Another biomass energy resource in Peru is bagasse, a residue of the sugarcane industry with high energy potential. Around 62 percent of the economy's bagasse production is burnt in the sugar mills for electricity generation (1.66 TWh) with the remainder used for heating.

ENERGY POLICY

Increasing energy imports combined with the depletion of domestic resources have given rise to concerns over energy supply security in Peru. One government response has been to promote the use of natural gas by supporting increased production in the Camisea project; this has the goal of reducing oil import dependency. Natural gas forms an integral element of the economy's revised overall energy mix, as shown in the National Plan for the Energy Matrix Transformation. Peru is also interested in increasing its use of biofuels (bioethanol from sugarcane and biodiesel from palm oil), with the associated benefits of job creation, new investment, increased exports, and climate change mitigation. One innovation has been the promotion and development of biofuels through Law 28054, which was approved in 2003, and first came into force in January 2009. It sets targets for increased contribution to the economy's energy mix: 2.0 percent for biodiesel (B2), 7.8 percent for bioethanol (E7.8) and 5.0 percent for biodiesel (B5) by 2011.[201]

Within the framework of the National Rural Electrification Programme (PNER by its Spanish acronym), which is coordinated by the Ministry of Energy and Mining, the government aims to achieve 57.9 percent electrification of rural households by 2011 and 70 percent by 2017, and to improve the electricity generation systems in isolated rural communities. The goals of the plan include encouraging sustainable socioeconomic development, improving the quality of life, and deterring the migration of people from rural regions to cities.[202]

In 1994, after a domestic energy shortage, the Ministry of Energy and Mines created the project Perú Ahorra Energía (PAE),[203] which started a strong energy savings campaign and projects that lasted through to 2000; one of them was the Technical Cooperation between the Ministry of Energy and Mines and the Inter-American Development Bank (IDB) which was approved on 22 February 2000 and completed on 6 March 2009.[204] On 8 September 2000, Law 27345 was published as a supreme decree[205] – this declared the promotion of efficient use of energy was in the interest of all Peru as it provided these benefits: energy security, supplier protection, promotion of economic competitiveness and the reduction of negative environmental impacts through the use and consumption of energy resources. Individual programmes have been set for the residential, public, transport, and productive and service sectors. In the residential sector, the focus is on the promotion of energy efficiency appliances, with financial mechanisms introduced to support their take-up. In the transport sector, the emphasis is on training and guidance about fuel efficiency for transport drivers (taxis, buses and freight vehicles). In the productive and service sector, the government is promoting the financing of energy efficiency pilot projects in small and medium enterprises through international cooperation funds run by the Ministry of Energy.[206]

The government is also promoting the increased use of compressed natural gas (CNG) for buses and passenger vehicles in Lima city. This includes the Lima Urban Transport Project (COSAC), also known as El Metropolitano – this is a mass transportation system based on large capacity natural-gas fuelled buses running in dedicated lanes on heavy transport routes, supported by smaller buses on feeder routes.

OUTLOOK

FINAL ENERGY DEMAND

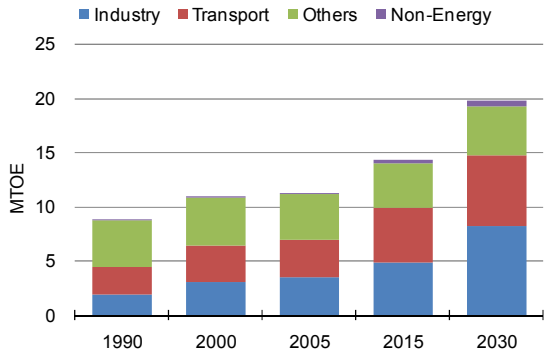
Peru's final energy demand is projected to grow at an average annual rate of 2.3 percent over the outlook period. At the same time, the economy's energy intensity will decline by 1.8 percent per year over the same period, as a result of improved energy efficiency in the transformation sector. In 2030, the largest share of the final energy demand will be consumed by industry (41.6 percent), followed by transport (33.5 percent), and the 'other' sector, which includes commercial, residential and agricultural use (22.8 percent); the remaining final energy demand will be consumed by non-energy use (3.0 percent).

[201] APEC Biofuels (2008).
[202] Ministerio de Energía y Minas (2008).
[203] Ministerio de Energía y Minas (2009B).
[204] Inter-American Development Bank (2009).
[205] Ministerio de Energía y Minas (2007C).
[206] Ministerio de Energía y Minas (2007A).

Petroleum products are projected to remain dominant in the energy mix, maintaining a share of around 59 percent throughout the outlook period. The transport sector is expected to account for 50 percent of those petroleum products, with the rest used in industry, the 'other' sector, and non-energy use.

The second largest energy demand will be for electricity (26 percent in 2030). Electricity use is projected to grow at an average annual rate of 3.9 percent during the outlook period – this is the fastest growing energy type.

Figure PE2: Final energy demand



Source: APERC analysis (2009)

Industry

Industry will be the largest energy consumer in Peru, increasing from 30 percent (3.4 Mtoe) of the economy's final energy demand in 2005 to 42 percent (8.2 Mtoe) in 2030. The greatest share of this will go to the mining industry for the extraction of non-ferrous metals. Over the outlook period the industrial energy demand is projected to grow at an average annual rate of 3.5 percent. The main driver for this growth is the continued expansion of mining, in particular the increasing production of copper.

Petroleum products are expected to form 51 percent of the total industrial energy demand in 2030, while electricity will make up 39 percent. The growth of petroleum product use over the period is expected to be at a robust average annual rate of 3.8 percent. At the end of the outlook period, the industry sector is expected to consume 35.9 percent of the economy's total petroleum products demand.

Natural gas demand for industry is projected to grow more slowly over the outlook period, at an average annual rate of 1 percent. It is expected to reach 0.2 Mtoe in 2030, which is only 2 percent of the total industrial energy demand. Growth in natural gas demand is restricted by the limited extent of the gas distribution network.

Electricity demand in the industrial sector is expected to rise to around 3.2 Mtoe (or 37.2 TWh) in 2030, at an average annual growth rate of 4.4 percent. Mining will account for the largest proportion of this growth, taking up 27.7 percent of the total industrial electricity demand.

Transport

The transport sector is the second biggest consumer of energy in Peru, accounting for 33.5 percent (6.6 Mtoe) of the economy's final energy demand. The largest share of the transport energy demand is from the road transport sub-sector, with diesel use projected to increase as a result of rising automobile sales. Overall, petroleum products will dominate transport energy demand, reaching 90 percent in 2030. The remainder (0.6 Mtoe) will come from new renewable energy sources, principally biofuels.

Other

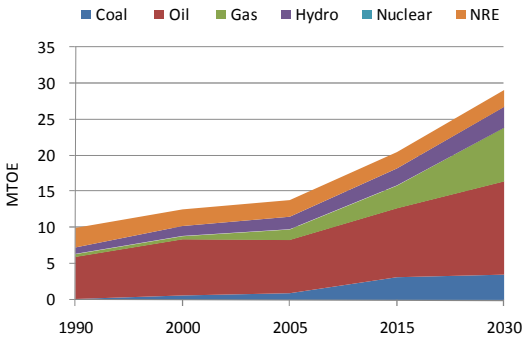
Over the outlook period, energy demand in the 'other' sector (which includes residential, commercial, public and agricultural users) is projected to increase at an average annual rate of 0.3 percent. Due to the limited extent of Peru's natural gas distribution network, LPG is expected to remain the dominant fossil fuel for this sector, and will increasingly replace firewood for cooking and heating. The total electricity demand in the 'other' sector is projected to reach 1.9 Mtoe (or 22 TWh) in 2030, based on an average annual growth rate of 3.2 percent. Electricity is expected to take over from firewood biomass as the dominant energy source for the 'other' sector by the second half of the outlook period, reaching 43 percent of the total demand by 2030. Demand for new renewable energies (mainly firewood) is expected to remain flat over the outlook period, due to increasing competition with commercial fuels. However, new renewable energies will still provide the second largest share of 'other' sector energy demand in 2030, at 34 percent.

PRIMARY ENERGY SUPPLY

Peru's primary energy supply is projected to grow at an average annual rate of 3 percent over the outlook period. This is faster than the approximately 1.1 percent growth rate between 1990 and 2005. Among the fossil fuels, natural gas is expected to grow the fastest, at an average annual rate of 6.7 percent, followed by coal (5.3

percent) and petroleum products (2.2 percent). Even with that rapid growth of natural gas supply, petroleum products are expected to continue to dominate the primary energy supply, accounting for 44 percent in 2030 (12.9 Mtoe). For renewables, hydro will grow at an average annual rate of 2.1 percent, reaching to 2.9 Mtoe in 2030.

Figure PE3: Primary energy supply



Source: APERC analysis (2009)

Given the economy's rising demand for oil, and the decline in domestic oil production, Peru's net oil imports are projected to grow at 6.8 percent a year until 2030. This means around 86 percent of Peru's total oil supply will come from imports in 2030, while in 2005 it was around 30 percent. In order to improve the security of the economy's oil supply, the Peruvian government has been intensifying exploration and production efforts in the upstream oil and gas sectors, and also promoting investment activities to change the makeup of the overall energy mix. This is also the basis for the projection that coal imports will grow at an average annual rate of 4.7 percent, reaching 2.9 Mtoe in 2030, or around 82 percent of Peru's total coal demand.

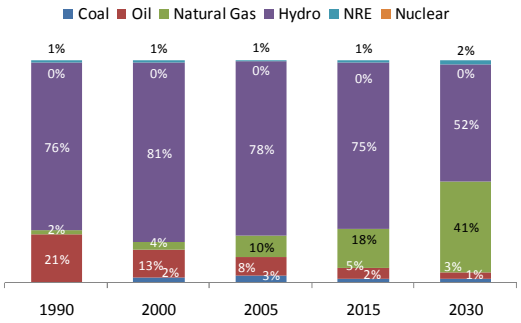
Natural gas production is projected to grow strongly during the outlook period. With the exploitation and promotion of use of natural gas from the Camisea project, Peru will become a net exporter of natural gas during the outlook period. Domestic production of natural gas is projected to grow at an average annual rate of 9.2 percent, reaching 13.3 Mtoe in 2030. The economy is expected to be able to export around 44 percent of its natural gas production at the end of 2030, largely as LNG.

ELECTRICITY

Peru's electricity demand is expected to increase at an average annual rate of 3.9 percent over the outlook period. Major demand growth will come from the industrial sector, with the total electricity demand in Peru reaching 59.3 TWh (or 5.1 Mtoe) in 2030. To meet the increasing demand, Peru will continue to rely on natural gas as the most cost-competitive option. Peru is expected to increase the installed capacity of natural-gas-fired electricity generation technologies from 1.2 GW in 2005 to 7.2 GW in 2030; this is at a robust average annual growth rate of 7.5 percent. Overall, thermal plants are projected to dominate the total installed generation capacity, with 54 percent. By the end of the outlook period, natural gas will surpass hydro, reaching 47 percent in 2030, when hydro will be at 41 percent.

The expansion of natural-gas-fired electricity generation will involve the construction of several plants, mainly within the Sistema Eléctrico Interconectado Nacional (SEIN). The natural gas resource made available by the exploitation of the Camisea project will drive the expected growth, which is expected to be at an average annual rate of 9.9 percent reaching 26.4 TWh in 2030 (the fastest growing of all the electricity generation technologies). However, hydropower will remain the principal generation source. Total electricity generation is projected to reach 64.6 TWh in 2030, of which hydropower is expected to provide 52 percent, while natural gas plants will provide 41 percent.

Figure PE4: Electricity generation mix



Source: APERC analysis (2009)

In Peru's short-term electricity planning, the government will continue to construct hydroelectric plants, particularly in the Amazon region where there is an abundance of water. However, over the outlook period, the construction of natural-gas-fired plants and upgrading of open-cycle natural-gas plants will be promoted, which should result in lower electricity tariffs. Currently, most of the natural-gas-fired plants in Peru use open-cycle technologies (based on gas turbines); this may provide the economy with an opportunity to improve its energy

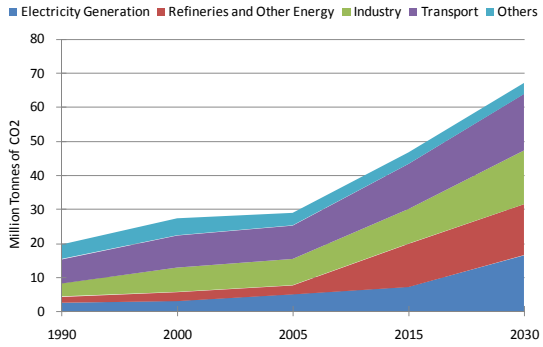
efficiency, through conversion to combined cycle plants, or even to trigeneration cycles for distributed generation.

Although starting from a negligible installed capacity in 2005, new renewable electricity generation in Peru is projected to have a high growth rate. This growth will be driven by the installation of wind farms, with a total installed capacity of 820 MW projected for the end of the period.

CO_2 EMISSIONS

Total CO_2 emissions from fuel combustion in Peru are estimated to reach 67.2 million tonnes in 2030; this is an increase of more than 250 percent on 2005 levels. Of the total emissions, about 46.7 percent (31.4 million tonnes) will come from energy production and transformation industries, including electricity generation, refining, and LNG liquefaction. The remainder, 35.9 million tonnes of CO_2, will come from the end-use sector; transport will account for 16.7 million tonnes of CO_2, followed by industry with 15.9 million tonnes of CO_2.

Figure PE5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table PE1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.4%	0.9%	0.1%	0.4%
Change in Energy Intensity of GDP	-1.7%	-0.4%	-1.5%	-1.1%
Change in GDP	4.0%	4.4%	4.0%	4.2%
Total Change	2.6%	5.0%	2.5%	3.4%

Source: APERC analysis (2009)

The decomposition analysis shown in this table indicates that economic growth underlies Peru's increasing CO_2 emissions over the outlook period. In addition, the increasing share of fossil fuels such as natural gas in Peru's energy mix will cause a slight increase in the CO_2 intensity of energy consumed.

CHALLENGES AND IMPLICATIONS

Sustained economic growth in Peru over the last six years has made a positive impact in the economy, through the creation of jobs and reduction of poverty. However, economic progress is being accompanied by a growing dependence on oil imports, which may grow by almost 500 percent over the outlook period. This dependency on imported oil threatens Peru's economic stability and energy security.

Peru is making progress in diversifying its energy mix by developing the significant gas resources of the Ucayali Basin. The Camisea project will make a major contribution to meeting Peru's growing energy demand. Peru may wish to seek additional ways to use this gas as a substitute for oil in the domestic market, rather than exporting it.

One of the economy's greatest challenges is to find a way to sustain growth while balancing its growing energy needs and its strong commitment to protect the environment. One option is the promotion of new renewable energy sources. Peru needs to act more definitely to support research and development (R&D) around this energy–economy–ecology balance, to better identify the economy's strengths, opportunities and weaknesses.

Peru has made considerable progress to improve its institutional and legal framework for environmental management. However, this projection shows that Peru's CO_2 emissions will grow substantially over the outlook period – further efforts will be necessary to achieve the economy's environmental protection goals. One option is to promote to foreign and private investors the opportunities that exist in Peru, for the development of 'effective' improvements in energy efficiency and use of lower carbon resources, as well as ecological protection of the economy's energy supply and demand chain.

REFERENCES

APEC Biofuels (2008) *Peru Biofuels Activities*. www.biofuels.apec.org/me_peru.html

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

Banco Central de Reserva del Perú (2009) *Memoria 2008*. Lima, Peru. www.bcrp.gob.pe

BP (2009) *BP Statistical Review of World Energy, June 2009*. London. www.bp.com

Castro, Paula (2007) *Opciones para la producción y uso del biodiesel en el Perú*, Soluciones Prácticas – ITDG, Lima, Peru.

COES (2006) *Estadística Anual de Operaciones*, Comité de Operación Económica del Sistema Interconectado Nacional (COES – SINAC), www.coes.org.pe

EIA (2009) "Peru Country Analysis Brief". Energy Information Administration, US Department of Energy. www.eia.doe.gov

El Comercio Newspaper (2008) "Alan García: En el 2015, la pobreza se reducirá a menos del 10%", Empresa Editora *El Comercio*, 27 May 2008. www.elcomercio.com.pe

INEI (2001) *Perú: Estimaciones y Proyecciones de Población, 1950–2050*, Boletín de Análisis Demográfico No. 35, August 2001, Instituto Nacional de Estadística e Informática, Dirección Técnica de Demografía e Indicadores Sociales, Lima, Peru. www.inei.gob.pe

INEI (2007) *Censo nacional de Población y Vivienda 2007*. Instituto Nacional de Estadística e Informática, http://censos.inei.gob.pe/censos2007/

INEI (2008A), *Índice de la pobreza total 2004–2008*. Instituto Nacional de Estadística e Informática, www1.inei.gob.pe/perucifrasHTM/inf-soc/cuadro.asp?cod=3773&name=pob09&ext=gif

INEI (2008B), *PIB por grandes actividades económicas*. Instituto Nacional de Estadística e Informática, www.inei.gob.pe

Inter-American Development Bank (2009), Project TC 9811015: Sustainable Energy Efficiency Services. www.iadb.org/projects/project.cfm?language=English&project=TC9811015

Ministerio de Energía y Minas (2006) *Plan referencial de Electricidad 2006–2015*. www.minem.gob.pe

Ministerio de Energía y Minas (2007A), *Aprueban Reglamento de la Ley de Promoción del Uso Eficiente de la Energía, Decreto Supremo No. 053-2007-EM*, El Peruano, 23 October 2007, Peru.

Ministerio de Energía y Minas (2007B), *Estadísticas Anuales de Hidrocarburos 2007, Capítulo IV*, Dirección General de Hidrocarburos, Lima, Peru. www.minem.gob.pe

Ministerio de Energía y Minas (2007C), *Ley de Promoción del Uso Eficiente de la Energía*, Ley No. 27345, El Peruano, 23 October 2007. www.elperuano.com.pe

Ministerio de Energía y Minas (2007D), *Libro Anual de Reservas al 31 de diciembre de 2007*, Dirección de Promoción y Concesiones de Hidrocarburos Líquidos. www.minem.gob.pe

Ministerio de Energía y Minas (2007E), *National Energy Balance 2007*. www.minem.gob.pe

Ministerio de Energía y Minas (2008), *Plan Nacional de Electrificación Rural (PNER) Periodo 2008–2017*, Dirección General de Electricficación Rural, Peru.

Ministerio de Energía y Minas (2009A), *Annual Mining Report 2008*, Peru. www.minem.gob.pe

Ministerio de Energía y Minas (2009B), *Perú Ahorra Energía*, Sistema Interactivo del Uso Eficiente de la Energía. http://siee.minem.gob.pe

World Bank (2009), *Peru – Country Brief*. www.worldbank.org

PHILIPPINES

- *The Philippines' primary energy supply is projected to nearly double from 43.6 Mtoe in 2005 to 79.6 Mtoe in 2030, based on an average annual growth rate of 2.4 percent.*
- *The key drivers of growth in the final energy demand in this economy are the service and transport sectors.*
- *The Philippines will remain a net energy importer despite efforts to expand the economy's energy supply through greater use of renewable energy technologies and alternative fuels such as biofuels.*

ECONOMY

The Philippines is located along the western rim of the Pacific Ocean. The archipelago of 7,107 islands and islets covers an area of 300,000 square kilometres of land. The total population in 2006 was 86.26 million, making it the second most populous Southeast Asian economy after Indonesia. More than half of the population lives in Luzon, the largest of the Philippines' three major island groups. Population growth remained steady at 2 percent per year between 1995 and 2005; this growth is expected to continue over the outlook period, reaching a total population in 2030 of 122 million.

The Philippines has a humid equatorial climate marked by high temperatures and heavy annual rainfall. The hottest months are April, May and June (average daily maximum of about 42°C) while the coldest months are December, January and February. The Philippines experiences about 20 tropical cyclones annually.

GDP increased at an average annual rate of 4.5 percent between 2000 and 2005, reaching US$250.6 billion in 2005. In GDP per capita terms, the growth over that period was from US$2,636 in 2000, to US$2,956 in 2005 (all GDP figures in 2005 US$ at PPP).[207] Economic growth has been accelerating since 2000, driven by IT-based development of the international services industry, and a substantial increase in fund transfers from overseas Filipino workers.

In 2005, the service sector contributed 53.8 percent of the total GDP. The next largest sector contributions were from industry (31.9 percent) and agriculture (14.3 percent). Within the industrial sector, manufacturing provided 72.9 percent, followed by construction (12.1 percent), and electricity, gas and water (11.3 percent). Processing and assembly operations such as the production of beverages, tobacco, textiles and clothing are included in the manufacturing subsector.

Heavier industries are dominated by the production of cement, and refined petroleum products.[208] Most industries are concentrated in the urban areas around metropolitan Manila, while metropolitan Cebu has also attracted foreign and local investors since 2000.

In the agriculture sector, production has traditionally concentrated on a few main crops, particularly rice and corn. Only coconut and sugar cane constitute important export commodities. Current rapid rates of urbanization and economic expansion have resulted in deforestation and indiscriminate conversion of agriculture land to residential, industrial and commercial uses, which may undermine food security and forest resources. This has prompted the government to adopt environmentally sustainable economic development as the central theme of current policy direction.

In urban areas such as metropolitan Manila, reliance on road transport is high due to the growing number of passenger vehicles. Road transport accounts for most of the intercity travel between Manila and the various provinces in Luzon, including the islands of the Visayas and Mindanao, as these islands are linked by provincial highways and bridges that cut travel time by almost half compared to marine transport. Traditionally, interisland travel has been based on roll-on-roll-off (RORO) vessels, which connect virtually all the islands in the archipelago. Since 2000, metropolitan Manila has experienced increasingly heavy traffic congestion; therefore an upgrade of the urban transport infrastructure is essential to bring efficient and convenient transport services to the people of Manila.

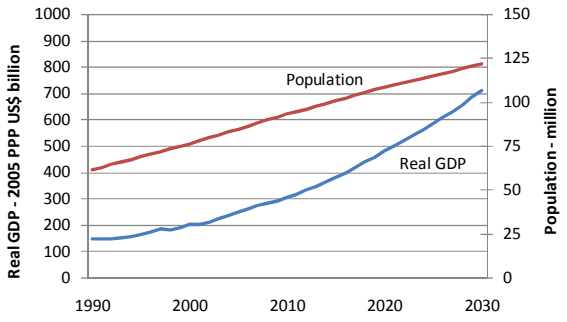
Economic development plans for the Philippines, founded on the Medium-term Philippine Development Plan 2004–2010, have identified the main growth drivers for the economy as the service and transport sectors, both of which need to expand in terms of investment and exports.

The government has also established policies to encourage product competiveness to reduce transport and distribution costs.

[207] IEA (2008).

[208] ADB (2008) pp 1–2.

Figure RP1: GDP and population



Source: APERC analysis 2009

ENERGY RESOURCES

The Philippines' indigenous energy reserves, which include crude oil, natural gas and coal (mainly lignite), are relatively limited. However, the Philippines has an extensive geothermal resource that could make the economy the world's largest producer and user of geothermal energy for electricity generation. Other renewable energy resources (solar, wind and biomass) are estimated to have huge theoretical generation capacities.

The Philippines's tropical climate also gives it huge potential for bio-fuels (from *Jatropha curcas*, corn or sugar cane). Bioethanol and biodiesel offer apparently viable alternatives to fossil fuel use for transport in this economy, given the suitable climate, low labour costs and land resources.

Because of its limited indigenous energy resources, the Philippines continues to rely partly on imported fuels. In 2006, the economy's energy self-sufficiency was at 55.4 percent.[209]

Electricity generation is dominated by natural gas. In 2006, natural gas provided 16,366 GWh, or 29 percent of total electricity generation, while coal accounted for 27 percent, geothermal 18.5 percent, and hydroelectric power plants 17.5 percent. That year electricity generation from oil-fired power plants dropped significantly to 8.2 percent (from 10.8 percent in 2005);[210] this was due to the Philippines limiting the use of oil-fired electricity plants in light of price fluctuations on the world market.

The economy is looking to develop its indigenous energy resources in the immediate future. Geothermal is already the largest indigenous energy resource. Development of its potential is ongoing, with the possibility of another 700 MW of capacity being added during the outlook period. The project on *The Study on Capability Enhancement on Policy and Planning for a More Effective and Comprehensive Philippine Energy Plan Formulation*, which was conducted by DOE and JICA, projected the maximum additional capacity available by 2030 to be 1200 MW. In addition, given the economy's vast hydro potential, the study estimated that total installed capacity of hydropower could reach 5,700 MW by 2030.[211]

The government's current energy plan identifies 41 hydro projects including large and small hydropower that would add capacity of 1,025 MW. Wind power in the Philippines is gaining interest from potential investors. Government projections for wind power additional installed capacity are 560 MW by 2014.[212]

Meanwhile the government has also estimated potential renewable energy generated from biomass to be 185 MW[213] – the plants would be located near metropolitan Luzon and the regional areas of Central Philippines and Mindanao.

ENERGY POLICIES

The development of the energy sector in the Philippines is based on the economy's two-tiered energy agenda of energy self-sufficiency and an efficient and globally competitive energy sector. The Philippine Energy Plan (PEP) was updated in 2007 to reflect this.[214]

The government has set its target for energy self-sufficiency at 59 percent by 2010, and to maintain this through to 2014; this is an increase from 55.4 percent in 2006.[215] This requires an increase in oil and gas reserves of 20 percent, an increase in indigenous coal production to meet increasing domestic demand, and an increase in electricity generation based on renewable sources. In addition, the use of alternative fuels will be promoted and energy efficiency and conservation programmes will be strengthened.

The government is actively promoting intensive upstream oil exploration and development through the Philippine Energy Contracting Round (PECR). The Department of Energy is responsible for issuing exploration and production licences, as well as overall regulation of the energy sector. In 1998 oil exploration in the Philippines was largely deregulated, allowing entry by foreign-owned firms; these frequently partner with the remaining dominant

209 DOE (2007).
210 Ibid.
211 DOE-JICA (2008).
212 DOE (2007).
213 Ibid.
214 Ibid.
215 Ibid.

player, the Philippine National Oil Company, for major projects.[216]

An April 2006 policy directive from the Department of Energy sets the objective of ensuring unified and coordinated effort in establishing a successful and robust natural gas industry. As part of the economy's efforts towards becoming the largest producer of geothermal energy in the world, the government is actively pursuing optimization of this resource through the "Resource Assessment of Low-Enthalpy Geothermal Resources in the Philippines". This five-year project started in 2007; it aims to promote and accelerate the development of small and low-temperature geothermal resources through detailed geo-scientific investigations, socio-economic and environmental baseline studies.[217]

As at the end of 2006, there were 28 oil and gas service contracts operating in the Philippines. Twenty-two of these contracts were granted during 2004–2006. There were also 38 existing coal operating contracts.[218] In the long-term, when the Malampaya gas field starts to deplete, the government assumption is that LNG imports of 3 million tonnes per year would begin from 2020.[219]

The government is also in the process of reforming the electricity generation sector. Privatization of the National Power Corporation's generation and transmission assets progressed in 2006 and 2007 with the successful bid-out of the 112 MW Pantabangan-Masiway Hydroelectric Plant in Nueva Ecija, and the 600 MW Masinlo coal-fired plant in Zambales. This resulted in a 24.8 percent privatization level.[220]

To further develop hydroelectricity as the mainstay of the economy's electricity generating options, the government is pursuing these goals: greater private sector participation in the development of hydropower; PNOC to take a stake of up to 20 percent in all its proposed hydropower projects (to attract private investors); and the passage of new legislation around renewable energy that will provide incentives to developers of hydropower.

Rural electrification remains a high priority for the government, which has now set a target of 100 percent village electrification by 2009, with an overall household electrification target of 90 percent by 2017.

Increased use of alternative fuels is mandated by the 2006 Biofuels Act, which requires biodiesel fuel and biogasoline to account for 2 percent and 10 percent of total fuel demand, respectively, by 2014.[221]

At the same time, the government has established a National Energy Efficiency and Conservation Program, with a target for energy savings of 1.3 Mtoe by 2014.[222] Actions taken by government to achieve this target include passage of the energy conservation programme into law; development of an energy efficiency benchmark for commercial and industrial buildings; inclusion of standardized energy-efficiency requirements in the government procurement process for lighting systems and other electrical equipment. An ongoing study is quantifying the actual savings derived from the energy efficiency measures taken, with the aim of creating a more effective monitoring mechanism.

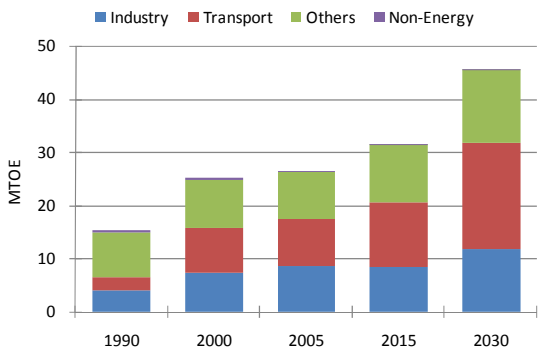
In the context of continuing volatility of world oil prices, concern about greenhouse gas emissions and the growing focus on energy security, the Philippines is also considering the introduction of nuclear power as a long-term energy option to improve its self-sufficiency. This is in line with regional direction at the ASEAN level.[223]

OUTLOOK

FINAL ENERGY DEMAND

The Philippines' total final energy demand is projected to grow nearly two-fold from 26.5 Mtoe in 2005 to 45.6 Mtoe in 2030, at an average annual rate of 2.2 percent.

Figure RP2: Final energy demand



Source: APERC analysis (2009)

A distinctive feature of the Philippines' energy demand is that the transport sector consumes around 44 percent of the total, and about three-quarters of that is used for road transportation. Energy

[216] EIA (2006).
[217] DOE (2007), p 19.
[218] Ibid.
[219] DOE-JICA (2008).
[220] DOE (2007).
[221] Ibid.
[222] DOE (2007), Annex A.1.1, p 86.
[223] DOE (2007).

consumption by the industry sector, which lacks substantial energy-intensive industries, remains at around 25–26 percent of the total demand – and is expected to remain at that level during the outlook period. The 'other' sector is projected to grow at 1.8 percent per year, faster than industry (1.2 percent). However, its share in the total final demand will decline from 33 percent in 2005 to 30 percent in 2030 due to the decreasing use of non-commercial fuel (biomass) in the residential sector.

Petroleum products dominate the overall energy mix, supplying both transport demand and also industrial users. As social modernization progresses, demand for electricity and gas may increase in the future.

Industry

Energy demand in the industrial sector is projected to grow at an average annual rate of 1.2 percent until 2030.

Transport

Over the outlook period, the transportation energy demand is projected to grow at an average annual rate of 3.3 percent – this is characterized by heavy reliance on the road transport subsector.

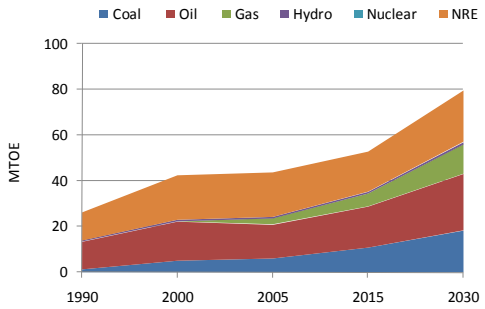
Other

Based on projected population and income growth, energy demand in the 'other' sector (largely residential and commercial) is projected to grow at an average annual rate of 1.8 percent per year. This is in contrast with the decline of 0.4 percent a year over the previous period 2000–2005.

PRIMARY ENERGY SUPPLY

Oil is expected to dominate the economy's primary energy supply at 31 percent, followed by renewables at 28 percent and coal at 23 percent.

Figure RP3: Primary energy supply



Source: APERC analysis (2009)

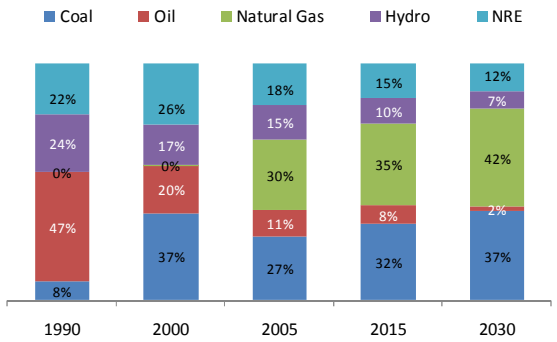
The economy's energy import dependence is expected to increase from 55.4 percent in 2006 to 65 percent in 2030; this is based on the Philippines importing most of the oil and coal requirements for its transport and electricity sectors.

The limited availability of indigenous energy sources, and difficulty in matching increases in domestic energy production to projected demand, set up the Philippines for greater dependency on fossil fuels. Over the long term, the projection is for domestic natural gas resources to be depleted and primary energy from geothermal and hydro fully developed by the end of the period, with imports of crude oil for transport and coal for electricity generation increasing substantially. The fossil fuel ratio in the energy supply structure is expected to rise from 66.5 percent in 2005 to 81 percent in 2030.

ELECTRICITY

The Philippines' electricity demand is projected to grow at an average annual rate of 4.5 percent over the outlook period. Significant changes in its energy mix are expected, particularly the growth in gas fired generation since its entry in 2001 – over the outlook period it will increase from a 30 percent share of total electricity generation in 2005 to 42 percent in 2030.

Figure RP4: Electricity generation mix



Source: APERC analysis (2009)

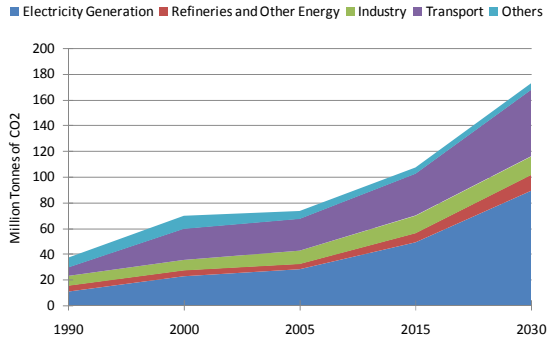
Due to the abundance of coal both domestically and regionally, and its cost advantage over other fossil fuels, coal is projected to make up the second largest share in the electricity generation mix – increasing from 27 percent in 2005 to 37 percent in 2030.

Despite aggressive promotion of renewable energy sources for electricity generation and the projected increased capacity, the share of renewables in the electricity generation mix is projected to decrease over the outlook period.

CO_2 EMISSIONS

The projected increase in CO_2 emissions for the Philippines over the outlook period is slower than its expected strong growth in energy demand. This is as a result of the measures taken to move away from fossil fuels, improve energy efficiency and conservation, and reduce emissions in other ways. CO_2 emissions are expected to grow at an annual average of 3.5 percent, increasing from 74 million tonnes of CO_2 in 2005 to 173 million tonnes in 2030.

Figure RP5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table RP1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	1.1%	1.9%	0.4%	1.0%
Change in Energy Intensity of GDP	0.0%	-2.3%	-1.4%	-1.8%
Change in GDP	3.5%	4.3%	4.2%	4.3%
Total Change	4.6%	3.8%	3.2%	3.5%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

The potential hydrocarbon energy resources in the Philippines are very limited, and while there were some new coal and natural gas discoveries between 2000 and 2005, it is unlikely their production will match projected demand growth. Utilizing alternative energy sources, such as geothermal, biomass and hydro, will be critical to the economy meeting its energy supply–demand balance in the future, and to avoid increasing its dependency on imported fuels further than already projected.

A remarkable feature of the Philippines is the very high rate of utilization of its geothermal resource – in volume the world's second largest after the United States. To develop its geothermal energy potential further so it can reach the projected total installed capacity of 3500 MW by 2030 assumed in this outlook, the economy will need to implement strategies to encourage exploration and increase utilization, and also establish a policy framework that supports investment.

This projection, based on 'business-as-usual' assumptions, shows energy demand concentrating in the transport and electricity sectors, which will increase the economy's dependence on imported coal, crude oil and natural gas. Reducing oil dependence in the transport sector remains the Philippines's biggest energy challenge. At the same time, improving energy efficiency will have the greatest impact on the economy's energy import ratios; these will also be improved with expanded use of renewable energy sources, particularly biomass, biofuels, wind and geothermal. This gives the Philippines the opportunity not only to reduce its energy imports, but also to make gains in the sustainability of its energy supply.

REFERENCES

ADB (2008) *Key Indicators for Asia and the Pacific.* Asian Development Bank. http://www.adb.org/Documents/Books/Key_Indicators/2008/pdf/phi.pdf

DOE (2005) *Philippine Energy Plan Update 2006*, Department of Energy, Philippines.

DOE (2007) *Philippine Energy Plan 2007–2014*, Department of Energy, Philippines.

DOE-JICA (2008) *The Study on Capability Enhancement of Policy and Planning for a More Effective and Comprehensive Philippine Energy Plan Formulation.* Department of Energy, Philippines and Japan International Cooperation Agency.

EIA (2006) *Economy Analysis Brief for the Philippines*, Energy Information Administration, US Department of Energy, Washington DC. www.eia.doe.gov

IEA (2008) *Energy balances of Non-OECD countries* (2008 edition). International Energy Agency. Paris, France. http://www.iea.org/

National Economic and Development Authority, Philippines (2004) *Medium-term Philippine Development Plan 2004–2010*. http://www.doe.gov.ph/PEP/MTDP%202004-2010.htm

RUSSIA

- *Russia's primary energy supply is projected to grow at 1.2 percent per year over the outlook period, buoyed by increasing demand in industrial sectors and transport.*
- *Significant energy conservation and economic restructuring efforts would help to reduce the Russian economy's very high level of energy intensity.*
- *Net exports of energy will drop from 46 percent of primary energy production in 2005 to 41 percent in 2030; however, Russia will maintain its position as a top world energy exporter with a more diversified structure (greater mix of products exported) and more varied product destination.*
- *Russia is expected to strengthen regional energy trade and cooperation with both Northeast Asian and American neighbours, while maintaining its strong position in the traditional European market.*
- *The inflow of investment to the energy sector would be facilitated by improved investor confidence about institutional stabilization and domestic energy price liberalization.*
- *Tapping hydrocarbon resources in the north of West Siberia, East Siberia, the Caspian offshore area, and on the continental shelves of the Arctic and Pacific Oceans should replace depleting traditional oil and gas fields in the West Siberia and Volga regions.*
- *The Russian nuclear industry will show significant growth, in both quantitative and qualitative terms: it will take a larger share in electricity generation, and will extend contracts abroad, while it will stay a key player in the practical implementation of closed nuclear fuel cycle technology in the international arena.*
- *Environmental issues will remain a focus of Russia's energy demand and supply chain development – significant improvement should be made in energy efficiency, fuel quality, pollution and emissions control, and industry regulation.*

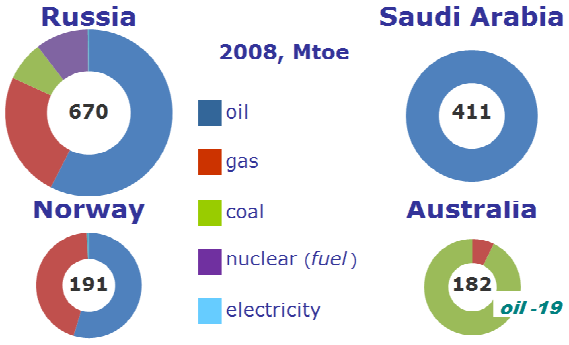
ECONOMY

Russia is located in Eastern Europe and Northern Asia; it borders the Arctic Ocean in the north, Central Europe in the west and the North Pacific Ocean in the east. Russia is the largest economy in the world in terms of land area, occupying almost one-seventh of the total landmass of the Earth; however, the overall population density is low, with the majority (73 percent) concentrated in urban areas. Economic development has been limited by the lack of suitable climate for agriculture (regions are either too cold or too dry), and Russia's unfavourable situation in relation to the major sea lanes of the world.

After a decade of economic contraction (to a level about 40 percent less than the 1990 GDP)[224], the Russian economy began growing again in 1999. The recovery was triggered by the rouble devaluation made in the aftermath of the 1998 financial crisis and the positive impact this had on the economy's competitiveness. Soaring world prices for oil and natural gas up to mid-2008 increasingly drove the growth from 2003 on. In the period from 2000 to 2008, the average annual GDP growth was 6.7 percent.

The Russian energy sector is very important for the security of the global energy supply, as it is the world's largest exporter of energy overall, and also the largest exporter of natural gas, and the second largest exporter of oil (see figure below). In addition, Russian-labelled nuclear fuel is used at 74 commercial reactors (17 percent of global market) and 30 research reactors in 17 countries worldwide, and the economy provides over 40 percent of the world's uranium enrichment services.[225]

Figure RUS1: Top world net energy exporters in 2008



Source: BP (2009), AEP (2009)

In 2008, exports of crude oil, petroleum products and natural gas accounted for two thirds of the economy's total exports – this leaves Russia

[224] Mastepanov (2000, 2004).

[225] AEP (2009).

extremely sensitive to volatility in world energy prices.

Russia is the world's third largest energy consumer. Natural gas makes up more than half of its total primary energy supply, followed by oil and coal. Due to the extremely cold climate across the economy, the most important use of energy resources is space heating. Heat supply constitutes almost 50 percent of final energy demand, and drastic improvement of building energy efficiency is of primary importance in Russia. Industrial energy consumption fell sharply in the 1990s following the dissolution of the Soviet Union, while many of the economy's industrial facilities remain technologically obsolete. Russia-wide statistics show that in 2005, the average age of industrial facilities and equipment was 21.5 years, and average depreciation of physical capital had reached 50.3 percent.[226] The replacement and renovation of these facilities with advanced technologies is crucial for Russia's economic development and for energy conservation. Russia's transport energy consumption has been declining from 1990 to 2005 at an annual rate of 1.9 percent, as the economic downturn has reduced passenger travel and freight traffic volumes.

ENERGY RESOURCES

In terms of proven reserves, Russia holds a quarter of the world's gas, 7 percent of oil reserves and 17 percent of coal reserves. Even more resources remain undiscovered, as the formidable geographical obstacles of climate, terrain, and distance to markets have hindered exploitation of these natural resources. However, as reserves in the traditional oil and gas regions are depleting, Russia will need to tap vast new reserves in its eastern and northern regions and sea shelves.

ENERGY POLICIES

The Russian Federal Government approved the *Energy Strategy of Russia up to 2020* in August 2003.[227] This outlines the economy's long-term energy policy, in response to the need to reduce the economy's energy intensity while sustaining Russia's top energy export position. A new version of the federal energy strategy was under consideration at the time of writing of this review – it will extend the outlook horizon out to 2030[228]. Important features of the current strategy include: a) greater emphasis on energy efficiency through economic restructuring and demand-side management; b) establishment of market-based energy pricing mechanisms; c) diversification of export markets; d) exploration and development of new oil and gas bearing areas; e) export infrastructure modernization and expansion; [229] f) development of new generation nuclear technologies, particularly advanced nuclear reactors, small ship-based movable power units and closed nuclear fuel cycle;[230] and g) refurbishment of gas-fired electricity plants with combined-cycle technologies[231].

The importance of improving the regulatory framework to promote further investment in the energy sector has been recognized by Russia's political institutions – amendments have been made to the law governing sub-soil exploration and exploitation, to tax codes and to industry technical regulations. Currently the prices for petroleum products and coal are liberalized; the gradual move from state-regulated pricing for natural gas and electricity to free market regulation has already started [232] and is expected to be finalized around 2012–14. An Oil Stabilization Fund was established in January 2004 to reduce the impact of the volatile energy export market on the Russian economy.

In November 2004 the President of the Russian Federation formalized the economy's ratification of the Kyoto Protocol. This decision reconfirmed Russia's strong commitment to address climate change and to work collaboratively with the international community. The ratification by the Russian Federation satisfied the "55 percent" clause of the Kyoto Protocol and thus brought the whole treaty into force, effective from 16 February 2005. Russia is deemed to be the largest potential host for joint implementation (JI) projects – this is due to the economy's 33 percent reduction in GHG emissions since 1990. In May 2007 all appropriate procedures for approval and verification of Russian-based joint implementation GHG reduction projects under the Kyoto Protocol were adopted. The establishment and operation of a Russian Registry of Carbon Units has been formalized, ready for practical implementation of GHG mitigation projects in Russia.

Nuclear safety is one of the major concerns of world energy development. Russia has adopted the 'closed fuel cycle' concept, which includes the processing of spent nuclear fuel and mandatory return of fission nuclear materials to the fuel cycle,

226 FSSS (2009).
227 ES (2003).
228 DES (2008).
229 Transneft (2009), Gazprom (2009).
230 FNPI (2006).
231 GSPI (2008).
232 FEC (2009).

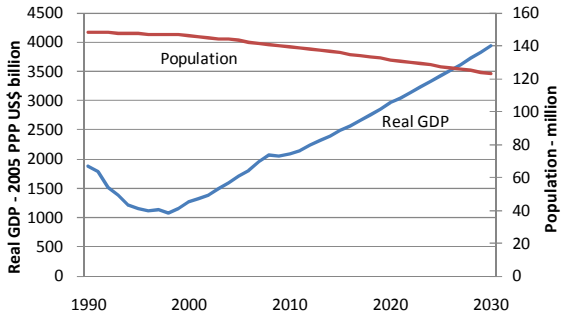
which both increase uranium utilization efficiency, and reduce volume of the radioactive wastes. A legal framework for managing nuclear wastes was established in amendments to the Environment Protection Law and Nuclear Energy Utilization Law made in June 2001.

OUTLOOK

FINAL ENERGY DEMAND

Over the outlook period, the Russian GDP is expected to continue to grow, although at a slower average annual rate of 3.4 percent. At the same time, Russia's total population is expected to decline, from 143 million in 2005 to 123 million in 2030. Despite the falling total population and relatively low rate of urbanization growth (from 73 percent to 78 percent), the standard of living is expected to improve across the economy, making a significant impact on the final energy demand.

Figure RUS2: GDP and population



Source: APERC analysis (2009)

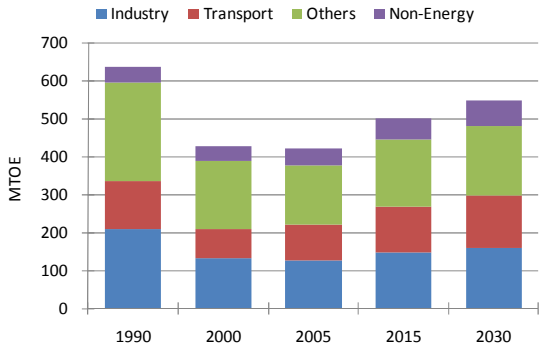
Russia's final energy demand is expected to grow at 1.1 percent per year over the outlook period, compared with the average annual decline of 2.7 percent over the previous 15 years. The industrial sector is projected to decrease its share only slightly, from 30 percent to 29 percent; this is less than might have been expected given recent structural shifts and increases in energy efficiency. Meanwhile, the 'other' sector will lose 3 percent of its 37 percent share, due to strong energy conservation measures in the residential and commercial subsectors.

Transport consumption will grow from 22 percent to 25 percent, due to rising car ownership and a shift from traditional railroad to truck logistics. The non-energy proportion of the final energy demand will rise marginally from 11 percent to 12 percent, as a result of petrochemical and basic chemistry development.

Industry

Russia's industrial energy demand is projected to grow at an average annual rate of 0.9 percent until 2030. The anticipated technological retrofitting of industrial facilities and the effects of subsidy cuts on energy prices are expected to contribute to improvements in energy efficiency. Moreover, firmly implemented policy to converge domestic energy prices with world benchmarks is expected to provide major stimulus for energy efficiency improvements in the long term. As a result, Russia's industrial energy demand in 2030 is projected to reach 75 percent of the 1990 level.

Figure RUS3: Final energy demand



Source: APERC analysis (2009)

Over the outlook period, a significant change in the industrial energy mix is expected. Natural gas and electricity are projected to grow at an average annual rate of 1.9 percent, and together will account for 60 percent of the industrial energy demand in 2030. Oil and heat are projected to decline by 0.7 and 0.3 percent per year, respectively. In absolute value terms coal will maintain its current level at 11–12 Mtoe per year.

Transport

A substantial increase in transport activities is expected over the outlook period, as the projected economic growth will drive transport energy demand. Rising incomes will gradually increase passenger vehicle ownership, from around 230 per 1,000 people in 2005 to about 660 per 1,000 in 2030.

Road transport will continue to consume the largest share of the energy used in the transport sector over the outlook period. The improvement in living standards and increased vehicle production will support a shift from public transport to individual passenger vehicles for commuting.

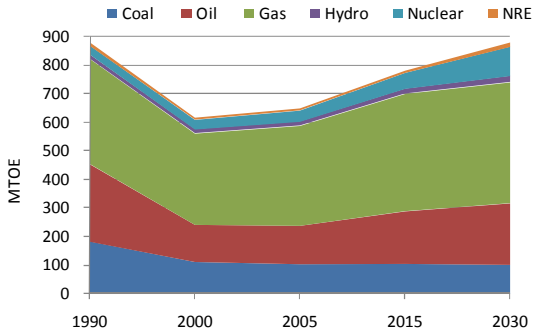
Other

Energy consumption in the 'other' economic sectors is expected to account for 34 percent of Russia's total final energy demand in 2030; gas use and home heating together make up 73 percent of that 'other' sector use. However, the current energy efficiency of heat generation and utilization in residential and commercial sectors is low. A gradual shift to more energy-efficient apartment and office buildings is expected over the outlook period. Coal and renewable energy sources will maintain shares of 2 percent and 1 percent respectively, mainly due to their importance in rural and remote areas.

PRIMARY ENERGY SUPPLY

Russia's total primary energy supply is expected to reach 875 Mtoe in 2030. Nuclear is projected to grow the fastest at an average annual rate of 3.9 percent per year, followed by renewables at 3.1 percent; at the same time natural gas will decrease its share from 54 percent to 48 percent, while growing at an average annual rate of 0.8 percent per year. Coal supply will remain almost at the same absolute level, which will result in its share of the total energy supply mix dropping from 16 percent in 2005 to 12 percent in 2030.

Figure RUS4: Primary energy supply



Source: APERC analysis (2009)

The high pace of growth in nuclear energy is a result of policy to accelerate the development of the nuclear industry, and to divert the use of natural gas from domestic market to export. Oil supply will increase at an average annual rate of 1.9 percent over the outlook period, while its share in electricity and heat generation is expected to decline.

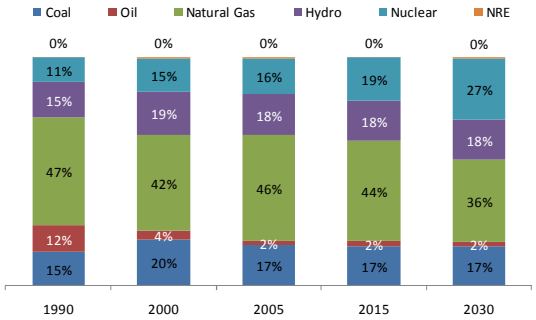
PRIMARY ENERGY PRODUCTION

The projected pace of growth for primary energy production/extraction in Russia will exceed the growth of exports for oil, coal, natural gas, and electricity. Total energy production in Russia is projected to increase by 307 Mtoe, while net exports are projected to increase by only 79 Mtoe. The higher elasticity of coal and natural gas exports to production will be driven by fast development in nuclear power generation and technological improvements at coal and natural gas power plants (to gradually increase the efficiency of electricity generation). Environmental and regional energy security concerns will be driving forces behind NRE growth from 7.3 Mtoe in 2005 to 15.4 Mtoe in 2030. Huge but yet untapped hydro resources in the Russian Far East will support 1.5 percent average annual growth for hydro electricity generation. Crude oil will be the only export item to experience contraction over the projected period, as domestic demand will require a much greater volume of petroleum products, and the Federal Government's export policy favours the export of petroleum products rather than crude oil.

ELECTRICITY

Electricity demand is projected to grow at an average annual rate of 1.6 percent, requiring an increase in installed generation capacity from 220 GW in 2005 to 304 GW by 2030. This will require construction of more than an average 8 GW of new capacity each year within the outlook period. Natural gas will be the main input fuel for electricity generation (36 percent share), followed by nuclear (27 percent), hydro (18 percent) and coal (17 percent). Electricity generation from renewable sources is expected to increase robustly at an average annual growth rate of 3.4 percent; however, its share will remain very small. Petroleum products will be the major fuel for remote on-site electricity generation in isolated areas, in particular for northern regions in the Russian Far East.

Figure RUS5: Electricity generation mix



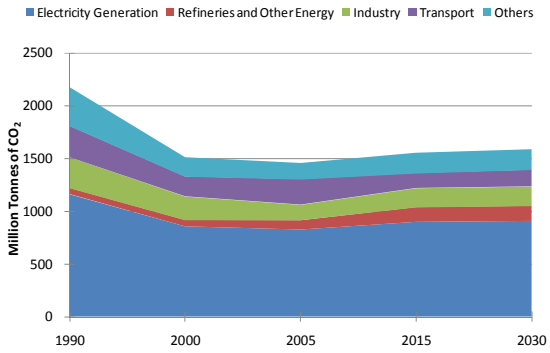
Source: APERC analysis (2009)

CO_2 EMISSIONS

Over the outlook period, Russia's total CO_2 emissions from the energy sector are projected to reach 1,590 million tonnes of CO_2, which is 590

million tonnes of CO_2 (27 percent) lower than the 1990 level. The emissions from electricity and heat production will contribute 57 percent of the total CO_2 emissions in 2030. The major factor behind the falling CO_2 emission index is the expected decline in energy intensity of GDP at an average annual rate of 2.1 percent per year (see table below). Primary energy decarbonisation will contribute 0.9 percent decline to the average annual growth of Russia's CO_2 emission from fossil fuels combustion.

Figure RUS6: CO_2 emissions by sector



Source: APERC analysis (2009)

Table RUS1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	1.9%	-1.2%	-0.6%	-0.9%
Change in Energy Intensity of GDP	-1.4%	-1.9%	-2.3%	-2.1%
Change in GDP	-0.7%	3.9%	3.1%	3.4%
Total Change	-0.2%	0.6%	0.1%	0.3%

Source: APERC analysis (2009)

CHALLENGES

Russia is one of the most energy-intensive economies in the world because of a) its severe climate; b) the embryonic state of its financial sector and underdeveloped service sectors; c) the disproportionally large share of energy-intensive industries in contrast to much lower share of manufacturing and agriculture; and d) the high proportion of technologically obsolete assets within industry and the energy supply infrastructure.

Refurbishment of the refining industry in Russia is required urgently, to meet tightening fuel quality standards and to drastically increase yield of light products (which is the lowest of all APEC member economies).

Energy exports are one of the major drivers of Russia's GDP growth. Net energy exports are estimated to make up 17 percent of Russia's total GDP in 2030, in comparison to 13 percent in 2005.

Russia will need to invest heavily in oil and gas exploration and development in new frontier areas, and in the development of the accompanying energy infrastructure needed to service both existing markets in Europe, and new markets in Asia-Pacific.

The planned high pace of development of the nuclear industry depends heavily on its acceptance by the domestic and international public.

IMPLICATIONS

Energy efficiency and mitigation of negative environmental impacts will remain a focus of the development of the energy supply and demand chain up to 2030. Significant improvements need to be made in these areas.

Two major factors will affect the energy intensity of the Russian economy. Abundance of mineral and energy resources will facilitate expansion of energy-intensive industries like metallurgy and basic chemistry. Additionally, growing wealth will drive demand for new construction, and eventually the development of domestic energy-intensive production of construction materials. At the same time, narrowing the gap between international and domestic energy prices will prompt the introduction of advanced energy-saving technologies.

Russia's energy industry development is critically dependent on three interrelated elements – sufficient and steady investment flow, adequate price mechanisms, and a market regulation framework. All of these elements have domestic and international dimensions for Russia.

Strong international institutions and regulatory frameworks will help Russia to sustain its perfectly diversified energy exports. This will impact positively on the world's primary energy supply, in these ways. First by securing international energy flows, through robust and diversified energy supply to major markets in Europe, Asia and North America. Second, through improving the global environment by expanding the share of natural gas and nuclear energy in the global energy supply mix.

In coming decades Russia will build international energy cooperation, moving towards securing global energy supply and easing the environmental footprint of energy consumption. This is rational behaviour for the world's top energy exporter and a powerful global player, which is favourably located between the Pacific and Atlantic energy markets. The likely cooperative efforts will include capacity building of human resources, information sharing on various aspects of economic activity in the energy sector, joint technological research and development

projects, creation and amendment of regulatory frameworks, implementation of innovative and efficient financial mechanisms, and finally – the international energy infrastructure development.

REFERENCES

AEP (2009) JSC Atomic Energy Power Corporation: http://www.atomenergoprom.ru/en/

BP (2009) "Statistical Review of World Energy, June 2009". http://www.bp.com/statisticalreview

DES (2008) "Draft version of the Energy Strategy of Russia up to 2030", under discussion (in Russian). http://www.vedomosti.ru (November 2008)

ES (2003) *Energy Strategy of Russia up to 2020* (in Russian). Ministry of Fuel and Energy of Russia. http://ec.europa.eu/energy/russia/events/doc/2003_strategy_2020_en.pdf http://ec.europa.eu/energy/russia/presentations/doc/energy-strategy2020_en.pdf

FEC (2009) Central Dispatching Department of the Federal Energy Commission (in Russian): http://www.riatec.ru

FSSS (2009) Federal State Statistics Service (in Russian): http://www.gks.ru/bgd/regl/b08_11/IssWWW.exe/Stg/d02/14-08.htm

FPNI (2006) *The Federal Programme "Development of Nuclear Power Engineering and Industrial Complex of Russia for 2007–2010 and until 2015"* (approved October 2006). http://www.programs-gov.ru/31_1.php (in Russian) http://www.tvel.ru/en/nuclear_power/fed_programma/ (English summary)

Gazprom (2009) Descriptions of natural gas pipeline projects, OAO Gazprom: http://www.gazprom.com/

GSPI (2008) *The General Scheme for allocation of the Power Industry up to 2020* (approved February). http://www.e-apbe.ru/scheme/gs.doc (in Russian)

Mastepanov, AM (ed) (2000, 2004) *Fuel and Energy in Russia: Handbook for Energy Complex Professionals* (editions 2000 and 2004, in Russian). Ministry of Fuel and Energy of the Russian Federation, Moscow.

Transneft (2009) "East Siberia – the Pacific Ocean Pipeline Project" and other oil and petroleum pipelines infrastructure projects. JSC Transneft: http://www.transneft.ru

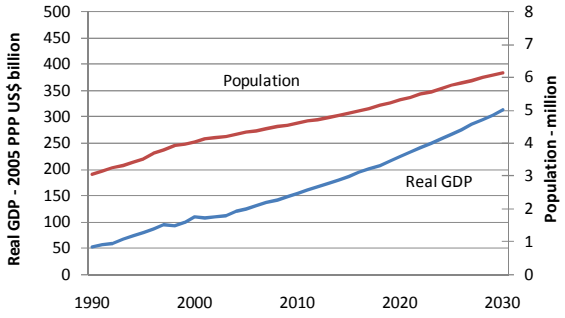
SINGAPORE

- *Singapore's primary energy supply is projected to grow at an annual average rate of 2.1 percent over the outlook period, spurred by increased demand for gas in electricity generation. Gas demand in the electricity sector is expected to rise from 5.9 Mtoe in 2005 to 16.5 Mtoe in 2030.*
- *Diversification of energy sources and stockpiling will ensure the security of Singapore's energy supply and safeguard energy users from the risks of supply disruptions.*
- *The absence of indigenous energy resources, high dependence on imported oil for transport fuels, and oil product trade will push the economy into strengthening energy efficiency measures and exploring alternative sources such as solar and bio-fuels.*

ECONOMY

The Republic of Singapore is an island city-state located off the southern tip of the Malay Peninsula. Its total land area is 704 square kilometres. The economy's population in 2006 was about 4.4 million, which makes its population density of 6,250 people per square kilometre the second highest in the world after Monaco. Singapore's climate is hot and humid – relative humidity ranges between 80 and 90 percent, and temperatures average around 20–35 degrees Celsius throughout the year. Most of the population lives in apartment blocks, and almost all areas in Singapore are built-up urban landscapes. Singapore has reclaimed land on the island's perimeter, using earth obtained from its own hills, the seabed, and neighbouring economies.

Figure SIN1: GDP and population



Source: APERC analysis (2009)

Singapore is a highly developed and successful economy. Its GDP grew steadily between 2000 and 2006 at an annual average rate of 4 percent. Most of the GDP is created in the service industries – in 2006, services accounted for 63 percent of GDP, while manufacturing contributed 28 percent.[233]

Most of Singapore's manufacturing output is for export. The main exports in 2006 were electronics (41.2 percent), petroleum and petroleum products (17.7 percent), electrical circuits and electrical machinery (13.7 percent), chemicals and chemical products (12.3 percent), manufactured goods including non-ferrous metals, iron and steel, metal products, textile, paper, rubber (4.8 percent), and other manufactured goods (6.4 percent). Other exports include food, beverage and tobacco, and crude materials.

Singapore is the third biggest oil-refining centre in the world (after the US Gulf Coast and Rotterdam), and the hub of Southeast Asian primary refined products trading. The economy has a refining capacity of about 1.3 million barrels of oil per day, which is operated by three refinery companies. To complement its oil refining industry, the economy has developed a significant downstream petrochemical industry – this is mainly located on Jurong Island, where it is still expanding. Petrochemical companies on the island have benefited from lower operating costs achieved by creating synergistic relationships, sharing facilities, and integrating utilities.

Singapore has developed a comprehensive road transport system that can efficiently handle both freight traffic and passenger travel. The economy has been striving to reduce dependency on automobiles and encourage the use of public transport. Private car ownership has been moderated through the use of various economic instruments, including a mandatory car certification scheme (that limits the number of vehicles for sale each year to the number of vehicle ownership certificates), and automatic tolling on congested roads. Rail transport plays a central role in the economy's land transport. The 138-kilometre mass rapid transit and 29-kilometre light rail transit systems, which have an average daily ridership of about 1.51 million passengers, are among the main modes of public transportation. The coverage of the mass rapid transit system is being extended, to 278 kilometres by 2020.[234] Singapore is also a major transport hub because of its strategic location on major sea and air routes. The Port of Singapore is

[233] Singapore Department of Statistics (2007).

[234] Land Transport Authority (2008A).

among the busiest ports in the world, in terms of shipping tonnage handled.

Singapore is also an important commercial centre. Many international business entities have offices in the city, and the economy is continuously promoting its position as a major global business hub. In the residential sector, Singapore has developed high-density residential towns, which accommodate nearly 85 percent of the Singaporean population. At the time of writing, about 25 residential towns, each with 20,000–70,000 apartment units, had been established.

ENERGY RESOURCES

Singapore has limited energy resources, either in fossil fuels or alternative energy sources. The economy imports nearly 100 percent of its energy needs, except for a small portion of energy produced from incinerating municipal waste. Oil and natural gas dominate the economy's energy mix. In 2006, Singapore consumed 900 thousand barrels of oil. The oil is mainly imported from the Middle East, and used mainly by the transport sector and the industrial sector. The economy exports petroleum products derived from the imported oil.

Natural gas is imported from Malaysia and Indonesia. This is supplied via two pipelines from Indonesia – West Natuna (9.2 million standard cubic metres per day) and South Sumatra (9.9 million standard cubic metres per day) – and via another two pipelines from Malaysia (supplying 4.2 million standard cubic metres per day and 2.8 million standard cubic metres per day). The natural gas is used mainly for electricity generation and in the industrial sector.

After the Indonesian gas supply interruptions between 2002 and 2004, Singapore has taken serious efforts to safeguard its energy supply security. The economy has opted to import liquefied natural gas (LNG) as another source of energy. An LNG terminal with annual importing capacity of 3 million tonnes is under construction. The terminal, with provisions for expansion, is scheduled to take its first delivery of gas around 2012.

Singapore is also exploring alternative energy sources to meet its rising energy demand. The options for generating renewable energy in the economy are limited, with no strong wind or strong tides that could generate electricity. Nonetheless, the economy has been making efforts to promote solar photovoltaic and bio-fuel options. It has already attracted solar panel manufacturers and bio-diesel producers to set up in Singapore. Recently, Singaporean leaders have said that the economy may consider nuclear energy as an option for its future needs.

ENERGY POLICIES

A major concern for Singapore is the implications of energy supply disruption for its economy. This is why the main objective of Singapore's energy policy is to support its economic growth. At the same time, the economy also has an awareness of the environmental ill effects of energy use. In response, Singapore has developed a framework to address its energy challenges as well as to move down a path of sustainable development in a holistic manner.

The National Energy Policy Framework [235] outlines five main strategies that Singapore needs to follow to maintain a balance between the policy objectives of economic competitiveness, energy security and environmental sustainability. The strategies are: 1) promote competitive energy markets; 2) diversify energy supplies; 3) improve energy efficiency; 4) build energy industry and invest in energy research and development; and 5) promote greater regional and international cooperation.

Singapore stockpiles oil to mitigate the risks of supply disruption. The economy has commercial arrangements with the refineries to hold oil stock to provide at least 90 days' supply. The economy also has oil stockpiled with independent storage companies. In the electricity generation sector, generation companies are required to put in place measures to improve electricity supply security, such as the requirement for these companies to hold 90-day fuel reserves. In addition, the turbines in gas-fired power plants can be switched over to diesel fuel in the case of gas supply disruption.

Singapore is also exploring its renewable energy potential. The economy has committed US$113 million in research funds to develop a renewable energy industry, with solar energy as a key research area.

OUTLOOK

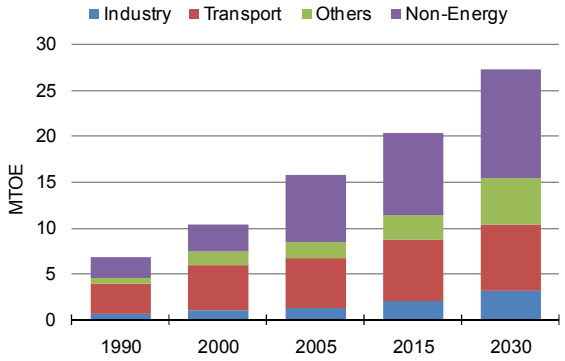
FINAL ENERGY DEMAND

Singapore's final energy demand is projected to rise from 15.8 Mtoe in 2005 to 27.2 Mtoe in 2030. This is a 72 percent increase over the outlook period, at an average annual rate of 2.2 percent. Petroleum products are expected to dominate the final energy demand in Singapore throughout the outlook period. Nevertheless, the share of petroleum products will fall from 82 percent in 2005 to 69 percent in 2030. A

[235] Ministry of Trade and Industry (2007).

projected decline in the transport sector's share in the total final energy demand, from 35 percent in 2005 to 26 percent by 2030, is the main driver behind the shrinking of petroleum products' share in the energy mix. Saturation of car ownership and the expansion of the mass rapid transit system are the main reasons for the expected fall in transport oil demand.

Figure SIN2: Final energy demand



Source: APERC analysis (2009)

Industry

The industry sector's final energy demand is expected to grow at an annual average rate of 4.0 percent, reaching about 3.2 Mtoe by 2030. Oil and natural gas will be the fastest growing energy sources, with oil use growing at an average annual rate of 5.9 percent and natural gas at 3.9 percent. Oil is also used for non-energy purposes, as feedstock in the economy's petrochemical industries. This non-energy use is the largest component of Singapore's final energy demand. It is expected to increase at an average annual rate of 5.7 percent over the outlook period, until it accounts for around 43 percent of the final demand in 2030.

Transport

The transport sector accounts for the second largest share of Singapore's final energy demand (26 percent in 2030). The transport share is projected to grow at an average annual rate of 1.1 percent over the outlook period. Oil will remain the dominant energy source in the sector, with its use growing at an average annual rate of 0.9 percent. Electricity's share in the transport demand is also expected to grow, at an average annual rate of 3.9 percent. This growth is driven by the expansion of the rail transport system.

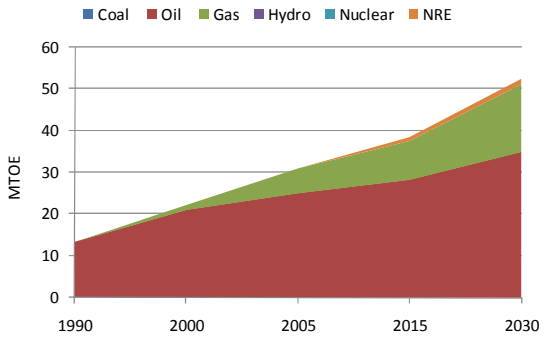
Other

Energy demand in the 'other' sector (which includes commercial and residential use) is projected to grow at an average annual rate of 4.4 percent over the outlook period; this is slower than the average annual growth rate of 8.0 percent between 1995 and 2005. By 2030, the final energy demand of the 'other' sector will reach 5.0 Mtoe, with electricity making up nearly 99 percent of the energy mix.

PRIMARY ENERGY SUPPLY

Singapore's primary energy supply is projected to increase from 31 Mtoe in 2005 to 52.6 Mtoe in 2030, at an annual average rate of 2.1 percent. In 2005, oil provided 81 percent and natural gas 19 percent of the primary energy consumed in Singapore. Over the outlook period, oil's share is projected to fall, to about 66 percent of the total, while gas's share is projected to rise to 31 percent. Electricity generation accounts for nearly 99 percent of the total increase in primary gas demand.

Figure SIN3: Primary energy supply

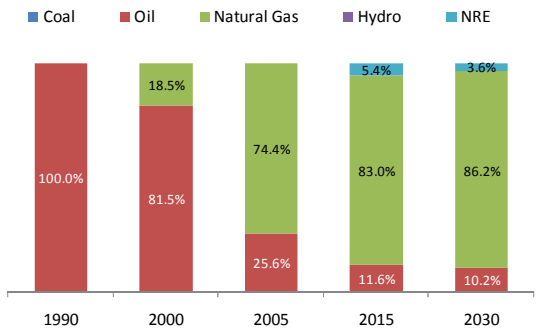


Source: APERC analysis (2009)

ELECTRICITY

Electricity generation in Singapore is projected to rise from 38 TWh in 2005 to 105 TWh in 2030, at an average annual rate of 4.1 percent. In 2005, 74 percent of the economy's electricity was generated from gas and 26 percent from oil. Gas's share in the electricity generation mix is projected to increase to 86 percent over the outlook period. A corresponding decrease is expected for oil, which will fall from 26 percent in 2005 to 10 percent in 2030. Electricity generation from municipal waste is projected to account for 4 percent of the total electricity generated in 2030.

Figure SIN4: Electricity generation mix



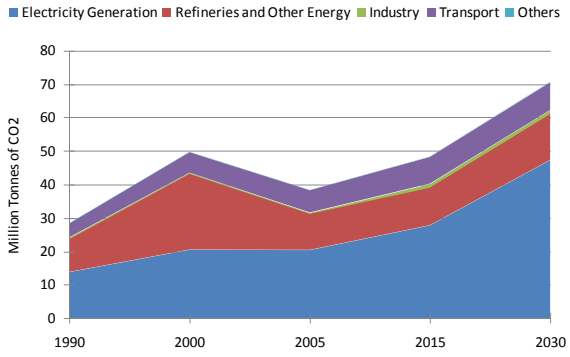
Source: APERC analysis (2009)

CO_2 EMISSIONS

Singapore's CO_2 emissions from fuel combustion are projected to rise from 38 million tonnes of CO_2 in 2005 to 71 million tonnes of CO_2 in 2030. This is an increase of about 84 percent over the outlook period. The electricity generation sector accounts for the largest share in the increase, driven by the significant electricity demand increase over that time.

The CO_2 intensity of the total primary energy supply is projected to grow marginally at an average annual rate of 0.3 percent, to reach 2.6 tonnes of CO_2 per tonne of primary energy supply.

Figure SIN5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table SIN1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-3.6%	0.1%	0.5%	0.3%
Change in Energy Intensity of GDP	-0.2%	-1.8%	-1.4%	-1.6%
Change in GDP	6.0%	4.1%	3.5%	3.8%
Total Change	2.0%	2.3%	2.6%	2.5%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

The projected energy outlook for Singapore shows that fossil fuels will continue to meet the economy's rising energy demand. Oil will remain the dominant source of energy in the transport sector and as feedstock for petrochemical industries. The economy is totally dependent on imported energy sources; as such, the main challenge is to ensure the security of supply. The economy has taken various preventive and contingency measures to meet and mitigate these challenges. Those measures are very expensive but they provide a high level of supply protection to the energy users in the economy.

Together with its efforts to ensure the security of its energy supply, Singapore is also tackling the negative environmental effects of energy use, especially GHG emissions. The economy is intensifying efforts in the area of energy efficiency improvement, especially in the electricity generation sector through the use of combined heat and electricity generation technologies and also by improving the efficiency of buildings' energy use. These initiatives will mitigate greenhouse gas emissions.

Singapore could capitalize on the opportunities arising from solar photovoltaic development, especially in the area of building integrated solar photovoltaics (BIPV). Singapore promotes solar photovoltaic technology by providing funds for research and development programmes and by providing incentives for solar BIPV manufacturers to set up plants in the economy. BIPV could be a new area of growth for the economy, and this could be hastened through the introduction of economic policies that would assist BIPV technology to penetrate and compete in the energy market.

REFERENCES

Energy Market Authority (2005) Statement of Opportunities for Electricity Industry: Plugging into Singapore. Singapore.

Land Transport Authority (2008a), Annual Report 2007/2008. Singapore. http://www.lta.gov.sg/corp_info/annual_report_0708/default.html

Land Transport Authority (2008b) Land Transport Master Plan: A People-centred Land Transport System. Singapore. http://app.lta.gov.sg/ltmp/pdf/LTMP_Report.pdf

Ministry of Trade and Industry (2007) National Energy Policy Report: Energy for Growth. Singapore. http://app.mti.gov.sg/data/pages/2546/doc/NEPR.pdf

Singapore Department of Statistics (2007) Economic Survey of Singapore 2006. Singapore. http://www.singstat.gov.sg/

CHINESE TAIPEI

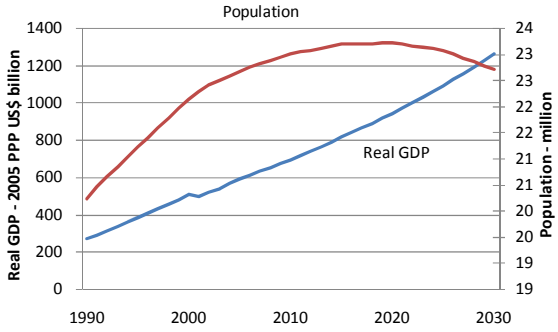
- *Chinese Taipei's primary energy supply is projected to grow at an average annual rate of 1.6 percent over the outlook period; this is due mainly to growth in the industry and transport sectors.*
- *Chinese Taipei will change its energy mix to reduce its CO_2 emissions, by increasing imports of natural gas and developing renewable energy sources.*
- *The Renewable Energy Development Act has been introduced to speed up the development of clean energy. The share of renewable energy is expected to rise from 1 percent of total electricity generation in 2005 to 7 percent in 2030.*
- *Government policy now includes consideration of nuclear power as a non-carbon energy option, with the aim of improving the economy's energy supply diversity.*

ECONOMY

Chinese Taipei 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.

The economy is made up of the islands of Taiwan, Penghu, Kinmen, Matsu, and several islets, with a total area of about 36,188 square kilometres. Only one quarter of the land is arable – in those areas the subtropical climate permits multi-cropping of rice and the growing of fruit and vegetables all year round.

Figure CT1: GDP and population



Source: APERC analysis (2009)

The population of Chinese Taipei is expected to increase at the slow average annual rate of 0.007 percent, from 22.65 million in 2005 to 22.69 million in 2030.

Chinese Taipei's GDP is projected to grow at an average annual rate of 3.1 percent over the outlook period, reaching US$1,261 billion in 2030; this compares to GDP average annual growth of 9 percent from 1990 to 2005.

The rapid economic development of the past decade has resulted in substantial changes to the economic structure of Chinese Taipei, with the emphasis moving from industrial production to the services sector. In 2007, 71.1 percent of domestic production was in the service sector, with industry accounting for 27.5 percent and the agriculture sector 1.5 percent. In 1990, services made up 54.6 percent and industry 41.2 percent of production.[236] Chinese Taipei's main industries are electronics, petrochemicals, and metals and mechanical. Within the manufacturing sector itself there has also been structural change, from energy-intensive industries to industries that are non-energy intensive. The non-energy-intensive industries also make up the largest share of exports; information technology, for instance, accounts for about 46 percent of the economy's total exports in 2007.[237]

Chinese Taipei imports almost all its crude oil for refining requirements. The economy's total refining capacity has reached 1.23 million barrels per day, which exceeds the domestic demand. This makes Chinese Taipei a net exporter of petroleum products; in 2007 these totalled about 16.7 Mtoe.[238]

In terms of overall energy use, industry accounts for most of the economy's energy consumption (51.8 percent in 2007), followed by transportation at 13.1 percent and residential use at 11.2 percent.[239] Energy use in the industry sector is dominated by chemical and petrochemical processing (35 percent in 2006), while iron and steel used 22 percent.[240]

Chinese Taipei has developed a comprehensive road transport system including two freeways that run north to south across the island of Taiwan. Transport sector energy consumption totalled 15 Mtoe in 2006 – most of

[236] BOE (2008A), p 116.
[237] IDB (2008), Statistics.
[238] BOE (2008B).
[239] BOE (2008A), p 38.
[240] IEA (2008), p II95.

this was used within road transportation (about 12 Mtoe or 80 percent), with international aviation using 2.6 Mtoe (17 percent).[241] Chinese Taipei has been striving to reduce its automobile dependency (in 2007 there were 5.7 million passenger cars in the economy)[242] and to encourage the use of public transport. These include a high-speed rail system, which runs 345.18 kilometres from Taipei to Kaoshung, and a 74.4 kilometre mass rapid transit system around Taipei city. There are plans for construction of further mass rapid transit systems in urban centres including Taipei, Taichung and Kaoshung. The policies encouraging a shift to public transport have been successful in Taipei city, with the daily ridership increasing at an average annual rate of 6.5 percent from 2000 to 2007; the Taipei Metro served, on average, 1.14 million passengers daily in 2007.[243]

In the 'other' sector, which includes residential, commercial, agriculture, and construction energy use, residential energy consumption in 2006 was 5.6 Mtoe (33.6 percent) and commercial 3.6 Mtoe (28.3 percent).[244] As the majority of the population is concentrated in major cities, electricity is the main source of energy for almost all homes; the electricity demand has grown at an average annual rate of 5.9 percent from 1990 to 2007.[245] Air conditioning in the summer season is a major source of residential electricity demand.

ENERGY RESOURCES

Chinese Taipei has very limited domestic energy resources. It relies on imports for most of its energy requirements and is a net importer of fossil energy – in 2007 its import dependency was 99.3 percent. Oil formed the biggest part of this primary supply, at 51.1 percent (coming mainly from Saudi Arabia, Kuwait and Iran), coal made up 32.1 percent (mainly from Australia, Indonesia and China), while imported LNG occupied 8.1 percent (coming mainly from Indonesia and Malaysia). Indigenous resources provided very small percentages of the economy's primary supply: natural gas 0.3 percent, hydro power 0.3 percent, geothermal, solar and wind power 0.1 percent combined. [246]

At the time of writing this review, there were three nuclear power plants in Chinese Taipei, each with two units, creating a total installed capacity of 5144 MW. A fourth nuclear power plant (also with two units) is currently under construction; it is scheduled to begin operation in 2010 and 2011, adding 1350 MW of capacity per unit.[247]

Taiwan's total electricity generation in 2007 was 243 TWh. This is mainly dependent on fossil fuels; their 78.2 percent share is made up of coal (53.6 percent), LNG (18.4 percent), and oil (6.2 percent). Nuclear generation accounted for 16.7 percent of total electricity generation in 2007, and renewable electricity 1.7 percent.[248]

The government's aim is to have a total electricity supply which provides a reserve capacity of 15–20 percent based on peak demand levels. Because of environmental issues and complex official approval processes, new power plants being constructed by Taiwan Power Company (TPC) fell behind schedule, which kept the total electricity below reserve capacity between 1990 and 2004. Reserve capacity remained under 8 percent between 1990 and 1996. In order to stabilize the power supply, TPC contracted with independent power producers (IPP) through a round of bidding when the reserve capacity was below 16 percent. Power produced by IPPs is sold to TPC through TPC's transmission lines. The reserve capacity has been more than 16 percent since 2004. The Ministry of Economic Affairs has announced it will open a fifth round of bidding to IPPs if the reserve capacity falls below 16 percent in the future.[249]

ENERGY POLICIES

Chinese Taipei's Energy Commission, which was established in 1979 under the Ministry of Economic Affairs (MOEA), became the Bureau of Energy in 2004. The Bureau is responsible for formulating and implementing the economy's energy policy. Recent policy development includes the establishment of a suite of energy-related legislation, covering renewable energy development, petroleum administration, natural gas business, and electricity. The aim is to create a better energy business environment.

The fundamental goal of the Chinese Taipei Energy Policy is to promote energy security, supported by secure imports of oil, natural gas and coal as well as the development of domestic energy

241 IEA (2008), p II95.
242 BOE (2008A), p 122.
243 TRTC (2008), p 25.
244 IEA (2008), p II95.
245 BOE (2008A), p 83.
246 BOE (2008A), p 12.
247 TPC (2008).
248 BOE (2008A), p 81.
249 BOE (2006).

resources including nuclear, fossil fuels, and new renewable energy sources.

On 5 June 2008, the Ministry of Economic Affairs released the *Framework of Taiwan's Sustainable Energy Policy*. This presents a "win-win-win" solution for energy, the environment and the economy. [250] The framework addresses the constraints that Chinese Taipei faces in terms of its insufficient natural resources and limited environmental carrying capacity. It states that sustainable energy policies should support the efficient use of the economy's limited energy resources, the development of clean energy, and the security of energy supply. The framework establishes these goals:

- reductions in energy intensity from 2005 levels – by 20 percent by 2015 and by 50 percent by 2025;
- Chinese Taipei's new government changed the economy's nuclear policy in 2008 from a "non-nuclear homeland policy" to allow reconsideration of nuclear power as a non-carbon energy option;
- reductions in total CO_2 emissions, so that total emissions return to the 2008 level between 2016 and 2020, and are further reduced to the 2000 level by 2025; at the same time, the share of low carbon energy in electricity generation systems will be increased from the current 40 percent to 55 percent by 2025;
- secured and stable energy supply, achieved by building a secure energy supply system to meet economic development goals, namely 6 percent average annual GDP growth rate from 2008 to 2012, and $US30,000 per capita income by 2015.

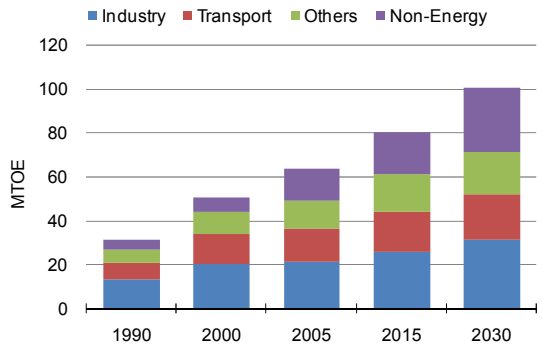
In order to reach these goals, Chinese Taipei has set these energy conservation targets and strategies: 1) industry sector: raise boiler efficiency, expand cogeneration, and increase share of high-value-added industries; 2) power sector: replace coal-fired and gas-fired power plants with high-efficiency generating units and reduce line losses by improving power dispatch and transmission facilities; 3) transportation sector: raise the fuel efficiency standard for private vehicles by 25 percent (on 2005 levels) by 2025, and raise appliance efficiency standards by 10 percent to 70 percent in 2011; 4) residential and commercial sectors: completely eliminate incandescent lights and replace with LED lighting by 2025 to increase energy efficiency and reduce total power consumption.[251]

OUTLOOK

FINAL ENERGY DEMAND

Chinese Taipei's total final energy demand is projected to grow at an average annual rate of 1.9 percent over the outlook period, increasing from 63.4 Mtoe in 2005 to 100.4 Mtoe by 2030. The industrial sector will account for the largest share of total 2030 demand (31 percent), followed by non-energy (29 percent), transport (21 percent) and the 'other' sector (19 percent). Demand for electricity is projected to increase at an average annual rate of 1.9 percent.

Figure CT2: Final energy demand



Source: APERC analysis (2009)

Industry

Energy demand in the industry sector is projected to grow at an average annual rate of 1.6 percent, lower than the average annual growth of 5.5 percent between 1987 and 2007. This reduction in demand growth is due to the structural shift in the industry sector, from energy-intensive to non-energy-intensive industries, as well as improvements in energy efficiency. Currently the dominance of petrochemical industry makes the Chinese Taipei industrial sector highly energy intensive. This energy intensity will reduce, as will the rate of increase in the sector's energy demand, as the electronics and IT industries are expected to grow more quickly than the petrochemical industry.

The share of coal in the industrial energy mix is expected to increase slowly at an average annual rate of 2.1 percent; this compares to 5.5 percent growth between 1987 and 2007. This is a result of a slowdown in crude steel production. At the same

[250] BOE (2008c).

[251] Ibid.

time the industrial use of natural gas is projected to grow at an average annual rate of 2 percent during the outlook period.

Transport

Chinese Taipei's transport energy consumption has grown in parallel with its economic development, improvement in living standards, and upgrades in transportation infrastructure. All transport sub-sectors exhibited substantial average annual growth of 5.2 percent between 1987 and 2007. The transport energy demand is projected to grow further over the outlook period, at an average annual rate of about 1.3 percent. Exports of high-value-added manufacturing products, and increase of direct air travel between Chinese Taipei and mainland China, is expected to spur growth in the air transport energy demand. To accommodate the predicted rise in air transport, Chinese Taipei is considering the construction of a new airport close to the centre of Taipei, and expansion of the freight handling capacity at Kaohsiung airport.

Chinese Taipei's population is expected to peak sometime in 2020. Over the outlook period, mass transit rail-systems are expected to gradually replace buses and passenger vehicles for city travel, just as the high-speed railways continue to replace the passenger vehicles for inter-city travel. As a result, gasoline demand is expected to grow only at an average annual rate of 0.6 percent between 2005 and 2030. By contrast, the diesel demand for freight trucks is expected to grow at an annual average rate of 1.9 percent; this is due to the growth in production of high-value-added manufactured goods, and the expansion of petrochemical industries, which favour trucks as the main mode of transport.

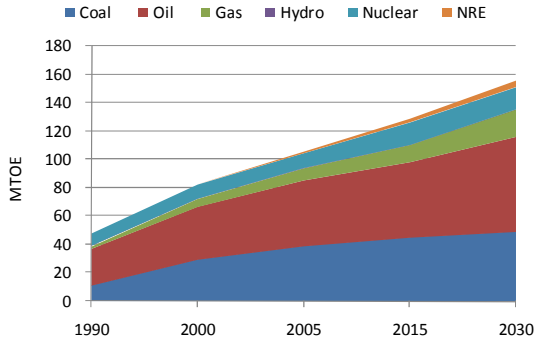
Other

Energy demand in the 'other' sector, which includes residential, commercial, agricultural, and construction demand, is primarily driven by income growth and the improvement in living standards. The energy demand of Chinese Taipei's 'other' sector is expected to grow at an average annual rate of 1.6 percent over the outlook period. Electricity is expected to continue to dominate the energy mix, accounting for 74.1 percent of 'other' sector energy consumption.

PRIMARY ENERGY SUPPLY

The share of new renewable energy (NRE) sources (which include biomass, biofuels, wind, solar, geothermal, and small hydro) in Chinese Taipei's primary energy mix is projected to increase significantly from 1.0 percent in 2005 to 2.9 percent in 2030. To speed up the development of 'clean energy', the Renewable Energy Development Act was enacted in June 2009. This new legislation focuses on encouraging new renewables-based generation that is connected to the main grid, through fixed feed-in tariffs – this is where TPC purchases power from renewable power generators on contracts involving preferential rates and grid-connecting obligations. The overall aim is to secure the market for electricity generated from renewable energy.

Figure CT3: Primary energy supply



Source: APERC analysis (2009)

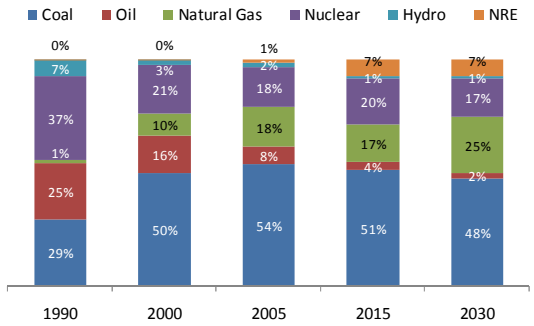
ELECTRICITY

By 2030, Chinese Taipei's total installed capacity is expected to reach 88.4 GW. The majority of this will be thermal (76.5 percent); this is made up of coal (48 percent of the total generation), natural gas (25 percent) and oil (2 percent). Other generation at the end of the outlook period will be from nuclear (17 percent), NRE (7 percent), and hydro (1 percent).

Chinese Taipei's total electricity generation is projected to increase from 223 TWh in 2005 to 359 TWh in 2030, growing at an average annual rate of 1.9 percent. Efforts to reduce the economy's CO_2 intensity of energy will mean the share of coal will decrease from 54 percent in 2005 to 48 percent in 2030 – it is being replaced by increased generation from natural gas and NRE sources. The natural gas share will increase significantly from 18 percent in 2005 to 25 percent in 2030. Some oil-fired electricity generation will also be replaced by natural gas, with oil's share projected to decrease from 8 percent in 2005 to 2 percent in 2030. Nuclear's share is expected to remain static throughout the outlook period. The share of electricity generation supplied by hydro is projected to be the smallest, decreasing from 2 percent in 2005 to 1 percent in 2030; this is due to

perceived negative impacts on the environment. At the same time, as a result of government policy to promote the development of renewable energy sources (mainly from wind power), the NRE share will increase from 1 percent in 2005 to 7 percent in 2030.

Figure CT4: Electricity generation mix



Source: APERC analysis (2009)

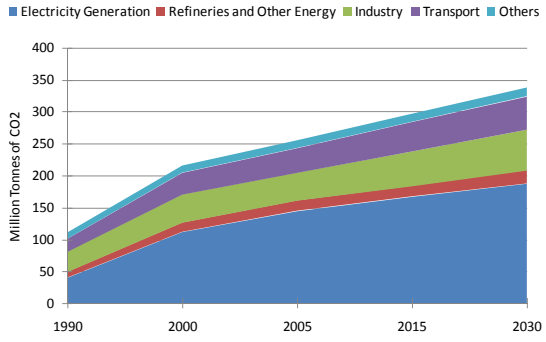
CO_2 EMISSIONS

Over the outlook period Chinese Taipei's total CO_2 emissions from fuel combustion are projected to reach 338 million tonnes of CO_2, which is 32 percent higher than in 2005 and 302 percent higher than the 1990 level.

The electricity generation sector is expected to account for the largest share, at 55 percent of total CO_2 emissions or 187 million tonnes of CO_2, followed by the industry sector at 19 percent (64 million tonnes of CO_2) and the transportation sector at 15 percent (52 million tonnes of CO_2).

The decomposition analysis shown in the following table indicates the increases in CO_2 emission are mainly driven by GDP growth. However, the significant reduction in the economy's energy intensity is expected to offset much of the increase resulting from economic growth.

Figure CT5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table CT1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.3%	-0.5%	-0.4%	-0.4%
Change in Energy Intensity of GDP	-3.2%	-1.7%	-1.6%	-1.7%
Change in GDP	8.9%	3.8%	3.0%	3.3%
Total Change	5.7%	1.5%	0.9%	1.1%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Chinese Taipei is expected to remain an energy importer over the outlook period, due to its lack of indigenous energy sources. The economy will continue to import almost all of its oil requirements. To minimize the impact of any oil supply disruptions, Chinese Taipei maintains an oil stockpile of no less than 60 days' supply.[252] The economy has also tried to diversify its energy supply mix by switching from oil to natural gas, coal and renewable energy. In addition, it has started to secure international joint venture agreements to acquire captive supply sources.

Chinese Taipei's new government changed the economy's nuclear policy in 2008 from a "non-nuclear homeland policy" to allow reconsideration of nuclear power as a non-carbon energy option. This projection shows that if nuclear energy's share of electricity generation remains static, and the NRE share remains small, that Chinese Taipei's greenhouse gas (GHG) emissions will increase by one third by 2030 compared with 2005 emissions. Even though the share of renewables is expected to increase from 1 percent in 2005 to 7 percent in 2030, electricity production from fossil fuels will still increase. It would be a rational response to add further nuclear units on the existing nuclear power generation sites; this could be in addition to improving the energy efficiency on both the supply and demand sides of electricity provision.

To decouple energy consumption and GDP growth, the service sector needs to be promoted and expanded and the industry sector needs to move to a less energy-intensive structure. For example, promoting knowledge-based industries such as the Green Silicon Island, high-value-added and low-energy-intensive scientific industry parks, could be one way to foster a less energy-intensive economy.

With limited domestic energy resources, the security of Chinese Taipei's energy supply is central to its energy policy goals of meeting a growing energy demand while reducing CO_2 emissions. The economy will have to look to

[252] BOE (2009), Article 24.

alternative energy sources, in particular replacing coal with natural gas and renewable energy. Chinese Taipei has already moved to promote renewable energy with the 2009 introduction of the Renewable Energy Development Act, which uses fixed feed-in tariffs and grid-connecting obligations to encourage NRE-based generation.

The establishment of international stockpiling through regional cooperation could be an important way of stabilizing domestic energy supply, as could the acquisition of equity in international energy resource developments by the national oil company.

REFERENCES

BOE (2006) *The program for fourth rounds of the bidding of Opening Electricity Market to IPPs*, Bureau of Energy of Ministry of Economic Affairs, Taipei. http://www.moeaboe.gov.tw/opengovinfo/Laws/electronic/LElecMain.aspx?PageId=l_elec_28

BOE (2008A) *Energy Statistical Hand Book 2007*. Bureau of Energy of Ministry of Economic Affairs, Taipei.

BOE (2008B), *Energy Statistical Annual Report*. Bureau of Energy of Ministry of Economic Affairs, Taipei. http://www.moeaboe.gov.tw/opengovinfo/Plan/all/energy_year/main_en/files/03/table-2-10.pdf

BOE (2008C) *Framework of Taiwan's Sustainable Energy Policy*. Bureau of Energy of Ministry of Economic Affairs, Taipei. http://www.moeaboe.gov.tw/English/files/Framework%20of%20Taiwan's%20Sustainable%20Energy%20Policy.pdf

BOE (2009) *Petroleum Administration Law*, Bureau of Energy of Ministry of Economic Affairs, Taipei http://www.moeaec.gov.tw/English/laws/EnLMain.aspx?PageId=laws_03

IDB (2008), *Major Indicators of Manufacturing Sector in 2007*. Industrial Development Bureau of Ministry of Economic Affairs, Taipei. http://www.moeaidb.gov.tw

IEA (2008) *Energy balances of Non-OECD countries* (2008 edition). International Energy Agency. Paris, France. http://www.iea.org/

TPC (2008) *Statistics of Taiwan Power Company*. Taiwan Power Company, Taipei

TRTC (2008) *2007 Annual Report*. Taipei Rapid Transit Corporation, Taipei. http://www.trtc.com.tw

THAILAND

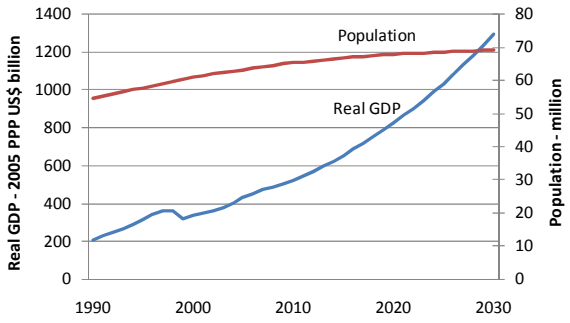
- *Thailand's final energy demand is projected to grow at an average annual rate of 3 percent over the outlook period; this is driven mainly by increased demand for oil and electricity in the transport and industrial sectors.*
- *Reducing the economy's high reliance on imported energy, especially oil, will be a major challenge. In addition to increasing domestic oil and natural gas reserves, and diversification of supply through use of alternative energy sources, Thailand aims to strengthen energy conservation measures to reduce energy demand in all sectors.*
- *One option that Thailand has to further secure its electricity supply is electricity interconnection with neighbouring economies through ASEAN and Greater Mekong Subregion (GMS) initiatives; a number of barriers still need to be overcome in this area (for example the establishment of transmission facilities, regulatory protocols and cross-border tariffs.)*

ECONOMY

Thailand is located in Southeast Asia. It shares borders with Malaysia to the south and Myanmar, Lao PDR and Cambodia to the north and east. It has an area of 513,115 square kilometres and in 2005 the population was about 63 million. The climate is generally hot and humid.

Thailand is the second largest economy in the Association of South East Asian Nations (ASEAN). Its total GDP in 2005 was US$426 billion, or about US$6800 per person. Thailand's economic growth was strong during the 1990s until 1997 when the economy was affected by the Asian financial crisis. In 1998 the GDP was down 10.5 percent on the previous year; there has been gradual improvement since: GDP growth between 1995 and 2000 was at an average annual rate of 1.3 percent, which increased to 5.1 percent between 2000 and 2005.

Figure THA1: GDP and population



Source: APERC analysis (2009)

Thailand's economic policy has a dual focus, on promoting exports and on strengthening the domestic economy toward sustained economic development. Thailand is also seeking to develop new technologies and is encouraging foreign investors to do so. Laws enacted after the 1997 Asian financial crisis have liberalized trade and foreign investment, and have made it easier for non-Thais to own property in Thailand. For example, the Alien Business Act of 2000 increases the proportion of a company's shares that can be owned by foreign firms.

This outlook assumes that Thailand's GDP will grow at an average annual rate of 4.3 percent between 2005 and 2015, and at 4.7 percent from 2015 to 2030. Population growth over the same period is expected to be at an average annual rate of 0.5 percent to 2015, and then declining at an average annual rate of 0.2 percent to 2030. The population in 2030 is projected to reach 69 million, with about half living in urban areas – this compares to about one third in rural areas in 2005.[253]

Thailand is an agricultural economy, which creates significant volumes of biomass residue, including paddy husks from rice milling, bagasse from sugar milling, wood chips from sawmills, and palm outer fibres, shells, frond (leaves) and empty fruit bunches from palm oil extracting plants. Apart from the traditional use of biomass for cooking in many rural areas, some residue is used as fuel within industry. Paddy husks are burned to produce steam for turbine operation in rice mills, and bagasse and palm residues are used to produce steam and electricity for on-site use. There have also been several efforts since 2000 to explore production of biofuels from biomass.

The major industrial consumers of energy in the Thai economy in 2005 were food and tobacco production (30 percent) and non-metallic mineral mining (29 percent). However, the sectors with the fastest rate of energy demand growth between 2000 and 2005 were non-metallic mineral mining (12 percent in 2000), machinery (10 percent in 2000), and wood and wood products (9 percent).[254]

Thailand's transport sector is dominated by road transport, which handled 85 percent of the

[253] UN Population Division (2003).

[254] IEA (2008).

passengers and 86 percent of the freight in 2006. The remaining domestic passenger movement that year was via mass rapid transit (8 percent), traditional rail (6 percent), and air (1 percent). The remaining domestic freight in 2006 was carried via inland waterways (6 percent), coastal waterways (6 percent), and rail (2 percent).[255]

In urban areas, mass rapid transit (MRT) is an increasingly significant mode of passenger transport. The annual growth rate between 2004 and 2006 was 58 percent.[256] In Bangkok, there are two MRT systems at the time of writing: the Sky Train and the Blue Line, which between them transport about 600,000 passengers daily. However, the coverage provided by MRT systems is still limited, and there are plans to expand the lines by 2020. The Bangkok Metropolitan Authority is also developing a bus rapid transit system that is expected to carry 50,000 passengers per day from 2009.[257]

ENERGY RESOURCES

Thailand has high levels of dependence on energy imports, particularly oil, with 90.5 percent of oil primary energy supply met by imports. Similarly, imports account for a large proportion of primary energy supply for coal (47.2 percent), petroleum products (44.2 percent), natural gas (28.6 percent) and electricity (2.3 percent).[258] In 2005, net energy imports accounted for 57 percent of the economy's energy supply; this was a marked decrease from 96 percent in 1980. Thailand's energy demand is expected to grow and the government has plans to significantly increase energy imports from neighbouring economies.

Although Thailand's coal reserves are large, most of Thailand's proven coal reserves are lignite coal of low calorific value. This means coal imports are required to supply electricity generation and the industry sector. Natural gas use in the economy is mainly for electricity generation – this accounted for almost 73 percent of consumption in 2005.[259] In that year all natural gas imports were from Myanmar.[260]

At the end of 2007 the Thai Energy Planning Policy Office estimated proven reserves of petroleum both onshore and offshore at 176 million barrels of crude oil, 265 million barrels of condensate, and 12 trillion cubic feet of natural gas. These crude oil and condensate reserves could supply Thailand's current demand for less than two years, while the gas reserves could supply the current demand for about 10 years.

In 2005, domestic electricity generation totalled 132,200 GWh. Of this, thermal generation (mostly from natural gas and coal) accounted for 94 percent and hydropower for 4 percent. In addition to domestic electricity production, 4,419 GWh of electricity was purchased from Lao PDR and Malaysia, bringing the total electricity supply to 136,619 GWh (with imports making up 3.2 percent of the total).[261]

ENERGY POLICIES

The Thai Energy Policy and Planning Office (EPPO) is within the Ministry of Energy at the time of writing. It is responsible for efficiently setting and managing energy policy, while taking into consideration economic and social development, and the environment. The EPPO is expected to develop energy policies and plans, coordinate their implementation, monitor and evaluate these policies, and to build international cooperation to promote energy conservation and efficiency.

The Thai government aims to strengthen the economy's energy security by reducing its high dependency on energy imports and promoting the exploitation of indigenous energy resources, by ensuring energy prices are competitive and will support sustained economic growth, and by contributing to the reduction of global GHG emissions. Key energy policies emphasized by the Thai energy minister in 2008 include: 1) enhancing energy security to ensure there is sufficient energy supply for the economy's development and to increase Thailand's energy self-reliance, in the interests of the people's wellbeing; 2) monitoring energy prices to ensure they are appropriate, stable and in line with current economic and investment conditions; 3) promoting research and development of all forms of alternative energy on a continuous basis; 4) emphasizing the energy-saving discipline as a part of Thai culture and encouraging local administration organizations to take a major role in disseminating this 'energy saving culture'.[262]

To improve energy security, the Thai government has adopted a range of comprehensive measures covering the oil, gas and electricity sectors, and also including comprehensive and careful study of nuclear energy as another option for increasing the

255 World Bank (2008), pp 22, 25, 31.

256 World Bank (2008), p 27.

257 APERC (2008), p 44.

258 Ministry of Energy (2006), pp 7, 9.

259 IEA ETB (2008).

260 Sajjakulnukit (2007).

261 IEA ETB (2008).

262 EPPO (2008B).

stability of the economy's future electricity supply. A feasibility study for a nuclear power plant is being carried out as a cooperative venture between the Electricity Generating Authority of Thailand (EGAT) and foreign energy consulting companies. EGAT has estimated that nuclear power could contribute up to 10 percent of the economy's total electricity generation from 2020.[263]

The government has also introduced specific measures to speed up the uptake of renewable energy and promote energy efficiency. These measures include speeding up the preparation of the 15-year Renewable Energy Development Plan (REDP), promoting electricity generation using renewable energy, and whole-hearted promotion of ethanol and biodiesel. Promotion of renewable sources for electricity generation includes research and development funding and subsidies for hydropower and solar power projects, and a plan to purchase renewable-sourced power from small power producers (SPPs) and very small power producers (VSPPs) from 2011.[264]

The government has launched an Energy Conservation Program with an annual budget of 100 billion baht (US$2.85 billion).[265] Phase 3 (2005–2011) includes these elements: providing credit for energy efficiency improvements in the household and industry sectors; mandatory energy labelling; and energy-saving standards for building, designing and monitoring energy saving in factories.

There are also energy policies that focus on substituting natural gas for coal and fuel oil in electricity generation, promoting clean coal technologies, and implementing more stringent sulphur dioxide and CO_2 emission standards for electricity generation plants.

The 2007 update of the economy's Power Development Plan (PDP) included the option of nuclear power development, coming online in 2020. At the same time, the government intends to increase public awareness of the benefits presented by nuclear energy to build public acceptance for its nuclear power development plan). In addition, Thailand is planning to buy additional hydroelectric capacity of 13,250 MW from its neighbours (Laos PDR, Myanmar and China) by 2021.[266]

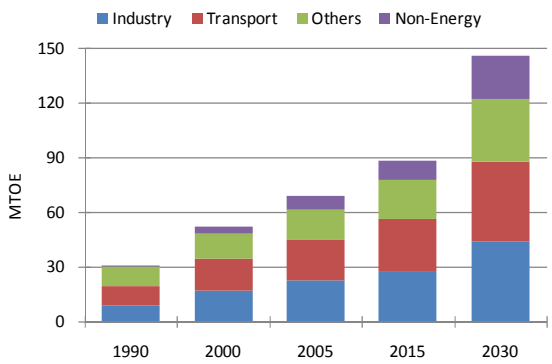
OUTLOOK

FINAL ENERGY DEMAND

As Thailand recovered following the 1997 economic crisis, its energy consumption increased at the robust annual average rate of 5 percent from 2000 to 2005. However, the global economic recession has had a marked effect on Thailand's GDP growth since 2008. As a result, our projection for its energy demand is for a slower average annual growth rate of about 2.5 percent from 2005 to 2015, with an increase after 2015 to an average annual rate of 3.4 percent, through to 2030.

In 2030 the transport and industry sectors are expected to still dominate the total final energy demand (each accounting for a 30 percent share), while the proportion used by the 'other' sector, which includes residential and commercial use, would rise slightly to 24 percent from 23 percent in 2005. This increase is due to anticipated income growth and improvement in people's living standards. In addition, strong economic growth after 2015 is expected to drive rapid growth in the commercial sector.

Figure THA2: Final energy demand



Source: APERC analysis (2009)

Industry

Thailand's industrial energy demand is projected to grow at an average annual rate of 2.6 percent, lower than the average annual growth rate of 5.3 percent between 1990 and 2005. The government's focus on improving energy efficiency, and the shift in the industrial structure from energy-intensive to non-energy-intensive industries, are the basis of this slowing demand.

Industry' demand for electricity is projected to increase from 4.9 Mtoe in 2005 to 18.7 Mtoe in 2030, at an average annual rate of 5.5 percent. This is the fastest rate of increase for an industrial fuel type. Oil demand will decline annually at 2.1 percent from 4.1 Mtoe to 2.4 Mtoe over the outlook period.

263 EGAT (2007B), p 83.

264 Narupat (2007).

265 EPPO (2008B).

266 EGAT (2007B), pp 38–41.

Transport

Between 1990 and 2005, Thailand's transportation energy consumption increased two-fold (at an average annual growth rate of 5 percent), mostly as a result of growth in road transport. Over the outlook period, the transport-based energy demand is projected to grow at an average annual rate of 2.8 percent.

The government aims to introduce 'gasohol' and biodiesel, with the aim of replacing 10 percent of current annual gasoline and diesel consumption by 2011; this outlook assumes this will be achieved by 2015.

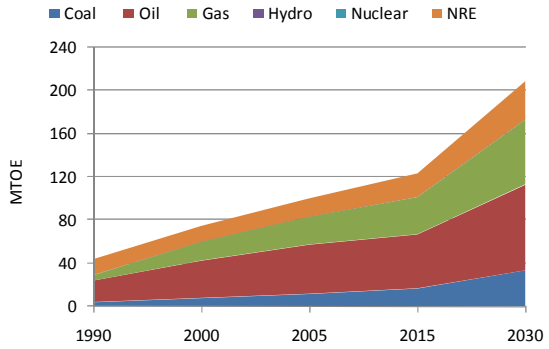
Other

Energy demand in the Thai 'other' sector (commercial and residential use) is projected to increase at an average annual rate of 3.0 percent over the outlook period. This is slightly higher than the sector's 2.8 percent average annual growth rate between 1990 and 2005. Along with income growth and improvement in people's living standards, this increase will be driven by substitution of electricity and petroleum products for non-commercial biomass. The demand for electricity is expected to grow the fastest, at an average annual rate of 4.3 percent over the outlook period. Demand for petroleum products (kerosene and LPG for cooking) is projected to grow at 4 percent, from 5.1 Mtoe in 2005 to 13.6 Mtoe in 2030.

PRIMARY ENERGY SUPPLY

Thailand's total primary energy supply is projected to grow at an average annual rate of 3 percent over the outlook period, from 100.6 Mtoe in 2005 to 213.0 Mtoe in 2030. Among the fossil fuels, coal is projected to grow at the fastest rate (4.4 percent), followed by natural gas (3.4 percent) and oil (2.3 percent).

Figure THA3: Primary energy supply



Source: APERC analysis (2009)

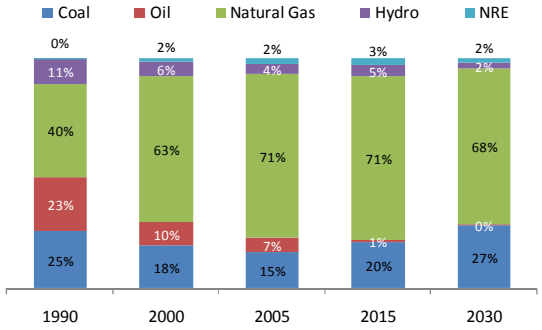
Coal's share of the total primary energy supply is expected to rise to 16 percent in 2030 from 11 percent in 2005; most of the coal is used for electricity generation. Due to the low quality of Thailand's indigenous coal resources, the economy will have to import 82 percent of the total 2030 coal requirements. Gas's share will also increase, from 26 to 28 percent; most gas is also used in electricity generation.

Oil's share will decline over the outlook period, from 45 percent in 2005 to 37 percent in 2030, but only because the coal and gas demands are growing faster. The increase in the oil demand is driven mainly by transport and industry. Net oil import dependency is projected to increase as a result of increasing demand and declining domestic oil production.

ELECTRICITY

Electricity generation in Thailand is projected to increase at an average annual rate of 4.5 percent, rising from 132 TWh in 2005 to 400.5 TWh in 2030; this is less than the 6.6 percent annual growth rate between 2000 and 2005. Over the outlook period, natural gas will remain dominant in the electricity generation mix, but the share will decline from 71 percent in 2005 to 68 percent in 2030.

Figure THA4: Electricity generation mix



Source: APERC analysis (2009)

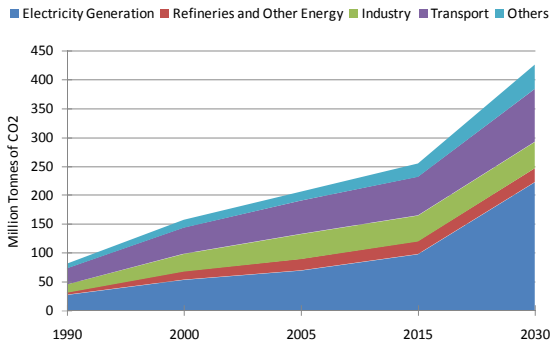
Thailand's total installed generating capacity is expected to increase from 27.7 GW in 2005 to 72.9 GW in 2030. Coal is projected to increase its share of total installed capacity from 10 percent in 2005 to 25 percent in 2030. The hydro share of installed capacity will decline from 13 percent in 2005 to 5 percent in 2030. Thailand is projected to import around 46.5 TWh of electricity from neighbouring economies by 2030.

CO_2 EMISSIONS

Over the outlook period, Thailand's total CO_2 emissions from fuel combustion are projected to

increase at an average annual rate of 2.9 percent, from 206.1 million tonnes of CO_2 in 2005 to 425 million tonnes of CO_2 in 2030. Fuel combustion for electricity generation and heating is the major contributor, accounting for 52 percent of total CO_2 emissions in 2030, or 222 million tonnes of CO_2.

Figure THA5: CO_2 emissions by sector



Source: APERC analysis (2009)

The decomposition analysis shown in the following table suggests that the growth rate of Thailand's CO_2 emissions from fuel combustion is the result, by and large, of economic growth.

Table THA1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	0.6%	-0.1%	-0.1%	-0.1%
Change in Energy Intensity of GDP	0.6%	-2.0%	-1.1%	-1.4%
Change in GDP	5.1%	4.3%	4.7%	4.5%
Total Change	6.3%	2.1%	3.5%	2.9%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATION

Thailand has had some success in reducing its dependence on imported energy in recent years. The share of net imported energy in the total final energy demand has fallen from 61.5 percent in 2000 to 59.1 percent in 2005.[267] However, this is still far from ideal for Thailand's energy security. This outlook, which makes 'business as usual' assumptions, projects that domestic energy production will increase slightly from 54.3 Mtoe in 2005 to 57.0 Mtoe in 2030, while the primary energy demand will increase more than two-fold in the same period.

In order to further reduce Thailand's dependence on imported energy, especially on oil imports, the economy must actively pursue its initiatives in the areas of cogeneration, nuclear and renewable energy, biofuels and natural gas for vehicles, as well as seeing through its intention to diversify its imported energy sources.

In addition, the government needs to speed up energy efficiency improvements in every economic sector. The transport sector, which accounts for over half of Thailand's final demand for oil, would appear to offer a number of opportunities. These include improving vehicle fuel efficiency, improving traffic management, improving the rail freight system, and improving public transport.[268]

There is also an opportunity for a strong expansion of energy cross-border trade from neighbouring economies. In doing this, a very important step is for Thailand to consider building strong relations with its neighbours, particularly those of the ASEAN and Greater Mekong Subregion (GMS) for power and gas interconnection.

Although economies in the GMS possess considerable sources of low-cost electricity generation (especially hydro), these resources are geographically isolated from load centres. Therefore, by interconnecting these areas of supply and demand it would be possible to provide equitable and cheaper access to electricity, lower costs (through economies of scale), and reduce GHG emissions and other pollutants.

International developers in Lao PDR have started hydro development and have expressed an interest in exporting electricity to Thailand, while there are also plans to build power plants in the Yunan Province of southern China for possible interconnection with Thailand and Viet Nam. Other bilateral arrangements are also being considered and studied, including the assessment of barriers to regional electricity trade and cooperation in the region.

REFERENCES

ADB (2005) *Regional Power Interconnection and Power Trade Arrangements*. Asian Development Bank, Manila.

APERC (2006) *APEC Energy Demand and Supply Outlook 2006*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

APERC (2008) *Urban Transport Energy use in the APEC Region, Benefits and Costs*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

[267] IEA (2008).

[268] Manopiniwes (2008).

EDMC (2008) *APEC Energy Database*. Energy Data and Modelling Centre, Institute of Energy Economics, Tokyo, Japan. www.ieej.or.jp/apec

EGAT (2007A) *Annual Report 2006*. Electricity Generating Authority of Thailand, http://www.egat.co.th/en/

EGAT (2007B) "Thailand Power Development Plan, Revision 1 (PDP 2007)". Electricity Generating Authority of Thailand, http://www.egat.co.th/en/

EPPO (2004) *Annual Report 2000–2004*. Energy Policy and Planning Office, Thailand, www.eppo.go.th

EPPO (2007) *Annual Report 2547 (2006)*. Energy Policy and Planning Office, Thailand, www.eppo.go.th

EPPO (2008A) "Energy Database". Energy Policy and Planning Office, Thailand, www.eppo.go.th

EPPO (2008B) *Policy Statement of the Government of Mr. Samak Sundaravej, Prime Minister to the National Assembly, 18 February B.E. 2251 (2008)*. Energy Policy and Planning Office, Thailand, www.eppo.go.th

IEA (2008) *Energy Database: 1971–2006*. International Energy Agency, Paris, France. http://www.iea.org/

IEA ETB (2008) *Energy Balance Table, 1971–2006*. International Energy Agency, Paris, France. http://www.iea.org/

Manopiniwes, Chanin (2008) "Thailand: Potentials of Making Transport More Energy Efficiency", paper presented to the Better Air Quality Conference, Bangkok, Thailand. http://www.baq2008.org

Ministry of Energy, Thailand (2003) *Annual Report 2003*. Bangkok, Thailand.

Ministry of Energy, Thailand (2006) *Thailand Energy Situation, 2549/2006*. Bangkok, Thailand.

Narupat, Amornkosit (2007) "Renewable Energy Policy: Recent Policies on SPP/VSPP", presented to Renewable Energy Asia 2007 Conference. BITEC, Bangkok, 6 June 2007.

Population Reference Bureau (2009) "Data by geography: Thailand: Summary", http://www.prb.org/Datafinder/Geography/Summary.aspx?region=163&region_type=2

Sajjakulnukit, Moonrod (2007) "Country Report, Thailand", presented to Workshop on Supply Potential of Coal and NRE in ASEAN, 24–25 January 2007, Bangkok, Thailand.

UN Population Division (2003) as reported on the Globalis Interactive World Map, Global Virtual University, http://globalis.gvu.unu.edu/indicator_detail.cfm?IndicatorID=30&Country=TH

World Bank (2008) *Thailand Infrastructure Annual Report 2008*. http://siteresources.worldbank.org/INTTHAILAND/Resources/333200-1177475763598/3714275-1234408023295/5826366-1234408105311/full-report.pdf

UNITED STATES

- *New 'corporate average fuel economy' standards, with an accelerated phase-in schedule, and a 'renewable fuels' standard will lead to a small reduction in total demand for oil products.*
- *Strengthened domestic natural gas reserves and a reluctance to build carbon-intense coal power plants will contribute to a continued preference for natural gas as the fuel for additional electricity generation.*
- *Spurred by state 'renewable portfolio' standards and federal incentives, renewables will grow fastest in the electric power mix, but still supply less than 10 percent of electricity in 2030.*
- *Though US energy intensity will fall dramatically, the absolute amounts of energy supplied and carbon dioxide emitted will continue to grow.*

ECONOMY

The United States is the largest economy in APEC and the world. In 2007, US GDP reached US$13,807 billion, which was more than a fifth of the world total.[269] To fuel its large economy and high living standards, the US consumes more energy than any other nation – in 2006, it consumed nearly 20 percent of the world's commercial energy.270 Only recently was the US overtaken by China as the world's largest emitter of carbon dioxide (CO2) emissions from fuel combustion. (The US remains number one in terms of cumulative additions to the present atmospheric burden of CO2, and on a per capita basis emits far more CO2 than China.)

Among economically advanced countries, the US ranks near the top in measures of energy intensity and per capita energy use.271 For example, among the 30 OECD countries, the US ranks seventh highest in energy intensity and fourth highest in per capita energy use. The US ranks ninth in energy intensity and second in per capita energy use within APEC, reflecting the more varied stages of economic development within the APEC economies.272

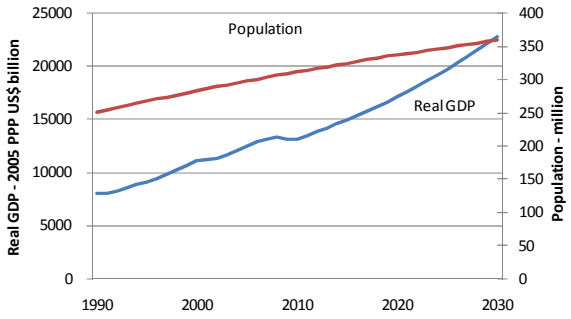
The largest share of US final energy demand, just over 40 percent, is in transportation. Approximately 65 percent of that transportation energy is consumed by a fleet of over 237 million personal vehicles (cars, SUVs, and other light duty trucks).[273] In 2006, over four-fifths of US travel was made by car, as compared to 1 percent by rail or bus.[274] Thus the efficiency of the US personal vehicle fleet, in combination with driving habits, plays an important role in total US energy consumption.

The industrial sector's share of energy consumption has gradually declined – going from an average of 20 percent in the 1990s, to below 18 percent since 2005. This suggests some improvement in industrial energy efficiency, but also mirrors the declining share of this sector in economic activity. The service sector now accounts for 80 percent of value added, the share of goods-producing industries having declined from 21 to 20 percent since 2000.275 In fact, energy consumption of the US industrial sector has declined 15 percent from a peak in 2000.

Of the 42 percent of energy not consumed in transport or industry, nearly three-fourths is consumed by the commercial and residential sectors. Most of this is devoted to the heating, cooling and lighting of buildings.276 Commercial and residential building space is likely to grow with the population and output of the service sector. In fact, in the residential sector the trend of recent years has been for housing area to increase faster than population, as people demand larger homes. [277] Improving the energy efficiency of the existing and future building stock and better use of building space are seen as key strategies to curb the growth of commercial and residential energy use.[278]

269 IMF (2008).
270 IEA (2008).
271 Energy intensity = energy input per unit of GDP output.
272 APERC estimates based on IMF (2008) and IEA (2008).
273 APERC estimates based on IEA (2008) and BTS (2008B).
274 BTS (2008A).
275 BEA (2008).
276 APERC calculations based on IEA (2008).
277 EIA (2005).
278 ARB (2008); DOE (2008B).

Figure US1: GDP and population



Source: APERC analysis

The US population is expected to increase due to natural growth and immigration.[279] This review adopts the estimates published by the United Nations population forecast, which give an average annual growth rate for the US population over the forecast period of 0.75 percent.[280] At this rate, the population will increase by 20 percent to reach 359 million by 2030. Thus, the US faces the challenge of supplying the considerable appetite for energy services of a population that will be much larger in 2030.

In 2008, the US entered a severe economic recession. Energy prices, which had reached historic highs in mid-2008, have since plummeted.[281] When growth will return and what form it will take are open questions. The current administration has called for the creation of a "clean energy economy" and has greatly increased funding of federal renewable energy and energy efficiency programmes.[282] An abundance of energy resources, both conventional and new renewable energy (NRE), and a history of innovations in energy technology, allow for many ways in which the US energy picture may develop.

ENERGY RESOURCES

Today, fossil fuels dominate the US primary energy mix, but NRE resources are growing fastest. Long-lived assets, such as large central power stations, and inexpensive fossil fuels operate to preserve the status quo. At the same time, clean technology ventures combine with environmental and energy security concerns to exert pressure for change.

Consistent with the economy's large motor vehicle energy demand, oil and oil products supply the largest share of US energy. Coal, nearly all of which is used to produce electricity, is second, at 24 percent. The economy's reliance on natural gas for a diverse set of uses – including electricity generation (one-third), heating and cooking in homes and commercial buildings (one-third), industrial processes (one-fifth) – is also substantial at 22 percent.[283]

The US has an immense fossil energy production system. In 2006, more than 700,000 oil and gas wells produced 1,862 million barrels of liquids and 524 billion cubic metres (bcm) of gas.[284] Though domestic oil production has declined nearly 50 percent from its peak in 1970, the US remains the world's third largest oil producer. The largest domestic fossil fuel resource, both in terms of reserves and production, is coal. The US produced 1,055 million metric tonnes of coal in 2006, making it the second largest producer in the world, behind China. In total domestic energy production, the US is also second only to China.[285]

Despite its rich energy resources, the US imports much of its energy requirements. Primary energy needs are largely met by net imports of oil (67 percent) and natural gas (16 percent).[286] The US imports oil from many countries. The three largest sources are Canada, Mexico and Saudi Arabia, which together supply about 40 percent of imports.[287] In contrast, almost all of US natural gas imports (86 percent) are delivered by pipeline from Canada. Most of the remaining gas imports arrive as LNG. The US now has nine LNG import terminals, with a combined capacity of roughly 100 million tonnes per year.[288]

Natural gas imports from Canada are expected to decline as Canada's domestic demand grows.[289] A major development in recent years has been the growing optimism that increased US domestic natural gas production could fill this gap.[290] High gas prices have driven intense development of unconventional gas resources. As a result, total domestic proved gas reserves increased from 5,000 bcm in 2000 to 6,700 bcm in 2007.[291]

Sustained high oil prices may slow or even reverse the decline of US domestic oil production.[292]

279 US Census (2008).
280 UN (2007).
281 EIA (2009C), EIA (2009I).
282 White House (2009B).
283 APERC calculations based on IEA (2008).
284 EIA (not dated).
285 Coal production from EIA (2008A). Rank based on IEA (2008).
286 APERC calculation based on IEA (2008).
287 EIA (2008C).
288 EIA (2009G) and EIA (2009H).
289 National Resources Canada (2008).
290 EIA (2009B).
291 EIA (2009F).
292 EIA (2009B).

However, the growth in vehicle fuel consumption is increasingly being met by expanded biofuels production. Current biofuels production is supplied almost exclusively by corn-ethanol distillers, but cellulosic feedstocks are expected to take over as technology becomes available.[293] The US capacity to sustainably supply biomass feedstocks for energy use is estimated to exceed 1 billion tonnes per year, which might displace 30 percent of current petroleum consumption.[294]

Wind and solar energy, like biofuels, have a large development potential and have experienced rapid growth in recent years. For several years, wind has been the second largest source of additions to the US electric generating capacity. In 2007, the 5,329 MW of new wind capacity represented 35 percent of total capacity additions.[295] Solar photovoltaics added 280 MW of new capacity in 2007 (the highest annual total to date), with grid-connected residential and commercial installations dominating this growth.[296] Together, liquid biofuels, wind, solar and geothermal took a 1.2 percent share of US primary energy in 2007, up from only 0.8 percent in 2000.[297]

The focus of much discussion in the electric power sector at the time of writing revolves around how to integrate greater shares of variable capacity (eg wind and solar power).[298] However, the current annual electricity generation of over 4.1 billion MWh is dominated by conventional sources. Coal provided almost half of 2008 electricity generation, and natural gas power plants – mostly combined-cycle – have provided by far the largest capacity addition over the past decade. The rapid increase in natural gas prices after 2000 temporarily slowed the growth of gas-fired generation, but it has since rebounded to provide more than 21 percent of 2008 generation.[299]

The US has the world's largest fleet of nuclear power plants, providing nearly 20 percent of electricity generation and 9 percent of the US primary energy supply. The last reactor to join the fleet was brought online in 1996, and no new reactors have been ordered since the 1970s. The high initial cost of nuclear plants, safety concerns, and the unresolved issue of waste disposal are the major obstacles to new reactors.[300]

ENERGY POLICIES

Since 2005, a number of important energy policies have been introduced at both the federal and state levels. At the federal level, the most important of these are the Energy Policy Act of 2005, the Energy Independence and Security Act of 2007 (EISA 2007), and the American Reinvestment and Recovery Act of 2009 (ARRA 2009). Much of the content in the Energy Policy Act of 2005 was superseded by EISA 2007 and/or ARRA 2009. At the state level, numerous energy policies have been adopted with varying degrees of stringency to reduce carbon dioxide emissions and promote renewable energy development.

The Energy Independence and Security Act of 2007 is a large package of energy policies with a broad scope, addressing everything from promotion of advanced vehicle technology to the installation of solar panels on specific government buildings. The policies and programmes in this package include funding for carbon capture and sequestration research and development, appliance efficiency standards, and support for international clean energy projects.[301] Two policies stand out for the clear and substantial impact they will have on US energy consumption—the corporate average fuel economy (CAFE) standards and the renewable fuels standard (RFS).

The updated CAFE standards require that passenger cars and trucks sold in the US meet higher fuel economy requirements in the years ahead. Specifically, the fleet of passenger vehicles sold in the US is required to achieve 35 miles per gallon (14.9 kilometres per litre) by 2020 and the "maximum feasible standard" thereafter. Given that the CAFE standard for 2006 was only about 26 miles per gallon, these new fuel economy standards represent a considerable improvement.[302] Recently, the White House requested that the agencies in charge of implementing this standard accelerate the compliance schedule with the goal of achieving the 2020 standard by 2016.[303]

The RFS requires set volumes of renewable vehicle fuels to be distributed each year, until 2022. The requirement for 2015 is 20.5 billion gallons and

293 DOE (2009B).

294 DOE (2005).

295 DOE (2008A).

296 EIA (2008B).

297 IEA (2008). By convention, the IEA uses a 100 percent transformation efficiency to represent the source energy of wind, hydro and solar electricity, but a 10 percent efficiency for geothermal. Other sources adopt a transformation efficiency for renewables similar to that of a conventional fossil fuel plant and tend to arrive at much larger values of source energy. In this report, we use the IEA method.

298 For example, NERC (2009) and Edison Institute (2008).

299 EIA (2009D).

300 CRS (2007).

301 US Congress (2007).

302 NHTSA (2008).

303 NHTSA (2009), EPA and NHTSA (2009).

for 2022, 36 billion gallons. In comparison, the 2006 volume of renewable fuels was about 4 billion gallons.[304] A variety of fuels derived from biomass are eligible, but in later years of the programme the lifecycle greenhouse gas emissions of additional fuels are required to be at least 50 percent lower than those of the gasoline or diesel that they replace.[305] Combined, the CAFE and RFS updates are perhaps the largest change in US transportation energy policy since CAFE standards were first introduced in 1978.

The recently enacted ARRA 2009 represents an unprecedented increase in the funding of federal energy efficiency and renewable energy programmes. ARRA 2009 is an US$800 billion package introduced by the administration to stimulate the flagging US economy. Concordant with the administration's policy of promoting a clean energy economy, the package includes major allocations to energy efficiency and renewable energy programmes.

One estimate has identified nearly $50 billion of funding for energy-related activities in the ARRA 2009.[306] Of this, US$16.8 billion is explicitly designated to support the activities of the federal Office of Energy Efficiency and Renewable Energy. These activities include research, development and deployment, support of state energy-efficiency programmes, and funding energy-saving upgrades of residential buildings.[307] To illustrate the scale of increase that this represents, the total 2009 budget request for the Office of Energy Efficiency and Renewable Energy submitted by the previous administration was just over US$1.2 billion.[308] In addition to direct allocations of federal funds, the legislation also extends influential tax credits that support energy-efficiency improvements and renewable energy production.[309]

Although the US did not ratify the Kyoto Protocol, many states have adopted legislation intended to limit greenhouse gas emissions. Twenty states, collectively home to nearly half the US population, have adopted greenhouse gas emission reduction targets, although the stringency of these varies considerably.[310]

Many states have also adopted policies to increase the share of renewable energy in the electricity generation mix. Twenty-nine states have adopted a mandatory renewable portfolio standard (RPS). Such policies require that a certain share of retail sales be provided by renewable generation by a specified year. The share and year varies by state, as do other provisions, such as eligible technologies and trading of renewable energy credits. For example, the Pennsylvania RPS requires 8 percent "Tier 1" renewables by 2020 and methane from coalmines is an eligible resource, where the California RPS aims at 33 percent renewables by 2020, with a more common definition of renewable energy.[311] While there is only limited experience to analyse, fulfilment of an RPS does appear to be stimulating renewable energy development.[312]

The sheer volume of energy-related policies introduced over the past several years is impressive. With a major energy bill to control greenhouse gas emissions now under consideration by Congress, there is a strong expectation of more to come.[313]

OUTLOOK

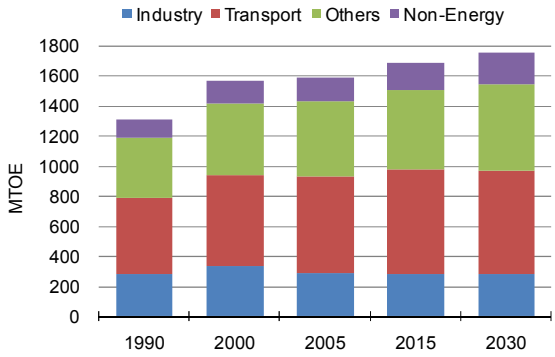
This business-as-usual outlook assumes that the US recession continues into 2010 and is followed by steady growth to 2030 at an average annual rate of 2.8 percent. US energy demand is forecast to increase by 13 percent from 2005 to 2030, which equates to a 38 percent reduction in energy intensity. With strong policy support, renewable energy sources are forecast to grow quickly and provide more than one-third of the additions to energy supply. The share of fossil fuels in the total energy supply correspondingly declines from 86 to 82 percent. The transportation sector and power sector are the key areas of change in this forecast.

FINAL ENERGY DEMAND

Oil consumption in the transportation sector, which from 1990 to 2005 increased by nearly 30 percent, is forecast to return to the 2000 level by 2030. There are three factors driving this tremendous change in course. First, oil prices are assumed to grow strongly after 2010, which dampens demand. Second, new CAFE standards are expected to result in considerable improvements to vehicle efficiency. And finally, liquid biofuels grow to take a 12 percent share in transportation energy. In this scenario, liquid biofuels contribute nearly half of the growth in final energy consumption. This outcome clearly illustrates the power that transportation energy polices have to impact the total energy outlook for the US.

304 EIA (2009A).
305 US Congress (2007).
306 Alliance to Save Energy (2009).
307 DOE (2009A).
308 DOE (2008C).
309 US Congress (2009).
310 Pew Center (2009).
311 NCSU (2007).
312 Wiser and Barbose (2008).
313 For example EPA (2009A).

Figure US2: Final energy demand



Source: APERC analysis (2009)

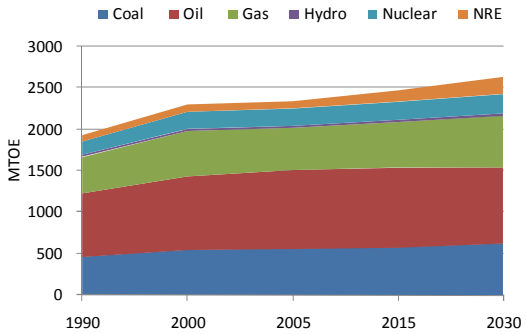
After biofuels, electricity experiences the most rapid growth in consumption. By 2030, electricity consumption is forecast to grow 35 percent over the 2005 level, primarily driven by the commercial and residential sectors. This outlook does not take into account the possible impact of the current administration's named goal of deploying one million plug-in hybrid vehicles by 2015, which would trade further increased electricity demand for reduced liquid fuels demand.[314] While the forecast growth in electricity consumption is substantial, it would be even larger without the existing state and federal efforts to promote energy efficiency that are included in this forecast.

Commercial and residential electricity consumption figures were adjusted downward to account for investments in energy efficiency that the federal government has begun to make as part of ARRA 2009. Although ARRA 2009 funds many programmes that may influence future energy supply and demand, only those programmes that directly promote energy efficiency and renewable energy are assessed in this review; accordingly, the benefits quantified here should not be construed as the full energy-related benefits of the Act. Based on the previous performance of the energy-efficiency programmes funded by the stimulus, the impact has been represented in this forecast as 7 Mtoe and 6 Mtoe reductions in electricity and natural gas consumption, respectively. These reductions are applied to residential/commercial consumption, prior to 2015.

PRIMARY ENERGY SUPPLY

Holding all other factors constant, the 2007 updates to the CAFE standards reduce the forecast increase in total energy demand from 20 percent to 13 percent. Similarly, favourable biofuels policies, notably the 2007 RFS, are forecast to reduce total demand for oil in 2030 by approximately 8 percent. The reduced oil demand of the transport sector, when combined with the modest increases in domestic oil production estimated to result from sustained high oil prices, leads to a 12 percent decrease in net oil imports.

Figure US3: Primary energy supply

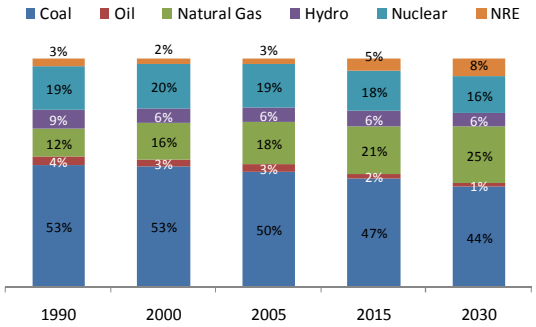


Source: APERC analysis (2009)

ELECTRICITY

To meet the additional electricity demand, US generation capacity is forecast to grow from just over 1 million MW in 2005 to 1.4 million MW in 2030.[315] The large existing capacity limits the extent of change in the generation mix. However, several strong and in many ways contradictory forces are at play in the power sector, which prevents easy assignment of shares of new capacity. In brief, the most important forces that are balanced in this forecast for the electricity sector are: state-level renewable portfolio standards, expectations relating to greenhouse gas regulation/legislation, and the relative costs of natural gas and coal generation.

Figure US4: Electricity generation mix



Source: APERC analysis (2009)

The forecast assumes that new renewable electricity generation capacity is driven by the state RPS mandates, with support from federal tax credits. Each state RPS was evaluated, and the stated target adjusted to account for factors that were judged to limit scope or stringency. Compliance with the resulting targets is forecast at 100 percent in light of

[314] White House (2009A).

[315] Figures given are nameplate capacity. Historical capacity data from EIA (2009E).

the favourable investment climate created by federal renewable energy tax credits and loan guarantees, which were most recently authorized by ARRA 2009.[316] Generation capacity of NRE (including new hydroelectric facilities) is forecast to reach 5.9 times the 2005 capacity by 2030.

After renewable energy mandates are fulfilled and existing generators utilized, there remains a 950 GWh deficit in 2030 that is filled by 260 GW of new fossil fuel and nuclear capacity. Though high cost and public opposition have imposed a long moratorium on new nuclear plant construction, capacity has grown through modifications made by existing operators. This "uprating" process is forecast to add 2 GW by 2030, net of capacity retirements. At the same time, concerns about global warming have stimulated interest in nuclear, and at present 19 proposed reactors are under review by the Nuclear Regulatory Commission.[317] Considerable uncertainty remains as to whether these proposed reactors, if approved, would actually move to construction.[318] In this forecast, 10 GW of new capacity is built by 2030, equivalent to seven new reactors.

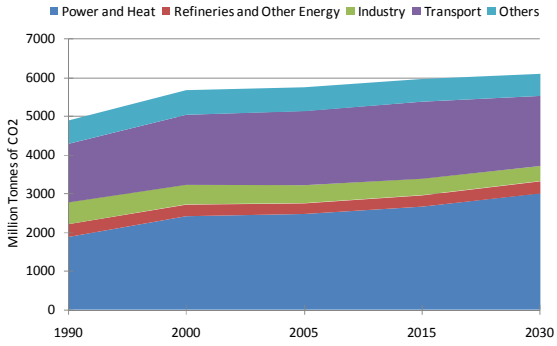
The uncertainty in the US power sector relating to carbon policy seems to have shifted from questioning whether a US carbon-limiting policy will be adopted, to how stringent a limit will be adopted. By 2008, major institutional lenders had committed to consider greenhouse gas emissions when deciding to loan to power plant developers, noting that, "…federal CO_2 control legislation… is likely to be adopted during the service life of many new power plants."[319] In 2009, responding to a Supreme Court order to re-evaluate a previous decision not to regulate greenhouse gases, the US Environmental Protection Agency (EPA) found that such gases pose a danger to public health and welfare.[320] This finding is likely to be challenged, but it suggests that if emissions limits are not soon addressed by Congress, then the EPA, a part of the administration, may regulate emissions based on pre-existing legislation.

The impact in this forecast of the increasing likelihood of a future cost associated with carbon emissions is that relatively low-emitting natural gas capacity is preferred over coal capacity, despite the high cost of natural gas. This forecast is consistent with recent activity in the power sector where carbon policy risk and high capital cost have contributed to the cancellation of many planned coal-fired power plants.[321] Also supporting this forecast is the much more optimistic outlook for domestic natural gas production supported by unconventional gas reserves. The result is that natural gas provides 46 percent of added power capacity where coal provides only 16 percent. However, given the higher utilization of the coal plants, coal provides 25 percent of added generation and natural gas 44 percent.

CO_2 EMISSIONS

Like the total US energy requirement, the economy's carbon intensity is forecast to decrease, but the absolute level of CO_2 emissions increases 5.9 percent. Emissions from bioenergy sources are not included in this forecast; therefore this figure does not represent the total growth in energy-related greenhouse gas emissions. [322] The unfavourable comparison between this substantial growth in CO_2 emissions and the emissions reductions targeted by many of the states may be interpreted as the difference between expressed goals and implemented regulations.

Figure US5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table US1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	-0.2%	-0.2%	-0.3%	-0.2%
Change in Energy Intensity of GDP	-1.6%	-1.3%	-2.3%	-1.9%
Change in GDP	3.0%	1.8%	2.8%	2.4%
Total Change	1.1%	0.4%	0.1%	0.2%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Recent national and state policies have dramatically changed the US energy outlook. Instead of continuing the rapid increase of recent years, oil consumption for transportation is projected to

316 Bolinger et al (2009).

317 Nuclear Regulatory Commission (2009).

318 CRS (2007).

319 Anon (2009).

320 EPA (2009B).

321 DOE (2009C).

322 See Farrell et al (2008).

decline due to increasing vehicle efficiency and substitution of biofuels. Moreover, electricity generated from renewables is expected to quadruple, spurred on by state requirements. In spite of these developments, significant economic and environmental challenges are found in this business-as-usual forecast. In this scenario, the US remains highly dependent on increasingly expensive oil and CO_2 emissions from fuel combustion grow to 6.1 billion tonnes in 2030.

Even with a reversal in growth of oil consumption, the oil price increase that is assumed in this forecast means the US will still spend nearly US$500 billion on net oil imports in 2030. This has two implications. First, the US would benefit from continuing to push CAFE standards higher beyond the immediate objectives; this will require research development and deployment of advanced vehicle technologies. Second, the US may also benefit from adopting less conventional approaches to transportation efficiency (such as transit-oriented development) that have recently been demonstrated in other APEC economies. The role of biofuels, already an important feature of the forecast, may also be increased. However, their potential economic and security benefits should be weighed against their greenhouse gas emissions, which were not estimated in this review.

Despite state and federal policies that promote investment in renewable power and energy efficiency, fossil fuels still dominate US electricity generation in 2030. CO_2 emissions from the power sector increase by 22 percent. In this scenario, final electricity demand increases by 35 percent, driving growth of both fossil and non-fossil generation. The implication is that to reduce the environmental impact of the power sector, incentives for renewables must be combined with aggressive and sustained strategies to reduce electricity demand growth, particularly in residential and commercial buildings. The recent federal stimulus is forecast to briefly increase electricity and natural gas savings, but without further investments economic growth will quickly overshadow those gains.

REFERENCES

Alliance to Save Energy (2009) "Energy Efficiency in the American Recovery and Reinvestment Act of 2009". Accessed (25 March) from http://ase.org/content/article/detail/5481

Anon (2009) "The Carbon Principles", http://carbonprinciples.org/index.php

ARB (2008) *Climate Change Scoping Plan*, California Air Resources Board. http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm

BEA (2008) "Value Added by Industry, Gross Output by Industry, Intermediate Inputs by Industry, the Components of Value Added by Industry, and Employment by Industry", US Bureau of Economic Analysis. http://www.bea.gov/industry/gdpbyind_data.htm

Bolinger, M et al (2009) *PTC, ITC, or Cash Grant? An Analysis of the Choice Facing Renewable Power Projects in the United States*. Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory. http://repositories.cdlib.org/lbnl/LBNL-1642E/

BTS (2008A) *National Transportation Statistics*, Table 1–37. Bureau of Transportation Statistics. http://www.bts.gov/publications/national_transportation_statistics/

BTS (2008B) *National Transportation Statistics*, Table 4–6. Bureau of Transportation Statistics. http://www.bts.gov/publications/national_transportation_statistics/

CRS (2007) *Nuclear Power: Outlook for New US Reactors*. Congressional Research Service. http://opencrs.com/document/RL33442

DOE (2005) *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*. US Department of Energy. http://www1.eere.energy.gov/biomass/publications.html

DOE (2008A) *Annual Report on US Wind Power Installation, Cost, and Performance Trends: 2007*. US Department of Energy. http://www1.eere.energy.gov/windandhydro/wind_pubs.html

DOE (2008B) "DOE to Pursue Zero-Net Energy Commercial Buildings", press release, 5 August 2008. US Department of Energy. http://www.energy.gov/6454.htm

DOE (2008C) *Fiscal Year 2009 Budget-in-Brief*. US Department of Energy. http://www1.eere.energy.gov/ba/pba/budget_09.html

DOE (2009A) "Economic Stimulus Act Provides $16.8 Billion for EERE Programs", press release: 18 February 2009. US Department of Energy. http://apps1.eere.energy.gov/news/archive.cfm/pubDate={d%20'2009-02-18'}

DOE (2009B) "Federal Biomass Policy". US Department of Energy. http://www1.eere.energy.gov/biomass/federal_biomass.html#alcoholfuels

DOE (2009C) "Tracking New Coal Fired Power Plants", presentation. US Department of Energy. Released: 5 January. http://www.netl.doe.gov/technologies/coalpower/refshelf.html

Edison Institute (2008) *Renewable Energy: Growth and Challenges in the Electric Power Industry*. Edison Electric Institute. http://www.eei.org/ourissues/ElectricityGeneration/Pages/default.aspx

EIA (2005) *Residential Energy Consumption Survey, 2005*. Energy Information Administration. http://www.eia.doe.gov/emeu/recs/

EIA (2008A) *Annual Coal Report*, Table 1. Energy Information Administration. http://www.eia.doe.gov/cneaf/coal/page/acr/acr_sum.html Ranking based on IEA (2008).

EIA (2008B) "Domestic Shipments of Photovoltaic Cells and Modules by Market Sector, End Use, and Type". Energy Information Administration. Released: October. http://www.eia.doe.gov/cneaf/solar.renewables/page/solarphotv/solarpv.html

EIA (2008C) "US Total Crude Oil and Products Imports". Energy Information Administration. Released 28 July. http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_a.htm

EIA (2009A) *Alternatives to Traditional Transportation Fuels, 2007*, Table C1. Energy Information Administration. http://www.eia.doe.gov/cneaf/alternate/page/atftables/afv_atf.html

EIA (2009B) *Annual Energy Outlook 2009*. Energy Information Administration. http://www.eia.doe.gov/oiaf/aeo/index.html

EIA (2009C) "Cushing, OK WTI Spot Price FOB (Dollars per Barrel)". Released 22 April. Energy Information Administration. http://tonto.eia.doe.gov/dnav/pet/hist/rwtcm.htm

EIA (2009D) *Electric Power Monthly*. Energy Information Administration. Released: 15 May. http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html

EIA (2009E) *Existing Nameplate and Net Summer Capacity by Energy Source and Producer Type (EIA-860)*. Energy Information Administration. Released: 29 January. http://www.eia.doe.gov/cneaf/electricity/epa/epat2p2.html.

EIA (2009F) *US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2007 Annual Report*. Energy Information Administration. http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/cr.html

EIA (2009G) *U.S. Natural Gas Imports and Exports: 2007*. Energy Information Administration. January 2009. http://tonto.eia.doe.gov/dnav/ng/ng_pub_analysis_move.asp

EIA (2009H) "US Natural Gas Imports by Country". Energy Information Administration. Released: 2 April. http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_a.htm

EIA (2009I) "US Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet)". Released 2 April. Energy Information Administration. http://tonto.eia.doe.gov/dnav/pet/hist/n9190us3m.htm

EIA (not dated) "Distribution and Production of Oil and Gas Wells by State". http://www.eia.doe.gov/pub/oil_gas/petrosystem/petrosysog.html

EPA (2009A) "EPA Proposes First National Reporting on Greenhouse Gas Emissions", press release: 10 March. US Environmental Protection Agency. http://yosemite.epa.gov/opa/admpress.nsf/d985312f6895893b852574ac005f1e40/4bd0e6c514ec1075852575750053e7c0!OpenDocument

EPA (2009B) Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act; Proposed Rule, EPA-HQ-OAR-2009-0171-0001. US Environmental Protection Agency. http://www.regulations.gov/search

EPA and NHTSA (2009) *Notice of Upcoming Joint* Rulemaking *to Establish Vehicle GHG Emissions and CAFE Standards*. US Environmental Protection Agency and National Highway Transportation and Safety Administration, US Department of Transportation. http://www.gpoaccess.gov/fr/

Farrell et al (2008) "Ethanol Can Contribute to Energy and Environmental Goals", *Science*, vol. 311, no. 5760 (for a discussion of greenhouse gas emissions from biofuels).

FHWA (2008*) Highway Statistics 2007*, table VM-1. Federal Highway Administration. http://www.fhwa.dot.gov/policyinformation/statistics/2007/

IEA (2008) *Energy Balances of OECD Countries*, 2008 edition. International Energy Agency. Viewed using "Beyond 2020" software.

IMF (2008) *World Economic Outlook*. International Monetary Fund. Online database: http://www.imf.org/external/ns/cs.aspx?id=28. October 2008.

National Resources Canada (2008) "Canadian Natural Gas, Review of 2007/08 & Outlook to 2020". http://rncan.gc.ca/eneene/sources/natnat/revrev-eng.php

NCSU (2007) *Database of State Incentives for Renewable Energy*. North Carolina State University. Accessed: 9 March 2009. http://www.dsireusa.org/

NERC (2009) *Accommodating High Levels of Variable Generation*. North American Electric Reliability Corporation. http://www.nerc.com/

NHTSA (2008) *Summary of Fuel Economy Performance*. National Highway Transportation and Safety Administration, US Department of Transportation. http://www.nhtsa.gov/portal/site/nhtsa/menuitem.43ac99aefa80569eea57529cdba046a0/

NHTSA (2009) *Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Year 2011*, NHTSA-2009-0062-0001. National Highway Transportation and Safety Administration, US Department of Transportation. http://www.regulations.gov/search

Nuclear Regulatory Commission (2009) "Combined License Applications for New Reactors". US Nuclear Regulatory Commission. Viewed: May 2009. http://www.nrc.gov/reactors/new-reactors/col.html

Pew Center (2009) "Greenhouse Gas Emissions Targets". Last updated: 27 February. http://www.pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm

UN (2007) *World Population Prospects, The 2006 Revision*. United Nations. http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm

US Census (2008) "Projections of the Population and Components of Change for the United States: 2010 to 2050". US Census Bureau. http://www.census.gov/population/www/projections/index.html

US Congress (2007) "Energy Independence and Security Act of 2007". *Public Law* 110-140. http://thomas.loc.gov/bss/d110/d110laws.html

US Congress (2009) "American Recovery and Reinvestment Act". *Public Law* 111-5. http://thomas.loc.gov/bss/d111/d111laws.html

White House (2009A) "President Obama Announces $2.4 Billion in Funding to Support Next Generation Electric Vehicles", press release: 19 March.

White House (2009B) "Weekly Address: President Barack Obama Discusses New White House Report on an American Recovery and Reinvestment Plan", press release: 24 January.

Wiser, R and Barnose G (2008) *Renewable Portfolio Standards in the United States – A Status Report with Data Through 2007*. Lawrence Berkeley National Laboratory. http://eetd.lbl.gov/ea/EMP/re-pubs.html

VIET NAM

- *Viet Nam's final energy demand is expected to grow at an average annual rate of 3.4 percent over the outlook period, from 45.2 Mtoe in 2005 to 104.0 Mtoe in 2030. The transport and industry sectors account for about 85 percent of this growth.*
- *Viet Nam is expected to become a net importer of energy after 2015 and the economy's energy import dependency is projected to reach 26 percent by 2030.*
- *CO_2 emissions from fuel combustion are projected to reach 312 million tonnes of CO_2 by 2030 – 385 percent higher than 2005 levels.*

ECONOMY

Viet Nam is located in Southeast Asia. It shares borders with Cambodia and Lao PDR to the west, and China to the north, while to the east and south it borders the Gulf of Tonkin, the Eastern Sea and the Gulf of Thailand. Viet Nam's total land area is 331,111 square kilometres, spread out in an elongated S shape; this also gives it an extensive marine exclusive economic zone along its 3,260-kilometre coastline. Viet Nam lies in the tropical monsoon zone. The typical features of this zone include warmth, humidity and abundant seasonal rainfall. In the north, there are four seasons, while in the centre and the south it is hot all year round, with just two seasons, rainy and dry. In 2005, Viet Nam's population was 83 million.

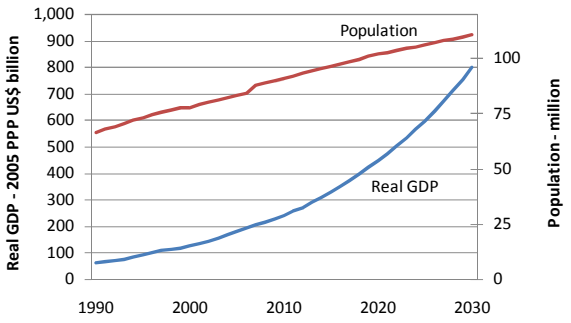
Market-oriented reforms since 1986 and rapid economic development have transformed the economy of Viet Nam over recent decades. The economic growth rate for the period 1990–2005 was an annual average of 7.6 percent, with GDP increasing from $60 billion (2005 US$ at PPP) in 1990 to $178.1 billion (2005 US$ at PPP) in 2005. In January 2007, Viet Nam joined the WTO, taking the organization's membership to 150.

Viet Nam experienced particularly high rates of economic growth in the 1990s (an annual average 8.3 percent) until the Asian economic crisis in 1997. Economic growth temporarily slowed to 5 percent in 1998 and 1999, and then gradually recovered to previous high levels, reaching 8.4 percent in 2005 and 8.2 percent in 2006. However, as for other ASEAN economies, Viet Nam's GDP growth slowed sharply to 6.2 percent in 2008 as a result of the global economic recession, and this trend is expected to continue, with 5 percent growth expected for 2009.

In 2005, Viet Nam had a GDP of US$178.1 billion, and an income per capita of US$2,143 (at 2005 US$ PPP). The government has set a target of GDP growth between 7.5 and 8.0 percent per year over the period 2006–2010.[323] The government also expects export growth to increase by 16 percent per year, total annual capital investment to the economy to reach around 40 percent of GDP, and population growth to be under 1.2 percent over the same period. This outlook, which takes into consideration the current global economic context and Viet Nam's future economic prospects, projects an average annual GDP growth rate of 6.2 percent over the outlook period, and population growth of 1.1 percent per year over the same period, with the total reaching 110 million people by 2030. The rate of urbanization growth is higher, at an average annual rate of 1.9 percent; this means 43 percent of the population is expected to be living in urban centres by 2030.

Viet Nam's economy is dependent on exports and on agriculture, including fisheries. Major export products include coal, crude oil, textiles, footwear, rice, and fish and agricultural products.[324] The sector making the highest contribution to GDP is industry.

Figure VN1: GDP and population



Source: APERC analysis (2009)

ENERGY RESOURCES

Viet Nam has diverse fossil energy resources, including oil, gas and coal, as well as renewable energy resources such as hydro, biomass, solar and geothermal. Natural gas and crude oil are found mainly offshore in the southern region, while coal reserves (mostly anthracite) are located in the north.

[323] MPI (2005).

[324] GSO (2007), p 453i.

Since 1990, Viet Nam has become a net energy exporter, with crude oil and coal as its main energy exports. However, after 2015 Viet Nam is expected to become a net importer of energy, as a result of its high energy demand growth and the limitations on available energy resources.

Over the period 1995–2005, oil production and exports have grown at an average annual rate of 8.4 percent. Viet Nam has eight oil-producing fields:[325] Bach Ho, Rong, Dai Hung, Rang Dong, Ruby, Emerald, Su Tu Den, and Bunga Kekwa. Most oil exploration and production activities occur off the southeast coast in the Cuu Long and Nam Con Son Basins. Before 2009, Viet Nam did not have its own refinery, so all crude oil production was exported and petroleum products were imported. However, since February 2009, a refinery with capacity of about 150,000 barrels per day has been in operation in Quang Nam province, providing around 6.5 million tonnes of petroleum products annually for domestic consumption.[326] Petroleum product demand in Viet Nam in 2025 is forecast to be three times greater than the current level, and this demand will not be able to be met from domestic resources. In addition, the revenue from crude oil exports is diminishing, while the cost of energy imports is increasing. This means it is crucial for Viet Nam to utilize its indigenous resources as efficiently as possible and to minimize imports.

Viet Nam's gas reserves offer more promise. Gas resources are found in many parts of Viet Nam, with the largest found in offshore basins. As well as the large gas fields discovered in the Cuu Long and Nam Con Son basins, there is the Malay-Tho Chu basin offshore of the south-west region and the Song Hong Basin in the north. Cuu Long basin is one of the developed natural gas production areas, with most of its gas production in association with crude oil production.[327]

Natural gas demand in Viet Nam, especially for electricity generation, has increased rapidly since 1995, and it is expected to continue to rise over the outlook period. At the same time, the current proved reserve is not very large compared with the reserves estimated in neighbouring economies, and local oil and gas experts report that their studies show a big gas discovery is unlikely. As a result, natural gas imports are expected to be required after 2020.

Viet Nam has two large coalfields located in the north, in Quang Ninh Province and Red River Delta. As at the end of 2006, coal reserves excluding peat in Viet Nam were estimated at 5,833 million tonnes. Of this geological reserve, 71.2 percent is anthracite, and is deposited in Quang Ninh Province. The remainder is sub-bituminous coal deposits of 1,580 million tonnes (27.1 percent) in the Khoai Chau region of the Red River Delta, and 96 million tonnes (1.7 percent) of fat coal deposits (used for making coke).[328] The coal reserve–production ratio (R/P), calculated as the geological reserves divided by production in 2006, is approximately 145 years. Viet Nam's coal production increased steadily from 4.6 million tonnes in 1990 to 30.8 million tonnes in 2005. This increase in coal production has resulted in growth in exports and domestic demand. In 2005, Viet Nam exported 14.7 million tonnes of coal, a record amount, and exports made up nearly 50 percent of the coal industry's sales that year. Export destinations included China, Japan, Korea, Chinese Taipei, Thailand and France.

Coal production changes in the outlook period include a shift from open cut mining to underground mining, as the producing coal seams in the Quang Ninh mines get deeper; this is expected to occur around 2010. In addition, commercial development of the sub-bituminous coal of the Red River Delta is scheduled to begin after 2015.

The government's projections for coal exports show they are expected to decrease to 8 million tonnes in 2010 from 11 million tonnes in 2006.[329] This document set out that, as domestic coal production steadily grows to 65.0–67.5 Mt by 2025, it will adequately satisfy the aggregate demand by electricity plants and general users, leaving sufficient capacity to direct high quality coal for export.

The rapid expansion of Viet Nam's economy between 1995 and 2005 has meant electricity demand has increased dramatically in the same period. The average annual rate of growth between 1990 and 2005 was 13 percent: the 2005 electricity demand of 53,463 GWh was over six times greater than the 1990 figure of 8,681 GWh. Peak demand more than tripled during this period, rising to 9,900 MW compared to 3,200 MW. The potential peak demand was even higher than reported, as power shortages led to load shedding and cuts in electricity supply during peak hours.

Viet Nam's electricity industry has made significant changes to try to meet the rapidly growing demand. It has expanded and improved the electricity system through power resource development,

325 MOIT – Petrovietnam (2006).

326 Vietnam News (2009).

327 MOIT – Petrovietnam (2006).

328 MOIT – Vinacomin (2006).

329 MPI (2006).

enhancement of high voltage transmission lines connecting the northern, central and southern regions, and reduction of transmission and distribution losses (T&D). T&D losses were reduced sharply from 20 percent in 1995 to 11.6 percent in 2006.[330] Electricity of Vietnam (EVN), the vertically integrated power utility in charge of development, management and operation of the state's electric power industry assets, was responsible for much of this, supplemented by Build–Operation–Transfer (BOT) and Independent Power Producers (IPP) schemes run in partnership with private investors. In 2006, 24.4 percent (14,994 GWh) of the electricity supply system in Viet Nam was owned by companies other than EVN.

There is a relatively limited choice of energy sources in Viet Nam. The construction of new nuclear, hydro and renewable electricity plants is constrained by availability of resources and construction sites. As a result, the relatively more flexible resources of coal and natural gas make up the majority of the electricity generation mix throughout the outlook period – accounting for more than 50 percent of generation between them. Nuclear power plants are scheduled to start operating from 2020. In 2025, the sources for electricity generation in Viet Nam are expected to be, in descending order, natural gas, domestic coal, hydro, imported coal, imported electricity, nuclear, renewable energy and fuel oil.[331]

Aggressive development of hydro and nuclear power plants to meet the demand growth will increase the electricity supply seven fold by 2025. However, the limits to hydro development, and the long lead time required for nuclear plant construction, mobilization of technology and funding, mean the majority of the electricity demand increase in the outlook period will be supplied by thermal generation, based on coal and natural gas.

ENERGY POLICIES

The key points of "Viet Nam's National Energy Development Strategies" include:[332]

- Diversified and effective exploitation of domestic natural resources, in combination with a reasonable import–export balance, with gradual reduction of primary energy exports, conserving fuels and ensuring energy security for the future.
- Development of energy in line with natural resource protection and environmental protection, ensuring sustainable development of the energy sector.
- Increasing the share of rural households using commercial energy to 50 percent by 2010 and 80 percent by 2020. By 2010, 95 percent of rural households will have access to electricity.
- Increasing the 3 percent renewable energy share of total commercial primary energy to 5 percent by 2025 and 11 percent by 2050.
- Reducing dependence on energy imports.
- Nuclear power development plan.
- Enhancing international cooperation in the energy arena.

The development of nuclear power has been actively pursued in Viet Nam since the mid 1990s. It formed an important part of the National Energy Research Program for 1995–2000, run by a group of organizations including the Institute of Energy (IE), Ministry of Industry and Trade (MOIT), Atomic Energy Research Institutes, and the Ministry of Science and Technology (MOST), with the assistance of foreign companies and the governments of Japan, France, Korea, Canada, and Russia. Through this programme, a number of engineers, researchers and policymakers from Viet Nam have engaged in study and offshore training in various areas related to nuclear power. The research programme results concluded nuclear power needed to be included as a key item in the economy's energy policy development in coming years. Since then, the government has begun to develop a legal and policy framework, and technical and human infrastructure, to facilitate the development of nuclear power, including the Atomic Energy Law (2008),[333] the "Strategy for utilization of atomic energy for peace in Viet Nam",[334] and a pre-feasibility study and a human resource development programme for the first nuclear power plant.[335]

These preparations have laid the groundwork for the first unit of Viet Nam's first nuclear power plant beginning operation in 2020. The share of nuclear power in the economy's energy mix is then expected to increase gradually, to reach 20–30 percent of the total electricity production by 2050.

The government has recognized the need to improve energy efficiency in parallel with its efforts to develop energy resources. In 2006, the Ministry of Industry and Trade (MOIT) launched the National Energy Efficiency Program for the period 2006–2015, which is the most comprehensive and effective

330 MOIT et al (2006).

331 MOIT and JICA (2008).

332 The Prime Minister of Viet Nam (2007).

333 Government of Viet Nam (2008).

334 MOST (2006).

335 MOIT and IE (2005), and MOIT and IE (2006).

of a variety of initiatives undertaken in this area since 1995.[336] This sets targets to reduce the economy's total energy consumption by 3–5 percent a year during 2006–2010, rising to 5–8 percent a year during 2011–2015 (compared to 'business as usual' levels). A State Steering Committee (chaired by MOIT) was established a year later, to oversee the implementation and monitoring of the programme, along with the Energy Efficiency and Conservation Office,[337] which has the role of coordinating the contribution of other governmental organizations.

Work to enhance international cooperation in the energy field has included numerous agreements and projects that have been established and implemented within a framework of cooperation at regional level. These include the ASEAN Power Grid, Trans ASEAN Gas Pipeline, and Regional Power Trade in the Greater Mekong Subregion. Viet Nam also has bilateral agreements on energy trade with neighbouring countries. In 2000, the governments of Viet Nam and Lao PDR signed an energy cooperation accord. Under this accord[338], Viet Nam will import about 2,000 MW of electricity from Lao PDR. The governments of Viet Nam and Cambodia have also signed an energy cooperation agreement[339], under which Viet Nam supplied 80–200 MW of electricity to Cambodia via a 220 KV transmission line between 2007 and 2008. In the future, when Cambodia builds hydro power plants and starts participating in the regional electricity market, Viet Nam will in turn buy electricity from Cambodia. Since 2006, Viet Nam has bought around 0.4 billion KWh of electricity from China per year, and this will increase in 2020 when a 500 KV line between the two economies will be complete. Similar cooperative activities are underway in the coal, oil and gas sectors.

OUTLOOK

FINAL ENERGY DEMAND

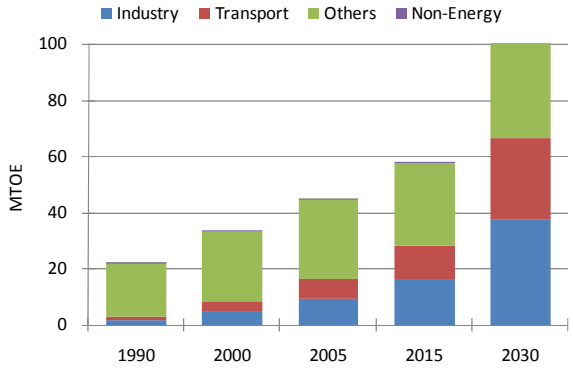
This outlook incorporates new assumptions about economic growth rates, based on the current global economic situation; this means it has lower forecasts for energy demand growth than the existing studies.

Based on our assumptions of 'business as usual' under the changed economic conditions, this projection forecasts a total final energy demand for Viet Nam that continues to rise at an average annual rate of about 3.4 percent over the outlook period. This is less than the projected GDP growth for the economy. As a result, the total final energy demand in 2030 will reach 104.0 Mtoe, which is a more than two-fold increase on 2005 levels. Energy consumption will increase in every sector of the economy, including the residential and commercial sectors, which are influenced by growing modernization within Viet Nam. The strongest growth, however, is in the industry and transport sectors.

The use of non-commercial energy (mostly biomass such as firewood) is expected to decrease during the outlook period, because of increasing urbanization, and in turn the demand for LPG and electricity will increase. In the transport sector, diesel oil fuel demand will increase rather rapidly, reflecting the high demand for personal car use, and road transport of freight.

By the end of the outlook period, oil products are expected to represent the largest share of the final energy demand (53 percent), followed by electricity (19 percent) and coal (12 percent). Between 2005 and 2030, consumption of electricity is projected to grow the fastest, at an average annual rate of 6.7 percent.

Figure VN2: Final energy demand



Source: APERC analysis (2009)

Industry

Industry is the sector that will consume the most energy in Viet Nam by the end of the outlook period, accounting for 35.8 percent of the total final energy consumption in 2030; this is higher than its 20 percent share in 2005.

Transport

The share of the final energy demand taken up by transport is expected to increase over the outlook period, from 15.7 percent in 2005 to 28.0 percent in 2030. It will increase at an annual average rate of 5.8 percent over this period. The main transport fuels are oil products (diesel, gasoline and fuel oil). Road

336 The Prime Minister of Viet Nam (2006).

337 Ibid.

338 APERC (2009), p 178.

339 Ibid.

transportation makes up about 80 percent of total transport energy consumption, while the remaining 20 percent is used in water-based, rail and air transportation.

Other

The energy used in the 'other' sector (which includes the residential and commerce subsectors) is expected to increase from 28.6 Mtoe in 2005 to 36.7 Mtoe in 2030, rising at an average annual rate of 1 percent.

PRIMARY ENERGY SUPPLY

Viet Nam's primary energy supply is projected to increase by 256 percent over the outlook period, from 51.3 Mtoe in 2005 to about 131.5 Mtoe in 2030. This is based on an average annual increase of 3.8 percent. The proportion of non-commercial energy sources (biomass such as firewood) in the mix will decrease gradually: in 2005 they made up 47 percent of the primary energy supply while in 2030 they will provide just over 14 percent, as rising household incomes and the shift to urban centres prompts a shift to commercial energy sources.

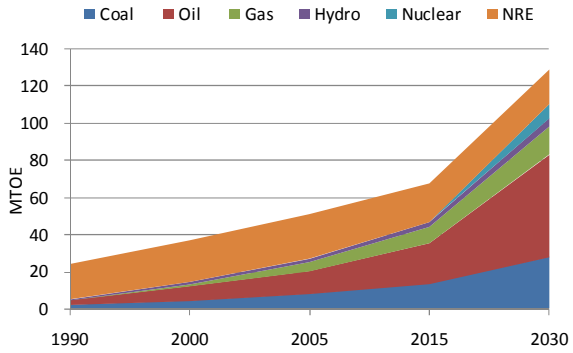
On top of the successful start of production at the economy's first oil refinery in early 2009, a second refinery with the same capacity is expected to be in action by 2015. This outlook also assumes a third refinery, with a 150,000 barrel/day capacity, will start operation after 2020. In the final decade of the outlook period, 20–25 million tonnes of domestic petroleum products from new refineries should be reaching the market, which will significantly contribute to the reduction of petroleum product imports to Viet Nam.

Oil will account for the largest share of the total primary energy supply by 2015. It is mainly utilized in the transportation and industrial sectors. In 2005, Viet Nam was an exporter of crude oil, but a net importer of oil products. As oil reserves decline over the outlook period, Viet Nam's oil import dependence is expected to increase to 57 percent in 2030.

Coal and natural gas demand growth will be driven mainly by the rapid development of the electricity and industrial sectors, accounting for 21 percent (coal) and 11 percent (gas) in 2030. Throughout the outlook period, coal and natural gas demand is expected to be met through indigenous supply.

Electricity imports are expected to increase from 2015 and will account for 2 percent of the primary energy supply by 2030.

Figure VN3: Primary energy supply



Source: APERC analysis (2009)

Excluding large-scale hydro, other types of new renewable energy (NRE) such as mini-hydro, wind, biomass, geothermal, and municipal solid waste landfill gas, will continue to be promoted. Together they will contribute 14 percent of the primary energy supply in 2030. Nuclear power – after it comes online in 2020 – is expected to provide 6 percent of the total primary energy supply in 2030.

ELECTRICITY

As mentioned above, APERC's analysis differs from the conventional view (as reflected in the government's "Master Plan on Power Development (PDP6)" [340] and "The Study on National Energy Master Plan in Viet Nam"[341]).

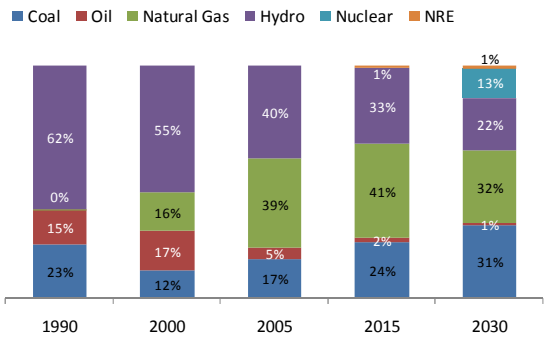
The current high electricity elasticity to GDP (1.9 in 2005) is expected to have dropped to 1.1 by 2030. The electricity demand forecast in PDP6 is substantially higher than our outlook, and this may have been prompted by high economic growth scenarios and electricity elasticity to GDP at the time PDP6 was prepared. The slower electricity demand growth in this outlook explains differences between this analysis (which has Viet Nam remaining a net coal exporter throughout the forecast period), and the government's earlier projections.

Plans for a nuclear power plant with 2,000–4,000 MW capacity in Ninh Thuan province, in central Viet Nam, are in development at the time of writing, with a pre-feasibility study under consideration by the government. The benefits to the economy of the development of nuclear power include diversification of energy sources, improvement of energy security, reduction of environmental effects associated with other generation technologies, and development of Viet Nam's science and technology capacity.

[340] MOIT et al (2006).

[341] MOIT and JICA (2008)

Figure VN4: Electricity generation mix



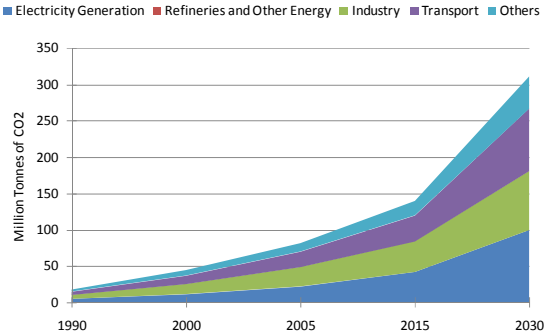
Source: APERC analysis (2009)

Electricity generation is projected to increase at an average annual rate of 6.1 percent, reaching 235 TWh in 2030. Over the outlook period, the hydro share of electricity production will decrease considerably, from 40 percent to 22 percent, as most possible locations for hydro become fully developed. By contrast, coal-fired electricity generation will gradually increase, and will take the biggest share in 2030, at 31 percent. The share provided by gas-fired plants is projected to increase in the near term; however, with the introduction of nuclear power after 2020, this share is expected to decrease to 32 percent by 2030. Meanwhile, the nuclear share will increase from 0 percent in 2005 to 13 percent in 2030. In addition, as the government continues to pursue its goal of increasing use of domestic resources, new renewable energy sources (NRE) are expected to contribute to electricity generation – especially in remote areas where connection with the grid is not economically feasible – increasing from 0 percent in 2005 to 1.3 percent in 2030.

CO_2 EMISSIONS

Viet Nam is currently one of the lowest per capita CO_2 emitters in APEC; 2005 levels were 1 tonne of CO_2 per person. CO_2 emissions from fuel combustion are projected to grow at an average annual rate of 6 percent over the outlook period, reaching about 312 million tonnes of CO_2 in 2030. Emissions are expected to increase rapidly as Viet Nam industrializes and the economy utilizes more carbon-intensive energy sources, instead of traditional energy sources including biomass. The decomposition analysis shown in this table suggests that the growth in Viet Nam's CO_2 emissions from fuel combustion is largely the result of economic growth.

Figure VN5: CO_2 emissions by sector



Source: APERC analysis (2009)

Table VN1: Analysis of reasons for change in CO_2 emissions from fuel combustion

(Average Annual Percent Change)

	1990-2005	2005-2015	2015-2030	2005-2030
Change in CO_2 Intensity of Energy	5.5%	2.5%	1.0%	1.6%
Change in Energy Intensity of GDP	-2.3%	-3.1%	-1.6%	-2.2%
Change in GDP	7.6%	6.2%	6.2%	6.2%
Total Change	10.9%	5.6%	5.5%	5.5%

Source: APERC analysis (2009)

CHALLENGES AND IMPLICATIONS

Viet Nam's indigenous energy resources have been developed primarily as a (significant) source of revenue to support economic development. However, given that Viet Nam is expected to shift from being a net exporter of energy to a net importer after 2015, it is imperative to optimize the balance between maintaining high economic growth and ensuring long-term energy security. In the interests of improving energy security, there may be an option of starting energy imports earlier than strictly required, while maintaining some reserves to support the development of domestic energy resources. In addition, the development of energy infrastructure needs to be considered alongside the issues of balancing energy demand and supply – development of the transport systems and ports that will be capable of receiving all the expected import energy types (oil, gas, coal) will require major funding and long-term construction commitments.

Viet Nam has set itself targets for the development of renewable energy resources. However, it appears the activities that agencies have begun in this area, such as establishing energy consulting centres focusing on renewable energy, are still in the study stages. In order to achieve the set targets for increasing the renewable energy share of the economy's commercial energy mix, Viet Nam needs to do a lot more to actively reduce and eliminate barriers to its development.

REFERENCES

APERC (2006) APEC Energy Overview 2005. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

APERC (2009) *APEC Energy Overview 2008*. Asia Pacific Energy Research Centre, Tokyo, Japan. www.ieej.or.jp/aperc

Government of Viet Nam (2008) *The Atomic Energy Law*.

GSO (2007) *Statistical Yearbook of Vietnam*. General Statistics Office of Vietnam, www.gso.gov.vn

MOIT and IE (2005) "The Pre-Feasibility Study on 1st Nuclear Power Plant in Vietnam". Ministry of Industry and Trade, and Institute of Energy, Viet Nam.

MOIT and IE (2006) "Human Resource Development Program for the 1st Nuclear Power Plant in Vietnam". Ministry of Industry and Trade, and Institute of Energy, Viet Nam.

MOIT, JICA and IE (2006) "Master Plan on Power Development (PDP6)". Ministry of Industry and Trade, Japan International Cooperation Agency, and Institute of Energy, Viet Nam.

MOIT and JICA (2008) "The Study on National Energy Master Plan in Vietnam". Ministry of Industry and Trade, and Japan International Cooperation Agency, Viet Nam.

MOIT – Petrovietnam (2006) "Master Plan on Vietnam Oil and Gas Sector 2006–2025". Ministry of Industry and Trade, Viet Nam.

MOIT – Vinacomin (2006) "Master Plan on Coal Development for Vietnam in Period 2006–2015 with expectation to 2025". Ministry of Industry and Trade, Viet Nam.

MOST (2006) "Strategy for utilization of atomic energy for peace in Viet Nam". Ministry of Science and Technology, Viet Nam.

MPI (2005) "Five-year Socio-economic Development Strategy: 2006–2010". Ministry of Planning and Investment, Viet Nam.

MPI (2006) "Commodity Export Plan in the period 2006–2010". Ministry of Planning and Investment, Viet Nam.

The Prime Minister of Viet Nam (2006) "Decision 79/2006/QD-TTG on approval of "National Energy Efficiency Program 2006–2015".

The Prime Minister of Viet Nam (2007) "Decision on National Energy Development Strategy of Vietnam for the Period up to 2020 with Outlook to 2050 (EDS)", December 2007.

Vietnam News (2009) "Partner sought first oil refinery", January 2009. http://vietnamnews.vnagency.com.vn/

APPENDIX

OUTLOOK RESULTS BY ECONOMY

OUTLOOK RESULTS BY ECONOMY

INTRODUCTION

This section provides a compilation of the outlook results by APEC member economy in table format. For each economy, the first page shows tables of macro economic assumptions, energy production, net imports, total primary energy supply, input for electricity and heat generation, and input for refineries and other energy sector. The second page shows total final energy demand, as well a final energy demand for each of the four sectors: industry, transportation, other, and non-energy. The third page shows electricity generation, installed generation capacity, measures of energy intensity, CO_2 emissions, and CO_2 emissions intensity. The fourth page shows a summary of the energy projections for the periods 2005, 2015, and 2030 in the form of an energy balance table (EBT) and energy investment requirements.

Note that:

- Figures are rounded off and may not add up to 100 percent.
- Data values that are very small are shown as blanks.
- Inputs to Power and Heat Generation, Petroleum Refineries, and Other Energy Sector are shown with negative signs.
- The following identity holds for coal, oil, gas, and NRE:

  Primary Energy Supply + Input for Electricity and Heat Generation (negative)
  + Input for Refineries and Other Energy Sector (negative)
  + Transfers and Statistical Differences (2005 only; 'oil' includes both crude oil and petroleum products)
  = Final Demand.

TERMINOLOGY

- "Coal" includes all coals, both primary and derived fuels, and peat;
- "Crude Oil" includes crude oil, natural gas liquids, refinery feedstocks, as well as other liquid hydrocarbons;
- "Petroleum Products" includes refinery gas, ethane, LPG, and other petroleum products;
- "Gas" includes natural gas and gas works gas;
- "NRE" includes biomass, liquid biofuels, geothermal, wind, solar, industrial waste, municipal waste, and other new renewable energy;
- "Heat" includes only heat produced for sale;
- "Net Imports" is imports minus exports and international marine bunkers; for 2005, it also includes net stock draw-downs (which are assumed to be zero in 2015 and 2030);
- "Transfers and Statistical Differences": for 2005, this includes all otherwise unaccounted for differences between Total Primary Energy Supply and Total Final Energy Demand, and is assumed to be zero in 2015 and 2030.
- "Electricity and Heat Generation" includes inputs and outputs of all electricity generating plants, combined heat and power plants, and heat plants; heat output includes only heat for sale, not heat used within the producer's establishment.
- "Other Energy Sector" is energy used in the energy sector itself, including own-use in power plants, oil and gas extraction, and coal mining, as well as distribution and transmission losses for gas distribution and electricity transmission;
- "Industry" includes mining other than mining for coal and other fuels (which are included in "Other Energy Sector") and construction; energy used by industry for transport is included in "Transport";

- "Transport" includes all fuels used in transport except international marine bunkers; international aviation is included;
- "Other" includes residential, commercial, agriculture, forestry, fishing, and all other public services;
- "Non-Energy" includes fuels used as raw materials rather than consumed as fuels, such as petrochemical feedstocks.

HISTORICAL DATA SOURCES

Historical population figures are APERC estimates based on United Nations (2006) and World Bank (2008). Historical GDP figures are APERC estimates based on the EDMC (2008A), which were based primarily on the World Bank (2008). Historical energy statistics for 1990, 2000, and 2005 are primarily drawn from the International Energy Agency (2008A) and International Energy Agency (2008B), except for Papua New Guinea, which is based on EDMC (2008B). Historical installed generating capacities are APERC estimates based on economy government statistics and International Energy Agency (2008C).

CO_2 EMISSIONS

Historical CO_2 emissions from fuel combustion for 1990 and 2000 are based on International Energy Agency (2008D). CO_2 emissions for 2005, 2015, and 2030 are modelled based on multiplying the consumption of each fuel by appropriate emission factors. The modelling approach is not compliant with IPCC Guidelines for National Greenhouse Gas Inventories.[342] It does, however, replicate fairly closely the historical data for 2005 in International Energy Agency (2008D). In order to achieve a closer match with International Energy Agency (2008D), emissions from transportation exclude international aviation.

REFERENCES

EDMC (2008A) *EDMC Handbook of Energy & Economic Statistics in Japan*, The Energy Data and Modelling Center, The Institute of Energy Economics, Tokyo, Japan. http://www.ieej.or.jp/edmc/public/publication-e.html.

EDMC (2008B) *Expert Group on Energy Data Analysis Database,* The Energy Data and Modelling Center, The Institute of Energy Economics, Tokyo, Japan. http://www.ieej.or.jp/egeda/

International Energy Agency (2008A) *Energy Balances of OECD Countries, 2008 Edition*, CD-ROM. http://www.iea.org/Textbase/stats/prodresult.asp?PRODUCT=Balances

International Energy Agency (2008B) *Energy Balances of Non-OECD Countries, 2008 Edition*, CD-ROM. http://www.iea.org/Textbase/stats/prodresult.asp?PRODUCT=Balances

International Energy Agency (2008C) *Electricity Information, 2008 Edition.* http://www.iea.org/Textbase/stats/prodresult.asp?PRODUCT=Electricity/Heat

International Energy Agency (2008D) *CO_2 Emissions from Fossil Fuel Combustion, 2008 Edition.* http://www.iea.org/textbase/publications/index.asp

IPPC (1996) "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" web page of the Intergovernmental Panel on Climate Change website, http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

United Nations (2006) *World Population Prospects: The 2006 Revision.* http://www.un.org/esa/population/publications/wpp2006/wpp2006.htm

World Bank (2008) *World Development Indicators.* http://www.worldbank.org/

[342] See IPCC (1996).

APEC

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	18 701	25 975	30 931	43 441	72 500	3.3	3.6	3.5	3.5	3.5
Population (million)	2 286	2 545	2 644	2 822	3 005	1.1	0.8	0.7	0.4	0.5
GDP per Capita (2005 US$ PPP per capita)	8 181	10 205	11 699	15 394	24 125	2.2	2.8	2.8	3.0	2.9

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**4,884.9**	**5,182.6**	**6,125.4**	**7,317.0**	**8,645.4**	**0.6**	**3.4**	**1.8**	**1.1**	**1.4**
Coal	1 418.4	1 580.3	2 226.6	2 846.9	3 338.5	1.1	7.1	2.5	1.1	1.6
	(29%)	(30%)	(36%)	(39%)	(39%)					
Oil	1 508.4	1 338.8	1 485.3	1 507.5	1 628.6	- 1.2	2.1	0.1	0.5	0.4
	(31%)	(26%)	(24%)	(21%)	(19%)					
Gas	1 156.0	1 290.6	1 372.0	1 680.9	1 912.2	1.1	1.2	2.1	0.9	1.3
	(24%)	(25%)	(22%)	(23%)	(22%)					
Hydro	92.3	107.6	125.3	165.8	191.2	1.5	3.1	2.8	1.0	1.7
	(2%)	(2%)	(2%)	(2%)	(2%)					
NRE	423.9	475.2	496.9	583.8	752.9	1.1	0.9	1.6	1.7	1.7
	(9%)	(9%)	(8%)	(8%)	(9%)					
Nuclear	285.9	390.1	419.3	532.2	822.0	3.2	1.4	2.4	2.9	2.7
	(6%)	(8%)	(7%)	(7%)	(10%)					
Net Import	**73.9**	**607.6**	**553.4**	**668.2**	**1,077.6**	**23.4**	**- 1.9**	**1.9**	**3.2**	**2.7**
Coal	- 51.6	- 8.6	- 117.0	- 250.9	- 327.4	- 16.4		7.9	1.8	4.2
Oil	284.6	714.8	775.1	1 047.3	1 322.7	9.6	1.6	3.1	1.6	2.2
Gas	- 158.5	- 97.6	- 104.3	- 129.7	81.0	- 4.7	1.3	2.2		
Electricity	- 0.6	- 1.0	- 0.7	1.5	1.4	4.4	- 5.3		- 0.7	
Primary Energy Supply	**4,958.9**	**5,790.2**	**6,678.8**	**7,985.3**	**9,722.9**	**1.6**	**2.9**	**1.8**	**1.3**	**1.5**
Coal	1 366.8	1 571.8	2 109.6	2 596.0	3 011.0	1.4	6.1	2.1	0.99	1.4
	(28%)	(27%)	(32%)	(33%)	(31%)					
Oil	1 793.0	2 053.6	2 260.4	2 543.6	2 927.0	1.4	1.9	1.2	0.9	1.0
	(36%)	(35%)	(34%)	(32%)	(30%)					
Gas	997.5	1 193.0	1 267.7	1 551.2	1 993.1	1.8	1.2	2.0	1.7	1.8
	(20%)	(21%)	(19%)	(19%)	(20%)					
Hydro	92.3	107.6	125.3	165.8	191.2	1.5	3.1	2.8	1.0	1.7
	(2%)	(2%)	(2%)	(2%)	(2%)					
NRE	423.9	475.1	497.1	595.0	777.2	1.1	0.9	1.8	1.8	1.8
	(9%)	(8%)	(7%)	(7%)	(8%)					
Nuclear	285.9	390.1	419.3	532.3	822.0	3.2	1.4	2.4	2.9	2.7
	(6%)	(7%)	(6%)	(7%)	(8%)					
Input for Electricity and Heat Generation	**-1,780.2**	**-2,256.0**	**-2,712.5**	**-3,383.2**	**-4,446.1**	**2.4**	**3.8**	**2.2**	**1.8**	**2.0**
Coal	- 751.6	-1 088.8	-1 431.3	-1 796.4	-2 203.9	3.8	5.6	2.3	1.4	1.7
	(42%)	(48%)	(53%)	(53%)	(50%)					
Oil	- 205.0	- 155.1	- 143.8	- 97.9	- 91.0	- 2.7	- 1.5	- 3.8	- 0.5	- 1.8
	(12%)	(7%)	(5%)	(3%)	(2%)					
Gas	- 370.1	- 442.3	- 518.5	- 664.2	- 919.1	1.8	3.2	2.5	2.2	2.3
	(21%)	(20%)	(19%)	(20%)	(21%)					
Hydro	- 92.3	- 107.6	- 125.3	- 165.8	- 191.2	1.5	3.1	2.8	1.0	1.7
	(5%)	(5%)	(5%)	(5%)	(4%)					
NRE	- 75.3	- 72.0	- 74.3	- 126.7	- 219.0	- 0.4	0.6	5.5	3.7	4.4
	(4%)	(3%)	(3%)	(4%)	(5%)					
Nuclear	- 285.9	- 390.1	- 419.3	- 532.3	- 822.0	3.2	1.4	2.4	2.9	2.7
	(16%)	(17%)	(15%)	(16%)	(18%)					
Input for Refineries and Other Energy Sector	**-518.6**	**-549.0**	**-665.3**	**-813.2**	**-983.4**	**0.6**	**3.9**	**2.0**	**1.3**	**1.6**
Coal	- 118.3	- 120.4	- 174.5	- 213.8	- 240.3	0.2	7.7	2.05	0.8	1.3
Oil	- 162.4	- 144.3	- 162.9	- 201.4	- 244.7	- 1.2	2.5	2.1	1.3	1.6
Gas	- 97.4	- 114.7	- 119.3	- 160.7	- 179.7	1.6	0.8	3.0	0.8	1.7
NRE	- 12.2	- 10.5	- 11.0	- 11.1	- 13.9	- 1.5	1.0	0.0	1.5	0.9
Electricity	- 104.7	- 129.1	- 154.9	- 191.4	- 258.6	2.1	3.7	2.1	2.0	2.1
Heat	- 23.5	- 30.0	- 42.7	- 34.9	- 46.1	2.5	7.3	- 2.0	1.9	0.3

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**3,517.3**	**3,993.3**	**4,470.7**	**5,254.8**	**6,248.0**	**1.3**	**2.3**	**1.6**	**1.2**	**1.3**
Coal	487.6	374.9	501.3	585.9	566.8	- 2.6	6.0	1.6	- 0.2	0.5
	(14%)	(9%)	(11%)	(11%)	(9%)					
Oil	1 432.9	1 753.7	1 947.9	2 244.3	2 591.3	2.0	2.1	1.4	1.0	1.1
	(41%)	(44%)	(44%)	(43%)	(41%)					
Gas	549.7	630.7	629.8	726.3	894.3	1.4	- 0.0	1.4	1.4	1.4
	(16%)	(16%)	(14%)	(14%)	(14%)					
NRE	336.5	392.8	411.8	457.2	544.3	1.6	0.9	1.1	1.2	1.1
	(10%)	(10%)	(9%)	(9%)	(9%)					
Electricity	491.6	669.0	807.0	1 042.0	1 413.8	3.1	3.8	2.6	2.1	2.3
	(14%)	(17%)	(18%)	(20%)	(23%)					
Heat	219.2	172.2	172.9	199.1	237.5	- 2.4	0.1	1.4	1.2	1.3
	(6%)	(4%)	(4%)	(4%)	(4%)					
Industry	**1,012.1**	**1,113.6**	**1,271.3**	**1,518.6**	**1,742.6**	**1.0**	**2.7**	**1.8**	**0.9**	**1.3**
Coal	290.1	284.3	395.0	476.2	469.7	- 0.2	6.8	1.9	- 0.1	0.7
	(29%)	(26%)	(31%)	(31%)	(27%)					
Oil	179.0	173.0	179.4	184.4	197.1	- 0.3	0.7	0.3	0.4	0.4
	(18%)	(16%)	(14%)	(12%)	(11%)					
Gas	185.5	227.0	214.9	255.4	306.6	2.0	- 1.1	1.7	1.2	1.4
	(18%)	(20%)	(17%)	(17%)	(18%)					
NRE	33.1	70.1	66.4	65.8	76.3	7.8	- 1.1	- 0.1	1.0	0.6
	(3%)	(6%)	(5%)	(4%)	(4%)					
Electricity	215.5	283.0	333.4	441.8	580.9	2.8	3.3	2.9	1.8	2.2
	(21%)	(25%)	(26%)	(29%)	(33%)					
Heat	109.0	76.2	82.2	95.0	112.0	- 3.5	1.5	1.5	1.1	1.2
	(11%)	(7%)	(6%)	(6%)	(6%)					
Transportation	**906.8**	**1,107.1**	**1,234.6**	**1,457.6**	**1,718.2**	**2.0**	**2.2**	**1.7**	**1.1**	**1.3**
Coal	10.0	5.6	4.2	3.7	3.7	- 5.7	- 5.6	- 1.1	0.0	- 0.5
	(1%)	(1%)	(0%)	(0%)	(0%)					
Oil	832.4	1 040.8	1 155.9	1 326.7	1 501.5	2.3	2.1	1.4	0.8	1.1
	(92%)	(94%)	(94%)	(91%)	(87%)					
Gas	52.5	48.0	54.0	57.2	61.7	- 0.9	2.4	0.6	0.5	0.5
	(6%)	(4%)	(4%)	(4%)	(4%)					
NRE		3.3	8.3	54.6	131.7		20.0	20.8	6.0	11.7
		(0%)	(1%)	(4%)	(8%)					
Electricity	11.9	9.4	12.3	15.4	19.5	- 2.3	5.4	2.3	1.6	1.9
	(1%)	(1%)	(1%)	(1%)	(1%)					
Other	**1,310.7**	**1,406.8**	**1,519.3**	**1,748.4**	**2,140.4**	**0.7**	**1.6**	**1.4**	**1.4**	**1.4**
Coal	167.5	74.8	78.4	80.6	79.6	- 7.7	0.9	0.3	- 0.1	0.1
	(13%)	(5%)	(5%)	(5%)	(4%)					
Oil	205.5	240.3	249.7	294.0	337.6	1.6	0.8	1.6	0.9	1.2
	(16%)	(17%)	(16%)	(17%)	(16%)					
Gas	260.0	299.7	302.2	348.2	447.9	1.4	0.2	1.4	1.7	1.6
	(20%)	(21%)	(20%)	(20%)	(21%)					
NRE	303.4	319.4	337.1	336.7	336.3	0.5	1.1	- 0.0	- 0.0	- 0.0
	(23%)	(23%)	(22%)	(19%)	(16%)					
Electricity	264.2	376.6	461.3	584.9	813.3	3.6	4.1	2.4	2.2	2.3
	(20%)	(27%)	(30%)	(33%)	(38%)					
Heat	110.2	96.0	90.7	104.0	125.5	- 1.4	- 1.1	1.4	1.3	1.3
	(8%)	(7%)	(6%)	(6%)	(6%)					
Non-Energy Use	**287.6**	**365.8**	**445.6**	**530.2**	**646.9**	**2.4**	**4.0**	**1.8**	**1.3**	**1.5**
Coal	20.0	10.2	23.8	25.3	13.8	- 6.5	18.3	0.6	- 4.0	- 2.1
	(7%)	(3%)	(5%)	(5%)	(2%)					
Oil	216.0	299.6	362.9	439.3	555.0	3.3	3.9	1.9	1.6	1.7
	(75%)	(82%)	(81%)	(83%)	(86%)					
Gas	51.7	55.9	58.9	65.6	78.0	0.8	1.0	1.1	1.2	1.1
	(18%)	(15%)	(13%)	(12%)	(12%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**6,940.6**	**9,290.7**	**11,192.7**	**14,325.5**	**19,431.5**	**3.0**	**3.8**	**2.5**	**2.1**	**2.2**
Coal	2 732.3	4 203.8	5 361.8	6 841.2	8 583.6	4.4	5.0	2.5	1.5	1.9
	(39%)	(45%)	(48%)	(48%)	(44%)					
Oil	757.7	589.8	562.2	350.5	335.5	- 2.5	- 1.0	- 4.6	- 0.3	- 2.0
	(11%)	(6%)	(5%)	(2%)	(2%)					
Gas	1 145.9	1 594.0	2 011.2	2 658.7	4 094.8	3.4	4.8	2.8	2.9	2.9
	(17%)	(17%)	(18%)	(19%)	(21%)					
Hydro	1 073.3	1 251.6	1 457.5	1 927.7	2 223.9	1.5	3.1	2.8	1.0	1.7
	(15%)	(13%)	(13%)	(13%)	(11%)					
NRE	137.7	155.7	192.4	481.2	1 016.5	1.2	4.3	9.6	5.1	6.9
	(2%)	(2%)	(2%)	(3%)	(5%)					
Nuclear	1 093.8	1 495.7	1 607.6	2 066.2	3 177.2	3.2	1.5	2.5	2.9	2.8
	(16%)	(16%)	(14%)	(14%)	(16%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**1,512,281**	**1,925,951**	**2,285,629**	**3,210,190**	**4,360,780**	**2.4**	**3.5**	**3.5**	**2.1**	**2.6**
Thermal	1 026 147	1 350 963	1 672 414	2 192 232	2 875 973	2.8	4.4	2.7	1.8	2.2
	(68%)	(70%)	(73%)	(68%)	(66%)					
Coal	496 896	751 339	872 651	1 214 746	1 523 636	4.2	3.0	3.4	1.5	2.3
	(33%)	(39%)	(38%)	(38%)	(35%)					
Oil	176 627	185 240	168 855	245 126	240 675	0.5	- 1.8	3.8	- 0.1	1.4
	(12%)	(10%)	(7%)	(8%)	(6%)					
Gas	207 624	414 384	630 908	732 359	1 111 662	7.2	8.8	1.5	2.8	2.3
	(14%)	(22%)	(28%)	(23%)	(25%)					
Hydro	283 149	352 886	364 933	583 748	688 818	2.2	0.7	4.8	1.1	2.6
	(19%)	(18%)	(16%)	(18%)	(16%)					
NRE	16 549	25 915	49 556	152 779	368 728	4.6	13.8	11.9	6.0	8.4
	(1%)	(1%)	(2%)	(5%)	(8%)					
Nuclear	186 435	196 187	198 726	281 431	427 261	0.5	0.3	3.5	2.8	3.1
	(12%)	(10%)	(9%)	(9%)	(10%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	265	223	216	184	134	- 1.7	- 0.6	- 1.6	- 2.1	- 1.9
Primary Energy Supply per Capita (kgoe per capita)	2 169	2 275	2 526	2 830	3 235	0.5	2.1	1.1	0.9	1.0
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	188	154	145	121	86	- 2.0	- 1.2	- 1.8	- 2.2	- 2.0
Final Energy Demand per Capita (kgoe per capita)	1 539	1 569	1 691	1 862	2 079	0.2	1.5	1.0	0.7	0.8
CO_2 Emissions (million tonnes)	**10,309**	**12,880**	**16,562**	**19,725**	**23,148**	**2.3**	**5.2**	**1.8**	**1.1**	**1.3**
Sector										
Electricity and Heat Generation	3 357	5 033	7 363	9 016	11 211	4.1	7.9	2.0	1.5	1.7
Refineries and Other Energy Sector	949	1 097	1 355	1 714	1 957	1.5	4.3	2.4	0.9	1.5
Industry	1 984	2 081	2 630	3 064	3 195	0.5	4.8	1.5	0.3	0.8
Transport	2 411	3 066	3 432	3 896	4 389	2.4	2.3	1.3	0.8	1.0
Other	1 608	1 603	1 782	2 034	2 396	- 0.0	2.1	1.3	1.1	1.2
Fuel										
Coal	4 599	5 855	8 333	10 283	11 989	2.4	7.3	2.1	1.0	1.5
Oil	4 203	5 012	5 449	6 026	6 755	1.8	1.7	1.0	0.8	0.9
Gas	1 507	2 013	2 780	3 417	4 405	2.9	6.7	2.1	1.7	1.9
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	551	496	535	454	319	- 1.1	1.5	- 1.6	- 2.3	- 2.0
CO_2 Emissions per Capita (tonnes per capita)	4. 5	5. 1	6. 3	7.	7. 7	1.2	4.4	1.1	0.6	0.8

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	2,226.6	1,485.3		1,372.0	125.3	419.3	496.9			6,125.4
Net Imports	(116.8)	773.4	1.7	(104.5)			0.2	(0.7)	8.8	562.2
Primary Energy Supply	**2,109.9**	**2,258.7**	**1.7**	**1,267.5**	**125.3**	**419.3**	**497.1**	**(0.7)**	**8.8**	**6,687.6**
Transfers and Statistical Diff.	(2.8)	(74.7)	68.9	0.1			(0.0)	0.0	0.0	(8.4)
Electricity and Heat Gen.	(1,431.3)		(143.8)	(518.5)	(125.3)	(419.3)	(74.3)	962.6	206.8	(1,543.2)
Petroleum Refineries		(2,184.0)	2,157.7							(26.3)
Other Energy Sector	(174.5)		(136.7)	(119.3)			(11.0)	(154.9)	(42.7)	(639.0)
Final Energy Demand	**501.3**		**1,947.9**	**629.8**			**411.8**	**807.0**	**172.9**	**4,470.7**
Industry	395.0		179.4	214.9			66.4	333.4	82.2	1,271.3
Transport	4.2		1,155.9	54.0			8.3	12.3		1,234.6
Other	78.4		249.7	302.2			337.1	461.3	90.7	1,519.3
Non-Energy Use	23.8		362.9	58.9			0.0			445.6

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	2,846.9	1,507.5		1,680.9	165.8	532.2	583.8			7,317.0
Net Imports	(250.9)	1,009.3	26.8	(129.7)			9.0	1.5	0.0	666.0
Primary Energy Supply	**2,596.0**	**2,516.8**	**26.8**	**1,551.2**	**165.8**	**532.3**	**592.8**	**1.5**	**0.0**	**7,983.1**
Electricity and Heat Gen.	(1,796.4)		(97.9)	(664.2)	(165.8)	(532.3)	(126.7)	1,231.9	234.0	(1,917.3)
Petroleum Refineries		(2,516.8)	2,473.4					(2.0)	(7.8)	(53.1)
Other Energy Sector	(213.8)		(158.0)	(160.7)			(11.1)	(189.4)	(27.2)	(760.1)
Final Energy Demand	**585.9**		**2,244.3**	**726.3**			**455.0**	**1,042.0**	**199.1**	**5,252.6**
Industry	476.2		184.4	255.4			65.8	441.8	95.0	1,518.6
Transport	3.7		1,326.7	57.2			54.6	15.4		1,457.6
Other	80.6		294.0	348.2			334.5	584.9	104.0	1,746.2
Non-Energy Use	25.3		439.3	65.6			0.0			530.2

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	3,338.5	1,628.6		1,912.2	191.2	822.0	752.9			8,645.4
Net Imports	(327.4)	1,262.7	35.7	81.0			22.1	1.4	0.0	1,075.4
Primary Energy Supply	**3,011.0**	**2,891.3**	**35.7**	**1,993.1**	**191.2**	**822.0**	**775.0**	**1.4**	**0.0**	**9,720.7**
Electricity and Heat Gen.	(2,203.9)		(91.0)	(919.1)	(191.2)	(822.0)	(219.0)	1,671.0	283.6	(2,491.5)
Petroleum Refineries		(2,891.3)	2,834.4					(2.4)	(9.8)	(69.0)
Other Energy Sector	(240.3)		(187.9)	(179.7)			(13.9)	(256.2)	(36.3)	(914.3)
Final Energy Demand	**566.8**		**2,591.3**	**894.3**			**542.1**	**1,413.8**	**237.5**	**6,245.8**
Industry	469.7		197.1	306.6			76.3	580.9	112.0	1,742.6
Transport	3.7		1,501.5	61.7			131.7	19.5		1,718.2
Other	79.6		337.6	447.9			334.1	813.3	125.5	2,138.2
Non-Energy Use	13.8		555.0	78.0			0.0			646.9

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
11071 - 14964	0.9 - 1.2	0.2 - 0.2	0.7 - 0.9

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2230 - 2981	5113 - 6897	3027 - 4156	704 - 931

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2164 - 2964	1561 - 2097	908 - 1201	6439 - 8703

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
6439 - 8703	3785 - 5069	2016 - 2787	639 - 847

AUSTRALIA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	416	592	696	851	1 201	3.6	3.3	2.0	2.3	2.2
Population (million)	17	19	20	23	26	1.2	1.3	1.0	0.8	0.9
GDP per Capita (2005 US$ PPP per capita)	24 384	30 899	34 106	37 675	47 076	2.4	2.0	1.0	1.5	1.3

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**157.5**	**233.6**	**268.2**	**399.0**	**513.5**	**4.0**	**2.8**	**4.1**	**1.7**	**2.6**
Coal	106.1	164.6	202.0	264.7	319.1	4.5	4.2	2.7	1.3	1.8
	(67%)	(70%)	(75%)	(66%)	(62%)					
Oil	29.0	33.9	24.1	30.0	32.0	1.6	- 6.6	2.2	0.4	1.1
	(18%)	(15%)	(9%)	(8%)	(6%)					
Gas	17.1	28.5	35.4	95.7	150.0	5.2	4.4	10.4	3.0	5.9
	(11%)	(12%)	(13%)	(24%)	(29%)					
Hydro	1.2	1.4	1.3	1.4	1.4	1.7	- 1.5	0.2	0.1	0.1
	(1%)	(1%)	(0%)	(0%)	(0%)					
NRE	4.0	5.1	5.3	7.2	11.0	2.4	0.7	3.1	2.9	3.0
	(3%)	(2%)	(2%)	(2%)	(2%)					
Nuclear										
Net Import	**-69.9**	**-123.1**	**-147.4**	**-254.0**	**-335.2**	**5.8**	**3.7**	**5.6**	**1.9**	**3.3**
Coal	- 71.1	- 116.5	- 148.8	- 203.9	- 254.9	5.1	5.0	3.2	1.5	2.2
Oil	3.6	2.7	13.8	14.7	22.6	- 3.1	39.0	0.7	2.9	2.0
Gas	- 2.3	- 9.3	- 12.4	- 64.8	- 102.9	14.7	6.0	18.0	3.1	8.8
Electricity										
Primary Energy Supply	**87.7**	**110.6**	**120.7**	**145.0**	**178.3**	**2.3**	**1.8**	**1.8**	**1.4**	**1.6**
Coal	35.0	48.2	53.2	60.8	64.2	3.2	2.0	1.4	0.36	0.8
	(40%)	(44%)	(44%)	(42%)	(36%)					
Oil	32.7	36.6	37.9	44.7	54.6	1.1	0.7	1.7	1.3	1.5
	(37%)	(33%)	(31%)	(31%)	(31%)					
Gas	14.8	19.3	23.0	30.8	47.1	2.7	3.6	3.0	2.9	2.9
	(17%)	(17%)	(19%)	(21%)	(26%)					
Hydro	1.2	1.4	1.3	1.4	1.4	1.7	- 1.5	0.2	0.1	0.1
	(1%)	(1%)	(1%)	(1%)	(1%)					
NRE	4.0	5.1	5.3	7.2	11.0	2.4	0.7	3.1	2.9	3.0
	(5%)	(5%)	(4%)	(5%)	(6%)					
Nuclear										
Input for Electricity and Heat Generation	**-35.2**	**-48.7**	**-61.7**	**-66.4**	**-76.2**	**3.3**	**4.8**	**0.7**	**0.9**	**0.8**
Coal	- 28.9	- 42.0	- 50.5	- 54.9	- 57.6	3.8	3.8	0.8	0.3	0.5
	(82%)	(86%)	(82%)	(83%)	(76%)					
Oil	- 0.9	- 0.5	- 0.8	- 0.4	- 0.3	- 5.5	9.2	- 6.7	- 2.5	- 4.2
	(3%)	(1%)	(1%)	(1%)	(0%)					
Gas	- 3.5	- 4.1	- 7.9	- 8.4	- 14.9	1.6	14.1	0.7	3.9	2.6
	(10%)	(8%)	(13%)	(13%)	(20%)					
Hydro	- 1.2	- 1.4	- 1.3	- 1.4	- 1.4	1.7	- 1.5	0.2	0.1	0.1
	(3%)	(3%)	(2%)	(2%)	(2%)					
NRE	- 0.7	- 0.7	- 1.2	- 1.4	- 2.0	- 0.1	11.4	1.5	2.5	2.1
	(2%)	(1%)	(2%)	(2%)	(3%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-7.6**	**-10.3**	**-10.7**	**-16.4**	**-22.6**	**3.0**	**0.8**	**4.3**	**2.2**	**3.0**
Coal	- 1.9	- 1.8	- 1.8	- 2.3	- 2.8	- 0.7	0.2	2.74	1.3	1.8
Oil	- 1.0	- 1.8	- 2.4	- 3.5	- 4.0	5.7	6.0	3.7	0.8	2.0
Gas	- 2.5	- 3.8	- 3.2	- 7.1	- 11.1	4.2	- 3.1	8.2	3.0	5.1
NRE										
Electricity	- 2.2	- 3.0	- 3.3	- 3.5	- 4.8	3.3	2.2	0.6	2.1	1.5
Heat	- 0.1									

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**58.0**	**72.0**	**77.9**	**85.3**	**111.0**	**2.2**	**1.6**	**0.9**	**1.8**	**1.4**
Coal	4.3	4.1	3.5	3.7	3.8	- 0.4	- 3.3	0.5	0.2	0.3
	(7%)	(6%)	(4%)	(4%)	(3%)					
Oil	30.4	37.1	39.0	40.8	50.4	2.0	1.0	0.4	1.4	1.0
	(52%)	(52%)	(50%)	(48%)	(45%)					
Gas	8.8	11.5	13.5	15.4	21.1	2.6	3.4	1.3	2.1	1.8
	(15%)	(16%)	(17%)	(18%)	(19%)					
NRE	3.3	4.4	4.1	5.8	9.0	2.9	- 1.5	3.6	3.0	3.2
	(6%)	(6%)	(5%)	(7%)	(8%)					
Electricity	11.1	14.9	17.8	19.6	26.7	2.9	3.6	1.0	2.1	1.6
	(19%)	(21%)	(23%)	(23%)	(24%)					
Heat										
Industry	**19.2**	**23.8**	**25.7**	**28.8**	**38.9**	**2.2**	**1.6**	**1.2**	**2.0**	**1.7**
Coal	4.1	4.0	3.3	3.5	3.6	- 0.2	- 3.8	0.5	0.2	0.3
	(21%)	(17%)	(13%)	(12%)	(9%)					
Oil	2.9	3.5	3.4	3.8	6.1	2.1	- 0.8	1.2	3.1	2.4
	(15%)	(15%)	(13%)	(13%)	(16%)					
Gas	5.7	7.2	8.5	10.0	14.1	2.4	3.4	1.7	2.3	2.1
	(30%)	(30%)	(33%)	(35%)	(36%)					
NRE	1.5	2.5	2.6	2.9	3.8	5.2	1.0	1.0	2.0	1.6
	(8%)	(10%)	(10%)	(10%)	(10%)					
Electricity	5.1	6.6	7.9	8.6	11.3	2.7	3.7	0.9	1.8	1.4
	(26%)	(28%)	(31%)	(30%)	(29%)					
Heat										
Transportation	**22.6**	**28.1**	**30.0**	**32.1**	**40.1**	**2.2**	**1.4**	**0.6**	**1.5**	**1.2**
Coal	0.1	0.1	0.1	0.1	0.1	2.0	0.9	- 0.2	0.4	0.1
	(0%)	(0%)	(0%)	(0%)	(0%)					
Oil	22.3	27.5	29.4	29.9	35.6	2.1	1.3	0.2	1.2	0.8
	(99%)	(98%)	(98%)	(93%)	(89%)					
Gas		0.3	0.4	0.4	0.5	40.7	3.0	0.6	1.6	1.2
		(1%)	(1%)	(1%)	(1%)					
NRE				1.5	3.6				6.1	
				(5%)	(9%)					
Electricity	0.2	0.2	0.2	0.2	0.3	2.6	1.3	0.7	1.6	1.2
	(1%)	(1%)	(1%)	(1%)	(1%)					
Other	**12.3**	**15.7**	**18.1**	**19.6**	**26.1**	**2.5**	**2.9**	**0.8**	**1.9**	**1.5**
Coal	0.1		0.1	0.1	0.1	- 10.3	17.9	0.0	- 0.4	- 0.2
	(1%)		(1%)	(1%)	(0%)					
Oil	1.7	2.0	2.9	3.1	3.7	1.6	7.8	0.6	1.2	0.9
	(14%)	(13%)	(16%)	(16%)	(14%)					
Gas	2.7	3.6	3.9	4.2	5.5	3.1	1.5	0.7	1.8	1.4
	(22%)	(23%)	(22%)	(21%)	(21%)					
NRE	1.9	2.0	1.5	1.5	1.5	0.6	- 5.1	- 0.2	0.3	0.1
	(15%)	(12%)	(8%)	(8%)	(6%)					
Electricity	5.9	8.0	9.6	10.7	15.2	3.2	3.6	1.1	2.3	1.8
	(48%)	(51%)	(53%)	(55%)	(58%)					
Heat										
Non-Energy Use	**4.0**	**4.4**	**4.1**	**4.7**	**5.9**	**1.1**	**- 1.6**	**1.5**	**1.5**	**1.5**
Coal										
Oil	3.5	4.1	3.3	4.0	5.0	1.5	- 4.1	1.9	1.5	1.6
	(89%)	(92%)	(81%)	(84%)	(84%)					
Gas	0.4	0.3	0.8	0.8	0.9	- 2.7	17.7	- 0.2	1.5	0.8
	(11%)	(8%)	(19%)	(16%)	(16%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**154.3**	**207.4**	**245.1**	**268.9**	**366.6**	**3.0**	**3.4**	**0.9**	**2.1**	**1.6**
Coal	119.0	160.6	192.7	212.4	262.6	3.0	3.7	1.0	1.4	1.2
	(77%)	(77%)	(79%)	(79%)	(72%)					
Oil	4.2	2.7	1.9	1.0	0.7	- 4.2	- 6.6	- 6.7	- 2.5	- 4.2
	(3%)	(1%)	(1%)							
Gas	16.4	26.2	32.2	35.5	80.5	4.8	4.2	1.0	5.6	3.7
	(11%)	(13%)	(13%)	(13%)	(22%)					
Hydro	14.1	16.8	15.5	15.8	16.0	1.7	- 1.5	0.2	0.1	0.1
	(9%)	(8%)	(6%)	(6%)	(4%)					
NRE	0.6	1.1	2.8	4.2	6.7	6.5	19.8	4.3	3.1	3.6
		(1%)	(1%)	(2%)	(2%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**34,731**	**42,047**	**43,374**	**47,226**	**65,321**	**1.9**	**0.6**	**0.9**	**2.2**	**1.7**
Thermal	27 170	33 342	33 850	36 336	52 151	2.1	0.3	0.7	2.4	1.7
	(78%)	(79%)	(78%)	(77%)	(80%)					
Coal	22 140	25 506	25 506	28 120	34 766	1.4	0.0	1.0	1.4	1.2
	(64%)	(61%)	(59%)	(60%)	(53%)					
Oil	2 100	1 970	1 606	800	550	- 0.6	- 4.0	- 6.7	- 2.5	- 4.2
	(6%)	(5%)	(4%)	(2%)	(1%)					
Gas	2 930	5 866	6 738	7 415	16 835	7.2	2.8	1.0	5.6	3.7
	(8%)	(14%)	(16%)	(16%)	(26%)					
Hydro	7 261	7 370	7 827	7 967	8 087	0.1	1.2	0.2	0.1	0.1
	(21%)	(18%)	(18%)	(17%)	(12%)					
NRE	300	1 335	1 697	2 923	5 083	16.1	4.9	5.6	3.8	4.5
	(1%)	(3%)	(4%)	(6%)	(8%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	211	187	174	170	149	- 1.2	- 1.5	- 0.2	- 0.9	- 0.6
Primary Energy Supply per Capita (kgoe per capita)	5 138	5 772	5 919	6 415	6 991	1.2	0.5	0.8	0.6	0.7
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	139	122	112	100	92	- 1.4	- 1.6	- 1.1	- 0.5	- 0.8
Final Energy Demand per Capita (kgoe per capita)	3 399	3 758	3 818	3 772	4 350	1.0	0.3	- 0.1	1.0	0.5
CO_2 Emissions (million tonnes)	**258**	**337**	**391**	**430**	**506**	**2.7**	**3.0**	**1.0**	**1.1**	**1.0**
Sector										
Electricity and Heat Generation	126	179	223	240	266	3.6	4.5	0.8	0.7	0.7
Refineries and Other Energy Sector	17	21	23	36	48	2.6	1.2	4.7	2.0	3.1
Industry	38	43	43	49	66	1.3	- 0.1	1.2	2.0	1.7
Transport	65	79	84	85	102	1.9	1.2	0.2	1.2	0.8
Other	12	15	19	20	25	2.1	4.6	0.6	1.5	1.1
Fuel										
Coal	140	192	223	243	257	3.2	3.1	0.9	0.4	0.6
Oil	85	102	113	117	143	1.9	2.0	0.4	1.3	1.0
Gas	33	44	55	69	106	2.8	4.7	2.4	2.9	2.7
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	621	570	562	505	421	- 0.8	- 0.3	- 1.1	- 1.2	- 1.1
CO_2 Emissions per Capita (tonnes per capita)	15. 1	17. 6	19. 2	19.	19. 8	1.5	1.7	- 0.1	0.3	0.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	202.0	24.1		35.4	1.3	0.0	5.3			268.2
Net Imports	(148.8)	6.2	7.5	(12.4)			0.0	0.0	0.0	(147.4)
Primary Energy Supply	**53.2**	**30.4**	**7.5**	**23.0**	**1.3**	**0.0**	**5.3**	**0.0**	**0.0**	**120.7**
Transfers and Statistical Diff.	2.6	3.6	0.8	1.5			0.0	0.0	0.0	8.5
Electricity and Heat Gen.	(50.5)		(0.8)	(7.9)	(1.3)	0.0	(1.2)	21.1	0.0	(40.6)
Petroleum Refineries		(33.9)	34.1							0.2
Other Energy Sector	(1.8)		(2.6)	(3.2)			0.0	(3.3)	0.0	(10.9)
Final Energy Demand	**3.5**		**39.0**	**13.5**			**4.1**	**17.8**	**0.0**	**77.9**
Industry	3.3		3.4	8.5			2.6	7.9	0.0	25.7
Transport	0.1		29.4	0.4			0.0	0.2		30.0
Other	0.1		2.9	3.9			1.5	9.6	0.0	18.1
Non-Energy Use	0.0		3.3	0.8			0.0			4.1

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	264.7	30.0		95.7	1.4	0.0	7.2			399.0
Net Imports	(203.9)	5.1	9.6	(64.8)			0.0	0.0	0.0	(254.0)
Primary Energy Supply	**60.8**	**35.1**	**9.6**	**30.8**	**1.4**	**0.0**	**7.2**	**0.0**	**0.0**	**145.0**
Electricity and Heat Gen.	(54.9)		(0.4)	(8.4)	(1.4)	0.0	(1.4)	23.1	0.0	(43.3)
Petroleum Refineries		(35.1)	34.9							(0.2)
Other Energy Sector	(2.3)		(3.3)	(7.1)			0.0	(3.5)	0.0	(16.2)
Final Energy Demand	**3.7**		**40.8**	**15.4**			**5.8**	**19.6**	**0.0**	**85.3**
Industry	3.5		3.8	10.0			2.9	8.6	0.0	28.8
Transport	0.1		29.9	0.4			1.5	0.2		32.1
Other	0.1		3.1	4.2			1.5	10.7	0.0	19.6
Non-Energy Use	0.0		4.0	0.8			0.0			4.7

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	319.1	32.0		150.0	1.4	0.0	11.0			513.5
Net Imports	(254.9)	7.6	15.0	(102.9)			0.0	0.0	0.0	(335.2)
Primary Energy Supply	**64.2**	**39.6**	**15.0**	**47.1**	**1.4**	**0.0**	**11.0**	**0.0**	**0.0**	**178.3**
Electricity and Heat Gen.	(57.6)		(0.3)	(14.9)	(1.4)	0.0	(2.0)	31.5	0.0	(44.7)
Petroleum Refineries		(39.6)	39.4							(0.2)
Other Energy Sector	(2.8)		(3.7)	(11.1)			0.0	(4.8)	0.0	(22.4)
Final Energy Demand	**3.8**		**50.4**	**21.1**			**9.0**	**26.7**	**0.0**	**111.0**
Industry	3.6		6.1	14.1			3.8	11.3	0.0	38.9
Transport	0.1		35.6	0.5			3.6	0.3		40.1
Other	0.1		3.7	5.5			1.5	15.2	0.0	26.1
Non-Energy Use	0.0		5.0	0.9			0.0			5.9

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
414 - 546	1.7 - 2.3	0.9 - 1.2	0.8 - 1.1

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
222 - 283	72 - 95	111 - 155	9 - 12

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
33 - 51	180 - 235	105 - 130	96 - 131

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
96 - 131	49 - 63	39 - 58	8 - 10

BRUNEI DARUSSALAM

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	5	6	6	7	9	1.4	2.4	1.4	1.7	1.6
Population (million)	0	0	0	0	0	2.8	1.8	1.2	0.6	0.9
GDP per Capita (2005 US$ PPP per capita)	18 693	16 342	16 869	17 276	20 308	- 1.3	0.6	0.2	1.1	0.7

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
			Mtoe							
Production	**15.6**	**19.7**	**21.1**	**21.3**	**18.4**	**2.3**	**1.4**	**0.1**	**- 1.0**	**- 0.5**
Coal										
Oil	7.70	10.22	11.06	11.17	9.61	2.9	1.6	0.1	- 1.0	- 0.6
	(49%)	(52%)	(53%)	(53%)	(52%)					
Gas	7.94	9.46	10.00	10.10	8.68	1.8	1.1	0.1	- 1.0	- 0.6
	(51%)	(48%)	(47%)	(47%)	(47%)					
Hydro					0.03					
					(0%)					
NRE					0.03					
					(0%)					
Nuclear										
Net Import	**-13.8**	**-17.2**	**-18.4**	**-15.9**	**-11.5**	**2.2**	**1.4**	**- 1.5**	**- 2.1**	**- 1.9**
Coal										
Oil	- 7.6	- 9.5	- 10.3	- 8.4	- 5.3	2.3	1.5	- 2.1	- 2.9	- 2.6
Gas	- 6.3	- 7.6	- 8.2	- 7.6	- 6.2	2.0	1.4	- 0.8	- 1.3	- 1.1
Electricity										
Primary Energy Supply	**1.8**	**2.5**	**2.6**	**5.4**	**6.8**	**3.4**	**0.8**	**7.4**	**1.6**	**3.9**
Coal										
Oil	0.12	0.67	0.79	2.82	4.29	18.6	3.1	13.6	2.8	7.0
	(7%)	(27%)	(30%)	(53%)	(63%)					
Gas	1.68	1.85	1.84	2.53	2.51	1.0	- 0.1	3.3	- 0.1	1.3
	(93%)	(73%)	(70%)	(47%)	(37%)					
Hydro					0.03					
					(0%)					
NRE										
Nuclear										
Input for Electricity and Heat Generation	**-0.5**	**-0.9**	**-1.1**	**-1.2**	**-1.3**	**6.4**	**4.8**	**1.1**	**0.5**	**0.8**
Coal										
Oil		- 0.01	- 0.01	- 0.01	- 0.01	5.2	7.0	3.8	0.7	1.9
		(1%)	(1%)	(1%)	(1%)					
Gas	- 0.46	- 0.86	- 1.08	- 1.21	- 1.28	6.5	4.8	1.1	0.4	0.7
	(99%)	(99%)	(99%)	(99%)	(97%)					
Hydro					- 0.03					
					(2%)					
NRE										
Nuclear										
Input for Refineries and Other Energy Sector	**-1.1**	**-1.1**	**-0.9**	**-2.9**	**-4.1**	**0.6**	**- 4.5**	**12.4**	**2.3**	**6.2**
Coal										
Oil	- 0.03	- 0.15	- 0.13	- 2.12	- 3.38	19.2	- 2.7	32.1	3.2	13.9
Gas	- 1.03	- 0.98	- 0.76	- 0.77	- 0.66	- 0.5	- 5.0	0.2	- 1.0	- 0.5
NRE										
Electricity	- 0.01	- 0.01	- 0.02	- 0.02	- 0.03	- 6.7	19.4	2.7	1.2	1.8
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**0.4**	**0.7**	**0.8**	**1.6**	**1.8**	**5.3**	**3.2**	**6.4**	**1.1**	**3.2**
Coal										
Oil	0.34	0.50	0.57	0.69	0.90	4.1	2.6	2.0	1.8	1.9
	(79%)	(70%)	(68%)	(45%)	(49%)					
Gas				0.56	0.57				0.2	
				(36%)	(31%)					
NRE										
Electricity	0.09	0.21	0.26	0.30	0.36	9.3	4.6	1.3	1.2	1.2
	(20%)	(30%)	(32%)	(19%)	(20%)					
Heat										
Industry	**0.1**	**0.1**	**0.2**	**0.3**	**0.3**	**3.8**	**4.2**	**4.4**	**0.6**	**2.1**
Coal										
Oil	0.08	0.12	0.12	0.15	0.16	4.2	1.4	1.8	0.6	1.1
	(79%)	(82%)	(72%)	(55%)	(56%)					
Gas				0.06	0.06				0.0	
				(24%)	(22%)					
NRE										
Electricity	0.02	0.03	0.05	0.05	0.06	2.3	14.4	1.0	1.1	1.0
	(21%)	(18%)	(28%)	(20%)	(22%)					
Heat										
Transportation	**0.2**	**0.3**	**0.4**	**0.5**	**0.7**	**4.3**	**3.3**	**2.2**	**2.2**	**2.2**
Coal										
Oil	0.23	0.34	0.40	0.50	0.69	4.3	3.3	2.2	2.2	2.2
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Other	**0.1**	**0.2**	**0.2**	**0.3**	**0.4**	**9.4**	**2.4**	**2.3**	**1.4**	**1.8**
Coal										
Oil	0.02	0.02	0.02	0.02	0.02	3.2	- 2.9	0.6	1.3	1.0
	(19%)	(11%)	(8%)	(7%)	(7%)					
Gas				0.03	0.04				3.1	
				(9%)	(11%)					
NRE										
Electricity	0.07	0.19	0.22	0.25	0.30	10.8	2.9	1.4	1.2	1.3
	(79%)	(89%)	(92%)	(84%)	(82%)					
Heat										
Non-Energy Use	**0.0**	**0.0**	**0.0**	**0.5**	**0.5**	**2.6**	**1.8**	**35.3**	**0.0**	**12.9**
Coal										
Oil	0.02	0.02	0.02	0.03	0.03	2.6	1.8	0.6	0.4	0.5
	(100%)	(100%)	(100%)	(5%)	(5%)					
Gas				0.47	0.47				0.0	
				(95%)	(95%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**1.2**	**2.5**	**3.3**	**3.8**	**4.5**	**8.1**	**5.1**	**1.4**	**1.2**	**1.3**
Coal										
Oil						7.7	4.7	3.6	0.7	1.8
	(1%)	(1%)	(1%)	(1%)	(1%)					
Gas	1.2	2.5	3.2	3.7	4.1	8.1	5.1	1.4	0.6	0.9
	(99%)	(99%)	(99%)	(99%)	(91%)					
Hydro					0.4					
					(8%)					
NRE										
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**186**	**707**	**1,013**	**1,160**	**1,422**	**14.3**	**7.5**	**1.4**	**1.4**	**1.4**
Thermal	186	707	1 013	1 159	1 269	14.3	7.5	1.4	0.6	0.9
	(100%)	(100%)	(100%)	(100%)	(89%)					
Coal										
Oil	8	8	14	19	21	0.0	12.5	3.3	0.7	1.7
	(4%)	(1%)	(1%)	(2%)	(1%)					
Gas	178	699	999	1 140	1 249	14.7	7.4	1.3	0.6	0.9
	(96%)	(99%)	(99%)	(98%)	(88%)					
Hydro					150					
					(11%)					
NRE				1	3				7.6	
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	375	457	421	745	736	2.0	- 1.6	5.9	- 0.1	2.3
Primary Energy Supply per Capita (kgoe per capita)	7 004	7 464	7 107	12 871	14 957	0.6	- 1.0	6.1	1.0	3.0
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	88	129	134	216	198	3.9	0.7	4.9	- 0.6	1.6
Final Energy Demand per Capita (kgoe per capita)	1 654	2 109	2 260	3 732	4 018	2.5	1.4	5.1	0.5	2.3
CO_2 Emissions (million tonnes)	**4**	**6**	**6**	**11**	**13**	**3.2**	**- 0.1**	**6.1**	**1.5**	**3.3**
Sector										
Electricity and Heat Generation	1	2	3	3	3	6.4	4.8	1.1	0.4	0.7
Refineries and Other Energy Sector	2	3	2	6	8	1.0	- 5.9	11.6	1.9	5.7
Industry	0	0	0	1	1	4.2	1.4	4.7	0.5	2.1
Transport	1	1	1	1	2	3.8	3.2	2.2	2.2	2.2
Other		0	0	0	0		- 2.9	7.5	2.2	4.3
Fuel										
Coal										
Oil	1	2	2	6	9	6.2	- 0.4	13.3	2.6	6.7
Gas	3	4	4	5	5	2.1	0.0	1.2	- 0.1	0.4
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	912	1 082	956	1 496	1 453	1.7	- 2.4	4.6	- 0.2	1.7
CO_2 Emissions per Capita (tonnes per capita)	17. 1	17. 7	16. 1	25. 8	29. 5	0.4	- 1.8	4.8	0.9	2.4

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	11.1		10.0	0.0	0.0	0.0			21.1
Net Imports	0.0	(10.3)	0.0	(8.2)			0.0	0.0	0.0	(18.4)
Primary Energy Supply	**0.0**	**0.8**	**0.0**	**1.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.6**
Transfers and Statistical Diff.	0.0	(0.1)	0.0	0.0			0.0	0.0	0.0	(0.1)
Electricity and Heat Gen.	0.0		(0.0)	(1.1)	0.0	0.0	0.0	0.3	0.0	(0.8)
Petroleum Refineries		(0.7)	0.6							(0.0)
Other Energy Sector	0.0		(0.1)	(0.8)			0.0	(0.0)	0.0	(0.9)
Final Energy Demand	**0.0**		**0.6**	**0.0**			**0.0**	**0.3**	**0.0**	**0.8**
Industry	0.0		0.1	0.0			0.0	0.0	0.0	0.2
Transport	0.0		0.4	0.0			0.0	0.0		0.4
Other	0.0		0.0	0.0			0.0	0.2	0.0	0.2
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	11.2		10.1	0.0	0.0	0.0			21.3
Net Imports	0.0	0.1	(8.4)	(7.6)			0.0	0.0	0.0	(15.9)
Primary Energy Supply	**0.0**	**11.3**	**(8.4)**	**2.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**5.4**
Electricity and Heat Gen.	0.0		(0.0)	(1.2)	0.0	0.0	0.0	0.3	0.0	(0.9)
Petroleum Refineries		(11.3)	10.5							(0.8)
Other Energy Sector	0.0		(1.4)	(0.8)			0.0	(0.0)	0.0	(2.2)
Final Energy Demand	**0.0**		**0.7**	**0.6**			**0.0**	**0.3**	**0.0**	**1.6**
Industry	0.0		0.1	0.1			0.0	0.1	0.0	0.3
Transport	0.0		0.5	0.0			0.0	0.0		0.5
Other	0.0		0.0	0.0			0.0	0.2	0.0	0.3
Non-Energy Use	0.0		0.0	0.5			0.0			0.5

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	9.6		8.7	0.0	0.0	0.0			18.4
Net Imports	0.0	9.6	(14.9)	(6.2)			(0.0)	0.0	0.0	(11.5)
Primary Energy Supply	**0.0**	**19.2**	**(14.9)**	**2.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6.8**
Electricity and Heat Gen.	0.0		(0.0)	(1.3)	(0.0)	0.0	0.0	0.4	0.0	(0.9)
Petroleum Refineries		(19.2)	17.9							(1.3)
Other Energy Sector	0.0		(2.1)	(0.7)			0.0	(0.0)	0.0	(2.8)
Final Energy Demand	**0.0**		**0.9**	**0.6**			**0.0**	**0.4**	**0.0**	**1.8**
Industry	0.0		0.2	0.1			0.0	0.1	0.0	0.3
Transport	0.0		0.7	0.0			0.0	0.0		0.7
Other	0.0		0.0	0.0			0.0	0.3	0.0	0.4
Non-Energy Use	0.0		0.0	0.5			0.0			0.5

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
22 - 33	11.0 - 16.7	5.0 - 8.1	5.9 - 8.6

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
10 - 16	8.4 - 12.1	3.2 - 4.7	0.2 - 0.2

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
12 - 18	8.1 - 13.2	.. - ..	1.2 - 1.7

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
1 - 2	0.6 - 0.9	0.4 - 0.6	0.2 - 0.2

CANADA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	747	996	1 130	1 380	2 068	2.9	2.6	2.0	2.7	2.4
Population (million)	28	31	32	35	39	1.0	1.0	0.9	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	26 879	32 372	34 972	39 138	52 766	1.9	1.6	1.1	2.0	1.7

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
			Mtoe							
Production	**273.7**	**372.5**	**402.1**	**406.9**	**459.9**	**3.1**	**1.5**	**0.1**	**0.8**	**0.5**
Coal	37.9	34.4	33.1	34.7	32.6	- 1.0	- 0.8	0.5	- 0.4	- 0.1
	(14%)	(9%)	(8%)	(9%)	(7%)					
Oil	94.1	128.4	147.4	160.4	190.3	3.2	2.8	0.8	1.1	1.0
	(34%)	(34%)	(37%)	(39%)	(41%)					
Gas	88.6	148.3	154.0	141.3	149.6	5.3	0.8	- 0.9	0.4	- 0.1
	(32%)	(40%)	(38%)	(35%)	(33%)					
Hydro	25.5	30.8	31.3	32.7	37.7	1.9	0.3	0.4	1.0	0.8
	(9%)	(8%)	(8%)	(8%)	(8%)					
NRE	8.2	11.6	12.3	12.9	17.1	3.5	1.2	0.5	1.9	1.3
	(3%)	(3%)	(3%)	(3%)	(4%)					
Nuclear	19.4	19.0	24.0	24.9	32.6	- 0.2	4.8	0.4	1.8	1.2
	(7%)	(5%)	(6%)	(6%)	(7%)					
Net Import	**-64.2**	**-120.4**	**-128.4**	**-109.5**	**-103.7**	**6.5**	**1.3**	**- 1.6**	**- 0.4**	**- 0.9**
Coal	- 13.7	- 2.7	- 3.1	- 15.7	- 9.7	- 14.8	2.1	17.8	- 3.1	4.7
Oil	- 16.7	- 40.6	- 49.9	- 50.4	- 54.3	9.3	4.2	0.1	0.5	0.3
Gas	- 33.8	- 74.1	- 73.4	- 40.1	- 34.6	8.2	- 0.2	- 5.9	- 1.0	- 3.0
Electricity		- 3.1	- 2.1	- 3.2	- 5.1		- 7.7	4.7	3.1	3.7
Primary Energy Supply	**209.5**	**252.1**	**273.7**	**297.4**	**356.3**	**1.9**	**1.7**	**0.8**	**1.2**	**1.1**
Coal	24.3	31.7	30.0	19.1	22.9	2.7	- 1.0	- 4.4	1.22	- 1.1
	(12%)	(13%)	(11%)	(6%)	(6%)					
Oil	77.4	87.9	97.5	110.1	136.2	1.3	2.1	1.2	1.4	1.3
	(37%)	(35%)	(36%)	(37%)	(38%)					
Gas	54.7	74.2	80.6	101.1	115.0	3.1	1.7	2.3	0.9	1.4
	(26%)	(29%)	(29%)	(34%)	(32%)					
Hydro	25.5	30.8	31.3	32.7	37.7	1.9	0.3	0.4	1.0	0.8
	(12%)	(12%)	(11%)	(11%)	(11%)					
NRE	8.2	11.6	12.3	12.8	17.0	3.5	1.2	0.4	1.9	1.3
	(4%)	(5%)	(4%)	(4%)	(5%)					
Nuclear	19.4	19.0	24.0	24.9	32.6	- 0.2	4.8	0.4	1.8	1.2
	(9%)	(8%)	(9%)	(8%)	(9%)					
Input for Electricity and Heat Generation	**-72.5**	**-89.8**	**-92.5**	**-98.8**	**-125.3**	**2.2**	**0.6**	**0.7**	**1.6**	**1.2**
Coal	- 21.0	- 27.8	- 24.2	- 14.7	- 18.7	2.8	- 2.7	- 4.9	1.6	- 1.0
	(29%)	(31%)	(26%)	(15%)	(15%)					
Oil	- 3.8	- 2.9	- 3.3	- 3.3	- 2.9	- 2.6	2.2	0.2	- 0.9	- 0.4
	(5%)	(3%)	(4%)	(3%)	(2%)					
Gas	- 1.9	- 7.4	- 7.5	- 20.9	- 28.9	14.7	0.4	10.8	2.2	5.5
	(3%)	(8%)	(8%)	(21%)	(23%)					
Hydro	- 25.5	- 30.8	- 31.3	- 32.7	- 37.7	1.9	0.3	0.4	1.0	0.8
	(35%)	(34%)	(34%)	(33%)	(30%)					
NRE	- 0.9	- 1.9	- 2.2	- 2.2	- 4.6	7.9	3.2	- 0.2	5.0	2.9
	(1%)	(2%)	(2%)	(2%)	(4%)					
Nuclear	- 19.4	- 19.0	- 24.0	- 24.9	- 32.6	- 0.2	4.8	0.4	1.8	1.2
	(27%)	(21%)	(26%)	(25%)	(26%)					
Input for Refineries and Other Energy Sector	**-21.9**	**-29.0**	**-31.3**	**-41.5**	**-43.4**	**2.9**	**1.5**	**2.9**	**0.3**	**1.3**
Coal	- 1.4	- 1.2	- 1.2	- 1.2	- 1.1	- 1.2	- 0.9	0.49	- 0.4	- 0.1
Oil	- 5.6	- 6.3	- 5.8	- 6.2	- 7.6	1.1	- 1.5	0.6	1.4	1.1
Gas	- 9.5	- 14.0	- 16.6	- 25.8	- 24.8	3.9	3.5	4.5	- 0.3	1.6
NRE										
Electricity	- 5.5	- 7.6	- 7.7	- 8.2	- 9.8	3.3	0.4	0.6	1.2	1.0
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**160.0**	**190.7**	**204.2**	**217.3**	**262.8**	**1.8**	**1.4**	**0.6**	**1.3**	**1.0**
Coal	3.1	3.5	3.6	3.1	3.0	1.3	0.4	- 1.4	- 0.2	- 0.7
	(2%)	(2%)	(2%)	(1%)	(1%)					
Oil	69.7	81.8	93.9	100.6	125.6	1.6	2.8	0.7	1.5	1.2
	(44%)	(43%)	(46%)	(46%)	(48%)					
Gas	43.3	53.4	51.6	54.4	61.4	2.1	- 0.7	0.5	0.8	0.7
	(27%)	(28%)	(25%)	(25%)	(23%)					
NRE	7.3	9.7	10.1	10.6	12.4	2.9	0.8	0.5	1.1	0.8
	(5%)	(5%)	(5%)	(5%)	(5%)					
Electricity	36.0	41.4	44.0	47.6	59.2	1.4	1.2	0.8	1.5	1.2
	(22%)	(22%)	(22%)	(22%)	(23%)					
Heat	0.6	0.8	0.9	1.0	1.1	2.5	2.8	0.4	1.0	0.8
	(0%)	(0%)	(0%)	(0%)	(0%)					
Industry	**47.1**	**55.0**	**57.7**	**60.0**	**68.9**	**1.6**	**1.0**	**0.4**	**0.9**	**0.7**
Coal	2.7	3.2	3.2	3.1	3.0	1.7	- 0.3	- 0.2	- 0.2	- 0.2
	(6%)	(6%)	(5%)	(5%)	(4%)					
Oil	6.8	6.5	8.8	8.0	9.1	- 0.5	6.5	- 1.0	0.9	0.1
	(14%)	(12%)	(15%)	(13%)	(13%)					
Gas	16.9	19.3	18.8	20.4	22.3	1.4	- 0.6	0.8	0.6	0.7
	(36%)	(35%)	(33%)	(34%)	(32%)					
NRE	5.7	7.7	7.9	8.2	9.4	3.1	0.4	0.4	0.9	0.7
	(12%)	(14%)	(14%)	(14%)	(14%)					
Electricity	14.4	17.5	18.2	19.4	24.0	1.9	0.8	0.6	1.4	1.1
	(31%)	(32%)	(32%)	(32%)	(35%)					
Heat	0.6	0.8	0.9	0.9	1.0	2.5	1.6	0.4	0.9	0.7
	(1%)	(1%)	(2%)	(2%)	(2%)					
Transportation	**44.0**	**53.2**	**56.5**	**58.7**	**64.3**	**1.9**	**1.2**	**0.4**	**0.6**	**0.5**
Coal										
Oil	40.9	47.9	51.7	53.6	58.3	1.6	1.5	0.4	0.6	0.5
	(93%)	(90%)	(91%)	(91%)	(91%)					
Gas	2.9	4.8	4.3	4.5	5.2	5.1	- 2.0	0.4	1.0	0.8
	(7%)	(9%)	(8%)	(8%)	(8%)					
NRE		0.1	0.2	0.2	0.2		5.0	0.7	1.5	1.2
		(0%)	(0%)	(0%)	(0%)					
Electricity	0.3	0.4	0.4	0.4	0.5	3.3	- 1.2	1.4	1.4	1.4
	(1%)	(1%)	(1%)	(1%)	(1%)					
Other	**53.8**	**62.5**	**66.0**	**70.5**	**89.3**	**1.5**	**1.1**	**0.7**	**1.6**	**1.2**
Coal	0.1					- 3.2	- 1.1	- 1.5	0.0	- 0.6
	(0%)									
Oil	10.7	11.8	13.2	14.4	21.5	1.0	2.3	0.9	2.7	2.0
	(20%)	(19%)	(20%)	(20%)	(24%)					
Gas	20.2	25.3	25.2	25.9	30.1	2.3	- 0.1	0.3	1.0	0.7
	(37%)	(40%)	(38%)	(37%)	(34%)					
NRE	1.6	1.8	2.0	2.2	2.8	1.3	2.0	0.8	1.6	1.3
	(3%)	(3%)	(3%)	(3%)	(3%)					
Electricity	21.2	23.5	25.5	27.8	34.7	1.0	1.6	0.9	1.5	1.2
	(39%)	(38%)	(39%)	(39%)	(39%)					
Heat			0.1	0.1	0.1	4.8		0.8	1.6	1.3
			(0%)	(0%)	(0%)					
Non-Energy Use	**15.0**	**20.0**	**24.0**	**28.1**	**40.4**	**2.9**	**3.7**	**1.6**	**2.5**	**2.1**
Coal	0.3	0.3	0.4			- 2.1	8.4			
	(2%)	(1%)	(2%)							
Oil	11.3	15.6	20.2	24.5	36.6	3.3	5.2	2.0	2.7	2.4
	(75%)	(78%)	(84%)	(87%)	(91%)					
Gas	3.4	4.1	3.4	3.5	3.8	1.9	- 3.6	0.4	0.5	0.5
	(23%)	(20%)	(14%)	(13%)	(9%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**481.9**	**605.5**	**625.9**	**687.5**	**862.3**	**2.3**	**0.7**	**0.9**	**1.5**	**1.3**
Coal	82.2	117.6	110.0	66.9	85.5	3.6	- 1.3	- 4.9	1.7	- 1.0
	(17%)	(19%)	(18%)	(10%)	(10%)					
Oil	16.5	14.7	15.3	15.6	13.7	- 1.1	0.8	0.2	- 0.9	- 0.4
	(3%)	(2%)	(2%)	(2%)	(2%)					
Gas	9.7	33.5	34.4	103.7	146.3	13.2	0.5	11.7	2.3	6.0
	(2%)	(6%)	(5%)	(15%)	(17%)					
Hydro	296.7	358.5	363.6	380.1	438.4	1.9	0.3	0.4	1.0	0.8
	(62%)	(59%)	(58%)	(55%)	(51%)					
NRE	3.9	8.4	10.6	25.6	53.4	8.0	4.7	9.2	5.0	6.7
	(1%)	(1%)	(2%)	(4%)	(6%)					
Nuclear	73.0	72.8	92.0	95.6	125.0	- 0.0	4.8	0.4	1.8	1.2
	(15%)	(12%)	(15%)	(14%)	(14%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**104,160**	**110,679**	**122,884**	**142,859**	**183,810**	**0.6**	**2.1**	**1.5**	**1.7**	**1.6**
Thermal	30 300	31 327	35 029	43 956	59 263	0.3	2.3	2.3	2.0	2.1
	(29%)	(28%)	(29%)	(31%)	(32%)					
Coal	17 710	17 503	17 469	11 169	15 076	- 0.1	- 0.0	- 4.4	2.0	- 0.6
	(17%)	(16%)	(14%)	(8%)	(8%)					
Oil	7 160	7 146	5 318	4 945	4 435	- 0.0	- 5.7	- 0.7	- 0.7	- 0.7
	(7%)	(6%)	(4%)	(3%)	(2%)					
Gas	5 430	6 678	12 242	27 841	39 751	2.1	12.9	8.6	2.4	4.8
	(5%)	(6%)	(10%)	(19%)	(22%)					
Hydro	59 380	67 407	71 757	76 388	87 498	1.3	1.3	0.6	0.9	0.8
	(57%)	(61%)	(58%)	(53%)	(48%)					
NRE	940	1 330	2 753	7 113	17 279	3.5	15.7	10.0	6.1	7.6
	(1%)	(1%)	(2%)	(5%)	(9%)					
Nuclear	13 540	10 615	13 345	15 402	19 771	- 2.4	4.7	1.4	1.7	1.6
	(13%)	(10%)	(11%)	(11%)	(11%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	280	253	242	216	172	- 1.0	- 0.9	- 1.2	- 1.5	- 1.4
Primary Energy Supply per Capita (kgoe per capita)	7 539	8 193	8 469	8 435	9 089	0.8	0.7	- 0.0	0.5	0.3
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	214	191	181	157	127	- 1.1	- 1.1	- 1.4	- 1.4	- 1.4
Final Energy Demand per Capita (kgoe per capita)	5 756	6 196	6 318	6 161	6 705	0.7	0.4	- 0.3	0.6	0.2
CO_2 Emissions (million tonnes)	**426**	**522**	**545**	**574**	**666**	**2.1**	**0.9**	**0.5**	**1.0**	**0.8**
Sector										
Electricity and Heat Generation	100	137	124	117	150	3.2	- 1.9	- 0.6	1.7	0.8
Refineries and Other Energy Sector	45	56	71	94	98	2.4	4.6	2.9	0.3	1.3
Industry	71	77	83	84	91	0.9	1.5	0.1	0.6	0.4
Transport	130	156	167	174	190	1.8	1.4	0.4	0.6	0.5
Other	80	95	99	105	136	1.7	0.9	0.5	1.8	1.3
Fuel										
Coal	101	129	114	76	91	2.5	- 2.4	- 4.0	1.2	- 0.9
Oil	207	230	264	273	319	1.1	2.8	0.3	1.0	0.8
Gas	118	162	166	224	256	3.3	0.5	3.0	0.9	1.7
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	570	524	482	416	322	- 0.8	- 1.7	- 1.5	- 1.7	- 1.6
CO_2 Emissions per Capita (tonnes per capita)	15. 3	17.	16. 9	16. 3	17.	1.0	- 0.1	- 0.3	0.3	0.0

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	33.1	147.4		154.0	31.3	24.0	12.3			402.1
Net Imports	(3.1)	(41.0)	(8.9)	(73.4)			0.0	(2.1)	0.0	(128.4)
Primary Energy Supply	**30.0**	**106.4**	**(8.9)**	**80.6**	**31.3**	**24.0**	**12.3**	**(2.1)**	**0.0**	**273.7**
Transfers and Statistical Diff.	(1.1)	(4.8)	10.3	(4.9)			0.0	0.0	0.0	(0.5)
Electricity and Heat Gen.	(24.2)		(3.3)	(7.5)	(31.3)	(24.0)	(2.2)	53.8	0.9	(37.7)
Petroleum Refineries		(101.6)	104.8							3.2
Other Energy Sector	(1.2)		(9.1)	(16.6)			0.0	(7.7)	0.0	(34.5)
Final Energy Demand	**3.6**		**93.9**	**51.6**			**10.1**	**44.0**	**0.9**	**204.2**
Industry	3.2		8.8	18.8			7.9	18.2	0.9	57.7
Transport	0.0		51.7	4.3			0.2	0.4		56.5
Other	0.0		13.2	25.2			2.0	25.5	0.1	66.0
Non-Energy Use	0.4		20.2	3.4			0.0			24.0

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	34.7	160.4		141.3	32.7	24.9	12.9			406.9
Net Imports	(15.7)	(52.0)	1.7	(40.1)			(0.1)	(3.2)	0.0	(109.5)
Primary Energy Supply	**19.1**	**108.4**	**1.7**	**101.1**	**32.7**	**24.9**	**12.8**	**(3.2)**	**0.0**	**297.4**
Electricity and Heat Gen.	(14.7)		(3.3)	(20.9)	(32.7)	(24.9)	(2.2)	59.1	1.0	(38.7)
Petroleum Refineries		(108.4)	111.8							3.5
Other Energy Sector	(1.2)		(9.7)	(25.8)			0.0	(8.2)	0.0	(45.0)
Final Energy Demand	**3.1**		**100.6**	**54.4**			**10.6**	**47.6**	**1.0**	**217.3**
Industry	3.1		8.0	20.4			8.2	19.4	0.9	60.0
Transport	0.0		53.6	4.5			0.2	0.4		58.7
Other	0.0		14.4	25.9			2.2	27.8	0.1	70.5
Non-Energy Use	0.0		24.5	3.5			0.0			28.1

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	32.6	190.3		149.6	37.7	32.6	17.1			459.9
Net Imports	(9.7)	(57.1)	3.0	(34.6)			(0.1)	(5.1)	0.0	(103.7)
Primary Energy Supply	**22.9**	**133.2**	**3.0**	**115.0**	**37.7**	**32.6**	**17.0**	**(5.1)**	**0.0**	**356.3**
Electricity and Heat Gen.	(18.7)		(2.9)	(28.9)	(37.7)	(32.6)	(4.6)	74.1	1.1	(50.1)
Petroleum Refineries		(133.2)	137.5							4.3
Other Energy Sector	(1.1)		(11.9)	(24.8)			0.0	(9.8)	0.0	(47.6)
Final Energy Demand	**3.0**		**125.6**	**61.4**			**12.4**	**59.2**	**1.1**	**262.8**
Industry	3.0		9.1	22.3			9.4	24.0	1.0	68.9
Transport	0.0		58.3	5.2			0.2	0.5		64.3
Other	0.0		21.5	30.1			2.8	34.7	0.1	89.3
Non-Energy Use	0.0		36.6	3.8			0.0			40.4

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
522 - 719	1.3 - 1.8	0.3 - 0.4	1.0 - 1.4

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
113 - 163	212 - 291	180 - 242	17 - 23

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
165 - 233	104 - 143	12 - 16	241 - 328

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
241 - 328	140 - 187	86 - 121	15 - 20

CHILE

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	87	162	200	274	438	6.4	4.2	3.2	3.2	3.2
Population (million)	13	15	16	18	20	1.6	1.1	0.9	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	6 623	10 529	12 248	15 354	22 241	4.7	3.1	2.3	2.5	2.4

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**7.6**	**8.4**	**9.5**	**10.8**	**15.5**	**1.0**	**2.5**	**1.3**	**2.4**	**2.0**
Coal	1.5	0.2	0.4	0.5	0.6	- 16.4	8.2	3.7	0.7	1.9
	(20%)	(3%)	(4%)	(5%)	(4%)					
Oil	1.1	0.4	0.3	0.1	0.1	- 9.1	- 5.1	- 11.2	- 1.9	- 5.7
	(14%)	(5%)	(3%)	(1%)	(0%)					
Gas	1.5	1.8	1.8	1.3	1.3	1.6	0.2	- 3.1	0.0	- 1.2
	(19%)	(21%)	(19%)	(12%)	(8%)					
Hydro	0.9	1.8	2.5	2.7	3.1	7.2	7.0	0.9	1.1	1.0
	(11%)	(21%)	(26%)	(25%)	(20%)					
NRE	2.7	4.3	4.6	6.2	10.4	4.8	1.6	3.0	3.5	3.3
	(35%)	(50%)	(48%)	(57%)	(67%)					
Nuclear										
Net Import	**6.4**	**17.5**	**20.0**	**33.0**	**51.5**	**10.6**	**2.7**	**5.1**	**3.0**	**3.8**
Coal	1.1	3.0	3.3	4.8	8.8	10.8	1.5	4.0	4.1	4.1
Oil	5.3	10.8	11.3	17.3	22.8	7.3	0.9	4.4	1.8	2.8
Gas		3.7	5.3	10.6	19.7		7.5	7.3	4.2	5.4
Electricity			0.2	0.2	0.2			0.0	0.0	0.0
Primary Energy Supply	**14.1**	**26.0**	**29.5**	**43.8**	**67.0**	**6.3**	**2.6**	**4.0**	**2.9**	**3.3**
Coal	2.6	3.3	3.6	5.3	9.4	2.4	2.1	4.0	3.83	3.9
	(18%)	(13%)	(12%)	(12%)	(14%)					
Oil	6.4	11.2	11.6	17.4	22.9	5.7	0.7	4.1	1.8	2.7
	(46%)	(43%)	(39%)	(40%)	(34%)					
Gas	1.5	5.4	7.0	11.9	21.0	13.8	5.4	5.4	3.8	4.5
	(11%)	(21%)	(24%)	(27%)	(31%)					
Hydro	0.9	1.8	2.5	2.7	3.1	7.2	7.0	0.9	1.1	1.0
	(6%)	(7%)	(8%)	(6%)	(5%)					
NRE	2.7	4.3	4.6	6.2	10.4	4.8	1.6	3.0	3.5	3.3
	(19%)	(16%)	(16%)	(14%)	(16%)					
Nuclear										
Input for Electricity and Heat Generation	**-3.2**	**-6.3**	**-8.7**	**-13.0**	**-22.9**	**7.0**	**6.7**	**4.1**	**3.8**	**3.9**
Coal	- 1.7	- 2.3	- 2.6	- 4.1	- 8.0	2.9	2.6	4.8	4.5	4.6
	(53%)	(36%)	(30%)	(32%)	(35%)					
Oil	- 0.5	- 0.3	- 0.4	- 0.5	- 0.8	- 4.5	5.7	3.2	2.2	2.6
	(15%)	(5%)	(5%)	(4%)	(3%)					
Gas	- 0.1	- 1.7	- 2.7	- 5.6	- 10.9	38.6	10.4	7.5	4.6	5.7
	(2%)	(26%)	(31%)	(43%)	(48%)					
Hydro	- 0.9	- 1.8	- 2.5	- 2.7	- 3.1	7.2	7.0	0.9	1.1	1.0
	(27%)	(28%)	(28%)	(21%)	(14%)					
NRE	- 0.1	- 0.3	- 0.6	- 0.1	- 0.1	13.4	11.6	- 16.1	0.0	- 6.8
	(3%)	(5%)	(7%)	(1%)	(0%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-1.3**	**-2.7**	**-3.3**	**-3.8**	**-4.6**	**7.3**	**4.3**	**1.4**	**1.2**	**1.3**
Coal	- 0.1	- 0.3	- 0.3	- 0.4	- 0.4	8.0	- 1.8	3.88	0.7	2.0
Oil	- 0.5	- 1.6	- 1.7	- 2.1	- 2.3	13.2	2.3	1.7	0.8	1.2
Gas	- 0.5	- 0.4	- 0.6	- 0.4	- 0.4	- 0.7	5.7	- 3.1	0.0	- 1.2
NRE						- 12.0				
Electricity	- 0.3	- 0.4	- 0.7	- 1.0	- 1.4	4.7	13.0	2.6	2.4	2.5
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**11.1**	**20.5**	**22.2**	**33.9**	**51.1**	**6.3**	**1.5**	**4.3**	**2.8**	**3.4**
Coal	0.7	0.7	0.8	0.8	1.0	- 0.3	1.8	0.7	1.1	0.9
	(7%)	(3%)	(4%)	(2%)	(2%)					
Oil	5.5	9.4	9.5	14.8	19.8	5.4	0.1	4.6	1.9	3.0
	(50%)	(46%)	(43%)	(44%)	(39%)					
Gas	1.0	3.3	3.8	5.9	9.6	13.4	2.4	4.7	3.3	3.8
	(9%)	(16%)	(17%)	(17%)	(19%)					
NRE	2.6	3.9	4.0	6.1	10.3	4.3	0.5	4.2	3.6	3.8
	(23%)	(19%)	(18%)	(18%)	(20%)					
Electricity	1.3	3.1	4.1	6.2	10.5	9.0	5.6	4.1	3.6	3.8
	(12%)	(15%)	(19%)	(18%)	(20%)					
Heat										
Industry	**4.4**	**9.1**	**9.9**	**15.5**	**25.9**	**7.5**	**1.9**	**4.6**	**3.5**	**3.9**
Coal	0.7	0.7	0.8	0.8	1.0	0.3	1.8	0.7	1.1	0.9
	(15%)	(8%)	(8%)	(5%)	(4%)					
Oil	1.4	2.1	2.0	3.0	4.2	3.7	- 0.1	4.0	2.2	2.9
	(32%)	(23%)	(20%)	(19%)	(16%)					
Gas	0.7	3.0	3.2	5.2	8.5	14.9	1.6	4.8	3.4	4.0
	(17%)	(33%)	(33%)	(33%)	(33%)					
NRE	0.7	1.1	1.1	2.2	4.6	5.3	- 0.1	7.2	5.0	5.9
	(15%)	(12%)	(11%)	(14%)	(18%)					
Electricity	0.9	2.2	2.8	4.3	7.6	9.7	4.8	4.4	3.9	4.1
	(20%)	(24%)	(28%)	(28%)	(29%)					
Heat										
Transportation	**3.2**	**6.0**	**6.3**	**11.3**	**15.8**	**6.6**	**1.1**	**6.0**	**2.3**	**3.7**
Coal										
Oil	3.1	5.9	6.3	10.8	14.5	6.6	1.0	5.6	2.0	3.4
	(99%)	(100%)	(99%)	(95%)	(92%)					
Gas						2.9	31.1	2.2	1.3	1.7
NRE				0.4	1.2				7.0	
				(4%)	(8%)					
Electricity						0.5	3.0	3.0	0.8	1.7
Other	**3.5**	**5.5**	**5.9**	**7.0**	**9.4**	**4.5**	**1.5**	**1.8**	**1.9**	**1.9**
Coal	0.1					- 16.1	5.4	- 2.6	0.0	- 1.0
	(2%)									
Oil	0.9	1.4	1.2	1.1	1.1	4.1	- 3.7	- 0.9	0.1	- 0.3
	(27%)	(26%)	(20%)	(15%)	(12%)					
Gas	0.2	0.3	0.5	0.7	1.0	5.4	7.6	3.6	2.7	3.0
	(6%)	(6%)	(8%)	(10%)	(11%)					
NRE	1.9	2.8	2.9	3.4	4.4	4.0	0.8	1.5	1.8	1.7
	(53%)	(51%)	(49%)	(48%)	(47%)					
Electricity	0.4	0.9	1.3	1.9	2.8	7.8	7.4	3.5	2.8	3.1
	(12%)	(17%)	(23%)	(27%)	(30%)					
Heat										
Non-Energy Use										
Coal										
Oil										
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**18.4**	**41.3**	**54.5**	**80.9**	**135.2**	**8.4**	**5.7**	**4.0**	**3.5**	**3.7**
Coal	6.3	8.6	8.3	15.3	32.4	3.2	- 0.7	6.3	5.1	5.6
	(34%)	(21%)	(15%)	(19%)	(24%)					
Oil	1.4	1.4	1.7	2.2	3.0	- 0.1	4.2	2.5	2.2	2.3
	(8%)	(3%)	(3%)	(3%)	(2%)					
Gas	0.2	10.1	15.0	31.0	62.1	45.1	8.2	7.6	4.7	5.9
	(1%)	(24%)	(27%)	(38%)	(46%)					
Hydro	10.2	20.4	28.6	31.3	36.6	7.2	7.0	0.9	1.1	1.0
	(55%)	(49%)	(52%)	(39%)	(27%)					
NRE	0.3	0.8	0.9	1.2	1.2	11.1	2.8	2.5	0.0	1.0
	(1%)	(2%)	(2%)	(1%)	(1%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**2,421**	**4,339**	**11,982**	**19,397**	**35,109**	**6.0**	**22.5**	**4.9**	**4.0**	**4.4**
Thermal			7 009	13 589	27 222			6.8	4.7	5.6
			(58%)	(70%)	(78%)					
Coal			2 143	3 936	8 331			6.3	5.1	5.6
			(18%)	(20%)	(24%)					
Oil			554	711	985			2.5	2.2	2.3
			(5%)	(4%)	(3%)					
Gas			4 312	8 943	17 906			7.6	4.7	5.9
			(36%)	(46%)	(51%)					
Hydro	2 421	4 128	4 726	5 170	6 050	5.5	2.7	0.9	1.1	1.0
	(100%)	(95%)	(39%)	(27%)	(17%)					
NRE		211	248	638	1 837		3.3	9.9	7.3	8.3
		(5%)	(2%)	(3%)	(5%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	161	160	148	160	153	- 0.1	- 1.5	0.8	- 0.3	0.1
Primary Energy Supply per Capita (kgoe per capita)	1 067	1 684	1 813	2 453	3 403	4.7	1.5	3.1	2.2	2.6
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	127	126	111	124	117	- 0.1	- 2.6	1.1	- 0.4	0.2
Final Energy Demand per Capita (kgoe per capita)	844	1 332	1 360	1 898	2 598	4.7	0.4	3.4	2.1	2.6
CO_2 Emissions (million tonnes)	**33**	**59**	**61**	**95**	**148**	**6.0**	**0.9**	**4.5**	**2.9**	**3.6**
Sector										
Electricity and Heat Generation	8	14	18	31	59	5.0	5.2	5.7	4.4	4.9
Refineries and Other Energy Sector	3	7	4	5	5	8.7	- 8.7	1.2	0.6	0.9
Industry	9	16	17	25	36	6.1	1.0	3.8	2.7	3.1
Transport	9	17	17	30	40	6.6	0.9	5.6	2.0	3.4
Other	4	5	5	5	6	3.7	- 1.6	0.3	1.0	0.7
Fuel										
Coal	10	13	14	21	38	2.4	2.1	4.0	3.8	3.9
Oil	19	33	31	47	62	5.7	- 1.6	4.3	1.9	2.8
Gas	3	12	16	27	48	13.8	5.4	5.4	3.8	4.5
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	375	362	307	348	337	- 0.4	- 3.2	1.3	- 0.2	0.4
CO_2 Emissions per Capita (tonnes per capita)	2. 5	3. 8	3. 8	5. 3	7. 5	4.4	- 0.3	3.6	2.3	2.8

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.4	0.3		1.8	2.5	0.0	4.6			9.5
Net Imports	3.3	11.3	(0.0)	5.3			(0.0)	0.2	0.0	20.0
Primary Energy Supply	**3.6**	**11.7**	**(0.0)**	**7.0**	**2.5**	**0.0**	**4.6**	**0.2**	**0.0**	**29.5**
Transfers and Statistical Diff.	(0.0)	(0.1)	0.1	0.0			0.0	0.0	0.0	(0.0)
Electricity and Heat Gen.	(2.6)		(0.4)	(2.7)	(2.5)	0.0	(0.6)	4.7	0.0	(4.0)
Petroleum Refineries		(11.5)	10.5							(1.1)
Other Energy Sector	(0.3)		(0.7)	(0.6)			0.0	(0.7)	0.0	(2.2)
Final Energy Demand	**0.8**		**9.5**	**3.8**			**4.0**	**4.1**	**0.0**	**22.2**
Industry	0.8		2.0	3.2			1.1	2.8	0.0	9.9
Transport	0.0		6.3	0.0			0.0	0.0		6.3
Other	0.0		1.2	0.5			2.9	1.3	0.0	5.9
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.5	0.1		1.3	2.7	0.0	6.2			10.8
Net Imports	4.8	13.4	3.9	10.6			0.0	0.2	0.0	33.0
Primary Energy Supply	**5.3**	**13.5**	**3.9**	**11.9**	**2.7**	**0.0**	**6.2**	**0.2**	**0.0**	**43.8**
Electricity and Heat Gen.	(4.1)		(0.5)	(5.6)	(2.7)	0.0	(0.1)	7.0	0.0	(6.1)
Petroleum Refineries		(13.5)	12.2							(1.3)
Other Energy Sector	(0.4)		(0.8)	(0.4)			0.0	(1.0)	0.0	(2.6)
Final Energy Demand	**0.8**		**14.8**	**5.9**			**6.1**	**6.2**	**0.0**	**33.9**
Industry	0.8		3.0	5.2			2.2	4.3	0.0	15.5
Transport	0.0		10.8	0.0			0.4	0.0		11.3
Other	0.0		1.1	0.7			3.4	1.9	0.0	7.0
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.6	0.1		1.3	3.1	0.0	10.4			15.5
Net Imports	8.8	15.2	7.6	19.7			0.0	0.2	0.0	51.5
Primary Energy Supply	**9.4**	**15.3**	**7.6**	**21.0**	**3.1**	**0.0**	**10.4**	**0.2**	**0.0**	**67.0**
Electricity and Heat Gen.	(8.0)		(0.8)	(10.9)	(3.1)	0.0	(0.1)	11.6	0.0	(11.3)
Petroleum Refineries		(15.3)	13.9							(1.4)
Other Energy Sector	(0.4)		(0.9)	(0.4)			0.0	(1.4)	0.0	(3.1)
Final Energy Demand	**1.0**		**19.8**	**9.6**			**10.3**	**10.5**	**0.0**	**51.1**
Industry	1.0		4.2	8.5			4.6	7.6	0.0	25.9
Transport	0.0		14.5	0.0			1.2	0.0		15.8
Other	0.0		1.1	1.0			4.4	2.8	0.0	9.4
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
51 - 72	0.6 - 0.9	.. - ..	0.6 - 0.9

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
0.5 - 0.7	20.9 - 28.2	24.1 - 35.7	5.7 - 7.4

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
8.4 - 11.7	6.3 - 9.1	0.3 - 0.4	36 - 51

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
36 - 51	15 - 21	16 - 23	5 - 7

CHINA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	1 252	3 376	5 333	11 214	23 305	10.4	9.6	7.7	5.0	6.1
Population (million)	1 143	1 267	1 308	1 383	1 452	1.0	0.6	0.6	0.3	0.4
GDP per Capita (2005 US$ PPP per capita)	1 095	2 664	4 079	8 109	16 046	9.3	8.9	7.1	4.7	5.6

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**886.3**	**1,074.0**	**1,643.9**	**2,210.7**	**2,709.7**	**1.9**	**8.9**	**3.0**	**1.4**	**2.0**
Coal	523.8	649.4	1 145.3	1 552.0	1 820.0	2.2	12.0	3.1	1.1	1.9
	(59%)	(60%)	(70%)	(70%)	(67%)					
Oil	138.3	163.1	181.4	195.0	190.0	1.7	2.2	0.7	- 0.2	0.2
	(16%)	(15%)	(11%)	(9%)	(7%)					
Gas	12.8	22.8	42.6	93.6	103.5	5.9	13.4	8.2	0.7	3.6
	(1%)	(2%)	(3%)	(4%)	(4%)					
Hydro	10.9	19.1	34.1	62.7	72.3	5.8	12.3	6.3	1.0	3.0
	(1%)	(2%)	(2%)	(3%)	(3%)					
NRE	200.4	215.3	226.5	251.7	293.2	0.7	1.0	1.1	1.0	1.0
	(23%)	(20%)	(14%)	(11%)	(11%)					
Nuclear		4.4	13.8	55.8	230.7		26.0	15.0	9.9	11.9
		(0%)	(1%)	(3%)	(9%)					
Net Import	**-23.0**	**31.9**	**76.2**	**229.7**	**571.1**		**19.0**	**11.7**	**6.3**	**8.4**
Coal	4.7	- 23.7	- 57.7	- 62.7	- 68.5		19.5	0.8	0.6	0.7
Oil	- 27.9	58.3	137.0	291.8	486.5		18.6	7.9	3.5	5.2
Gas		- 2.0	- 2.5	1.4	154.2		4.4			
Electricity	0.2	- 0.7	- 0.5	- 0.9	- 1.2		- 5.8	4.9	2.2	3.3
Primary Energy Supply	**863.2**	**1,105.9**	**1,720.1**	**2,440.4**	**3,280.8**	**2.5**	**9.2**	**3.6**	**2.0**	**2.6**
Coal	528.5	625.6	1 087.6	1 489.3	1 751.5	1.7	11.7	3.2	1.09	1.9
	(61%)	(57%)	(63%)	(61%)	(53%)					
Oil	110.4	221.4	318.4	486.8	676.5	7.2	7.5	4.3	2.2	3.1
	(13%)	(20%)	(19%)	(20%)	(21%)					
Gas	12.8	20.8	40.1	95.0	257.7	4.9	14.1	9.0	6.9	7.7
	(1%)	(2%)	(2%)	(4%)	(8%)					
Hydro	10.9	19.1	34.1	62.7	72.3	5.8	12.3	6.3	1.0	3.0
	(1%)	(2%)	(2%)	(3%)	(2%)					
NRE	200.4	215.3	226.5	251.7	293.2	0.7	1.0	1.1	1.0	1.0
	(23%)	(19%)	(13%)	(10%)	(9%)					
Nuclear		4.4	13.8	55.8	230.7		26.0	15.0	9.9	11.9
		(0%)	(1%)	(2%)	(7%)					
Input for Electricity and Heat Generation	**-174.6**	**-358.2**	**-670.7**	**-1,042.8**	**-1,574.7**	**7.5**	**13.4**	**4.5**	**2.8**	**3.5**
Coal	- 146.9	- 315.0	- 598.7	- 878.9	-1 133.8	7.9	13.7	3.9	1.7	2.6
	(84%)	(88%)	(89%)	(84%)	(72%)					
Oil	- 16.0	- 15.8	- 17.9	- 7.6	- 8.4	- 0.1	2.6	- 8.3	0.7	- 3.0
	(9%)	(4%)	(3%)	(1%)	(1%)					
Gas	- 0.8	- 2.5	- 4.6	- 15.8	- 78.2	11.5	13.2	13.2	11.3	12.0
	(0%)	(1%)	(1%)	(2%)	(5%)					
Hydro	- 10.9	- 19.1	- 34.1	- 62.7	- 72.3	5.8	12.3	6.3	1.0	3.0
	(6%)	(5%)	(5%)	(6%)	(5%)					
NRE		- 1.4	- 1.5	- 22.2	- 51.3		2.4	30.5	5.8	15.0
		(0%)	(0%)	(2%)	(3%)					
Nuclear		- 4.4	- 13.8	- 55.8	- 230.7		26.0	15.0	9.9	11.9
		(1%)	(2%)	(5%)	(15%)					
Input for Refineries and Other Energy Sector	**-68.3**	**-120.9**	**-208.3**	**-306.6**	**-397.5**	**5.9**	**11.5**	**3.9**	**1.7**	**2.6**
Coal	- 41.3	- 60.4	- 122.9	- 166.6	- 195.4	3.9	15.3	3.09	1.1	1.9
Oil	- 11.2	- 22.7	- 28.8	- 49.0	- 67.7	7.3	4.9	5.4	2.2	3.5
Gas	- 1.9	- 2.3	- 2.4	- 5.2	- 5.8	1.8	0.6	8.2	0.7	3.6
NRE										
Electricity	- 12.2	- 26.1	- 42.9	- 67.7	- 100.0	7.9	10.5	4.7	2.6	3.4
Heat	- 1.7	- 9.4	- 11.3	- 18.0	- 28.6	18.3	3.7	4.8	3.1	3.8

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**663.1**	**780.3**	**1,116.2**	**1,534.8**	**1,995.4**	**1.6**	**7.4**	**3.2**	**1.8**	**2.4**
Coal	314.7	257.2	373.3	443.8	422.4	- 2.0	7.7	1.7	- 0.3	0.5
	(47%)	(33%)	(33%)	(29%)	(21%)					
Oil	83.5	178.9	271.2	430.3	600.4	7.9	8.7	4.7	2.2	3.2
	(13%)	(23%)	(24%)	(28%)	(30%)					
Gas	9.7	14.9	31.9	74.0	173.7	4.3	16.5	8.8	5.9	7.0
	(1%)	(2%)	(3%)	(5%)	(9%)					
NRE	200.4	213.9	225.0	229.5	241.9	0.7	1.0	0.2	0.4	0.3
	(30%)	(27%)	(20%)	(15%)	(12%)					
Electricity	41.4	89.9	171.5	288.0	446.8	8.1	13.8	5.3	3.0	3.9
	(6%)	(12%)	(15%)	(19%)	(22%)					
Heat	13.2	25.5	43.4	69.2	110.1	6.8	11.2	4.8	3.1	3.8
	(2%)	(3%)	(4%)	(5%)	(6%)					
Industry	**240.6**	**292.7**	**477.2**	**650.9**	**725.7**	**2.0**	**10.3**	**3.2**	**0.7**	**1.7**
Coal	177.1	182.3	279.8	349.5	335.7	0.3	8.9	2.3	- 0.3	0.7
	(74%)	(62%)	(59%)	(54%)	(46%)					
Oil	20.0	29.2	39.7	45.7	42.5	3.9	6.4	1.4	- 0.5	0.3
	(8%)	(10%)	(8%)	(7%)	(6%)					
Gas	3.2	5.5	12.4	29.8	54.4	5.5	17.5	9.2	4.1	6.1
	(1%)	(2%)	(3%)	(5%)	(7%)					
NRE										
Electricity	29.5	56.9	116.2	182.7	230.0	6.8	15.3	4.6	1.5	2.8
	(12%)	(19%)	(24%)	(28%)	(32%)					
Heat	10.7	18.8	29.2	43.3	63.1	5.8	9.1	4.0	2.5	3.1
	(4%)	(6%)	(6%)	(7%)	(9%)					
Transportation	**37.2**	**73.8**	**114.2**	**201.4**	**335.2**	**7.1**	**9.1**	**5.8**	**3.5**	**4.4**
Coal	9.9	5.5	4.1	3.6	3.6	- 5.7	- 5.7	- 1.2	- 0.0	- 0.5
	(27%)	(7%)	(4%)	(2%)	(1%)					
Oil	26.7	66.9	108.3	190.7	311.1	9.6	10.1	5.8	3.3	4.3
	(72%)	(91%)	(95%)	(95%)	(93%)					
Gas		0.2	0.1	0.1	0.2	16.4	- 16.2	2.2	3.4	2.9
		(0%)	(0%)	(0%)	(0%)					
NRE				4.5	16.9				9.2	
				(2%)	(5%)					
Electricity	0.5	1.2	1.7	2.4	3.3	8.8	8.0	3.3	2.2	2.6
	(1%)	(2%)	(2%)	(1%)	(1%)					
Other	**342.5**	**362.4**	**433.5**	**567.4**	**805.7**	**0.6**	**3.6**	**2.7**	**2.4**	**2.5**
Coal	108.6	60.8	67.4	70.7	70.8	- 5.6	2.1	0.5	0.0	0.2
	(32%)	(17%)	(16%)	(12%)	(9%)					
Oil	17.8	44.2	61.3	106.4	138.4	9.5	6.7	5.7	1.8	3.3
	(5%)	(12%)	(14%)	(19%)	(17%)					
Gas	1.9	5.0	12.1	36.6	111.1	10.4	19.1	11.7	7.7	9.3
	(1%)	(1%)	(3%)	(6%)	(14%)					
NRE	200.4	213.9	225.0	225.0	225.0	0.7	1.0	- 0.0	0.0	- 0.0
	(59%)	(59%)	(52%)	(40%)	(28%)					
Electricity	11.4	31.8	53.6	102.8	213.5	10.8	11.0	6.7	5.0	5.7
	(3%)	(9%)	(12%)	(18%)	(26%)					
Heat	2.5	6.7	14.2	26.0	47.0	10.4	16.4	6.2	4.0	4.9
	(1%)	(2%)	(3%)	(5%)	(6%)					
Non-Energy Use	**42.8**	**51.4**	**91.3**	**115.0**	**128.8**	**1.8**	**12.2**	**2.3**	**0.8**	**1.4**
Coal	19.2	8.7	22.1	20.0	12.2	- 7.6	20.5	- 1.0	- 3.2	- 2.4
	(45%)	(17%)	(24%)	(17%)	(9%)					
Oil	19.0	38.6	61.8	87.5	108.5	7.3	9.9	3.5	1.4	2.3
	(44%)	(75%)	(68%)	(76%)	(84%)					
Gas	4.6	4.1	7.3	7.6	8.2	- 1.1	12.3	0.3	0.5	0.4
	(11%)	(8%)	(8%)	(7%)	(6%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**621.2**	**1,356.2**	**2,499.6**	**4,146.5**	**6,373.5**	**8.1**	**13.0**	**5.2**	**2.9**	**3.8**
Coal	442.8	1 062.1	1 972.3	3 065.9	4 007.1	9.1	13.2	4.5	1.8	2.9
	(71%)	(78%)	(79%)	(74%)	(63%)					
Oil	49.0	46.1	60.6	24.1	30.4	- 0.6	5.6	- 8.8	1.6	- 2.7
	(8%)	(3%)	(2%)	(1%)						
Gas	2.8	5.8	11.9	38.5	291.4	7.6	15.7	12.4	14.5	13.6
				(1%)	(5%)					
Hydro	126.7	222.4	397.0	728.8	841.0	5.8	12.3	6.3	1.0	3.0
	(20%)	(16%)	(16%)	(18%)	(13%)					
NRE		3.1	4.6	73.2	310.1		8.6	31.8	10.1	18.3
				(2%)	(5%)					
Nuclear		16.7	53.1	215.9	893.5		26.0	15.1	9.9	12.0
		(1%)	(2%)	(5%)	(14%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**143,597**	**325,017**	**524,383**	**918,114**	**1,460,302**	**8.5**	**10.0**	**5.8**	**3.1**	**4.2**
Thermal	107 547	243 237	397 087	604 064	881 002	8.5	10.3	4.3	2.5	3.2
	(75%)	(75%)	(76%)	(66%)	(60%)					
Coal	101 840	237 120	380 910	583 321	762 393	8.8	9.9	4.4	1.8	2.8
	(71%)	(73%)	(73%)	(64%)	(52%)					
Oil	5 707	5 707	5 707	6 107	7 720	0.0	0.0	0.7	1.6	1.2
	(4%)	(2%)	(1%)	(1%)	(1%)					
Gas		410	10 470	14 636	110 889			3.4	14.5	9.9
			(2%)	(2%)	(8%)					
Hydro	36 050	79 350	117 390	260 000	320 000	8.2	8.1	8.3	1.4	4.1
	(25%)	(24%)	(22%)	(28%)	(22%)					
NRE		330	3 060	25 050	139 300			23.4	12.1	16.5
			(1%)	(3%)	(10%)					
Nuclear		2 100	6 846	29 000	120 000		26.7	15.5	9.9	12.1
		(1%)	(1%)	(3%)	(8%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	689	328	323	218	141	- 7.2	- 0.3	- 3.9	- 2.9	- 3.3
Primary Energy Supply per Capita (kgoe per capita)	755	873	1 315	1 765	2 259	1.5	8.6	3.0	1.7	2.2
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	529	231	209	137	86	- 8.0	- 2.0	- 4.2	- 3.1	- 3.5
Final Energy Demand per Capita (kgoe per capita)	580	616	854	1 110	1 374	0.6	6.8	2.7	1.4	1.9
CO_2 Emissions (million tonnes)	**2,237**	**3,084**	**5,131**	**7,271**	**9,225**	**3.3**	**10.7**	**3.5**	**1.6**	**2.4**
Sector										
Electricity and Heat Generation	639	1 315	2 461	3 575	4 741	7.5	13.4	3.8	1.9	2.7
Refineries and Other Energy Sector	204	317	566	796	956	4.5	12.3	3.5	1.2	2.1
Industry	778	832	1 271	1 608	1 600	0.7	8.8	2.4	- 0.0	0.9
Transport	122	228	346	595	961	6.4	8.7	5.6	3.3	4.2
Other	494	392	487	697	968	- 2.3	4.5	3.6	2.2	2.8
Fuel										
Coal	1 935	2 496	4 291	5 877	6 957	2.6	11.4	3.2	1.1	2.0
Oil	284	552	767	1 192	1 694	6.9	6.8	4.5	2.4	3.2
Gas	18	36	72	201	574	7.0	15.2	10.8	7.2	8.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	1 786	913	962	648	396	- 6.5	1.0	- 3.9	- 3.2	- 3.5
CO_2 Emissions per Capita (tonnes per capita)	2.	2. 4	3. 9	5. 3	6. 4	2.2	10.0	3.0	1.3	1.9

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1,145.3	181.4		42.6	34.1	13.8	226.5			1,643.9
Net Imports	(57.5)	110.4	26.5	(2.7)			0.0	(0.5)	0.0	76.2
Primary Energy Supply	**1,087.8**	**291.9**	**26.5**	**39.9**	**34.1**	**13.8**	**226.5**	**(0.5)**	**0.0**	**1,720.1**
Transfers and Statistical Diff.	7.1	(1.4)	1.0	(1.1)			0.0	0.0	0.0	5.5
Electricity and Heat Gen.	(598.7)		(17.9)	(4.6)	(34.1)	(13.8)	(1.5)	215.0	54.7	(401.1)
Petroleum Refineries		(290.4)	283.8							(6.6)
Other Energy Sector	(122.9)		(22.3)	(2.4)			0.0	(42.9)	(11.3)	(201.7)
Final Energy Demand	**373.3**		**271.2**	**31.9**			**225.0**	**171.5**	**43.4**	**1,116.2**
Industry	279.8		39.7	12.4			0.0	116.2	29.2	477.2
Transport	4.1		108.3	0.1			0.0	1.7		114.2
Other	67.4		61.3	12.1			225.0	53.6	14.2	433.5
Non-Energy Use	22.1		61.8	7.3			0.0			91.3

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1,552.0	195.0		93.6	62.7	55.8	251.7			2,210.7
Net Imports	(62.7)	292.1	(0.3)	1.4			0.0	(0.9)	0.0	229.7
Primary Energy Supply	**1,489.3**	**487.1**	**(0.3)**	**95.0**	**62.7**	**55.8**	**251.7**	**(0.9)**	**0.0**	**2,440.4**
Electricity and Heat Gen.	(878.9)		(7.6)	(15.8)	(62.7)	(55.8)	(22.2)	356.5	87.3	(599.1)
Petroleum Refineries		(487.1)	476.0							(11.1)
Other Energy Sector	(166.6)		(37.9)	(5.2)			0.0	(67.7)	(18.0)	(295.4)
Final Energy Demand	**443.8**		**430.3**	**74.0**			**229.5**	**288.0**	**69.2**	**1,534.8**
Industry	349.5		45.7	29.8			0.0	182.7	43.3	650.9
Transport	3.6		190.7	0.1			4.5	2.4		201.4
Other	70.7		106.4	36.6			225.0	102.8	26.0	567.4
Non-Energy Use	20.0		87.5	7.6			0.0			115.0

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1,820.0	190.0		103.5	72.3	230.7	293.2			2,709.7
Net Imports	(68.5)	478.9	7.6	154.2			0.0	(1.2)	0.0	571.1
Primary Energy Supply	**1,751.5**	**668.9**	**7.6**	**257.7**	**72.3**	**230.7**	**293.2**	**(1.2)**	**0.0**	**3,280.8**
Electricity and Heat Gen.	(1,133.8)		(8.4)	(78.2)	(72.3)	(230.7)	(51.3)	548.0	138.8	(887.9)
Petroleum Refineries		(668.9)	653.2							(15.7)
Other Energy Sector	(195.4)		(52.0)	(5.8)			0.0	(100.0)	(28.6)	(381.8)
Final Energy Demand	**422.4**		**600.4**	**173.7**			**241.9**	**446.8**	**110.1**	**1,995.4**
Industry	335.7		42.5	54.4			0.0	230.0	63.1	725.7
Transport	3.6		311.1	0.2			16.9	3.3		335.2
Other	70.8		138.4	111.1			225.0	213.5	47.0	805.7
Non-Energy Use	12.2		108.5	8.2			0.0			128.8

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
3122 - 4406	0.9 - 1.3	0.2 - 0.2	0.7 - 1.0

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
535 - 725	1714 - 2405	620 - 923	254 - 352

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
385 - 558	89 - 129	502 - 671	2147 - 3048

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2147 - 3048	1407 - 1962	510 - 765	230 - 321

HONG KONG, CHINA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	128	199	243	353	575	4.5	4.1	3.8	3.3	3.5
Population (million)	6	7	7	8	8	1.6	0.4	1.0	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	22 359	29 785	35 690	47 000	68 978	2.9	3.7	2.8	2.6	2.7

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
			Mtoe							
Production					0.1	1.1	0.0	- 5.2	8.1	2.6
Coal										
Oil										
Gas										
Hydro										
NRE					0.1	1.1	0.0	- 5.2	8.1	2.6
					(100%)					
Nuclear										
Net Import	10.6	15.9	18.0	20.9	23.0	4.1	2.6	1.5	0.7	1.0
Coal	5.5	3.7	6.7	7.5	8.5	- 3.8	12.3	1.2	0.8	1.0
Oil	5.3	8.9	8.6	9.5	9.2	5.4	- 0.7	1.0	- 0.2	0.3
Gas		2.5	2.2	3.0	4.1		- 2.2	3.3	2.1	2.6
Electricity	- 0.2	0.8	0.6	0.9	1.2		- 6.3	4.4	2.4	3.2
Primary Energy Supply	10.7	15.9	18.1	20.9	23.1	4.1	2.6	1.5	0.7	1.0
Coal	5.5	3.7	6.7	7.5	8.5	- 3.8	12.3	1.2	0.84	1.0
	(52%)	(23%)	(37%)	(36%)	(37%)					
Oil	5.3	8.9	8.6	9.5	9.2	5.4	- 0.7	1.0	- 0.2	0.3
	(49%)	(56%)	(48%)	(45%)	(40%)					
Gas		2.5	2.2	3.0	4.1		- 2.2	3.3	2.1	2.6
		(15%)	(12%)	(15%)	(18%)					
Hydro										
NRE	0.05	0.05	0.05	0.03	0.09	- 0.4	0.4	- 6.1	8.1	2.2
	(0.5%)	(0.3%)	(0.3%)	(0.1%)	(0.4%)					
Nuclear										
Input for Electricity and Heat Generation	-6.2	-6.7	-8.9	-10.5	-12.6	0.8	5.7	1.7	1.2	1.4
Coal	- 6.1	- 4.2	- 6.7	- 7.5	- 8.5	- 3.6	9.5	1.2	0.8	1.0
	(98%)	(63%)	(75%)	(72%)	(67%)					
Oil	- 0.1				- 0.1	- 9.3	0.0	- 0.8	2.9	1.4
	(2%)				(0%)					
Gas		- 2.5	- 2.2	- 2.9	- 4.0		- 2.2	2.9	2.0	2.4
		(36%)	(25%)	(28%)	(31%)					
Hydro										
NRE					- 0.1				8.1	
					(1%)					
Nuclear										
Input for Refineries and Other Energy Sector	-0.4	-0.4	-0.5	-0.6	-0.8	0.4	4.9	1.9	1.6	1.7
Coal										
Oil	- 0.4	- 0.6	- 0.7	- 0.7	- 0.7	3.8	1.9	- 0.0	0.0	- 0.0
Gas	0.3	0.6	0.6	0.6	0.6	5.6	0.9	0.0	0.0	0.0
NRE										
Electricity	- 0.3	- 0.3	- 0.4	- 0.5	- 0.7	2.1	3.9	2.3	1.9	2.0
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**7.2**	**12.0**	**12.0**	**14.0**	**15.1**	**5.2**	**- 0.0**	**1.5**	**0.5**	**0.9**
Coal										
Oil	4.8	8.2	7.9	8.8	8.4	5.7	- 0.9	1.1	- 0.2	0.3
	(66%)	(69%)	(66%)	(63%)	(56%)					
Gas	0.3	0.6	0.6	0.7	0.8	5.6	0.9	1.7	0.6	1.0
	(5%)	(5%)	(5%)	(5%)	(5%)					
NRE	0.1	0.1	0.1			- 0.4	0.4			
	(1%)	(0%)	(0%)							
Electricity	2.1	3.1	3.4	4.5	5.9	4.3	2.0	2.7	1.9	2.2
	(29%)	(26%)	(29%)	(32%)	(39%)					
Heat										
Industry	**1.6**	**1.8**	**1.0**	**0.9**	**0.6**	**1.4**	**- 11.8**	**- 1.0**	**- 2.2**	**- 1.7**
Coal										
Oil	0.9	1.4	0.6	0.5	0.3	3.6	- 15.2	- 1.1	- 3.8	- 2.7
	(61%)	(75%)	(62%)	(61%)	(48%)					
Gas						4.9	- 2.0	0.9	0.0	0.4
NRE										
Electricity	0.6	0.4	0.4	0.3	0.3	- 3.3	- 3.8	- 0.9	- 0.3	- 0.5
	(38%)	(24%)	(36%)	(37%)	(49%)					
Heat										
Transportation	**3.4**	**6.5**	**6.7**	**7.7**	**7.7**	**6.8**	**0.5**	**1.4**	**0.0**	**0.6**
Coal										
Oil	3.4	6.5	6.7	7.7	7.7	6.8	0.5	1.4	0.0	0.6
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Other	**2.1**	**3.5**	**4.1**	**5.3**	**6.7**	**5.2**	**3.4**	**2.4**	**1.6**	**1.9**
Coal										
Oil	0.3	0.2	0.4	0.4	0.3	- 2.7	15.1	- 0.6	- 1.8	- 1.3
	(13%)	(6%)	(10%)	(8%)	(5%)					
Gas	0.3	0.5	0.6	0.7	0.7	5.7	1.0	1.7	0.6	1.0
	(15%)	(15%)	(14%)	(13%)	(11%)					
NRE	0.1	0.1	0.1			- 0.4	0.4			
	(3%)	(1%)	(1%)							
Electricity	1.5	2.7	3.1	4.2	5.6	6.4	2.8	3.0	2.0	2.4
	(69%)	(77%)	(75%)	(79%)	(84%)					
Heat										
Non-Energy Use	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**- 0.1**	**5.2**	**- 1.5**	**- 0.1**	**- 0.7**
Coal										
Oil	0.2	0.2	0.2	0.2	0.2	- 0.1	5.2	- 1.5	- 0.1	- 0.7
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**28.9**	**31.3**	**38.5**	**48.5**	**62.7**	**0.8**	**4.2**	**2.3**	**1.7**	**2.0**
Coal	28.4	19.0	27.1	32.3	39.4	- 4.0	7.4	1.8	1.3	1.5
	(98%)	(61%)	(70%)	(67%)	(63%)					
Oil	0.5	0.1	0.1	0.2	0.3	- 12.6	0.2	2.8	3.0	2.9
	(2%)									
Gas		12.2	11.3	15.7	22.0		- 1.6	3.3	2.3	2.7
		(39%)	(29%)	(32%)	(35%)					
Hydro										
NRE				0.3	1.1				8.1	
				(1%)	(2%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)			**11,804**	**13,293**	**15,682**			**1.2**	**1.1**	**1.1**
Thermal			11 804	13 143	15 182			1.1	1.0	1.0
			(100%)	(99%)	(97%)					
Coal			7 437	8 200	8 987			1.0	0.6	0.8
			(63%)	(62%)	(57%)					
Oil			236	242	202			0.2	- 1.2	- 0.6
			(2%)	(2%)	(1%)					
Gas			4 131	4 702	5 993			1.3	1.6	1.5
			(35%)	(35%)	(38%)					
Hydro										
NRE				150	500				8.4	
				(1%)	(3%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	84	80	74	59	40	- 0.4	- 1.5	- 2.3	- 2.5	- 2.4
Primary Energy Supply per Capita (kgoe per capita)	1 872	2 386	2 653	2 782	2 777	2.5	2.1	0.5	- 0.0	0.2
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	56	60	49	40	26	0.7	- 4.0	- 2.2	- 2.7	- 2.5
Final Energy Demand per Capita (kgoe per capita)	1 259	1 797	1 758	1 858	1 816	3.6	- 0.4	0.6	- 0.2	0.1
CO_2 Emissions (million tonnes)	**34**	**41**	**42**	**48**	**54**	**1.8**	**0.7**	**1.3**	**0.7**	**1.0**
Sector										
Electricity and Heat Generation	25	23	32	37	43	- 0.8	7.0	1.5	1.1	1.2
Refineries and Other Energy Sector	1	1	1	1	1	0.7	3.9	- 0.1	0.0	- 0.1
Industry	3	4	2	2	1	3.6	- 15.0	- 1.0	- 3.6	- 2.6
Transport	5	12	5	6	6	9.7	- 14.4	1.4	0.0	0.6
Other	2	2	3	3	3	1.8	6.8	0.6	- 0.4	0.0
Fuel										
Coal	24	17	27	30	34	- 3.6	9.5	1.2	0.8	1.0
Oil	10	18	11	11	10	6.3	- 10.3	0.5	- 0.6	- 0.2
Gas		6	5	7	10		- 2.2	3.3	2.1	2.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	269	207	174	136	94	- 2.6	- 3.3	- 2.4	- 2.5	- 2.5
CO_2 Emissions per Capita (tonnes per capita)	6.	6. 2	6. 2	6. 4	6. 5	0.2	0.2	0.3	0.0	0.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.0			0.0
Net Imports	6.7	0.0	8.6	2.2			0.0	0.6	0.0	18.0
Primary Energy Supply	**6.7**	**0.0**	**8.6**	**2.2**	**0.0**	**0.0**	**0.1**	**0.6**	**0.0**	**18.1**
Transfers and Statistical Diff.	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
Electricity and Heat Gen.	(6.7)		(0.0)	(2.2)	0.0	0.0	0.0	3.3	0.0	(5.6)
Petroleum Refineries		0.0	0.0							0.0
Other Energy Sector	0.0		(0.7)	0.6			0.0	(0.4)	0.0	(0.5)
Final Energy Demand	**0.0**		**7.9**	**0.6**			**0.1**	**3.4**	**0.0**	**12.0**
Industry	0.0		0.6	0.0			0.0	0.4	0.0	1.0
Transport	0.0		6.7	0.0			0.0	0.0		6.7
Other	0.0		0.4	0.6			0.1	3.1	0.0	4.1
Non-Energy Use	0.0		0.2	0.0			0.0			0.2

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.0			0.0
Net Imports	7.5	0.0	9.5	3.0			0.0	0.9	0.0	20.9
Primary Energy Supply	**7.5**	**0.0**	**9.5**	**3.0**	**0.0**	**0.0**	**0.0**	**0.9**	**0.0**	**20.9**
Electricity and Heat Gen.	(7.5)		(0.0)	(2.9)	0.0	0.0	(0.0)	4.2	0.0	(6.3)
Petroleum Refineries		0.0	0.0							0.0
Other Energy Sector	0.0		(0.7)	0.6			0.0	(0.5)	0.0	(0.6)
Final Energy Demand	**0.0**		**8.8**	**0.7**			**0.0**	**4.5**	**0.0**	**14.0**
Industry	0.0		0.5	0.0			0.0	0.3	0.0	0.9
Transport	0.0		7.7	0.0			0.0	0.0		7.7
Other	0.0		0.4	0.7			0.0	4.2	0.0	5.3
Non-Energy Use	0.0		0.2	0.0			0.0			0.2

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.1			0.1
Net Imports	8.5	0.0	9.2	4.1			0.0	1.2	0.0	23.0
Primary Energy Supply	**8.5**	**0.0**	**9.2**	**4.1**	**0.0**	**0.0**	**0.1**	**1.2**	**0.0**	**23.1**
Electricity and Heat Gen.	(8.5)		(0.1)	(4.0)	0.0	0.0	(0.1)	5.4	0.0	(7.2)
Petroleum Refineries		0.0	0.0							0.0
Other Energy Sector	0.0		(0.7)	0.6			0.0	(0.7)	0.0	(0.8)
Final Energy Demand	**0.0**		**8.4**	**0.8**			**0.0**	**5.9**	**0.0**	**15.1**
Industry	0.0		0.3	0.0			0.0	0.3	0.0	0.6
Transport	0.0		7.7	0.0			0.0	0.0		7.7
Other	0.0		0.3	0.7			0.0	5.6	0.0	6.7
Non-Energy Use	0.0		0.2	0.0			0.0			0.2

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
10 - 13	0.1 - 0.1	.. - ..	0.1 - 0.1

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
.. - ..	8.3 - 10.7	1.30 - 1.70	0.5 - 0.7

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
0.3 - 0.4	0.4 - 0.6	0.10 - 0.15	9 - 12

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
9 - 12	8 - 11	0.5 - 0.7	0.4 - 0.5

INDONESIA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	372	562	708	1 090	2 010	4.2	4.7	4.4	4.2	4.3
Population (million)	178	206	221	244	272	1.5	1.3	1.0	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	2 085	2 724	3 209	4 463	7 391	2.7	3.3	3.4	3.4	3.4

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**170.0**	**235.6**	**276.7**	**397.2**	**491.1**	**3.3**	**3.3**	**3.7**	**1.4**	**2.3**
Coal	6.1	46.2	103.7	208.4	288.5	22.3	17.6	7.2	2.2	4.2
	(4%)	(20%)	(37%)	(52%)	(59%)					
Oil	74.6	71.3	52.4	55.1	48.8	- 0.5	- 6.0	0.5	- 0.8	- 0.3
	(44%)	(30%)	(19%)	(14%)	(10%)					
Gas	42.6	63.0	62.7	65.2	66.2	4.0	- 0.1	0.4	0.1	0.2
	(25%)	(27%)	(23%)	(16%)	(13%)					
Hydro	0.6	0.9	0.9	1.0	1.2	4.0	1.4	0.4	1.4	1.0
	(0%)	(0%)	(0%)	(0%)	(0%)					
NRE	46.0	54.2	56.9	67.5	86.4	1.7	1.0	1.7	1.7	1.7
	(27%)	(23%)	(21%)	(17%)	(18%)					
Nuclear										
Net Import	**-67.2**	**-84.1**	**-100.7**	**-170.3**	**-159.5**	**2.3**	**3.7**	**5.4**	**- 0.4**	**1.9**
Coal	- 2.6	- 35.5	- 80.7	- 161.1	- 215.3	29.9	17.8	7.2	2.0	4.0
Oil	- 40.4	- 16.8	12.2	18.8	71.1	- 8.4		4.4	9.3	7.3
Gas	- 24.1	- 31.7	- 32.1	- 28.0	- 15.3	2.8	0.2	- 1.3	- 4.0	- 2.9
Electricity										
Primary Energy Supply	**102.8**	**151.4**	**176.0**	**226.9**	**331.6**	**3.9**	**3.1**	**2.6**	**2.6**	**2.6**
Coal	3.6	10.7	23.0	47.4	73.2	11.6	16.6	7.5	2.94	4.7
	(3%)	(7%)	(13%)	(21%)	(22%)					
Oil	34.2	54.5	64.6	72.1	117.6	4.8	3.5	1.1	3.3	2.4
	(33%)	(36%)	(37%)	(32%)	(35%)					
Gas	18.5	31.3	30.6	37.1	50.9	5.4	- 0.4	1.9	2.1	2.1
	(18%)	(21%)	(17%)	(16%)	(15%)					
Hydro	0.6	0.9	0.9	1.0	1.2	4.0	1.4	0.4	1.4	1.0
	(1%)	(1%)	(1%)	(0%)	(0%)					
NRE	45.9	54.1	56.8	69.4	88.8	1.7	1.0	2.0	1.7	1.8
	(45%)	(36%)	(32%)	(31%)	(27%)					
Nuclear										
Input for Electricity and Heat Generation	**-8.0**	**-22.2**	**-32.3**	**-56.2**	**-97.9**	**10.8**	**7.8**	**5.7**	**3.8**	**4.5**
Coal	- 2.3	- 7.2	- 13.5	- 32.0	- 54.0	12.0	13.4	9.0	3.5	5.7
	(29%)	(32%)	(42%)	(57%)	(55%)					
Oil	- 3.8	- 4.5	- 8.7	- 1.6	- 0.9	1.6	14.3	- 15.7	- 4.0	- 8.9
	(48%)	(20%)	(27%)	(3%)	(1%)					
Gas	- 0.3	- 5.5	- 3.5	- 5.9	- 9.3	33.0	- 8.5	5.3	3.0	3.9
	(4%)	(25%)	(11%)	(11%)	(10%)					
Hydro	- 0.6	- 0.9	- 0.9	- 1.0	- 1.2	4.0	1.5	0.4	1.4	1.0
	(7%)	(4%)	(3%)	(2%)	(1%)					
NRE	- 0.9	- 4.2	- 5.7	- 15.8	- 32.6	16.1	6.3	10.8	4.9	7.2
	(12%)	(19%)	(18%)	(28%)	(33%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-18.6**	**-20.4**	**-21.7**	**-23.8**	**-29.4**	**1.0**	**1.2**	**0.9**	**1.4**	**1.2**
Coal						- 7.9				
Oil	- 2.6	- 3.6	- 4.1	- 4.5	- 8.1	3.4	2.7	0.8	4.0	2.7
Gas	- 12.4	- 14.0	- 14.4	- 15.1	- 15.3	1.2	0.5	0.5	0.1	0.3
NRE	- 3.0	- 1.6	- 1.5	- 1.8	- 2.3	- 6.0	- 1.5	2.0	1.7	1.8
Electricity	- 0.5	- 1.2	- 1.7	- 2.4	- 3.7	8.0	8.6	3.3	2.8	3.0
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**79.2**	**118.6**	**133.5**	**163.5**	**231.7**	**4.1**	**2.4**	**2.0**	**2.4**	**2.2**
Coal	0.6	5.3	9.5	15.4	19.2	23.6	12.4	4.9	1.5	2.8
	(1%)	(4%)	(7%)	(9%)	(8%)					
Oil	27.6	47.2	52.4	66.1	108.7	5.5	2.1	2.3	3.4	3.0
	(35%)	(40%)	(39%)	(40%)	(47%)					
Gas	6.6	11.0	12.7	16.1	26.3	5.2	2.9	2.4	3.3	2.9
	(8%)	(9%)	(10%)	(10%)	(11%)					
NRE	42.0	48.3	49.6	51.7	53.9	1.4	0.5	0.4	0.3	0.3
	(53%)	(41%)	(37%)	(32%)	(23%)					
Electricity	2.3	6.8	9.2	14.2	23.7	11.3	6.2	4.5	3.5	3.9
	(3%)	(6%)	(7%)	(9%)	(10%)					
Heat										
Industry	**16.7**	**30.4**	**34.4**	**42.6**	**61.2**	**6.2**	**2.5**	**2.2**	**2.4**	**2.3**
Coal	0.6	5.3	9.5	15.4	19.2	23.5	12.4	4.9	1.5	2.8
	(4%)	(17%)	(28%)	(36%)	(31%)					
Oil	5.0	8.9	9.2	8.5	15.0	5.8	0.7	- 0.7	3.8	2.0
	(30%)	(29%)	(27%)	(20%)	(25%)					
Gas	2.6	4.7	5.7	6.5	10.6	6.2	4.1	1.3	3.3	2.5
	(15%)	(15%)	(17%)	(15%)	(17%)					
NRE	7.2	8.6	6.3	6.5	6.7	1.8	- 6.1	0.4	0.1	0.2
	(43%)	(28%)	(18%)	(15%)	(11%)					
Electricity	1.2	2.9	3.7	5.6	9.8	9.5	4.5	4.4	3.7	4.0
	(7%)	(10%)	(11%)	(13%)	(16%)					
Heat										
Transportation	**11.0**	**21.8**	**25.7**	**34.9**	**59.8**	**7.0**	**3.4**	**3.1**	**3.7**	**3.4**
Coal										
Oil	11.0	21.8	25.7	34.8	58.6	7.0	3.4	3.1	3.5	3.4
	(100%)	(100%)	(100%)	(100%)	(98%)					
Gas							- 6.3	- 9.1	0.0	- 3.7
NRE				0.1	1.2				18.7	
				(0%)	(2%)					
Electricity										
Other	**43.6**	**56.8**	**61.9**	**69.9**	**83.7**	**2.7**	**1.7**	**1.2**	**1.2**	**1.2**
Coal							7.6			
Oil	7.7	13.2	12.9	16.1	23.6	5.5	- 0.4	2.2	2.6	2.4
	(18%)	(23%)	(21%)	(23%)	(28%)					
Gas				0.1	0.1		3.5	2.3	2.3	2.3
				(0%)	(0%)					
NRE	34.7	39.7	43.4	45.1	46.0	1.3	1.8	0.4	0.1	0.2
	(80%)	(70%)	(70%)	(65%)	(55%)					
Electricity	1.1	3.9	5.6	8.6	14.0	13.0	7.4	4.5	3.3	3.8
	(3%)	(7%)	(9%)	(12%)	(17%)					
Heat										
Non-Energy Use	**7.8**	**9.6**	**11.5**	**16.2**	**27.0**	**2.0**	**3.8**	**3.4**	**3.5**	**3.5**
Coal										
Oil	3.8	3.3	4.6	6.6	11.5	- 1.4	6.9	3.7	3.7	3.7
	(48%)	(34%)	(40%)	(41%)	(42%)					
Gas	4.1	6.3	6.9	9.5	15.6	4.5	1.9	3.2	3.3	3.3
	(52%)	(66%)	(60%)	(59%)	(58%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**33.3**	**92.6**	**127.4**	**193.9**	**318.4**	**10.8**	**6.6**	**4.3**	**3.4**	**3.7**
Coal	10.5	34.0	51.8	124.9	212.1	12.5	8.8	9.2	3.6	5.8
	(32%)	(37%)	(41%)	(64%)	(67%)					
Oil	14.2	17.7	38.9	7.0	3.8	2.2	17.1	- 15.7	- 4.0	- 8.9
	(43%)	(19%)	(31%)	(4%)	(1%)					
Gas	0.8	26.1	19.3	32.4	50.8	42.6	- 5.9	5.3	3.0	4.0
	(2%)	(28%)	(15%)	(17%)	(16%)					
Hydro	6.7	10.0	10.8	11.2	13.7	4.1	1.4	0.4	1.4	1.0
	(20%)	(11%)	(8%)	(6%)	(4%)					
NRE	1.1	4.9	6.6	18.4	37.9	16.1	6.3	10.8	4.9	7.2
	(3%)	(5%)	(5%)	(9%)	(12%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**15,842**	**34,442**	**28,891**	**41,023**	**63,064**	**8.1**	**- 3.5**	**3.6**	**2.9**	**3.2**
Thermal	12 742	29 603	23 630	34 112	52 603	8.8	- 4.4	3.7	2.9	3.3
	(80%)	(86%)	(82%)	(83%)	(83%)					
Coal	1 742	5 942	9 229	20 372	34 596	13.1	9.2	8.2	3.6	5.4
	(11%)	(17%)	(32%)	(50%)	(55%)					
Oil	9 100	14 933	8 729	4 007	2 732	5.1	- 10.2	- 7.5	- 2.5	- 4.5
	(57%)	(43%)	(30%)	(10%)	(4%)					
Gas	1 900	8 728	5 673	9 734	15 275	16.5	- 8.3	5.5	3.0	4.0
	(12%)	(25%)	(20%)	(24%)	(24%)					
Hydro	2 959	4 226	4 405	4 555	5 605	3.6	0.8	0.3	1.4	1.0
	(19%)	(12%)	(15%)	(11%)	(9%)					
NRE	140	613	856	2 356	4 856	15.9	6.9	10.7	4.9	7.2
	(1%)	(2%)	(3%)	(6%)	(8%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	277	269	249	208	165	- 0.3	- 1.6	- 1.8	- 1.5	- 1.6
Primary Energy Supply per Capita (kgoe per capita)	577	734	798	929	1 219	2.4	1.7	1.5	1.8	1.7
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	213	211	189	150	115	- 0.1	- 2.2	- 2.3	- 1.7	- 2.0
Final Energy Demand per Capita (kgoe per capita)	444	575	605	670	852	2.6	1.0	1.0	1.6	1.4
CO_2 Emissions (million tonnes)	**140**	**265**	**328**	**447**	**688**	**6.6**	**4.3**	**3.2**	**2.9**	**3.0**
Sector										
Electricity and Heat Generation	22	55	89	146	240	9.7	10.0	5.1	3.3	4.0
Refineries and Other Energy Sector	37	44	41	43	50	1.7	- 1.0	0.4	1.0	0.8
Industry	24	60	80	103	148	9.5	6.0	2.6	2.4	2.5
Transport	33	66	77	105	176	7.1	3.3	3.1	3.5	3.3
Other	24	41	40	50	73	5.6	- 0.4	2.2	2.6	2.4
Fuel										
Coal	12	50	92	189	293	15.4	12.9	7.5	2.9	4.7
Oil	93	159	181	194	314	5.6	2.6	0.7	3.2	2.2
Gas	35	56	54	64	81	4.7	- 0.5	1.5	1.7	1.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	376	472	463	410	342	2.3	- 0.4	- 1.2	- 1.2	- 1.2
CO_2 Emissions per Capita (tonnes per capita)	. 8	1. 3	1. 5	1. 8	2. 5	5.1	2.9	2.1	2.2	2.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	103.7	52.4		62.7	0.9	0.0	56.9			276.7
Net Imports	(80.7)	(1.6)	13.7	(32.1)			(0.1)	0.0	0.0	(100.7)
Primary Energy Supply	**23.0**	**50.9**	**13.7**	**30.6**	**0.9**	**0.0**	**56.8**	**0.0**	**0.0**	**176.0**
Transfers and Statistical Diff.	0.0	(1.4)	2.1	0.0			0.0	0.0	0.0	0.6
Electricity and Heat Gen.	(13.5)		(8.7)	(3.5)	(0.9)	0.0	(5.7)	11.0	0.0	(21.4)
Petroleum Refineries		(49.4)	48.0							(1.4)
Other Energy Sector	0.0		(2.7)	(14.4)			(1.5)	(1.7)	0.0	(20.3)
Final Energy Demand	**9.5**		**52.4**	**12.7**			**49.6**	**9.2**	**0.0**	**133.5**
Industry	9.5		9.2	5.7			6.3	3.7	0.0	34.4
Transport	0.0		25.7	0.0			0.0	0.0		25.7
Other	0.0		12.9	0.0			43.4	5.6	0.0	61.9
Non-Energy Use	0.0		4.6	6.9			0.0			11.5

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	208.4	55.1		65.2	1.0	0.0	67.5			397.2
Net Imports	(161.1)	6.2	10.9	(28.0)			1.8	0.0	0.0	(170.3)
Primary Energy Supply	**47.4**	**61.2**	**10.9**	**37.1**	**1.0**	**0.0**	**69.4**	**0.0**	**0.0**	**226.9**
Electricity and Heat Gen.	(32.0)		(1.6)	(5.9)	(1.0)	0.0	(15.8)	16.7	0.0	(39.6)
Petroleum Refineries		(61.2)	59.5							(1.8)
Other Energy Sector	0.0		(2.7)	(15.1)			(1.8)	(2.4)	0.0	(22.1)
Final Energy Demand	**15.4**		**66.1**	**16.1**			**51.7**	**14.2**	**0.0**	**163.5**
Industry	15.4		8.5	6.5			6.5	5.6	0.0	42.6
Transport	0.0		34.8	0.0			0.1	0.0		34.9
Other	0.0		16.1	0.1			45.1	8.6	0.0	69.9
Non-Energy Use	0.0		6.6	9.5			0.0			16.2

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	288.5	48.8		66.2	1.2	0.0	86.4			491.1
Net Imports	(215.3)	61.4	7.4	(15.3)			2.3	0.0	0.0	(159.5)
Primary Energy Supply	**73.2**	**110.2**	**7.4**	**50.9**	**1.2**	**0.0**	**88.8**	**0.0**	**0.0**	**331.6**
Electricity and Heat Gen.	(54.0)		(0.9)	(9.3)	(1.2)	0.0	(32.6)	27.4	0.0	(70.5)
Petroleum Refineries		(110.2)	107.0							(3.2)
Other Energy Sector	0.0		(4.9)	(15.3)			(2.3)	(3.7)	0.0	(26.2)
Final Energy Demand	**19.2**		**108.7**	**26.3**			**53.9**	**23.7**	**0.0**	**231.7**
Industry	19.2		15.0	10.6			6.7	9.8	0.0	61.2
Transport	0.0		58.6	0.0			1.2	0.0		59.8
Other	0.0		23.6	0.1			46.0	14.0	0.0	83.7
Non-Energy Use	0.0		11.5	15.6			0.0			27.0

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
296 - 412	0.9 - 1.3	0.3 - 0.5	0.6 - 0.8

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
107 - 149	94 - 124	74 - 110	21 - 30

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
70 - 92	59 - 86	43 - 57	124 - 177

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
124 - 177	47 - 63	57 - 86	19 - 27

JAPAN

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	3 609	4 154	4 141	4 671	5 582	1.4	- 0.1	1.2	1.2	1.2
Population (million)	124	127	128	126	117	0.3	0.1	- 0.2	- 0.5	- 0.4
GDP per Capita (2005 US$ PPP per capita)	29 217	32 744	32 410	37 113	47 701	1.1	- 0.2	1.4	1.7	1.6

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**75.2**	**105.8**	**99.9**	**132.9**	**151.1**	**3.5**	**- 1.1**	**2.9**	**0.9**	**1.7**
Coal	4.5	1.6				- 10.1				
	(6%)	(1%)								
Oil	0.7	0.8	0.8	0.7	0.7	1.1	- 0.7	- 0.7	- 0.0	- 0.3
	(1%)	(1%)	(1%)	(1%)	(0%)					
Gas	1.9	2.3	2.9	3.0	3.0	1.8	4.8	0.4	0.0	0.1
	(3%)	(2%)	(3%)	(2%)	(2%)					
Hydro	7.7	7.5	6.6	7.6	7.6	- 0.2	- 2.6	1.4	0.1	0.6
	(10%)	(7%)	(7%)	(6%)	(5%)					
NRE	7.7	9.8	10.3	11.8	13.6	2.4	1.0	1.4	0.9	1.1
	(10%)	(9%)	(10%)	(9%)	(9%)					
Nuclear	52.7	83.9	79.4	109.8	126.2	4.8	- 1.1	3.3	0.9	1.9
	(70%)	(79%)	(80%)	(83%)	(84%)					
Net Import	**368.7**	**420.8**	**428.5**	**425.2**	**402.7**	**1.3**	**0.4**	**- 0.1**	**- 0.4**	**- 0.2**
Coal	72.7	96.4	111.0	108.1	107.3	2.9	2.9	- 0.3	- 0.1	- 0.1
Oil	253.8	261.0	249.8	229.6	199.8	0.3	- 0.9	- 0.8	- 0.9	- 0.9
Gas	42.2	63.4	67.7	87.4	95.6	4.1	1.3	2.6	0.6	1.4
Electricity										
Primary Energy Supply	**443.9**	**526.6**	**528.4**	**558.1**	**553.8**	**1.7**	**0.1**	**0.5**	**- 0.1**	**0.2**
Coal	77.2	98.0	111.0	108.1	107.3	2.4	2.5	- 0.3	- 0.05	- 0.1
	(17%)	(19%)	(21%)	(19%)	(19%)					
Oil	254.5	261.8	250.5	230.3	200.5	0.3	- 0.9	- 0.8	- 0.9	- 0.9
	(57%)	(50%)	(47%)	(41%)	(36%)					
Gas	44.2	65.7	70.6	90.4	98.6	4.0	1.5	2.5	0.6	1.3
	(10%)	(12%)	(13%)	(16%)	(18%)					
Hydro	7.7	7.5	6.6	7.6	7.6	- 0.2	- 2.6	1.4	0.1	0.6
	(2%)	(1%)	(1%)	(1%)	(1%)					
NRE	7.7	9.8	10.3	11.8	13.6	2.4	1.0	1.4	0.9	1.1
	(2%)	(2%)	(2%)	(2%)	(2%)					
Nuclear	52.7	83.9	79.4	109.8	126.2	4.8	- 1.1	3.3	0.9	1.9
	(12%)	(16%)	(15%)	(20%)	(23%)					
Input for Electricity and Heat Generation	**-173.6**	**-220.5**	**-226.6**	**-265.0**	**-281.6**	**2.4**	**0.5**	**1.6**	**0.4**	**0.9**
Coal	- 25.4	- 48.3	- 62.3	- 62.0	- 62.7	6.6	5.2	- 0.0	0.1	0.0
	(15%)	(22%)	(27%)	(23%)	(22%)					
Oil	- 50.6	- 27.5	- 26.9	- 25.1	- 19.7	- 5.9	- 0.5	- 0.7	- 1.6	- 1.2
	(29%)	(12%)	(12%)	(9%)	(7%)					
Gas	- 33.4	- 47.2	- 44.6	- 51.5	- 54.8	3.5	- 1.1	1.5	0.4	0.8
	(19%)	(21%)	(20%)	(19%)	(19%)					
Hydro	- 7.7	- 7.5	- 6.6	- 7.6	- 7.6	- 0.2	- 2.6	1.4	0.1	0.6
	(4%)	(3%)	(3%)	(3%)	(3%)					
NRE	- 3.8	- 6.0	- 6.9	- 8.9	- 10.6	4.7	2.6	2.6	1.2	1.8
	(2%)	(3%)	(3%)	(3%)	(4%)					
Nuclear	- 52.7	- 83.9	- 79.4	- 109.8	- 126.2	4.8	- 1.1	3.3	0.9	1.9
	(30%)	(38%)	(35%)	(41%)	(45%)					
Input for Refineries and Other Energy Sector	**-37.7**	**-43.2**	**-43.9**	**-41.8**	**-45.1**	**1.4**	**0.3**	**- 0.5**	**0.5**	**0.1**
Coal	- 19.8	- 20.6	- 19.9	- 15.1	- 15.3	0.4	- 0.7	- 2.71	0.1	- 1.0
Oil	- 14.0	- 16.8	- 15.6	- 11.6	- 13.0	1.9	- 1.5	- 2.9	0.8	- 0.7
Gas	3.4	3.1	1.1	- 5.2	- 6.1	- 0.8	- 19.6		1.1	
NRE						- 3.5	- 9.3			
Electricity	- 7.4	- 9.1	- 9.5	- 9.7	- 10.5	2.1	1.0	0.2	0.5	0.4
Heat		0.1	0.1	- 0.1	- 0.1	13.8	0.0		0.0	

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**305.3**	**351.2**	**353.8**	**356.5**	**341.7**	**1.4**	**0.1**	**0.1**	**- 0.3**	**- 0.1**
Coal	33.3	27.0	29.7	31.0	29.3	- 2.1	1.9	0.4	- 0.4	- 0.1
	(11%)	(8%)	(8%)	(9%)	(9%)					
Oil	188.2	215.8	207.4	193.6	167.8	1.4	- 0.8	- 0.7	- 1.0	- 0.8
	(62%)	(61%)	(59%)	(54%)	(49%)					
Gas	15.2	23.1	28.7	33.7	37.7	4.2	4.5	1.6	0.8	1.1
	(5%)	(7%)	(8%)	(9%)	(11%)					
NRE	3.9	3.7	3.4	2.9	3.0	- 0.5	- 1.9	- 1.4	0.2	- 0.5
	(1%)	(1%)	(1%)	(1%)	(1%)					
Electricity	64.5	81.1	84.0	94.7	103.4	2.3	0.7	1.2	0.6	0.8
	(21%)	(23%)	(24%)	(27%)	(30%)					
Heat	0.2	0.5	0.6	0.6	0.6	10.5	2.1	- 0.1	0.0	- 0.0
	(0%)	(0%)	(0%)	(0%)	(0%)					
Industry	**104.9**	**103.3**	**100.7**	**100.5**	**98.4**	**- 0.2**	**- 0.5**	**- 0.0**	**- 0.1**	**- 0.1**
Coal	31.9	26.0	28.7	30.0	28.3	- 2.0	2.0	0.4	- 0.4	- 0.1
	(30%)	(25%)	(29%)	(30%)	(29%)					
Oil	37.8	38.5	35.0	31.3	28.1	0.2	- 1.9	- 1.1	- 0.7	- 0.9
	(36%)	(37%)	(35%)	(31%)	(29%)					
Gas	3.7	5.1	6.7	8.4	9.7	3.3	5.4	2.4	1.0	1.5
	(4%)	(5%)	(7%)	(8%)	(10%)					
NRE	2.5	2.6	2.6	1.5	1.3	0.4	- 0.5	- 5.3	- 0.7	- 2.6
	(2%)	(3%)	(3%)	(1%)	(1%)					
Electricity	29.0	31.1	27.8	29.4	30.9	0.7	- 2.2	0.6	0.3	0.4
	(28%)	(30%)	(28%)	(29%)	(31%)					
Heat										
Transportation	**76.2**	**94.6**	**92.5**	**84.3**	**72.0**	**2.2**	**- 0.5**	**- 0.9**	**- 1.0**	**- 1.0**
Coal										
Oil	74.8	93.0	90.8	81.9	68.8	2.2	- 0.5	- 1.0	- 1.2	- 1.1
	(98%)	(98%)	(98%)	(97%)	(95%)					
Gas				0.2	1.0				10.4	
				(0%)	(1%)					
NRE				0.5	0.8				2.2	
				(1%)	(1%)					
Electricity	1.4	1.6	1.6	1.6	1.5	1.0	0.5	0.0	- 0.6	- 0.4
	(2%)	(2%)	(2%)	(2%)	(2%)					
Other	**90.9**	**115.8**	**122.7**	**133.6**	**137.5**	**2.4**	**1.2**	**0.9**	**0.2**	**0.5**
Coal	1.0	0.6	0.6	0.7	0.6	- 4.3	- 0.0	0.5	- 0.8	- 0.3
	(1%)	(1%)	(1%)	(0%)	(0%)					
Oil	43.2	47.3	44.4	43.1	37.9	0.9	- 1.3	- 0.3	- 0.8	- 0.6
	(47%)	(41%)	(36%)	(32%)	(28%)					
Gas	11.2	17.8	21.7	24.7	26.6	4.7	4.1	1.3	0.5	0.8
	(12%)	(15%)	(18%)	(18%)	(19%)					
NRE	1.3	1.1	0.8	0.9	0.9	- 2.2	- 5.6	1.0	0.2	0.5
	(1%)	(1%)	(1%)	(1%)	(1%)					
Electricity	34.0	48.4	54.6	63.7	70.9	3.6	2.4	1.6	0.7	1.1
	(37%)	(42%)	(44%)	(48%)	(52%)					
Heat	0.2	0.5	0.6	0.6	0.6	10.5	2.1	- 0.1	0.0	- 0.0
	(0%)	(0%)	(0%)	(0%)	(0%)					
Non-Energy Use	**33.2**	**37.5**	**37.9**	**38.1**	**33.7**	**1.2**	**0.2**	**0.0**	**- 0.8**	**- 0.5**
Coal	0.4	0.4	0.4	0.4	0.4	- 1.4	0.3	1.2	- 0.0	0.5
	(1%)	(1%)	(1%)	(1%)	(1%)					
Oil	32.5	36.9	37.2	37.3	32.9	1.3	0.2	0.0	- 0.8	- 0.5
	(98%)	(99%)	(98%)	(98%)	(98%)					
Gas	0.3	0.2	0.4	0.4	0.4	- 4.9	13.8	0.0	0.0	0.0
	(1%)	(0%)	(1%)	(1%)	(1%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**835.5**	**1,048.6**	**1,088.4**	**1,214.3**	**1,324.5**	**2.3**	**0.7**	**1.1**	**0.6**	**0.8**
Coal	116.7	232.3	303.8	294.1	309.8	7.1	5.5	- 0.3	0.3	0.1
	(14%)	(22%)	(28%)	(24%)	(23%)					
Oil	247.9	137.1	137.1	109.6	87.4	- 5.8	- 0.0	- 2.2	- 1.5	- 1.8
	(30%)	(13%)	(13%)	(9%)	(7%)					
Gas	167.1	251.3	241.5	269.5	302.6	4.2	- 0.8	1.1	0.8	0.9
	(20%)	(24%)	(22%)	(22%)	(23%)					
Hydro	89.3	87.3	76.5	88.0	88.7	- 0.2	- 2.6	1.4	0.1	0.6
	(11%)	(8%)	(7%)	(7%)	(7%)					
NRE	12.3	18.7	24.8	31.7	51.7	4.3	5.8	2.5	3.3	3.0
	(1%)	(2%)	(2%)	(3%)	(4%)					
Nuclear	202.3	322.0	304.8	421.6	484.3	4.8	- 1.1	3.3	0.9	1.9
	(24%)	(31%)	(28%)	(35%)	(37%)					
	1990	**2000**	**2005**	**2015**	**2030**	**Growth Rates (% per annum) 90-00**	**00-05**	**05-15**	**15-30**	**05-30**
Installed Generation Capacity (MW)	**172,260**	**215,860**	**240,655**	**280,049**	**306,047**	**2.3**	**2.2**	**1.5**	**0.6**	**1.0**
Thermal	104 090	138 420	143 030	151 749	152 968	2.9	0.7	0.6	0.1	0.3
	(60%)	(64%)	(59%)	(54%)	(50%)					
Coal	12 230	29 220	37 670	41 148	43 351	9.1	5.2	0.9	0.3	0.6
	(7%)	(14%)	(16%)	(15%)	(14%)					
Oil	53 470	51 980	46 620	44 809	35 728	- 0.3	- 2.2	- 0.4	- 1.5	- 1.1
	(31%)	(24%)	(19%)	(16%)	(12%)					
Gas	38 390	57 220	58 740	65 792	73 889	4.1	0.5	1.1	0.8	0.9
	(22%)	(27%)	(24%)	(23%)	(24%)					
Hydro	36 450	39 600	42 583	49 006	49 396	0.8	1.5	1.4	0.1	0.6
	(21%)	(18%)	(18%)	(17%)	(16%)					
NRE	240	327	6 317	11 894	26 250	3.1		6.5	5.4	5.9
			(3%)	(4%)	(9%)					
Nuclear	31 480	37 513	48 725	67 400	77 434	1.8	5.4	3.3	0.9	1.9
	(18%)	(17%)	(20%)	(24%)	(25%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	123	127	128	119	99	0.3	0.1	- 0.7	- 1.2	- 1.0
Primary Energy Supply per Capita (kgoe per capita)	3 593	4 151	4 135	4 434	4 732	1.5	- 0.1	0.7	0.4	0.5
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	85	85	85	76	61	- 0.0	0.2	- 1.1	- 1.5	- 1.3
Final Energy Demand per Capita (kgoe per capita)	2 471	2 768	2 769	2 832	2 920	1.1	0.0	0.2	0.2	0.2
CO_2 Emissions (million tonnes)	**1,085**	**1,207**	**1,238**	**1,207**	**1,148**	**1.1**	**0.5**	**- 0.3**	**- 0.3**	**- 0.3**
Sector										
Electricity and Heat Generation	335	387	435	444	438	1.4	2.3	0.2	- 0.1	0.0
Refineries and Other Energy Sector	115	127	116	99	108	1.0	- 1.9	- 1.5	0.5	- 0.3
Industry	253	235	239	236	223	- 0.7	0.3	- 0.1	- 0.4	- 0.3
Transport	218	268	259	234	199	2.1	- 0.6	- 1.0	- 1.1	- 1.1
Other	164	190	190	193	181	1.5	- 0.0	0.2	- 0.4	- 0.2
Fuel										
Coal	312	382	446	431	427	2.0	3.1	- 0.3	- 0.1	- 0.2
Oil	669	671	627	569	495	0.0	- 1.4	- 1.0	- 0.9	- 0.9
Gas	103	154	165	207	226	4.1	1.4	2.3	0.6	1.3
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	301	291	299	258	206	- 0.3	0.6	- 1.4	- 1.5	- 1.5
CO_2 Emissions per Capita (tonnes per capita)	8. 8	9. 5	9. 7	9. 6	9. 8	0.8	0.4	- 0.1	0.2	0.0

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.8		2.9	6.6	79.4	10.3			99.9
Net Imports	111.0	213.1	36.7	67.7			0.0	(0.0)	0.0	428.5
Primary Energy Supply	**111.0**	**213.8**	**36.7**	**70.6**	**6.6**	**79.4**	**10.3**	**(0.0)**	**0.0**	**528.4**
Transfers and Statistical Diff.	0.8	0.9	(1.6)	1.7			(0.0)	(0.1)	0.0	1.7
Electricity and Heat Gen.	(62.3)		(26.9)	(44.6)	(6.6)	(79.4)	(6.9)	93.6	0.5	(132.5)
Petroleum Refineries		(214.7)	211.6							(3.1)
Other Energy Sector	(19.9)		(12.4)	1.1			(0.0)	(9.5)	0.1	(40.7)
Final Energy Demand	**29.7**		**207.4**	**28.7**			**3.4**	**84.0**	**0.6**	**353.8**
Industry	28.7		35.0	6.7			2.6	27.8	0.0	100.7
Transport	0.0		90.8	0.0			0.0	1.6		92.5
Other	0.6		44.4	21.7			0.8	54.6	0.6	122.7
Non-Energy Use	0.4		37.2	0.4			0.0			37.9

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.7		3.0	7.6	109.8	11.8			132.9
Net Imports	108.1	195.0	34.6	87.4			0.0	0.0	0.0	425.2
Primary Energy Supply	**108.1**	**195.7**	**34.6**	**90.4**	**7.6**	**109.8**	**11.8**	**0.0**	**0.0**	**558.1**
Electricity and Heat Gen.	(62.0)		(25.1)	(51.5)	(7.6)	(109.8)	(8.9)	104.4	0.7	(159.9)
Petroleum Refineries		(195.7)	192.8							(2.9)
Other Energy Sector	(15.1)		(8.7)	(5.2)			0.0	(9.7)	(0.1)	(38.8)
Final Energy Demand	**31.0**		**193.6**	**33.7**			**2.9**	**94.7**	**0.6**	**356.5**
Industry	30.0		31.3	8.4			1.5	29.4	0.0	100.5
Transport	0.0		81.9	0.2			0.5	1.6		84.3
Other	0.7		43.1	24.7			0.9	63.7	0.6	133.6
Non-Energy Use	0.4		37.3	0.4			0.0			38.1

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.7		3.0	7.6	126.2	13.6			151.1
Net Imports	107.3	169.3	30.5	95.6			0.0	0.0	0.0	402.7
Primary Energy Supply	**107.3**	**170.0**	**30.5**	**98.6**	**7.6**	**126.2**	**13.6**	**0.0**	**0.0**	**553.8**
Electricity and Heat Gen.	(62.7)		(19.7)	(54.8)	(7.6)	(126.2)	(10.6)	113.9	0.7	(167.0)
Petroleum Refineries		(170.0)	167.4							(2.5)
Other Energy Sector	(15.3)		(10.5)	(6.1)			0.0	(10.5)	(0.1)	(42.5)
Final Energy Demand	**29.3**		**167.8**	**37.7**			**3.0**	**103.4**	**0.6**	**341.7**
Industry	28.3		28.1	9.7			1.3	30.9	0.0	98.4
Transport	0.0		68.8	1.0			0.8	1.5		72.0
Other	0.6		37.9	26.6			0.9	70.9	0.6	137.5
Non-Energy Use	0.4		32.9	0.4			0.0			33.7

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
616 - 798	0.5 - 0.6	.. - ..	0.5 - 0.6

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2.6 - 3.7	390 - 493	146 - 208	77 - 93

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
66 - 94	21 - 33	2 - 3	526 - 669

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
526 - 669	334 - 412	118 - 167	75 - 90

KOREA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	456	822	1 027	1 457	2 304	6.1	4.6	3.6	3.1	3.3
Population (million)	43	47	48	49	49	0.9	0.5	0.2	- 0.1	0.0
GDP per Capita (2005 US$ PPP per capita)	10 628	17 489	21 273	29 546	47 379	5.1	4.0	3.3	3.2	3.3

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**22.6**	**32.6**	**42.9**	**54.7**	**73.4**	**3.7**	**5.7**	**2.5**	**2.0**	**2.2**
Coal	7.6	1.8	1.2	0.8	0.4	- 13.4	- 7.5	- 3.5	- 4.6	- 4.2
	(33%)	(5%)	(3%)	(2%)	(1%)					
Oil		0.7	0.5	0.6	0.6		- 4.4	0.8	0.0	0.3
		(2%)	(1%)	(1%)	(1%)					
Gas			0.4	0.3	0.3			- 3.8	0.0	- 1.5
			(1%)	(1%)	(0%)					
Hydro	0.5	0.3	0.3	0.3	0.6	- 4.5	- 1.7	- 1.5	5.5	2.7
	(2%)	(1%)	(1%)	(0%)	(1%)					
NRE	0.7	1.4	2.2	3.5	3.9	6.9	9.2	4.9	0.8	2.4
	(3%)	(4%)	(5%)	(6%)	(5%)					
Nuclear	13.8	28.4	38.3	49.2	67.6	7.5	6.1	2.6	2.1	2.3
	(61%)	(87%)	(89%)	(90%)	(92%)					
Net Import	**70.7**	**156.8**	**169.6**	**193.8**	**239.1**	**8.3**	**1.6**	**1.3**	**1.4**	**1.4**
Coal	18.0	37.7	48.3	58.8	70.0	7.7	5.1	2.0	1.2	1.5
Oil	50.0	102.1	94.4	96.4	115.2	7.4	- 1.6	0.2	1.2	0.8
Gas	2.7	17.0	26.9	38.6	53.9	20.1	9.6	3.7	2.2	2.8
Electricity										
Primary Energy Supply	**93.4**	**189.4**	**212.5**	**248.5**	**312.6**	**7.3**	**2.3**	**1.6**	**1.5**	**1.6**
Coal	25.6	39.4	49.5	59.6	70.5	4.4	4.6	1.9	1.12	1.4
	(27%)	(21%)	(23%)	(24%)	(23%)					
Oil	50.0	102.8	94.9	97.5	116.5	7.5	- 1.6	0.3	1.2	0.8
	(54%)	(54%)	(45%)	(39%)	(37%)					
Gas	2.7	17.0	27.4	38.9	54.2	20.1	10.0	3.6	2.2	2.8
	(3%)	(9%)	(13%)	(16%)	(17%)					
Hydro	0.5	0.3	0.3	0.3	0.6	- 4.5	- 1.7	- 1.5	5.5	2.7
	(1%)	(0%)	(0%)	(0%)	(0%)					
NRE	0.7	1.4	2.2	3.0	3.2	6.7	9.0	3.0	0.5	1.5
	(1%)	(1%)	(1%)	(1%)	(1%)					
Nuclear	13.8	28.4	38.3	49.2	67.6	7.5	6.1	2.6	2.1	2.3
	(15%)	(15%)	(18%)	(20%)	(22%)					
Input for Electricity and Heat Generation	**-26.9**	**-66.2**	**-93.5**	**-111.5**	**-146.2**	**9.4**	**7.1**	**1.8**	**1.8**	**1.8**
Coal	- 6.0	- 23.6	- 36.3	- 45.0	- 58.2	14.7	9.0	2.2	1.7	1.9
	(22%)	(36%)	(39%)	(40%)	(40%)					
Oil	- 4.5	- 8.0	- 7.2	- 0.6	- 0.6	5.9	- 2.3	- 21.6	0.2	- 9.2
	(17%)	(12%)	(8%)	(1%)	(0%)					
Gas	- 2.0	- 5.8	- 11.1	- 15.2	- 17.8	10.9	14.0	3.2	1.0	1.9
	(8%)	(9%)	(12%)	(14%)	(12%)					
Hydro	- 0.5	- 0.3	- 0.3	- 0.3	- 0.6	- 4.5	- 1.7	- 1.5	5.5	2.7
	(2%)	(1%)	(0%)	(0%)	(0%)					
NRE		- 0.1	- 0.4	- 1.1	- 1.3		28.4	12.3	1.0	5.4
		(0%)	(0%)	(1%)	(1%)					
Nuclear	- 13.8	- 28.4	- 38.3	- 49.2	- 67.6	7.5	6.1	2.6	2.1	2.3
	(51%)	(43%)	(41%)	(44%)	(46%)					
Input for Refineries and Other Energy Sector	**-10.3**	**-17.9**	**-16.5**	**-14.6**	**-12.7**	**5.7**	**- 1.7**	**- 1.2**	**- 0.9**	**- 1.0**
Coal	- 8.7	- 8.2	- 8.2	- 5.7	- 2.8	- 0.6	- 0.0	- 3.52	- 4.6	- 4.2
Oil	- 0.7	- 7.1	- 5.3	- 5.4	- 5.4	26.6	- 5.7	0.2	0.0	0.1
Gas		- 0.4	- 0.2	- 0.2	- 0.2	38.8	- 9.3	- 3.8	- 0.0	- 1.5
NRE										
Electricity	- 0.9	- 2.2	- 2.6	- 3.2	- 4.2	8.8	3.9	1.8	1.9	1.8
Heat		- 0.1	- 0.1	- 0.1	- 0.1		13.3	0.7	0.6	0.6

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**65.2**	**130.2**	**143.6**	**168.0**	**212.7**	**7.2**	**2.0**	**1.6**	**1.6**	**1.6**
Coal	11.7	8.4	8.5	8.9	9.4	- 3.3	0.3	0.5	0.4	0.4
	(18%)	(6%)	(6%)	(5%)	(4%)					
Oil	43.9	83.6	82.1	91.5	110.5	6.6	- 0.4	1.1	1.3	1.2
	(67%)	(64%)	(57%)	(54%)	(52%)					
Gas	0.7	10.9	16.0	23.6	36.2	32.1	7.9	4.0	2.9	3.3
	(1%)	(8%)	(11%)	(14%)	(17%)					
NRE	0.7	1.3	1.8	1.8	1.9	5.9	6.9	- 0.2	0.2	0.1
	(1%)	(1%)	(1%)	(1%)	(1%)					
Electricity	8.1	22.6	30.8	37.5	49.5	10.8	6.3	2.0	1.9	1.9
	(12%)	(17%)	(21%)	(22%)	(23%)					
Heat		3.3	4.5	4.8	5.3		6.4	0.7	0.6	0.6
		(3%)	(3%)	(3%)	(2%)					
Industry	**19.3**	**37.8**	**39.7**	**45.2**	**56.4**	**7.0**	**1.0**	**1.3**	**1.5**	**1.4**
Coal	3.1	7.8	7.5	8.0	8.8	9.8	- 0.7	0.6	0.6	0.6
	(16%)	(21%)	(19%)	(18%)	(16%)					
Oil	10.9	11.0	7.9	6.7	5.3	0.1	- 6.4	- 1.6	- 1.6	- 1.6
	(56%)	(29%)	(20%)	(15%)	(9%)					
Gas	0.1	2.9	4.2	7.4	14.3	44.4	7.7	6.0	4.5	5.1
	(0%)	(8%)	(10%)	(16%)	(25%)					
NRE	0.3	1.1	1.5	1.4	1.4	14.0	6.8	- 0.5	0.2	- 0.1
	(1%)	(3%)	(4%)	(3%)	(3%)					
Electricity	5.0	12.9	15.8	18.7	23.7	10.0	4.1	1.7	1.6	1.6
	(26%)	(34%)	(40%)	(41%)	(42%)					
Heat		2.1	2.8	2.9	2.9		6.0	0.2	0.0	0.1
		(6%)	(7%)	(6%)	(5%)					
Transportation	**14.9**	**30.0**	**31.7**	**37.3**	**48.5**	**7.3**	**1.1**	**1.7**	**1.8**	**1.7**
Coal										
Oil	14.8	29.8	31.1	36.2	46.8	7.3	0.8	1.5	1.7	1.6
	(99%)	(99%)	(98%)	(97%)	(96%)					
Gas			0.3	0.7	1.1			8.4	3.0	5.1
			(1%)	(2%)	(2%)					
NRE					0.1			15.1	1.3	6.6
					(0%)					
Electricity	0.1	0.2	0.2	0.3	0.5	7.2	5.1	3.5	3.3	3.4
	(1%)	(1%)	(1%)	(1%)	(1%)					
Other	**24.3**	**37.3**	**41.8**	**45.4**	**56.0**	**4.4**	**2.3**	**0.8**	**1.4**	**1.2**
Coal	8.7	0.6	1.0	0.9	0.7	- 23.9	11.0	- 0.8	- 1.7	- 1.3
	(36%)	(2%)	(2%)	(2%)	(1%)					
Oil	11.6	17.8	12.7	8.4	6.5	4.4	- 6.6	- 4.0	- 1.7	- 2.6
	(48%)	(48%)	(30%)	(18%)	(12%)					
Gas	0.6	8.0	11.5	15.4	20.8	29.6	7.4	3.0	2.0	2.4
	(2%)	(22%)	(27%)	(34%)	(37%)					
NRE	0.5	0.3	0.4	0.4	0.4	- 5.4	6.5	0.3	0.3	0.3
	(2%)	(1%)	(1%)	(1%)	(1%)					
Electricity	3.1	9.5	14.7	18.4	25.2	12.0	9.1	2.3	2.1	2.2
	(13%)	(25%)	(35%)	(41%)	(45%)					
Heat		1.2	1.7	1.9	2.4		7.2	1.7	1.3	1.5
		(3%)	(4%)	(4%)	(4%)					
Non-Energy Use	**6.7**	**25.0**	**30.4**	**40.1**	**51.9**	**14.0**	**4.0**	**2.8**	**1.7**	**2.2**
Coal										
Oil	6.7	25.0	30.4	40.1	51.9	14.0	4.0	2.8	1.7	2.2
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**105.4**	**288.5**	**387.8**	**472.5**	**623.8**	**10.6**	**6.1**	**2.0**	**1.9**	**1.9**
Coal	17.7	111.4	148.8	193.1	255.2	20.2	6.0	2.6	1.9	2.2
	(17%)	(39%)	(38%)	(41%)	(41%)					
Oil	18.9	34.6	26.0	0.7	0.6	6.3	- 5.6	- 30.5	- 0.9	- 14.0
	(18%)	(12%)	(7%)							
Gas	9.6	29.5	62.2	84.5	98.9	11.9	16.1	3.1	1.1	1.9
	(9%)	(10%)	(16%)	(18%)	(16%)					
Hydro	6.4	4.0	3.7	3.2	7.1	- 4.5	- 1.7	- 1.5	5.5	2.7
	(6%)	(1%)	(1%)	(1%)	(1%)					
NRE		0.1	0.4	2.0	2.4		30.7	16.5	1.2	7.1
Nuclear	52.9	109.0	146.8	188.9	259.5	7.5	6.1	2.6	2.1	2.3
	(50%)	(38%)	(38%)	(40%)	(42%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**21,006**	**48,452**	**62,312**	**89,002**	**109,199**	**8.7**	**5.2**	**3.6**	**1.4**	**2.3**
Thermal	10 672	31 316	39 835	56 369	67 485	11.4	4.9	3.5	1.2	2.1
	(51%)	(65%)	(64%)	(63%)	(62%)					
Coal	3 700	14 031	18 272	28 627	39 484	14.3	5.4	4.6	2.2	3.1
	(18%)	(29%)	(29%)	(32%)	(36%)					
Oil	3 662	4 490	4 874	3 613	2 913	2.1	1.7	- 2.9	- 1.4	- 2.0
	(17%)	(9%)	(8%)	(4%)	(3%)					
Gas	3 310	12 795	16 689	24 128	25 088	14.5	5.5	3.8	0.3	1.6
	(16%)	(26%)	(27%)	(27%)	(23%)					
Hydro	2 340	3 149	3 883	4 700	4 700	3.0	4.3	1.9	- 0.0	0.8
	(11%)	(6%)	(6%)	(5%)	(4%)					
NRE	378	271	878	3 417	4 098	- 3.3	26.5	14.6	1.2	6.4
	(2%)	(1%)	(1%)	(4%)	(4%)					
Nuclear	7 616	13 716	17 716	24 516	32 916	6.1	5.3	3.3	2.0	2.5
	(36%)	(28%)	(28%)	(28%)	(30%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	205	230	207	171	136	1.2	- 2.1	- 1.9	- 1.5	- 1.7
Primary Energy Supply per Capita (kgoe per capita)	2 178	4 030	4 401	5 039	6 428	6.3	1.8	1.4	1.6	1.5
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	143	158	140	115	92	1.0	- 2.5	- 1.9	- 1.5	- 1.6
Final Energy Demand per Capita (kgoe per capita)	1 521	2 769	2 974	3 407	4 375	6.2	1.4	1.4	1.7	1.6
CO_2 Emissions (million tonnes)	**242**	**427**	**464**	**495**	**594**	**5.8**	**1.7**	**0.7**	**1.2**	**1.0**
Sector										
Electricity and Heat Generation	43	132	193	217	276	12.0	7.8	1.2	1.6	1.4
Refineries and Other Energy Sector	37	56	48	38	27	4.2	- 2.9	- 2.2	- 2.4	- 2.3
Industry	46	72	64	70	84	4.5	- 2.3	0.9	1.3	1.1
Transport	45	91	90	105	136	7.3	- 0.3	1.6	1.7	1.7
Other	72	76	70	65	71	0.5	- 1.7	- 0.7	0.6	0.1
Fuel										
Coal	105	160	212	239	282	4.3	5.7	1.2	1.1	1.1
Oil	131	227	189	167	187	5.7	- 3.5	- 1.2	0.8	- 0.0
Gas	6	39	63	90	125	20.1	9.8	3.6	2.2	2.8
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	532	519	452	340	258	- 0.2	- 2.7	- 2.8	- 1.8	- 2.2
CO_2 Emissions per Capita (tonnes per capita)	5. 7	9. 1	9. 6	10.	12. 2	4.8	1.2	0.4	1.3	1.0

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1.2	0.5		0.4	0.3	38.3	2.2			42.9
Net Imports	48.3	123.6	(29.2)	26.9			0.0	0.0	0.0	169.6
Primary Energy Supply	**49.5**	**124.1**	**(29.2)**	**27.4**	**0.3**	**38.3**	**2.2**	**0.0**	**0.0**	**212.5**
Transfers and Statistical Diff.	3.5	(0.2)	(0.2)	(0.1)			0.0	0.0	0.0	3.1
Electricity and Heat Gen.	(36.3)		(7.2)	(11.1)	(0.3)	(38.3)	(0.4)	33.4	4.6	(55.6)
Petroleum Refineries		(124.0)	123.4							(0.5)
Other Energy Sector	(8.2)		(4.7)	(0.2)			0.0	(2.6)	(0.1)	(15.9)
Final Energy Demand	**8.5**		**82.1**	**16.0**			**1.8**	**30.8**	**4.5**	**143.6**
Industry	7.5		7.9	4.2			1.5	15.8	2.8	39.7
Transport	0.0		31.1	0.3			0.0	0.2		31.7
Other	1.0		12.7	11.5			0.4	14.7	1.7	41.8
Non-Energy Use	0.0		30.4	0.0			0.0			30.4

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.8	0.6		0.3	0.3	49.2	3.5			54.7
Net Imports	58.8	126.2	(29.2)	38.6			(0.5)	0.0	0.0	193.8
Primary Energy Supply	**59.6**	**126.8**	**(29.2)**	**38.9**	**0.3**	**49.2**	**3.0**	**0.0**	**0.0**	**248.5**
Electricity and Heat Gen.	(45.0)		(0.6)	(15.2)	(0.3)	(49.2)	(1.1)	40.6	4.9	(65.9)
Petroleum Refineries		(126.8)	126.2							(0.6)
Other Energy Sector	(5.7)		(4.9)	(0.2)			0.0	(3.2)	(0.1)	(14.0)
Final Energy Demand	**8.9**		**91.5**	**23.6**			**1.8**	**37.5**	**4.8**	**168.0**
Industry	8.0		6.7	7.4			1.4	18.7	2.9	45.2
Transport	0.0		36.2	0.7			0.0	0.3		37.3
Other	0.9		8.4	15.4			0.4	18.4	1.9	45.4
Non-Energy Use	0.0		40.1	0.0			0.0			40.1

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.4	0.6		0.3	0.6	67.6	3.9			73.4
Net Imports	70.0	126.2	(10.2)	53.9			(0.7)	0.0	0.0	239.1
Primary Energy Supply	**70.5**	**126.8**	**(10.2)**	**54.2**	**0.6**	**67.6**	**3.2**	**0.0**	**0.0**	**312.6**
Electricity and Heat Gen.	(58.2)		(0.6)	(17.8)	(0.6)	(67.6)	(1.3)	53.6	5.4	(87.2)
Petroleum Refineries		(126.8)	126.2							(0.6)
Other Energy Sector	(2.8)		(4.9)	(0.2)			0.0	(4.2)	(0.1)	(12.1)
Final Energy Demand	**9.4**		**110.5**	**36.2**			**1.9**	**49.5**	**5.3**	**212.7**
Industry	8.8		5.3	14.3			1.4	23.7	2.9	56.4
Transport	0.0		46.8	1.1			0.1	0.5		48.5
Other	0.7		6.5	20.8			0.4	25.2	2.4	56.0
Non-Energy Use	0.0		51.9	0.0			0.0			51.9

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
234 - 313	0.6 - 0.7	.. - ..	0.6 - 0.7

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
0.8 - 1.1	165 - 219	47 - 67	21 - 26

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
51 - 72	12 - 19	1 - 2	170 - 221

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
170 - 221	119 - 153	31 - 44	20 - 24

MALAYSIA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	122	242	300	451	843	7.1	4.4	4.2	4.3	4.2
Population (million)	18	23	26	30	35	2.5	2.0	1.6	1.1	1.3
GDP per Capita (2005 US$ PPP per capita)	6 727	10 396	11 678	15 048	23 973	4.4	2.4	2.6	3.2	2.9

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**50.3**	**80.4**	**97.0**	**101.4**	**112.6**	**4.8**	**3.8**	**0.4**	**0.7**	**0.6**
Coal	0.1	0.2	0.4	1.0	1.0	13.1	18.4	8.8	0.0	3.4
	(0%)	(0%)	(0%)	(1%)	(1%)					
Oil	32.3	34.5	38.0	40.0	30.1	0.6	2.0	0.5	- 1.9	- 0.9
	(64%)	(43%)	(39%)	(39%)	(27%)					
Gas	15.5	42.5	55.4	56.3	75.0	10.6	5.4	0.2	1.9	1.2
	(31%)	(53%)	(57%)	(55%)	(67%)					
Hydro	0.3	0.6	0.4	2.1	2.5	6.4	- 6.9	16.8	1.1	7.1
	(1%)	(1%)	(0%)	(2%)	(2%)					
NRE	2.1	2.5	2.8	2.1	4.0	1.9	2.0	- 3.1	4.5	1.4
	(4%)	(3%)	(3%)	(2%)	(4%)					
Nuclear										
Net Import	**-27.0**	**-29.1**	**-31.1**	**-21.8**	**17.9**	**0.8**	**1.3**	**- 3.5**		
Coal	1.0	1.6	6.4	13.5	22.3	4.9	32.2	7.8	3.4	5.1
Oil	- 19.3	- 12.3	- 12.5	- 7.7	23.4	- 4.4	0.3	- 4.7		
Gas	- 8.7	- 18.4	- 24.8	- 27.4	- 27.6	7.8	6.2	1.0	0.0	0.4
Electricity			- 0.2	- 0.2	- 0.2			0.9	- 0.0	0.4
Primary Energy Supply	**23.3**	**51.3**	**65.9**	**79.6**	**130.5**	**8.2**	**5.2**	**1.9**	**3.4**	**2.8**
Coal	1.0	1.8	6.8	14.5	23.3	5.5	31.0	7.8	3.21	5.0
	(4%)	(3%)	(10%)	(18%)	(18%)					
Oil	13.0	22.2	25.5	31.1	52.3	5.5	2.8	2.0	3.5	2.9
	(56%)	(43%)	(39%)	(39%)	(40%)					
Gas	6.8	24.1	30.5	28.8	47.4	13.5	4.8	- 0.6	3.4	1.8
	(29%)	(47%)	(46%)	(36%)	(36%)					
Hydro	0.3	0.6	0.4	2.1	2.5	6.4	- 6.9	16.8	1.1	7.1
	(1%)	(1%)	(1%)	(3%)	(2%)					
NRE	2.1	2.5	2.8	3.2	5.2	1.8	2.0	1.4	3.3	2.5
	(9%)	(5%)	(4%)	(4%)	(4%)					
Nuclear										
Input for Electricity and Heat Generation	**-5.3**	**-14.9**	**-19.8**	**-27.4**	**-48.5**	**10.8**	**6.0**	**3.3**	**3.9**	**3.6**
Coal	- 0.6	- 1.1	- 5.5	- 12.8	- 21.2	6.3	37.1	8.7	3.4	5.5
	(12%)	(8%)	(28%)	(47%)	(44%)					
Oil	- 3.0	- 1.0	- 0.7	- 0.1	- 0.1	- 10.7	- 7.3	- 15.2	- 4.0	- 8.6
	(56%)	(7%)	(3%)	(0%)	(0%)					
Gas	- 1.4	- 12.1	- 13.2	- 12.3	- 24.7	24.4	1.7	- 0.7	4.7	2.5
	(26%)	(81%)	(66%)	(45%)	(51%)					
Hydro	- 0.3	- 0.6	- 0.4	- 2.1	- 2.5	6.4	- 6.9	16.8	1.1	7.1
	(6%)	(4%)	(2%)	(8%)	(5%)					
NRE					- 0.1				4.8	
					(0%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-5.6**	**-11.6**	**-10.9**	**-9.0**	**-11.9**	**7.4**	**- 1.1**	**- 2.0**	**1.9**	**0.3**
Coal										
Oil	- 0.1	- 2.8	- 2.8			38.3	- 0.4		0.9	
Gas	- 4.5	- 7.0	- 6.8	- 6.9	- 9.2	4.7	- 0.7	0.2	1.9	1.2
NRE	- 0.8	- 1.0	- 1.1	- 1.1	- 1.2	1.9	2.2	0.2	0.3	0.2
Electricity	- 0.3	- 0.7	- 0.2	- 0.9	- 1.5	10.3	- 19.4	14.6	3.4	7.7
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**14.5**	**30.8**	**39.9**	**55.4**	**92.9**	**7.8**	**5.3**	**3.3**	**3.5**	**3.4**
Coal	0.4	0.6	1.3	1.7	2.1	4.1	16.7	2.5	1.3	1.8
	(3%)	(2%)	(3%)	(3%)	(2%)					
Oil	10.0	19.6	23.0	31.0	52.3	6.9	3.3	3.0	3.5	3.3
	(69%)	(64%)	(58%)	(56%)	(56%)					
Gas	1.1	3.9	7.0	9.6	13.5	13.4	12.6	3.2	2.3	2.7
	(8%)	(13%)	(17%)	(17%)	(15%)					
NRE	1.3	1.5	1.7	2.0	3.9	1.5	2.0	1.9	4.5	3.5
	(9%)	(5%)	(4%)	(4%)	(4%)					
Electricity	1.7	5.3	6.9	11.0	21.1	11.9	5.7	4.7	4.4	4.5
	(12%)	(17%)	(17%)	(20%)	(23%)					
Heat										
Industry	**5.3**	**11.1**	**15.6**	**22.1**	**35.9**	**7.7**	**7.0**	**3.6**	**3.3**	**3.4**
Coal	0.4	0.6	1.3	1.7	2.1	4.1	16.7	2.5	1.3	1.8
	(8%)	(6%)	(9%)	(8%)	(6%)					
Oil	3.5	5.3	5.5	7.3	12.7	4.1	0.6	3.0	3.7	3.4
	(67%)	(48%)	(35%)	(33%)	(35%)					
Gas	0.5	2.3	5.3	7.2	9.2	17.8	18.0	3.1	1.7	2.2
	(9%)	(21%)	(34%)	(33%)	(26%)					
NRE	0.1	0.1	0.1	0.1	0.2	2.6	2.0	3.0	3.0	3.0
	(1%)	(1%)	(1%)	(1%)	(1%)					
Electricity	0.8	2.8	3.4	5.8	11.7	12.9	3.8	5.5	4.8	5.1
	(16%)	(25%)	(22%)	(26%)	(33%)					
Heat										
Transportation	**5.5**	**12.1**	**15.4**	**21.3**	**37.3**	**8.2**	**5.0**	**3.3**	**3.8**	**3.6**
Coal										
Oil	5.5	12.1	15.3	20.8	34.9	8.2	4.8	3.1	3.5	3.4
	(100%)	(100%)	(99%)	(98%)	(94%)					
Gas			0.1	0.2	0.2			5.1	1.8	3.1
			(1%)	(1%)	(1%)					
NRE				0.3	2.1				13.8	
				(1%)	(6%)					
Electricity							4.6	9.1	3.6	5.7
Other	**2.9**	**5.4**	**6.8**	**9.2**	**15.4**	**6.4**	**4.7**	**3.1**	**3.4**	**3.3**
Coal										
Oil	0.8	1.5	1.6	2.4	4.3	7.2	1.7	3.7	4.1	3.9
	(26%)	(28%)	(24%)	(25%)	(28%)					
Gas				0.1	0.1	- 6.7	11.8	7.8	6.1	6.8
				(1%)	(1%)					
NRE	1.2	1.4	1.6	1.6	1.6	1.5	2.0	0.0	- 0.0	0.0
	(42%)	(26%)	(23%)	(17%)	(10%)					
Electricity	0.9	2.5	3.6	5.3	9.4	10.7	7.8	3.9	3.9	3.9
	(31%)	(45%)	(52%)	(57%)	(61%)					
Heat										
Non-Energy Use	**0.8**	**2.3**	**2.2**	**2.8**	**4.3**	**10.4**	**- 0.7**	**2.4**	**3.1**	**2.8**
Coal										
Oil	0.2	0.7	0.6	0.6	0.4	12.4	- 3.1	- 1.1	- 2.0	- 1.6
	(27%)	(33%)	(29%)	(21%)	(10%)					
Gas	0.6	1.5	1.5	2.2	3.9	9.5	0.4	3.6	4.0	3.8
	(73%)	(67%)	(71%)	(79%)	(90%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**23.0**	**69.3**	**84.8**	**141.6**	**265.3**	**11.6**	**4.1**	**5.3**	**4.3**	**4.7**
Coal	2.8	4.6	23.1	58.0	98.1	4.9	38.4	9.6	3.6	5.9
	(12%)	(7%)	(27%)	(41%)	(37%)					
Oil	11.1	4.1	3.2	0.6	0.3	- 9.5	- 4.9	- 15.2	- 4.0	- 8.6
	(48%)	(6%)	(4%)							
Gas	5.1	53.2	53.3	57.8	136.8	26.5	0.1	0.8	5.9	3.8
	(22%)	(77%)	(63%)	(41%)	(52%)					
Hydro	4.0	7.4	5.2	24.6	28.9	6.4	- 6.9	16.8	1.1	7.1
	(17%)	(11%)	(6%)	(17%)	(11%)					
NRE				0.6	1.1				4.8	
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**4,615**	**11,424**	**21,142**	**30,813**	**59,474**	**9.5**	**13.1**	**3.8**	**4.5**	**4.2**
Thermal	3 580	9 361	19 047	25 879	53 465	10.1	15.3	3.1	5.0	4.2
	(78%)	(82%)	(90%)	(84%)	(90%)					
Coal	570	600	4 612	11 035	18 660	0.5		9.1	3.6	5.8
	(12%)	(5%)	(22%)	(36%)	(31%)					
Oil	2 080	943	620	184	100	- 7.6	- 8.0	- 11.4	- 4.0	- 7.0
	(45%)	(8%)	(3%)	(1%)						
Gas	930	7 818	13 815	14 660	34 705	23.7	12.1	0.6	5.9	3.8
	(20%)	(68%)	(65%)	(48%)	(58%)					
Hydro	1 035	2 063	2 083	4 683	5 504	7.1	0.2	8.4	1.1	4.0
	(22%)	(18%)	(10%)	(15%)	(9%)					
NRE			12	251	505			35.5	4.8	16.1
				(1%)	(1%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	192	212	220	177	155	1.0	0.8	- 2.2	- 0.9	- 1.4
Primary Energy Supply per Capita (kgoe per capita)	1 288	2 202	2 570	2 657	3 709	5.5	3.1	0.3	2.2	1.5
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	119	128	133	123	110	0.7	0.9	- 0.8	- 0.7	- 0.8
Final Energy Demand per Capita (kgoe per capita)	803	1 325	1 557	1 850	2 640	5.1	3.3	1.7	2.4	2.1
CO_2 Emissions (million tonnes)	**57**	**122**	**150**	**205**	**339**	**8.0**	**4.3**	**3.1**	**3.4**	**3.3**
Sector										
Electricity and Heat Generation	15	35	55	80	142	9.0	9.0	3.9	3.9	3.9
Refineries and Other Energy Sector	11	25	15	15	20	9.0	- 9.9	0.0	2.0	1.2
Industry	14	24	35	46	69	5.9	7.3	2.9	2.7	2.8
Transport	15	33	41	56	94	8.0	4.9	3.1	3.5	3.4
Other	2	5	5	7	14	7.0	1.8	3.7	4.1	4.0
Fuel										
Coal	4	7	28	58	93	5.5	31.3	7.7	3.2	5.0
Oil	38	65	64	85	146	5.6	- 0.3	2.9	3.6	3.3
Gas	14	49	58	61	100	13.1	3.4	0.5	3.3	2.2
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	464	504	502	454	402	0.8	- 0.1	- 1.0	- 0.8	- 0.9
CO_2 Emissions per Capita (tonnes per capita)	3. 1	5. 2	5. 9	6. 8	9. 6	5.3	2.3	1.5	2.3	2.0

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.4	38.0		55.4	0.4	0.0	2.8			97.0
Net Imports	6.4	(11.3)	(1.2)	(24.8)			(0.0)	(0.2)	0.0	(31.1)
Primary Energy Supply	**6.8**	**26.7**	**(1.2)**	**30.5**	**0.4**	**0.0**	**2.8**	**(0.2)**	**0.0**	**65.9**
Transfers and Statistical Diff.	0.1	(2.2)	3.1	(3.6)			0.0	0.1	0.0	(2.5)
Electricity and Heat Gen.	(5.5)		(0.7)	(13.2)	(0.4)	0.0	0.0	7.3	0.0	(12.5)
Petroleum Refineries		(24.5)	21.4							(3.1)
Other Energy Sector	0.0		0.3	(6.8)			(1.1)	(0.2)	0.0	(7.9)
Final Energy Demand	**1.3**		**23.0**	**7.0**			**1.7**	**6.9**	**0.0**	**40.0**
Industry	1.3		5.5	5.3			0.1	3.4	0.0	15.6
Transport	0.0		15.3	0.1			0.0	0.0		15.4
Other	0.0		1.6	0.0			1.6	3.6	0.0	6.8
Non-Energy Use	0.0		0.6	1.5			0.0			2.2

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1.0	40.0		56.3	2.1	0.0	2.1			101.4
Net Imports	13.5	(9.5)	0.6	(27.4)			1.1	(0.2)	0.0	(21.8)
Primary Energy Supply	**14.5**	**30.5**	**0.6**	**28.8**	**2.1**	**0.0**	**3.2**	**(0.2)**	**0.0**	**79.6**
Electricity and Heat Gen.	(12.8)		(0.1)	(12.3)	(2.1)	0.0	(0.0)	12.2	0.0	(15.2)
Petroleum Refineries		(30.5)	30.2							(0.3)
Other Energy Sector	0.0		0.3	(6.9)			(1.1)	(0.9)	0.0	(8.6)
Final Energy Demand	**1.7**		**31.0**	**9.6**			**2.0**	**11.0**	**0.0**	**55.4**
Industry	1.7		7.3	7.2			0.1	5.8	0.0	22.1
Transport	0.0		20.8	0.2			0.3	0.0		21.3
Other	0.0		2.4	0.1			1.6	5.3	0.0	9.2
Non-Energy Use	0.0		0.6	2.2			0.0			2.8

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1.0	30.1		75.0	2.5	0.0	4.0			112.6
Net Imports	22.3	4.9	17.3	(27.6)			1.2	(0.2)	0.0	17.9
Primary Energy Supply	**23.3**	**35.0**	**17.3**	**47.4**	**2.5**	**0.0**	**5.2**	**(0.2)**	**0.0**	**130.5**
Electricity and Heat Gen.	(21.2)		(0.1)	(24.7)	(2.5)	0.0	(0.1)	22.8	0.0	(25.7)
Petroleum Refineries		(35.0)	34.6							(0.4)
Other Energy Sector	0.0		0.4	(9.2)			(1.2)	(1.5)	0.0	(11.5)
Final Energy Demand	**2.1**		**52.3**	**13.5**			**3.9**	**21.1**	**0.0**	**92.9**
Industry	2.1		12.7	9.2			0.2	11.7	0.0	35.9
Transport	0.0		34.9	0.2			2.1	0.0		37.3
Other	0.0		4.3	0.1			1.6	9.4	0.0	15.4
Non-Energy Use	0.0		0.4	3.9			0.0			4.3

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
151 - 219	1.1 - 1.6	0.4 - 0.6	0.7 - 1.0

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
57 - 84	46 - 63	37.0 - 56.0	11 - 15

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
30 - 46	62 - 91	0.6 - 0.9	58 - 81

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
58 - 81	27 - 36	20 - 30	11 - 15

MEXICO

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	764	1 074	1 174	1 556	2 495	3.5	1.8	2.9	3.2	3.1
Population (million)	83	98	103	113	125	1.6	1.0	0.9	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	9 176	10 966	11 387	13 735	19 887	1.8	0.8	1.9	2.5	2.3

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**193.4**	**225.9**	**259.2**	**276.9**	**319.8**	**1.6**	**2.8**	**0.7**	**1.0**	**0.8**
Coal	3.4	5.4	5.2	7.1	8.8	4.8	- 1.0	3.3	1.4	2.1
	(2%)	(2%)	(2%)	(3%)	(3%)					
Oil	152.8	171.1	197.3	182.2	202.3	1.1	2.9	- 0.8	0.7	0.1
	(79%)	(76%)	(76%)	(66%)	(63%)					
Gas	22.8	31.3	36.9	67.0	81.3	3.3	3.3	6.2	1.3	3.2
	(12%)	(14%)	(14%)	(24%)	(25%)					
Hydro	2.0	2.8	2.4	2.7	3.5	3.5	- 3.5	1.4	1.7	1.6
	(1%)	(1%)	(1%)	(1%)	(1%)					
NRE	11.7	13.1	14.7	14.5	20.7	1.1	2.4	- 0.1	2.4	1.4
	(6%)	(6%)	(6%)	(5%)	(6%)					
Nuclear	0.8	2.1	2.8	3.3	3.3	10.8	5.6	1.6	0.0	0.7
	(0%)	(1%)	(1%)	(1%)	(1%)					
Net Import	**-70.4**	**-75.8**	**-82.6**	**-70.0**	**-48.8**	**0.7**	**1.7**	**- 1.6**	**- 2.4**	**- 2.1**
Coal	0.1	1.4	3.7	7.3	14.8	33.6	20.8	7.1	4.8	5.7
Oil	- 70.7	- 79.4	- 93.5	- 81.5	- 89.3	1.2	3.3	- 1.4	0.6	- 0.2
Gas	0.4	2.2	7.3	4.3	25.8	19.4	27.4	- 5.2	12.7	5.2
Electricity	- 0.1	0.1	- 0.1	- 0.1	- 0.1			- 0.0	- 0.0	0.0
Primary Energy Supply	**123.0**	**150.2**	**176.6**	**206.9**	**271.0**	**2.0**	**3.3**	**1.6**	**1.8**	**1.7**
Coal	3.5	6.8	8.8	14.4	23.5	7.0	5.3	5.0	3.31	4.0
	(3%)	(5%)	(5%)	(7%)	(9%)					
Oil	82.0	91.7	103.8	100.7	113.0	1.1	2.5	- 0.3	0.8	0.3
	(67%)	(61%)	(59%)	(49%)	(42%)					
Gas	23.1	33.5	44.2	71.3	107.1	3.8	5.7	4.9	2.7	3.6
	(19%)	(22%)	(25%)	(34%)	(40%)					
Hydro	2.0	2.8	2.4	2.7	3.5	3.5	- 3.5	1.4	1.7	1.6
	(2%)	(2%)	(1%)	(1%)	(1%)					
NRE	11.7	13.1	14.7	14.5	20.7	1.1	2.4	- 0.1	2.4	1.4
	(10%)	(9%)	(8%)	(7%)	(8%)					
Nuclear	0.8	2.1	2.8	3.3	3.3	10.8	5.6	1.6	0.0	0.7
	(1%)	(1%)	(2%)	(2%)	(1%)					
Input for Electricity and Heat Generation	**-28.6**	**-47.6**	**-58.0**	**-67.2**	**-103.9**	**5.2**	**4.0**	**1.5**	**2.9**	**2.4**
Coal	- 1.8	- 4.8	- 8.0	- 12.1	- 20.5	10.2	10.8	4.2	3.6	3.8
	(6%)	(10%)	(14%)	(18%)	(20%)					
Oil	- 16.1	- 22.9	- 17.0	- 10.6	- 11.9	3.6	- 5.9	- 4.6	0.7	- 1.4
	(56%)	(48%)	(29%)	(16%)	(11%)					
Gas	- 3.4	- 9.0	- 20.5	- 33.5	- 58.3	10.1	17.9	5.0	3.8	4.3
	(12%)	(19%)	(35%)	(50%)	(56%)					
Hydro	- 2.0	- 2.8	- 2.4	- 2.7	- 3.5	3.5	- 3.5	1.4	1.7	1.6
	(7%)	(6%)	(4%)	(4%)	(3%)					
NRE	- 4.4	- 5.9	- 7.4	- 5.0	- 6.4	3.0	4.7	- 3.9	1.7	- 0.6
	(15%)	(12%)	(13%)	(7%)	(6%)					
Nuclear	- 0.8	- 2.1	- 2.8	- 3.3	- 3.3	10.8	5.6	1.6	- 0.0	0.7
	(3%)	(5%)	(5%)	(5%)	(3%)					
Input for Refineries and Other Energy Sector	**-18.2**	**-20.4**	**-30.5**	**-35.9**	**-44.8**	**1.1**	**8.3**	**1.6**	**1.5**	**1.6**
Coal	- 0.1	- 0.7	- 0.4	- 0.5	- 0.7	16.6	- 10.9	3.29	1.4	2.1
Oil	- 10.7	- 7.7	- 14.0	- 10.1	- 11.7	- 3.3	12.8	- 3.2	1.0	- 0.7
Gas	- 5.5	- 8.3	- 11.2	- 20.3	- 24.7	4.2	6.1	6.2	1.3	3.2
NRE										
Electricity	- 1.8	- 3.7	- 4.9	- 4.9	- 7.8	7.3	5.6	0.1	3.1	1.9
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**88.3**	**100.6**	**108.6**	**130.6**	**166.8**	**1.3**	**1.5**	**1.9**	**1.6**	**1.7**
Coal	1.6	1.4	1.4	1.8	2.4	- 1.2	0.2	2.6	1.9	2.2
	(2%)	(1%)	(1%)	(1%)	(1%)					
Oil	56.7	63.0	70.3	80.0	89.4	1.1	2.2	1.3	0.7	1.0
	(64%)	(63%)	(65%)	(61%)	(54%)					
Gas	14.2	15.2	13.8	17.5	24.1	0.7	- 1.9	2.4	2.2	2.3
	(16%)	(15%)	(13%)	(13%)	(14%)					
NRE	7.3	7.2	7.3	9.5	14.3	- 0.2	0.3	2.7	2.8	2.7
	(8%)	(7%)	(7%)	(7%)	(9%)					
Electricity	8.6	13.9	15.8	21.8	36.6	4.9	2.6	3.3	3.5	3.4
	(10%)	(14%)	(15%)	(17%)	(22%)					
Heat										
Industry	**27.7**	**29.8**	**27.6**	**37.0**	**53.6**	**0.7**	**- 1.5**	**3.0**	**2.5**	**2.7**
Coal	1.5	1.4	1.4	1.8	2.4	- 1.1	0.2	2.6	1.9	2.2
	(6%)	(5%)	(5%)	(5%)	(4%)					
Oil	9.0	7.7	5.7	8.4	8.9	- 1.6	- 5.7	4.0	0.3	1.8
	(32%)	(26%)	(21%)	(23%)	(17%)					
Gas	10.8	11.0	10.0	12.2	16.8	0.2	- 2.0	2.0	2.2	2.1
	(39%)	(37%)	(36%)	(33%)	(31%)					
NRE	1.7	1.2	1.3	1.5	1.9	- 3.9	1.9	1.3	2.0	1.7
	(6%)	(4%)	(5%)	(4%)	(4%)					
Electricity	4.6	8.6	9.2	13.2	23.6	6.4	1.5	3.6	4.0	3.8
	(17%)	(29%)	(33%)	(36%)	(44%)					
Heat										
Transportation	**31.3**	**38.0**	**47.5**	**57.5**	**70.9**	**2.0**	**4.6**	**1.9**	**1.4**	**1.6**
Coal										
Oil	31.2	37.2	46.6	53.9	62.4	1.8	4.6	1.5	1.0	1.2
	(100%)	(98%)	(98%)	(94%)	(88%)					
Gas		0.6	0.7	1.3	1.6		2.7	5.6	1.8	3.3
		(2%)	(2%)	(2%)	(2%)					
NRE				2.2	6.7				7.6	
				(4%)	(9%)					
Electricity	0.1	0.1	0.1	0.1	0.2	2.9	2.1	2.1	2.9	2.6
	(0%)	(0%)	(0%)	(0%)	(0%)					
Other	**20.0**	**23.6**	**25.0**	**27.5**	**32.8**	**1.7**	**1.2**	**1.0**	**1.2**	**1.1**
Coal										
Oil	9.6	11.5	11.4	11.6	12.1	1.8	- 0.1	0.1	0.3	0.2
	(48%)	(49%)	(46%)	(42%)	(37%)					
Gas	0.8	0.8	1.1	1.6	2.3	- 0.4	6.3	3.9	2.5	3.1
	(4%)	(3%)	(4%)	(6%)	(7%)					
NRE	5.6	6.0	6.0	5.8	5.6	0.7	- 0.0	- 0.3	- 0.2	- 0.2
	(28%)	(26%)	(24%)	(21%)	(17%)					
Electricity	4.0	5.3	6.5	8.6	12.8	3.0	4.3	2.7	2.7	2.7
	(20%)	(22%)	(26%)	(31%)	(39%)					
Heat										
Non-Energy Use	**9.4**	**9.3**	**8.6**	**8.6**	**9.5**	**- 0.1**	**- 1.6**	**0.0**	**0.7**	**0.4**
Coal										
Oil	6.9	6.6	6.6	6.1	6.1	- 0.4	- 0.0	- 0.8	- 0.0	- 0.3
	(73%)	(71%)	(77%)	(71%)	(64%)					
Gas	2.5	2.7	2.0	2.5	3.4	0.7	- 5.8	2.3	2.1	2.2
	(27%)	(29%)	(23%)	(29%)	(36%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**124.1**	**203.6**	**242.0**	**312.3**	**517.1**	**5.1**	**3.5**	**2.6**	**3.4**	**3.1**
Coal	7.8	19.1	32.9	50.4	86.3	9.4	11.5	4.4	3.7	3.9
	(6%)	(9%)	(14%)	(16%)	(17%)					
Oil	70.4	97.2	66.8	43.1	51.1	3.3	- 7.2	- 4.3	1.1	- 1.1
	(57%)	(48%)	(28%)	(14%)	(10%)					
Gas	14.5	39.7	93.5	161.3	307.6	10.6	18.7	5.6	4.4	4.9
	(12%)	(19%)	(39%)	(52%)	(59%)					
Hydro	23.5	33.1	27.7	31.8	40.9	3.5	- 3.5	1.4	1.7	1.6
	(19%)	(16%)	(11%)	(10%)	(8%)					
NRE	5.1	6.4	10.4	13.0	18.5	2.2	10.3	2.2	2.4	2.3
	(4%)	(3%)	(4%)	(4%)	(4%)					
Nuclear	2.9	8.2	10.8	12.7	12.7	10.8	5.6	1.6	0.0	0.7
	(2%)	(4%)	(4%)	(4%)	(2%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**8,555**	**11,856**	**47,070**	**61,532**	**95,894**	**3.3**	**31.8**	**2.7**	**3.0**	**2.9**
Thermal			33 672	45 233	74 730			3.0	3.4	3.2
			(72%)	(74%)	(78%)					
Coal			4 700	6 825	11 689			3.8	3.7	3.7
			(10%)	(11%)	(12%)					
Oil			12 935	14 142	16 762			0.9	1.1	1.0
			(27%)	(23%)	(17%)					
Gas			16 037	24 266	46 279			4.2	4.4	4.3
			(34%)	(39%)	(48%)					
Hydro	7 880	9 634	10 536	12 515	16 100	2.0	1.8	1.7	1.7	1.7
	(92%)	(81%)	(22%)	(20%)	(17%)					
NRE		857	1 497	2 150	3 430		11.8	3.7	3.2	3.4
		(7%)	(3%)	(3%)	(4%)					
Nuclear	675	1 365	1 365	1 634	1 634	7.3	0.0	1.8	0.0	0.7
	(8%)	(12%)	(3%)	(3%)	(2%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	161	140	150	133	109	- 1.4	1.5	- 1.2	- 1.3	- 1.3
Primary Energy Supply per Capita (kgoe per capita)	1 478	1 533	1 713	1 826	2 160	0.4	2.3	0.6	1.1	0.9
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	116	94	93	84	67	- 2.1	- 0.2	- 1.0	- 1.5	- 1.3
Final Energy Demand per Capita (kgoe per capita)	1 062	1 027	1 054	1 153	1 329	- 0.3	0.5	0.9	1.0	0.9
CO_2 Emissions (million tonnes)	**293**	**357**	**401**	**493**	**644**	**2.0**	**2.4**	**2.1**	**1.8**	**1.9**
Sector										
Electricity and Heat Generation	65	111	132	158	253	5.5	3.5	1.9	3.2	2.6
Refineries and Other Energy Sector	47	46	48	73	87	- 0.2	0.8	4.4	1.2	2.4
Industry	59	55	46	61	76	- 0.7	- 3.3	2.9	1.4	2.0
Transport	91	109	138	160	186	1.8	4.9	1.5	1.0	1.2
Other	32	37	38	40	43	1.7	0.3	0.4	0.5	0.5
Fuel										
Coal	14	27	39	58	94	7.0	7.3	4.0	3.3	3.6
Oil	232	261	262	277	312	1.2	0.1	0.5	0.8	0.7
Gas	47	68	100	158	238	3.7	7.9	4.7	2.8	3.5
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	384	332	342	317	258	- 1.4	0.6	- 0.8	- 1.4	- 1.1
CO_2 Emissions per Capita (tonnes per capita)	3. 5	3. 6	3. 9	4. 3	5. 1	0.3	1.3	1.1	1.1	1.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	5.2	197.3		36.9	2.4	2.8	14.7			259.2
Net Imports	3.7	(105.2)	11.7	7.3			0.0	(0.1)	0.0	(82.6)
Primary Energy Supply	**8.8**	**92.1**	**11.7**	**44.2**	**2.4**	**2.8**	**14.7**	**(0.1)**	**0.0**	**176.6**
Transfers and Statistical Diff.	0.9	(12.4)	9.8	1.3			0.0	0.0	0.0	(0.3)
Electricity and Heat Gen.	(8.0)		(17.0)	(20.5)	(2.4)	(2.8)	(7.4)	20.8	0.0	(37.2)
Petroleum Refineries		(79.8)	72.3							(7.5)
Other Energy Sector	(0.4)		(6.5)	(11.2)			0.0	(4.9)	0.0	(23.0)
Final Energy Demand	**1.4**		**70.4**	**13.8**			**7.3**	**15.8**	**0.0**	**108.6**
Industry	1.4		5.7	10.0			1.3	9.2	0.0	27.6
Transport	0.0		46.6	0.7			0.0	0.1		47.5
Other	0.0		11.4	1.1			6.0	6.5	0.0	25.0
Non-Energy Use	0.0		6.6	2.0			0.0			8.6

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	7.1	182.2		67.0	2.7	3.3	14.5			276.9
Net Imports	7.3	(87.9)	6.5	4.3			0.0	(0.1)	0.0	(70.0)
Primary Energy Supply	**14.4**	**94.3**	**6.5**	**71.3**	**2.7**	**3.3**	**14.5**	**(0.1)**	**0.0**	**206.9**
Electricity and Heat Gen.	(12.1)		(10.6)	(33.5)	(2.7)	(3.3)	(5.0)	26.8	0.0	(40.4)
Petroleum Refineries		(94.3)	91.9							(2.4)
Other Energy Sector	(0.5)		(7.7)	(20.3)			0.0	(4.9)	0.0	(33.5)
Final Energy Demand	**1.8**		**80.0**	**17.5**			**9.5**	**21.8**	**0.0**	**130.6**
Industry	1.8		8.4	12.2			1.5	13.2	0.0	37.0
Transport	0.0		53.9	1.3			2.2	0.1		57.5
Other	0.0		11.6	1.6			5.8	8.6	0.0	27.5
Non-Energy Use	0.0		6.1	2.5			0.0			8.6

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	8.8	202.3		81.3	3.5	3.3	20.7			319.8
Net Imports	14.8	(93.5)	4.2	25.8			0.0	(0.1)	0.0	(48.8)
Primary Energy Supply	**23.5**	**108.8**	**4.2**	**107.1**	**3.5**	**3.3**	**20.7**	**(0.1)**	**0.0**	**271.0**
Electricity and Heat Gen.	(20.5)		(11.9)	(58.3)	(3.5)	(3.3)	(6.4)	44.5	0.0	(59.4)
Petroleum Refineries		(108.8)	106.0							(2.8)
Other Energy Sector	(0.7)		(8.9)	(24.7)			0.0	(7.8)	0.0	(42.0)
Final Energy Demand	**2.4**		**89.4**	**24.1**			**14.3**	**36.6**	**0.0**	**166.8**
Industry	2.4		8.9	16.8			1.9	23.6	0.0	53.6
Transport	0.0		62.4	1.6			6.7	0.2		70.9
Other	0.0		12.1	2.3			5.6	12.8	0.0	32.8
Non-Energy Use	0.0		6.1	3.4			0.0			9.5

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
339 - 471	0.7 - 1.0	0.3 - 0.4	0.4 - 0.6

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
136 - 182	116 - 167	73 - 102	15 - 20

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
165 - 226	65 - 91	3 - 4	106 - 150

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
106 - 150	47 - 67	47 - 68	12 - 15

NEW ZEALAND

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	65	86	102	120	162	2.8	3.5	1.7	2.0	1.9
Population (million)	3	4	4	5	5	1.1	1.4	0.9	0.6	0.7
GDP per Capita (2005 US$ PPP per capita)	18 793	22 216	24 566	26 494	32 562	1.7	2.0	0.8	1.4	1.1

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**12.0**	**15.0**	**12.6**	**16.8**	**21.9**	**2.3**	**- 3.5**	**2.9**	**1.8**	**2.2**
Coal	1.4	2.3	3.1	4.2	4.8	5.3	5.6	3.2	0.9	1.8
	(12%)	(16%)	(24%)	(25%)	(22%)					
Oil	2.0	1.9	1.1	1.2	2.0	- 0.2	- 11.2	1.4	3.5	2.6
	(16%)	(13%)	(8%)	(7%)	(9%)					
Gas	3.9	5.1	3.2	3.7	6.1	2.6	- 8.8	1.4	3.5	2.6
	(32%)	(34%)	(25%)	(22%)	(28%)					
Hydro	2.0	2.1	2.0	2.0	2.0	0.4	- 0.9	0.1	0.1	0.1
	(17%)	(14%)	(16%)	(12%)	(9%)					
NRE	2.8	3.6	3.2	5.7	6.9	2.7	- 2.1	5.8	1.3	3.1
	(23%)	(24%)	(26%)	(34%)	(32%)					
Nuclear										
Net Import	**1.8**	**3.1**	**4.7**	**4.7**	**6.2**	**5.8**	**8.9**	**- 0.2**	**2.0**	**1.1**
Coal	- 0.3	- 1.3	- 1.1	- 2.0	- 2.6	17.6	- 4.0	6.5	1.9	3.7
Oil	2.0	4.4	5.8	6.6	8.8	8.1	5.7	1.4	1.9	1.7
Gas										
Electricity										
Primary Energy Supply	**13.8**	**18.1**	**17.3**	**21.4**	**28.1**	**2.8**	**- 0.9**	**2.2**	**1.8**	**2.0**
Coal	1.1	1.0	2.0	2.2	2.2	- 0.8	14.0	0.9	- 0.12	0.3
	(8%)	(6%)	(12%)	(10%)	(8%)					
Oil	4.0	6.3	6.8	7.8	10.8	4.7	1.7	1.3	2.2	1.9
	(29%)	(35%)	(40%)	(36%)	(39%)					
Gas	3.9	5.1	3.2	3.7	6.1	2.6	- 8.8	1.4	3.5	2.6
	(28%)	(28%)	(18%)	(17%)	(22%)					
Hydro	2.0	2.1	2.0	2.0	2.0	0.4	- 0.9	0.1	0.1	0.1
	(15%)	(12%)	(12%)	(9%)	(7%)					
NRE	2.8	3.6	3.2	5.7	7.0	2.7	- 2.1	5.9	1.3	3.1
	(20%)	(20%)	(19%)	(27%)	(25%)					
Nuclear										
Input for Electricity and Heat Generation	**-5.3**	**-7.2**	**-7.5**	**-10.1**	**-13.2**	**3.0**	**1.0**	**3.0**	**1.8**	**2.3**
Coal	- 0.2	- 0.6	- 1.7	- 1.7	- 1.7	10.8	24.0	- 0.0	- 0.0	- 0.0
	(4%)	(8%)	(23%)	(17%)	(13%)					
Oil								- 0.0	0.0	- 0.0
Gas	- 1.2	- 1.9	- 1.7	- 1.8	- 3.7	4.6	- 2.0	0.5	4.8	3.1
	(23%)	(27%)	(23%)	(18%)	(28%)					
Hydro	- 2.0	- 2.1	- 2.0	- 2.0	- 2.0	0.4	- 0.9	0.1	0.1	0.1
	(38%)	(29%)	(27%)	(20%)	(16%)					
NRE	- 1.9	- 2.5	- 2.0	- 4.5	- 5.7	3.0	- 4.5	8.3	1.6	4.2
	(35%)	(35%)	(27%)	(44%)	(43%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-1.8**	**-1.0**	**-0.8**	**-0.9**	**-1.1**	**- 5.3**	**- 5.6**	**1.2**	**1.6**	**1.5**
Coal	- 0.3				0.1		10.5	3.17	0.9	1.8
Oil	0.4	- 0.3	- 0.1	- 0.1	- 0.1		- 20.1	2.4	- 0.0	0.9
Gas	- 1.3	- 0.2	- 0.1	- 0.1	- 0.2	- 19.6	- 3.1	1.4	3.5	2.6
NRE	- 0.1	- 0.1	- 0.1	- 0.1	- 0.1	0.0	0.0	0.0	- 0.0	0.0
Electricity	- 0.4	- 0.5	- 0.4	- 0.5	- 0.6	2.2	- 2.1	1.5	1.7	1.6
Heat								0.0	- 0.0	0.0

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**9.5**	**13.2**	**13.0**	**14.8**	**19.4**	**3.3**	**- 0.3**	**1.3**	**1.8**	**1.6**
Coal	0.7	0.5	0.5	0.5	0.5	- 3.7	0.9	0.3	- 0.5	- 0.1
	(7%)	(4%)	(4%)	(3%)	(2%)					
Oil	4.4	5.8	6.8	7.7	10.7	2.8	3.3	1.2	2.2	1.8
	(46%)	(44%)	(53%)	(52%)	(55%)					
Gas	1.3	3.1	1.3	1.7	2.2	9.1	- 15.9	2.6	1.7	2.1
	(14%)	(23%)	(10%)	(11%)	(11%)					
NRE	0.7	0.9	1.1	1.1	1.2	2.5	3.2	0.5	0.1	0.3
	(8%)	(7%)	(8%)	(8%)	(6%)					
Electricity	2.4	2.9	3.3	3.8	4.8	1.9	2.5	1.4	1.7	1.6
	(25%)	(22%)	(25%)	(25%)	(25%)					
Heat										
Industry	**2.9**	**3.0**	**3.3**	**3.6**	**4.3**	**0.3**	**1.8**	**1.0**	**1.1**	**1.1**
Coal	0.6	0.4	0.4	0.4	0.3	- 4.4	0.6	0.0	- 0.5	- 0.3
	(19%)	(12%)	(11%)	(10%)	(8%)					
Oil	0.3	0.3	0.4	0.4	0.6	1.4	3.1	1.6	2.0	1.9
	(9%)	(10%)	(11%)	(12%)	(13%)					
Gas	0.5	0.5	0.5	0.6	0.7	- 0.7	1.4	1.6	0.3	0.8
	(18%)	(17%)	(16%)	(17%)	(15%)					
NRE	0.6	0.6	0.8	0.8	0.8	0.4	4.5	0.0	- 0.0	0.0
	(21%)	(21%)	(24%)	(22%)	(18%)					
Electricity	1.0	1.2	1.2	1.4	1.9	2.4	0.4	1.4	2.1	1.8
	(33%)	(40%)	(38%)	(39%)	(45%)					
Heat										
Transportation	**3.4**	**4.8**	**5.7**	**6.6**	**9.5**	**3.4**	**3.6**	**1.5**	**2.4**	**2.1**
Coal										
Oil	3.4	4.7	5.7	6.5	9.3	3.5	3.6	1.4	2.4	2.0
	(98%)	(99%)	(99%)	(98%)	(98%)					
Gas	0.1					- 28.5	14.9	2.3	0.0	0.9
	(2%)									
NRE				0.1	0.1				2.4	
				(1%)	(1%)					
Electricity				0.1	0.1	22.2	2.1	4.3	4.1	4.2
				(1%)	(1%)					
Other	**2.3**	**3.0**	**3.3**	**3.5**	**4.3**	**2.5**	**2.0**	**0.8**	**1.3**	**1.1**
Coal	0.1	0.1	0.1	0.1	0.1	- 1.3	1.9	1.2	- 0.4	0.3
	(5%)	(4%)	(4%)	(4%)	(3%)					
Oil	0.5	0.4	0.5	0.5	0.6	- 0.7	3.4	- 1.1	1.2	0.3
	(20%)	(15%)	(16%)	(13%)	(13%)					
Gas	0.2	0.5	0.3	0.4	0.5	10.2	- 6.9	1.7	2.2	2.0
	(8%)	(16%)	(10%)	(11%)	(13%)					
NRE	0.1	0.3	0.3	0.3	0.3	9.5	0.2	- 0.2	0.0	- 0.1
	(5%)	(10%)	(9%)	(8%)	(7%)					
Electricity	1.4	1.6	2.0	2.3	2.8	1.4	4.0	1.3	1.4	1.3
	(61%)	(56%)	(61%)	(64%)	(65%)					
Heat										
Non-Energy Use	**0.8**	**2.4**	**0.7**	**1.0**	**1.2**	**11.1**	**- 21.7**	**2.9**	**1.7**	**2.2**
Coal										
Oil	0.3	0.3	0.3	0.3	0.3	- 0.4	- 1.3	0.7	- 0.9	- 0.3
	(38%)	(13%)	(40%)	(32%)	(22%)					
Gas	0.5	2.1	0.4	0.7	1.0	15.0	- 27.3	4.3	2.7	3.3
	(62%)	(87%)	(60%)	(68%)	(78%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**32.3**	**39.2**	**43.1**	**49.5**	**63.8**	**2.0**	**1.9**	**1.4**	**1.7**	**1.6**
Coal	0.6	1.6	5.8	5.8	5.8	10.4	28.6	0.0	0.0	0.0
	(2%)	(4%)	(13%)	(12%)	(9%)					
Oil								0.0	- 0.0	0.0
Gas	5.7	9.6	9.5	10.0	21.8	5.3	- 0.2	0.5	5.3	3.4
	(18%)	(24%)	(22%)	(20%)	(34%)					
Hydro	23.3	24.4	23.3	23.5	23.8	0.4	- 0.9	0.1	0.1	0.1
	(72%)	(62%)	(54%)	(48%)	(37%)					
NRE	2.6	3.6	4.5	10.1	12.4	3.3	4.4	8.5	1.4	4.2
	(8%)	(9%)	(10%)	(21%)	(19%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**7,190**	**8,160**	**8,836**	**10,045**	**12,712**	**1.3**	**1.6**	**1.3**	**1.6**	**1.5**
Thermal	2 300	2 510	2 763	2 857	4 998	0.9	1.9	0.3	3.8	2.4
	(32%)	(31%)	(31%)	(28%)	(39%)					
Coal	996	886	886	886	886	- 1.2	0.0	0.0	0.0	0.0
	(14%)	(11%)	(10%)	(9%)	(7%)					
Oil	340		156	156	156			0.0	0.0	0.0
	(5%)		(2%)	(2%)	(1%)					
Gas	964	1 624	1 721	1 815	3 956	5.4	1.2	0.5	5.3	3.4
	(13%)	(20%)	(19%)	(18%)	(31%)					
Hydro	4 620	5 190	5 346	5 502	5 682	1.2	0.6	0.3	0.2	0.2
	(64%)	(64%)	(61%)	(55%)	(45%)					
NRE	270	460	727	1 686	2 032	5.5	9.6	8.8	1.3	4.2
	(4%)	(6%)	(8%)	(17%)	(16%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	212	211	170	179	174	- 0.1	- 4.2	0.5	- 0.2	0.1
Primary Energy Supply per Capita (kgoe per capita)	3 991	4 690	4 181	4 745	5 663	1.6	- 2.3	1.3	1.2	1.2
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	147	154	128	123	120	0.5	- 3.6	- 0.4	- 0.2	- 0.3
Final Energy Demand per Capita (kgoe per capita)	2 756	3 415	3 140	3 269	3 897	2.2	- 1.7	0.4	1.2	0.9
CO_2 Emissions (million tonnes)	**22**	**27**	**34**	**37**	**50**	**1.9**	**4.3**	**0.9**	**2.0**	**1.6**
Sector										
Electricity and Heat Generation	4	7	11	11	16	6.3	10.0	0.2	2.2	1.4
Refineries and Other Energy Sector	3	1	1	1	2	- 9.5	1.6	1.9	0.9	1.3
Industry	4	4	4	4	5	- 1.9	1.6	1.1	0.6	0.8
Transport	9	13	15	17	24	3.5	2.9	1.4	2.4	2.0
Other	2	3	3	3	3	2.0	- 0.3	0.1	1.2	0.8
Fuel										
Coal	5	4	9	9	9	- 1.0	16.1	0.0	- 0.1	- 0.1
Oil	10	16	19	21	29	4.6	3.0	1.3	2.2	1.8
Gas	8	7	6	7	12	- 0.9	- 2.1	0.9	3.7	2.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	347	317	331	307	307	- 0.9	0.9	- 0.8	0.0	- 0.3
CO_2 Emissions per Capita (tonnes per capita)	6. 5	7. 1	8. 1	8. 1	10.	0.8	2.9	- 0.0	1.4	0.8

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	3.1	1.1		3.2	2.0	0.0	3.2			12.6
Net Imports	(1.1)	4.1	1.6	0.0			0.0	0.0	0.0	4.7
Primary Energy Supply	**2.0**	**5.2**	**1.6**	**3.2**	**2.0**	**0.0**	**3.2**	**0.0**	**0.0**	**17.3**
Transfers and Statistical Diff.	0.2	(0.0)	0.1	(0.0)			0.0	0.0	0.0	0.3
Electricity and Heat Gen.	(1.7)		(0.0)	(1.7)	(2.0)	0.0	(2.0)	3.7	0.0	(3.8)
Petroleum Refineries		(5.2)	5.4							0.2
Other Energy Sector	0.0		(0.3)	(0.1)			(0.1)	(0.4)	(0.0)	(1.0)
Final Energy Demand	**0.5**		**6.8**	**1.3**			**1.1**	**3.3**	**0.0**	**13.0**
Industry	0.4		0.4	0.5			0.8	1.2	0.0	3.3
Transport	0.0		5.7	0.0			0.0	0.0		5.7
Other	0.1		0.5	0.3			0.3	2.0	0.0	3.3
Non-Energy Use	0.0		0.3	0.4			0.0			0.7

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	4.2	1.2		3.7	2.0	0.0	5.7			16.8
Net Imports	(2.0)	5.3	1.3	0.0			0.0	0.0	0.0	4.7
Primary Energy Supply	**2.2**	**6.5**	**1.3**	**3.7**	**2.0**	**0.0**	**5.7**	**0.0**	**0.0**	**21.4**
Electricity and Heat Gen.	(1.7)		(0.0)	(1.8)	(2.0)	0.0	(4.5)	4.3	0.0	(5.8)
Petroleum Refineries		(6.5)	6.8							0.3
Other Energy Sector	0.0		(0.4)	(0.1)			(0.1)	(0.5)	(0.0)	(1.2)
Final Energy Demand	**0.5**		**7.7**	**1.7**			**1.1**	**3.8**	**0.0**	**14.8**
Industry	0.4		0.4	0.6			0.8	1.4	0.0	3.6
Transport	0.0		6.5	0.0			0.1	0.1		6.6
Other	0.1		0.5	0.4			0.3	2.3	0.0	3.5
Non-Energy Use	0.0		0.3	0.7			0.0			1.0

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	4.8	2.0		6.1	2.0	0.0	6.9			21.9
Net Imports	(2.6)	4.4	4.4	0.0			0.0	0.0	0.0	6.2
Primary Energy Supply	**2.2**	**6.5**	**4.4**	**6.1**	**2.0**	**0.0**	**7.0**	**0.0**	**0.0**	**28.1**
Electricity and Heat Gen.	(1.7)		(0.0)	(3.7)	(2.0)	0.0	(5.7)	5.5	0.0	(7.7)
Petroleum Refineries		(6.5)	6.8							0.3
Other Energy Sector	0.1		(0.4)	(0.2)			(0.1)	(0.6)	(0.0)	(1.4)
Final Energy Demand	**0.5**		**10.7**	**2.2**			**1.2**	**4.8**	**0.0**	**19.4**
Industry	0.3		0.6	0.7			0.8	1.9	0.0	4.3
Transport	0.0		9.3	0.0			0.1	0.1		9.5
Other	0.1		0.6	0.5			0.3	2.8	0.0	4.3
Non-Energy Use	0.0		0.3	1.0			0.0			1.2

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
32 - 46	1.0 - 1.4	0.1 - 0.2	0.9 - 1.2

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
3.6 - 5.2	13.5 - 20.2	11.3 - 15.9	3.6 - 4.8

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
4.9 - 7.0	2.6 - 3.7	1.4 - 2.0	23 - 33

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
23 - 33	9 - 14	10 - 15	3.5 - 4.7

PAPUA NEW GUINEA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	8	12	13	19	30	4.8	1.2	4.0	3.0	3.4
Population (million)	4	5	6	7	9	2.6	2.3	2.0	1.5	1.7
GDP per Capita (2005 US$ PPP per capita)	1 941	2 407	2 279	2 783	3 482	2.2	- 1.1	2.0	1.5	1.7

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
			Mtoe							
Production	**4.6**	**4.0**	**3.0**	**13.1**	**18.5**	**- 1.4**	**- 5.5**	**15.8**	**2.3**	**7.5**
Coal										
Oil	4.5	3.7	2.5	2.5	2.1	- 2.1	- 7.6	0.1	- 1.0	- 0.6
	(98%)	(91%)	(82%)	(19%)	(12%)					
Gas	0.1	0.1	0.2	10.1	15.8	5.2	15.2	45.4	3.0	18.2
	(2%)	(3%)	(8%)	(77%)	(86%)					
Hydro		0.1	0.1	0.1	0.1	7.2	- 0.8	3.3	1.9	2.4
		(2%)	(3%)	(1%)	(1%)					
NRE		0.2	0.2	0.4	0.4		8.1	4.5	0.0	1.8
		(4%)	(8%)	(3%)	(2%)					
Nuclear										
Net Import	**-3.7**	**-2.7**	**-1.2**	**-9.1**	**-12.1**	**- 3.1**	**- 15.7**	**22.8**	**1.9**	**9.8**
Coal										
Oil	- 3.7	- 2.7	- 1.2	- 0.9	0.2	- 3.1	- 15.7	- 2.6		
Gas				- 8.2	- 12.3				2.7	
Electricity										
Primary Energy Supply	**0.9**	**1.3**	**1.8**	**4.0**	**6.3**	**3.9**	**7.8**	**8.1**	**3.1**	**5.1**
Coal										
Oil	0.8	0.9	1.3	1.6	2.3	1.9	7.3	2.1	2.5	2.4
	(87%)	(72%)	(70%)	(40%)	(36%)					
Gas	0.1	0.1	0.2	1.9	3.5	5.2	15.2	23.3	4.0	11.3
	(8%)	(9%)	(13%)	(49%)	(55%)					
Hydro		0.1	0.1	0.1	0.1	7.2	- 0.8	3.3	1.9	2.4
		(6%)	(4%)	(3%)	(2%)					
NRE		0.2	0.2	0.4	0.4		8.1	4.5	0.0	1.8
		(13%)	(13%)	(9%)	(6%)					
Nuclear										
Input for Electricity and Heat Generation	**-0.4**	**-0.6**	**-0.9**	**-1.3**	**-2.4**	**4.2**	**9.3**	**3.3**	**4.3**	**3.9**
Coal										
Oil	- 0.3	- 0.2	- 0.5	- 0.6	- 0.9	- 4.3	16.3	1.6	3.5	2.7
	(90%)	(38%)	(52%)	(44%)	(39%)					
Gas		- 0.1	- 0.1	- 0.2	- 0.9		0.2	6.6	9.9	8.5
		(20%)	(13%)	(18%)	(39%)					
Hydro		- 0.1	- 0.1	- 0.1	- 0.1	7.2	- 1.0	3.4	1.9	2.5
		(14%)	(8%)	(9%)	(6%)					
NRE		- 0.2	- 0.2	- 0.4	- 0.4		8.1	4.5	- 0.0	1.8
		(28%)	(26%)	(29%)	(16%)					
Nuclear										
Input for Refineries and Other Energy Sector			**-0.2**	**-1.8**	**-2.7**	**2.3**		**25.3**	**2.7**	**11.2**
Coal										
Oil								4.1	1.0	2.3
Gas			- 0.1	- 1.7	- 2.6			30.4	2.7	13.0
NRE										
Electricity					- 0.1	2.3	33.0	- 2.6	4.4	1.5
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**0.6**	**0.9**	**1.0**	**1.3**	**2.0**	**3.7**	**2.9**	**2.8**	**2.7**	**2.7**
Coal										
Oil	0.4	0.7	0.8	1.0	1.3	5.6	2.4	2.6	2.0	2.2
	(65%)	(78%)	(76%)	(75%)	(68%)					
Gas	0.1									
	(12%)									
NRE										
Electricity	0.1	0.2	0.2	0.3	0.6	3.2	4.3	3.5	4.4	4.0
	(23%)	(22%)	(24%)	(25%)	(32%)					
Heat										
Industry	**0.2**	**0.5**	**0.5**	**0.8**	**1.2**	**9.7**	**2.5**	**3.4**	**3.2**	**3.3**
Coal										
Oil	0.1	0.3	0.4	0.5	0.7	14.5	1.8	3.6	2.3	2.8
	(46%)	(70%)	(68%)	(70%)	(61%)					
Gas										
NRE										
Electricity	0.1	0.1	0.2	0.2	0.5	3.3	3.9	2.9	4.9	4.1
	(54%)	(30%)	(32%)	(30%)	(39%)					
Heat										
Transportation	**0.2**	**0.3**	**0.3**	**0.4**	**0.5**	**3.9**	**2.2**	**1.6**	**1.6**	**1.6**
Coal										
Oil	0.2	0.3	0.3	0.4	0.5	3.9	2.2	1.6	1.6	1.6
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Other	**0.1**	**0.1**	**0.1**	**0.2**	**0.3**	**- 5.3**	**9.5**	**3.4**	**2.7**	**3.0**
Coal										
Oil	0.1		0.1	0.1	0.1	- 11.5	15.3	1.5	2.1	1.8
	(72%)		(47%)	(39%)	(36%)					
Gas										
NRE										
Electricity		0.1	0.1	0.1	0.2	2.9	5.5	4.9	3.1	3.8
		(63%)	(53%)	(61%)	(64%)					
Heat										
Non-Energy Use										
Coal										
Oil										
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)		**2.4**	**3.3**	**4.3**	**8.2**		**6.7**	**2.8**	**4.4**	**3.7**
Coal										
Oil		0.9	1.7	1.9	3.2		15.0	1.0	3.5	2.5
		(37%)	(53%)	(45%)	(39%)					
Gas		0.4	0.4	0.7	2.9		- 1.0	6.8	9.9	8.6
		(16%)	(11%)	(17%)	(36%)					
Hydro		0.9	0.9	1.2	1.6		- 0.9	3.4	1.9	2.5
		(39%)	(27%)	(29%)	(20%)					
NRE		0.2	0.3	0.4	0.4		8.1	4.5	0.0	1.8
		(8%)	(8%)	(10%)	(5%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**302**	**322**	**473**	**669**	**1,244**	**0.6**	**8.0**	**3.5**	**4.2**	**3.9**
Thermal	162	172	275	377	877	0.6	9.9	3.2	5.8	4.7
	(54%)	(53%)	(58%)	(56%)	(70%)					
Coal										
Oil	122	132	222	275	459	0.8	11.0	2.2	3.5	3.0
	(40%)	(41%)	(47%)	(41%)	(37%)					
Gas	40	40	54	102	418	0.0	6.1	6.6	9.9	8.6
	(13%)	(12%)	(11%)	(15%)	(34%)					
Hydro	140	150	162	236	311	0.7	1.5	3.8	1.9	2.6
	(46%)	(47%)	(34%)	(35%)	(25%)					
NRE			36	56	56			4.5	0.0	1.8
			(8%)	(8%)	(5%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	112	103	141	207	208	- 0.9	6.6	3.9	0.0	1.6
Primary Energy Supply per Capita (kgoe per capita)	217	247	321	575	723	1.3	5.4	6.0	1.5	3.3
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	79	71	77	69	65	- 1.1	1.7	- 1.2	- 0.4	- 0.7
Final Energy Demand per Capita (kgoe per capita)	154	172	176	191	227	1.1	0.5	0.8	1.1	1.0
CO_2 Emissions (million tonnes)	**2**	**3**	**5**	**9**	**15**	**2.8**	**8.2**	**7.6**	**3.3**	**5.0**
Sector										
Electricity and Heat Generation	1	1	2	2	5	- 1.1	12.6	2.5	5.5	4.3
Refineries and Other Energy Sector			0	4	6			26.6	2.7	11.7
Industry	0	1	1	2	2	14.5	1.8	3.6	2.3	2.8
Transport	1	1	1	1	2	3.9	2.2	1.6	1.6	1.6
Other	0	0	0	0	0	- 11.5	15.3	1.5	2.1	1.8
Fuel										
Coal										
Oil	2	3	4	5	7	1.9	7.4	2.1	2.5	2.4
Gas		0	1	4	8		15.2	23.3	4.0	11.3
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	299	247	345	483	499	- 1.9	6.9	3.4	0.2	1.5
CO_2 Emissions per Capita (tonnes per capita)	. 6	. 6	. 8	1. 3	1. 7	0.3	5.8	5.5	1.7	3.2

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	2.5		0.2	0.1	0.0	0.2			3.0
Net Imports	0.0	(1.5)	0.3	0.0			0.0	(0.0)	0.0	(1.2)
Primary Energy Supply	**0.0**	**1.0**	**0.3**	**0.2**	**0.1**	**0.0**	**0.2**	**(0.0)**	**0.0**	**1.8**
Transfers and Statistical Diff.	0.0	(0.0)	(0.0)	0.0			0.0	0.0	0.0	(0.0)
Electricity and Heat Gen.	0.0		(0.5)	(0.1)	(0.1)	0.0	(0.2)	0.3	0.0	(0.6)
Petroleum Refineries		(1.0)	1.0							0.0
Other Energy Sector	0.0		(0.0)	(0.1)			0.0	(0.0)	0.0	(0.2)
Final Energy Demand	**0.0**		**0.8**	**0.0**			**0.0**	**0.2**	**0.0**	**1.0**
Industry	0.0		0.4	0.0			0.0	0.2	0.0	0.5
Transport	0.0		0.3	0.0			0.0	0.0		0.3
Other	0.0		0.1	0.0			0.0	0.1	0.0	0.1
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	2.5		10.1	0.1	0.0	0.4			13.1
Net Imports	0.0	(1.3)	0.4	(8.2)			0.0	0.0	0.0	(9.1)
Primary Energy Supply	**0.0**	**1.2**	**0.4**	**1.9**	**0.1**	**0.0**	**0.4**	**0.0**	**0.0**	**4.0**
Electricity and Heat Gen.	0.0		(0.6)	(0.2)	(0.1)	0.0	(0.4)	0.4	0.0	(0.9)
Petroleum Refineries		(1.2)	1.2							(0.0)
Other Energy Sector	0.0		(0.0)	(1.7)			0.0	(0.0)	0.0	(1.8)
Final Energy Demand	**0.0**		**1.0**	**0.0**			**0.0**	**0.3**	**0.0**	**1.3**
Industry	0.0		0.5	0.0			0.0	0.2	0.0	0.8
Transport	0.0		0.4	0.0			0.0	0.0		0.4
Other	0.0		0.1	0.0			0.0	0.1	0.0	0.2
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	2.1		15.8	0.1	0.0	0.4			18.5
Net Imports	0.0	(0.7)	0.9	(12.3)			0.0	0.0	0.0	(12.1)
Primary Energy Supply	**0.0**	**1.4**	**0.9**	**3.5**	**0.1**	**0.0**	**0.4**	**0.0**	**0.0**	**6.3**
Electricity and Heat Gen.	0.0		(0.9)	(0.9)	(0.1)	0.0	(0.4)	0.7	0.0	(1.7)
Petroleum Refineries		(1.4)	1.4							(0.0)
Other Energy Sector	0.0		(0.0)	(2.6)			0.0	(0.1)	0.0	(2.7)
Final Energy Demand	**0.0**		**1.3**	**0.0**			**0.0**	**0.6**	**0.0**	**2.0**
Industry	0.0		0.7	0.0			0.0	0.5	0.0	1.2
Transport	0.0		0.5	0.0			0.0	0.0		0.5
Other	0.0		0.1	0.0			0.0	0.2	0.0	0.3
Non-Energy Use	0.0		0.0	0.0			0.0			0.0

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
11 - 16	2.0 - 2.8	0.6 - 0.8	1.4 - 2.0

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
3.5 - 4.7	1.3 - 1.8	6.0 - 8.7	0.3 - 0.4

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
1.3 - 2.0	7.8 - 10.7	.. - ..	2.1 - 3.0

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2.1 - 3.0	0.8 - 1.1	1.0 - 1.5	0.3 - 0.4

PERU

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	97	144	176	272	487	4.0	4.2	4.4	4.0	4.2
Population (million)	22	26	27	31	36	1.7	1.2	1.2	1.0	1.1
GDP per Capita (2005 US$ PPP per capita)	4 466	5 592	6 452	8 854	13 725	2.3	2.9	3.2	3.0	3.1

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
	Mtoe									
Production	**10.6**	**9.3**	**10.8**	**15.3**	**21.0**	**- 1.3**	**3.0**	**3.5**	**2.1**	**2.7**
Coal	0.1			0.5	0.6	- 15.9	20.1	33.3	0.7	12.7
	(1%)			(3%)	(3%)					
Oil	6.5	5.2	5.3	3.0	1.9	- 2.3	0.3	- 5.3	- 3.0	- 3.9
	(62%)	(56%)	(49%)	(20%)	(9%)					
Gas	0.4	0.4	1.5	7.2	13.3	0.9	26.9	17.2	4.2	9.2
	(4%)	(5%)	(14%)	(47%)	(63%)					
Hydro	0.9	1.4	1.7	2.4	2.9	4.4	4.3	3.3	1.4	2.1
	(8%)	(15%)	(16%)	(15%)	(14%)					
NRE	2.7	2.3	2.3	2.2	2.2	- 1.6	0.3	- 0.6	0.2	- 0.1
	(25%)	(25%)	(22%)	(14%)	(11%)					
Nuclear										
Net Import	**-0.6**	**3.2**	**3.1**	**5.2**	**8.1**		**- 1.0**	**5.6**	**3.0**	**4.0**
Coal	0.1	0.6	0.9	2.6	2.9	22.9	8.4	11.0	0.7	4.7
Oil	- 0.7	2.6	2.1	6.6	11.0		- 3.9	12.0	3.5	6.8
Gas				- 4.0	- 5.8				2.5	
Electricity										
Primary Energy Supply	**10.0**	**12.5**	**13.9**	**20.5**	**29.1**	**2.3**	**2.0**	**4.0**	**2.4**	**3.0**
Coal	0.1	0.6	1.0	3.2	3.5	15.8	8.7	12.7	0.70	5.3
	(1%)	(5%)	(7%)	(15%)	(12%)					
Oil	5.8	7.8	7.4	9.6	12.9	2.9	- 1.0	2.6	2.0	2.2
	(59%)	(62%)	(53%)	(47%)	(44%)					
Gas	0.4	0.4	1.5	3.1	7.5	0.9	26.9	7.9	6.0	6.7
	(4%)	(4%)	(11%)	(15%)	(26%)					
Hydro	0.9	1.4	1.7	2.4	2.9	4.4	4.3	3.3	1.4	2.1
	(9%)	(11%)	(12%)	(12%)	(10%)					
NRE	2.7	2.3	2.3	2.3	2.3	- 1.6	0.3	- 0.1	0.1	0.0
	(27%)	(18%)	(17%)	(11%)	(8%)					
Nuclear										
Input for Electricity and Heat Generation	**-1.8**	**-2.4**	**-3.6**	**-5.2**	**-9.8**	**3.2**	**8.3**	**3.7**	**4.3**	**4.1**
Coal		- 0.1	- 0.2	- 0.2	- 0.2		18.4	- 2.6	2.2	0.2
		(4%)	(6%)	(3%)	(2%)					
Oil	- 0.8	- 0.7	- 0.6	- 0.5	- 0.6	- 1.0	- 2.4	- 1.9	1.1	- 0.1
	(43%)	(28%)	(17%)	(10%)	(6%)					
Gas	- 0.1	- 0.2	- 1.0	- 2.1	- 5.9	11.7	36.4	8.3	7.1	7.6
	(4%)	(8%)	(26%)	(41%)	(61%)					
Hydro	- 0.9	- 1.4	- 1.7	- 2.4	- 2.9	4.5	4.3	3.3	1.4	2.1
	(51%)	(57%)	(47%)	(45%)	(30%)					
NRE		- 0.1	- 0.1		- 0.1	1.8	17.1	- 11.4	8.5	0.1
		(2%)	(3%)		(1%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-0.9**	**-1.2**	**-1.4**	**-4.2**	**-5.1**	**3.2**	**2.9**	**11.8**	**1.3**	**5.4**
Coal		- 0.1	- 0.1	- 2.4	- 2.6	9.9	5.4	33.32	0.7	12.7
Oil	- 0.3	- 0.5	- 0.5	- 0.5	- 0.6	6.7	- 0.6	0.7	0.3	0.4
Gas	- 0.3	- 0.3	- 0.4	- 0.9	- 1.4	- 2.1	10.0	7.7	3.1	4.9
NRE	- 0.1	- 0.1	- 0.1	- 0.1	- 0.1	2.9	- 0.7	3.4	- 1.5	0.5
Electricity	- 0.2	- 0.2	- 0.2	- 0.3	- 0.5	2.5	1.3	2.5	2.9	2.7
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**8.8**	**11.0**	**11.3**	**14.3**	**19.7**	**2.2**	**0.6**	**2.4**	**2.2**	**2.3**
Coal	0.1	0.4	0.6	0.6	0.6	14.8	6.1	0.2	0.2	0.2
	(1%)	(4%)	(5%)	(4%)	(3%)					
Oil	5.0	6.9	6.5	8.5	11.7	3.2	- 1.2	2.8	2.2	2.4
	(57%)	(63%)	(57%)	(60%)	(59%)					
Gas	0.1		0.1	0.2	0.2	- 34.3		1.2	1.3	1.2
	(1%)		(1%)	(1%)	(1%)					
NRE	2.6	2.1	2.1	2.1	2.1	- 1.8	- 0.2	0.1	- 0.1	0.0
	(29%)	(20%)	(19%)	(15%)	(11%)					
Electricity	1.0	1.5	2.0	2.9	5.1	3.9	5.6	3.9	3.9	3.9
	(12%)	(14%)	(17%)	(20%)	(26%)					
Heat										
Industry	**1.9**	**3.0**	**3.4**	**4.9**	**8.2**	**4.7**	**2.6**	**3.5**	**3.5**	**3.5**
Coal	0.1	0.4	0.6	0.6	0.6	15.3	6.3	0.2	0.2	0.2
	(6%)	(15%)	(17%)	(12%)	(8%)					
Oil	1.1	1.7	1.6	2.4	4.2	4.8	- 1.2	3.9	3.8	3.8
	(57%)	(57%)	(48%)	(49%)	(51%)					
Gas			0.1	0.1	0.2			1.0	1.0	1.0
			(4%)	(3%)	(2%)					
NRE	0.1					- 23.6	- 16.7	- 6.7	- 0.0	- 2.7
	(4%)									
Electricity	0.6	0.8	1.1	1.7	3.2	3.2	5.0	4.8	4.2	4.4
	(32%)	(28%)	(31%)	(35%)	(39%)					
Heat										
Transportation	**2.5**	**3.4**	**3.5**	**5.0**	**6.6**	**3.1**	**0.6**	**3.7**	**1.8**	**2.5**
Coal										
Oil	2.5	3.4	3.5	4.7	5.9	3.1	0.6	3.1	1.5	2.1
	(100%)	(100%)	(100%)	(95%)	(90%)					
Gas										
NRE				0.3	0.6				5.6	
				(5%)	(10%)					
Electricity										
Other	**4.3**	**4.4**	**4.2**	**4.1**	**4.5**	**0.3**	**- 1.1**	**- 0.2**	**0.6**	**0.3**
Coal						1.3	- 9.0	7.2	0.0	2.8
Oil	1.3	1.6	1.2	1.1	1.0	1.8	- 6.4	- 0.8	- 0.2	- 0.5
	(31%)	(37%)	(28%)	(26%)	(23%)					
Gas						- 31.0		2.9	3.6	3.3
NRE	2.5	2.1	2.1	1.9	1.5	- 1.5	- 0.2	- 1.3	- 1.5	- 1.4
	(58%)	(49%)	(51%)	(46%)	(34%)					
Electricity	0.4	0.6	0.9	1.1	1.9	5.0	6.3	2.7	3.5	3.2
	(9%)	(15%)	(21%)	(28%)	(43%)					
Heat										
Non-Energy Use	**0.1**	**0.1**	**0.2**	**0.3**	**0.6**	**4.4**	**7.2**	**5.6**	**4.2**	**4.8**
Coal										
Oil	0.1	0.1	0.2	0.3	0.6	4.4	7.2	5.6	4.2	4.8
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**13.8**	**19.9**	**25.5**	**36.8**	**64.6**	**3.7**	**5.1**	**3.7**	**3.8**	**3.8**
Coal		0.3	0.8	0.6	0.9		18.3	- 2.6	2.5	0.4
		(2%)	(3%)	(2%)	(1%)					
Oil	3.0	2.5	2.1	1.7	2.1	- 1.6	- 3.7	- 1.9	1.2	- 0.0
	(21%)	(13%)	(8%)	(5%)	(3%)					
Gas	0.2	0.7	2.5	6.5	26.4	11.7	28.4	10.2	9.8	9.9
	(2%)	(4%)	(10%)	(18%)	(41%)					
Hydro	10.5	16.2	20.0	27.5	33.8	4.4	4.3	3.3	1.4	2.1
	(76%)	(81%)	(78%)	(75%)	(52%)					
NRE	0.1	0.2	0.2	0.4	1.4	1.6	0.4	9.8	8.5	9.0
	(1%)	(1%)	(1%)	(1%)	(2%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**2,400**	**2,861**	**5,170**	**7,932**	**15,317**	**1.8**	**12.6**	**4.4**	**4.5**	**4.4**
Thermal			1 962	2 570	8 201			2.7	8.0	5.9
			(38%)	(32%)	(54%)					
Coal			142	149	216			0.5	2.5	1.7
			(3%)	(2%)	(1%)					
Oil			630	644	772			0.2	1.2	0.8
			(12%)	(8%)	(5%)					
Gas			1 190	1 777	7 214			4.1	9.8	7.5
			(23%)	(22%)	(47%)					
Hydro	2 400	2 860	3 207	5 121	6 296	1.8	2.3	4.8	1.4	2.7
	(100%)	(100%)	(62%)	(65%)	(41%)					
NRE		1	1	240	820		0.0		8.5	
				(3%)	(5%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	102	87	79	75	60	- 1.6	- 2.1	- 0.4	- 1.5	- 1.1
Primary Energy Supply per Capita (kgoe per capita)	457	488	508	668	820	0.7	0.8	2.8	1.4	1.9
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	90	76	64	53	41	- 1.7	- 3.4	- 2.0	- 1.7	- 1.8
Final Energy Demand per Capita (kgoe per capita)	403	427	414	465	556	0.6	- 0.6	1.2	1.2	1.2
CO_2 Emissions (million tonnes)	**19**	**27**	**29**	**47**	**67**	**3.4**	**1.1**	**5.0**	**2.5**	**3.4**
Sector										
Electricity and Heat Generation	3	3	5	7	16	1.8	10.9	3.6	5.7	4.9
Refineries and Other Energy Sector	2	3	3	13	15	4.3	- 0.5	17.3	1.1	7.3
Industry	4	7	8	10	16	6.4	1.6	2.8	3.0	2.9
Transport	7	9	10	13	17	2.9	0.9	3.1	1.5	2.1
Other	4	5	4	3	3	1.6	- 6.3	- 0.7	- 0.2	- 0.4
Fuel										
Coal	1	3	4	13	14	15.6	8.2	12.6	0.7	5.3
Oil	18	24	21	27	36	2.8	- 1.8	2.2	2.0	2.1
Gas	1	1	3	7	17	0.2	26.9	7.7	6.0	6.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	201	190	164	172	138	- 0.6	- 2.9	0.5	- 1.5	- 0.7
CO_2 Emissions per Capita (tonnes per capita)	. 9	1. 1	1. 1	1. 5	1. 9	1.7	- 0.1	3.7	1.5	2.4

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	5.3		1.5	1.7	0.0	2.3			10.8
Net Imports	0.9	4.3	(2.2)	0.0			(0.0)	0.0	0.0	3.1
Primary Energy Supply	**1.0**	**9.5**	**(2.2)**	**1.5**	**1.7**	**0.0**	**2.3**	**0.0**	**0.0**	**13.8**
Transfers and Statistical Diff.	0.0	(1.3)	1.5	0.0			0.0	0.0	0.0	0.2
Electricity and Heat Gen.	(0.2)		(0.6)	(1.0)	(1.7)	0.0	(0.1)	2.2	0.0	(1.4)
Petroleum Refineries		(8.2)	8.1							(0.2)
Other Energy Sector	(0.1)		(0.4)	(0.4)			(0.1)	(0.2)	0.0	(1.2)
Final Energy Demand	**0.6**		**6.5**	**0.1**			**2.1**	**2.0**	**0.0**	**11.3**
Industry	0.6		1.6	0.1			0.0	1.1	0.0	3.4
Transport	0.0		3.5	0.0			0.0	0.0		3.5
Other	0.0		1.2	0.0			2.1	0.9	0.0	4.2
Non-Energy Use	0.0		0.2	0.0			0.0			0.2

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.5	3.0		7.2	2.4	0.0	2.2			15.3
Net Imports	2.6	5.8	0.8	(4.0)			0.1	0.0	0.0	5.2
Primary Energy Supply	**3.2**	**8.8**	**0.8**	**3.1**	**2.4**	**0.0**	**2.3**	**0.0**	**0.0**	**20.5**
Electricity and Heat Gen.	(0.2)		(0.5)	(2.1)	(2.4)	0.0	(0.0)	3.2	0.0	(2.0)
Petroleum Refineries		(8.8)	8.6							(0.2)
Other Energy Sector	(2.4)		(0.4)	(0.9)			(0.1)	(0.3)	0.0	(4.0)
Final Energy Demand	**0.6**		**8.5**	**0.2**			**2.1**	**2.9**	**0.0**	**14.3**
Industry	0.6		2.4	0.1			0.0	1.7	0.0	4.9
Transport	0.0		4.7	0.0			0.3	0.0		5.0
Other	0.0		1.1	0.0			1.9	1.1	0.0	4.1
Non-Energy Use	0.0		0.3	0.0			0.0			0.3

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.6	1.9		13.3	2.9	0.0	2.2			21.0
Net Imports	2.9	7.3	3.7	(5.8)			0.1	0.0	0.0	8.1
Primary Energy Supply	**3.5**	**9.2**	**3.7**	**7.5**	**2.9**	**0.0**	**2.3**	**0.0**	**0.0**	**29.1**
Electricity and Heat Gen.	(0.2)		(0.6)	(5.9)	(2.9)	0.0	(0.1)	5.6	0.0	(4.2)
Petroleum Refineries		(9.2)	9.0							(0.2)
Other Energy Sector	(2.6)		(0.4)	(1.4)			(0.1)	(0.5)	0.0	(4.9)
Final Energy Demand	**0.6**		**11.7**	**0.2**			**2.1**	**5.1**	**0.0**	**19.7**
Industry	0.6		4.2	0.2			0.0	3.2	0.0	8.2
Transport	0.0		5.9	0.0			0.6	0.0		6.6
Other	0.0		1.0	0.0			1.5	1.9	0.0	4.5
Non-Energy Use	0.0		0.6	0.0			0.0			0.6

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
44 - 60	0.5 - 0.7	0.0 - 0.1	0.5 - 0.7

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
3.1 - 4.6	17.6 - 22.2	19.1 - 27.4	4.6 - 6.2

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
5 - 7	6.6 - 9.3	0.3 - 0.4	32 - 43

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
32 - 43	14 - 17	14 - 21	4.3 - 5.7

PHILIPPINES

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	149	201	250	382	711	3.0	4.5	4.3	4.2	4.3
Population (million)	61	76	85	101	122	2.2	2.1	1.8	1.3	1.5
GDP per Capita (2005 US$ PPP per capita)	2 431	2 636	2 956	3 794	5 826	0.8	2.3	2.5	2.9	2.8

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**13.7**	**20.9**	**24.2**	**23.5**	**27.8**	**4.3**	**3.0**	**- 0.3**	**1.1**	**0.6**
Coal	0.6	0.6	1.4	2.7	4.8	0.8	16.3	6.8	4.0	5.1
	(4%)	(3%)	(6%)	(11%)	(17%)					
Oil	0.2	0.1		0.8	0.5	- 13.9	- 11.7	39.3	- 3.1	12.1
	(2%)	(0%)		(3%)	(2%)					
Gas			2.7	3.6	1.1			3.1	- 7.4	- 3.3
			(11%)	(15%)	(4%)					
Hydro	0.5	0.7	0.7	0.8	1.0	2.6	1.4	1.2	1.5	1.4
	(4%)	(3%)	(3%)	(3%)	(4%)					
NRE	12.3	19.5	19.4	15.6	20.3	4.7	- 0.1	- 2.2	1.8	0.2
	(90%)	(93%)	(80%)	(66%)	(73%)					
Nuclear										
Net Import	**12.5**	**21.5**	**19.4**	**29.3**	**51.8**	**5.6**	**- 2.0**	**4.2**	**3.9**	**4.0**
Coal	0.7	4.4	4.7	8.2	13.6	20.1	1.4	5.7	3.4	4.3
Oil	11.8	17.1	14.7	19.2	26.4	3.8	- 2.9	2.7	2.2	2.4
Gas				2.0	11.8				12.6	
Electricity										
Primary Energy Supply	**26.2**	**42.4**	**43.6**	**52.8**	**79.6**	**5.0**	**0.6**	**1.9**	**2.8**	**2.4**
Coal	1.3	5.0	6.1	10.9	18.4	14.5	3.8	6.0	3.58	4.5
	(5%)	(12%)	(14%)	(21%)	(23%)					
Oil	12.0	17.2	14.8	18.0	24.8	3.6	- 3.0	2.0	2.2	2.1
	(46%)	(40%)	(34%)	(34%)	(31%)					
Gas			2.7	5.6	12.9			7.7	5.8	6.5
			(6%)	(11%)	(16%)					
Hydro	0.5	0.7	0.7	0.8	1.0	2.6	1.4	1.2	1.5	1.4
	(2%)	(2%)	(2%)	(2%)	(1%)					
NRE	12.3	19.5	19.4	17.6	22.5	4.7	- 0.1	- 1.0	1.7	0.6
	(47%)	(46%)	(44%)	(33%)	(28%)					
Nuclear										
Input for Electricity and Heat Generation	**-8.6**	**-16.9**	**-17.7**	**-23.3**	**-39.4**	**7.0**	**1.0**	**2.8**	**3.6**	**3.2**
Coal	- 0.5	- 4.0	- 4.5	- 8.0	- 14.6	24.0	2.4	5.8	4.1	4.8
	(5%)	(24%)	(26%)	(34%)	(37%)					
Oil	- 2.9	- 2.2	- 1.3	- 1.6	- 0.8	- 2.8	- 9.5	1.9	- 4.9	- 2.2
	(34%)	(13%)	(7%)	(7%)	(2%)					
Gas			- 2.7	- 5.4	- 12.3			7.3	5.7	6.3
			(15%)	(23%)	(31%)					
Hydro	- 0.5	- 0.7	- 0.7	- 0.8	- 1.0	2.6	1.4	1.2	1.5	1.4
	(6%)	(4%)	(4%)	(3%)	(3%)					
NRE	- 4.7	- 10.0	- 8.5	- 7.6	- 10.6	7.8	- 3.2	- 1.2	2.3	0.9
	(55%)	(59%)	(48%)	(32%)	(27%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-3.7**	**-4.2**	**-4.5**	**-5.8**	**-8.8**	**1.1**	**1.6**	**2.6**	**2.8**	**2.7**
Coal	- 0.2	- 0.2	- 0.4	- 0.8	- 1.4	- 0.2	14.9	6.84	4.0	5.1
Oil	- 1.2	- 1.2	- 0.9	- 1.6	- 2.8	- 0.1	- 7.0	6.7	3.6	4.9
Gas										
NRE	- 1.9	- 2.0	- 2.3	- 2.0	- 2.1	0.3	2.8	- 1.4	0.4	- 0.3
Electricity	- 0.4	- 0.8	- 1.0	- 1.4	- 2.5	7.2	5.5	3.9	3.7	3.8
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**15.2**	**25.1**	**26.5**	**31.5**	**45.6**	**5.1**	**1.1**	**1.7**	**2.5**	**2.2**
Coal	0.4	0.8	1.3	2.1	2.4	6.2	10.1	4.9	0.8	2.4
	(3%)	(3%)	(5%)	(7%)	(5%)					
Oil	7.3	13.6	12.7	14.7	21.2	6.5	- 1.4	1.5	2.5	2.1
	(48%)	(54%)	(48%)	(47%)	(46%)					
Gas				0.2	0.6				7.6	
				(1%)	(1%)					
NRE	5.7	7.6	8.6	8.0	9.7	2.8	2.7	- 0.7	1.3	0.5
	(37%)	(30%)	(32%)	(25%)	(21%)					
Electricity	1.8	3.1	3.9	6.4	11.7	5.8	4.4	5.1	4.1	4.5
	(12%)	(13%)	(15%)	(20%)	(26%)					
Heat										
Industry	**3.9**	**7.3**	**8.6**	**8.4**	**11.7**	**6.5**	**3.3**	**- 0.2**	**2.2**	**1.2**
Coal	0.4	0.7	1.2	2.1	2.4	4.0	12.3	6.1	0.8	2.9
	(11%)	(9%)	(14%)	(25%)	(20%)					
Oil	1.9	1.8	1.8	1.7	1.6	- 0.7	0.5	- 0.9	- 0.3	- 0.6
	(49%)	(24%)	(21%)	(20%)	(14%)					
Gas										
NRE	0.8	3.8	4.3	2.0	2.0	17.0	2.5	- 7.3	0.0	- 3.0
	(20%)	(51%)	(49%)	(24%)	(17%)					
Electricity	0.8	1.1	1.4	2.7	5.7	3.9	3.5	7.0	5.2	5.9
	(20%)	(15%)	(16%)	(31%)	(49%)					
Heat										
Transportation	**2.7**	**8.4**	**8.8**	**12.1**	**20.1**	**12.2**	**1.0**	**3.2**	**3.4**	**3.3**
Coal										
Oil	2.7	8.4	8.8	11.6	18.3	12.2	1.0	2.8	3.1	3.0
	(100%)	(100%)	(100%)	(96%)	(91%)					
Gas										
NRE				0.5	1.7				8.4	
				(4%)	(9%)					
Electricity							- 7.8	7.3	5.7	6.3
Other	**8.4**	**9.0**	**8.9**	**10.9**	**13.9**	**0.7**	**- 0.4**	**2.1**	**1.6**	**1.8**
Coal										
Oil	2.5	3.2	2.0	1.4	1.3	2.7	- 9.4	- 3.1	- 0.9	- 1.8
	(29%)	(36%)	(22%)	(13%)	(9%)					
Gas				0.2	0.6				7.6	
				(2%)	(4%)					
NRE	4.9	3.8	4.4	5.5	6.0	- 2.6	2.8	2.4	0.6	1.3
	(58%)	(42%)	(49%)	(51%)	(43%)					
Electricity	1.0	2.0	2.5	3.7	6.0	6.9	4.9	4.0	3.2	3.5
	(12%)	(22%)	(29%)	(34%)	(43%)					
Heat										
Non-Energy Use	**0.2**	**0.4**	**0.2**	**0.1**	**0.1**	**4.6**	**- 9.2**	**- 10.4**	**- 1.5**	**- 5.2**
Coal		0.2	0.1				- 1.8			
		(41%)	(61%)							
Oil	0.2	0.2	0.1	0.1	0.1	- 0.8	- 16.4	- 1.5	- 1.5	- 1.5
	(100%)	(59%)	(39%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**25.2**	**45.3**	**56.5**	**91.4**	**165.5**	**6.0**	**4.5**	**4.9**	**4.0**	**4.4**
Coal	1.9	16.7	15.3	29.3	61.8	24.0	- 1.7	6.7	5.1	5.8
	(8%)	(37%)	(27%)	(32%)	(37%)					
Oil	11.8	9.2	6.1	7.2	3.5	- 2.5	- 7.7	1.6	- 4.7	- 2.2
	(47%)	(20%)	(11%)	(8%)	(2%)					
Gas			16.9	31.9	68.9			6.6	5.3	5.8
			(30%)	(35%)	(42%)					
Hydro	6.1	7.8	8.4	9.5	11.8	2.6	1.5	1.2	1.5	1.4
	(24%)	(17%)	(15%)	(10%)	(7%)					
NRE	5.5	11.6	9.9	13.5	19.4	7.8	- 3.2	3.2	2.5	2.7
	(22%)	(26%)	(18%)	(15%)	(12%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)		**13,185**	**15,594**	**20,155**	**31,018**		**3.4**	**2.6**	**2.9**	**2.8**
Thermal		8 953	10 393	13 895	22 568		3.0	2.9	3.3	3.2
		(68%)	(67%)	(69%)	(73%)					
Coal		3 963	3 967	4 922	10 075		0.0	2.2	4.9	3.8
		(30%)	(25%)	(24%)	(32%)					
Oil		4 987	3 663	4 115	2 000		- 6.0	1.2	- 4.7	- 2.4
		(38%)	(23%)	(20%)	(6%)					
Gas		3	2 763	4 858	10 493			5.8	5.3	5.5
			(18%)	(24%)	(34%)					
Hydro		2 301	3 223	3 600	4 500		7.0	1.1	1.5	1.3
		(17%)	(21%)	(18%)	(15%)					
NRE		1 931	1 978	2 660	3 950		0.5	3.0	2.7	2.8
		(15%)	(13%)	(13%)	(13%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	176	211	175	138	112	1.8	- 3.7	- 2.3	- 1.4	- 1.8
Primary Energy Supply per Capita (kgoe per capita)	427	557	516	525	652	2.7	- 1.5	0.2	1.5	0.9
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	102	125	106	82	64	2.0	- 3.2	- 2.5	- 1.7	- 2.0
Final Energy Demand per Capita (kgoe per capita)	249	330	313	313	374	2.8	- 1.0	- 0.0	1.2	0.7
CO_2 Emissions (million tonnes)	**37**	**70**	**74**	**107**	**173**	**6.4**	**1.1**	**3.8**	**3.2**	**3.5**
Sector										
Electricity and Heat Generation	11	23	28	49	89	7.8	4.4	5.7	4.0	4.7
Refineries and Other Energy Sector	5	5	4	7	12	- 0.1	- 2.1	5.5	3.8	4.5
Industry	8	8	10	14	14	0.6	4.9	2.8	0.4	1.3
Transport	7	24	25	33	52	14.0	0.4	2.8	3.1	3.0
Other	8	10	6	5	5	2.7	- 9.4	- 2.2	0.5	- 0.6
Fuel										
Coal	4	19	24	43	74	15.9	4.6	6.0	3.6	4.5
Oil	33	50	43	51	70	4.3	- 3.0	1.7	2.1	1.9
Gas			6	13	30			7.7	5.8	6.5
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	251	348	295	282	243	3.3	- 3.3	- 0.5	- 1.0	- 0.8
CO_2 Emissions per Capita (tonnes per capita)	. 6	. 9	. 9	1. 1	1. 4	4.1	- 1.0	2.1	1.9	2.0

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	1.4	0.0		2.7	0.7	0.0	19.4			24.2
Net Imports	4.7	10.5	4.3	0.0			0.0	0.0	0.0	19.4
Primary Energy Supply	**6.1**	**10.5**	**4.3**	**2.7**	**0.7**	**0.0**	**19.4**	**0.0**	**0.0**	**43.6**
Transfers and Statistical Diff.	0.1	(0.0)	0.1	0.0			0.0	0.0	0.0	0.3
Electricity and Heat Gen.	(4.5)		(1.3)	(2.7)	(0.7)	0.0	(8.5)	4.9	0.0	(12.9)
Petroleum Refineries		(10.5)	10.5							(0.0)
Other Energy Sector	(0.4)		(0.8)	0.0			(2.3)	(1.0)	0.0	(4.5)
Final Energy Demand	**1.3**		**12.7**	**0.0**			**8.6**	**3.9**	**0.0**	**26.5**
Industry	1.2		1.8	0.0			4.3	1.4	0.0	8.6
Transport	0.0		8.8	0.0			0.0	0.0		8.8
Other	0.0		2.0	0.0			4.4	2.5	0.0	8.9
Non-Energy Use	0.1		0.1	0.0			0.0			0.2

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	2.7	0.8		3.6	0.8	0.0	15.6			23.5
Net Imports	8.2	22.0	(4.8)	2.0			2.0	0.0	0.0	29.3
Primary Energy Supply	**10.9**	**22.8**	**(4.8)**	**5.6**	**0.8**	**0.0**	**17.6**	**0.0**	**0.0**	**52.8**
Electricity and Heat Gen.	(8.0)		(1.6)	(5.4)	(0.8)	0.0	(7.6)	7.9	0.0	(15.5)
Petroleum Refineries		(22.8)	22.5							(0.3)
Other Energy Sector	(0.8)		(1.3)	0.0			(2.0)	(1.4)	0.0	(5.5)
Final Energy Demand	**2.1**		**14.7**	**0.2**			**8.0**	**6.4**	**0.0**	**31.5**
Industry	2.1		1.7	0.0			2.0	2.7	0.0	8.4
Transport	0.0		11.6	0.0			0.5	0.0		12.1
Other	0.0		1.4	0.2			5.5	3.7	0.0	10.9
Non-Energy Use	0.0		0.1	0.0			0.0			0.1

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	4.8	0.5		1.1	1.0	0.0	20.3			27.8
Net Imports	13.6	38.4	(14.1)	11.8			2.1	0.0	0.0	51.8
Primary Energy Supply	**18.4**	**38.9**	**(14.1)**	**12.9**	**1.0**	**0.0**	**22.5**	**0.0**	**0.0**	**79.6**
Electricity and Heat Gen.	(14.6)		(0.8)	(12.3)	(1.0)	0.0	(10.6)	14.2	0.0	(25.2)
Petroleum Refineries		(38.9)	38.3							(0.6)
Other Energy Sector	(1.4)		(2.2)	0.0			(2.1)	(2.5)	0.0	(8.2)
Final Energy Demand	**2.4**		**21.2**	**0.6**			**9.7**	**11.7**	**0.0**	**45.6**
Industry	2.4		1.6	0.0			2.0	5.7	0.0	11.7
Transport	0.0		18.3	0.0			1.7	0.0		20.1
Other	0.0		1.3	0.6			6.0	6.0	0.0	13.9
Non-Energy Use	0.0		0.1	0.0			0.0			0.1

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
70 - 104	0.6 - 0.9	.. - ..	0.6 - 0.9

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
1.8 - 2.8	35.9 - 50.6	25.5 - 40.0	7.1 - 10.6

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
19 - 27	3.6 - 5.5	1.0 - 1.4	47 - 70

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
47 - 70	19 - 27	21 - 33	7 - 10

RUSSIA

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	1 872	1 260	1 697	2 482	3 942	- 3.9	6.1	3.9	3.1	3.4
Population (million)	148	146	143	136	123	- 0.1	- 0.4	- 0.5	- 0.6	- 0.6
GDP per Capita (2005 US$ PPP per capita)	12 624	8 612	11 859	18 290	31 997	- 3.8	6.6	4.4	3.8	4.1

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**1,280.3**	**966.5**	**1,188.3**	**1,361.5**	**1,494.5**	**- 2.8**	**4.2**	**1.4**	**0.6**	**0.9**
Coal	179.6	117.0	142.5	150.0	180.0	- 4.2	4.0	0.5	1.2	0.9
	(14%)	(12%)	(12%)	(11%)	(12%)					
Oil	526.3	323.3	468.7	510.0	520.0	- 4.8	7.7	0.8	0.1	0.4
	(41%)	(33%)	(39%)	(37%)	(35%)					
Gas	516.7	470.6	515.7	620.0	655.0	- 0.9	1.8	1.9	0.4	1.0
	(40%)	(49%)	(43%)	(46%)	(44%)					
Hydro	14.3	14.1	14.9	17.2	21.5	- 0.1	1.0	1.5	1.5	1.5
	(1%)	(1%)	(1%)	(1%)	(1%)					
NRE	12.2	7.1	7.3	8.4	15.4	- 5.3	0.7	1.4	4.1	3.0
	(1%)	(1%)	(1%)	(1%)	(1%)					
Nuclear	31.3	34.4	39.3	55.9	102.6	1.0	2.7	3.6	4.1	3.9
	(2%)	(4%)	(3%)	(4%)	(7%)					
Net Import	**-401.4**	**-351.9**	**-540.7**	**-582.3**	**-619.8**	**- 1.3**	**9.0**	**0.7**	**0.4**	**0.5**
Coal	2.3	- 6.2	- 39.1	- 45.5	- 79.3		44.5	1.5	3.8	2.9
Oil	- 253.6	- 192.7	- 334.4	- 325.8	- 303.8	- 2.7	11.7	- 0.3	- 0.5	- 0.4
Gas	- 149.4	- 151.7	- 166.1	- 209.0	- 231.6	0.2	1.8	2.3	0.7	1.3
Electricity	- 0.7	- 1.2	- 1.1	- 2.0	- 5.0	5.4	- 2.5	6.5	6.3	6.4
Primary Energy Supply	**878.9**	**614.6**	**647.6**	**779.2**	**874.7**	**- 3.5**	**1.1**	**1.9**	**0.8**	**1.2**
Coal	181.9	110.8	103.4	104.5	100.7	- 4.8	- 1.4	0.1	- 0.25	- 0.1
	(21%)	(18%)	(16%)	(13%)	(12%)					
Oil	272.7	130.6	134.4	184.2	216.2	- 7.1	0.6	3.2	1.1	1.9
	(31%)	(21%)	(21%)	(24%)	(25%)					
Gas	367.3	318.9	349.6	411.0	423.4	- 1.4	1.9	1.6	0.2	0.8
	(42%)	(52%)	(54%)	(53%)	(48%)					
Hydro	14.3	14.1	14.9	17.2	21.5	- 0.1	1.0	1.5	1.5	1.5
	(2%)	(2%)	(2%)	(2%)	(2%)					
NRE	12.2	6.9	7.3	8.4	15.4	- 5.5	0.9	1.4	4.1	3.1
	(1%)	(1%)	(1%)	(1%)	(2%)					
Nuclear	31.3	34.4	39.3	55.9	102.6	1.0	2.7	3.6	4.1	3.9
	(4%)	(6%)	(6%)	(7%)	(12%)					
Input for Electricity and Heat Generation	**-444.3**	**-341.8**	**-355.9**	**-407.4**	**-468.6**	**- 2.6**	**0.8**	**1.4**	**0.9**	**1.1**
Coal	- 104.9	- 79.9	- 76.9	- 76.0	- 78.0	- 2.7	- 0.8	- 0.1	0.2	0.1
	(24%)	(23%)	(22%)	(19%)	(17%)					
Oil	- 62.1	- 23.2	- 16.8	- 18.3	- 17.0	- 9.4	- 6.3	0.9	- 0.5	0.0
	(14%)	(7%)	(5%)	(4%)	(4%)					
Gas	- 227.7	- 186.4	- 203.7	- 234.0	- 237.0	- 2.0	1.8	1.4	0.1	0.6
	(51%)	(55%)	(57%)	(57%)	(51%)					
Hydro	- 14.3	- 14.1	- 14.9	- 17.2	- 21.5	- 0.1	1.0	1.5	1.5	1.5
	(3%)	(4%)	(4%)	(4%)	(5%)					
NRE	- 4.0	- 3.8	- 4.4	- 6.0	- 12.5	- 0.5	2.9	3.1	5.1	4.3
	(1%)	(1%)	(1%)	(1%)	(3%)					
Nuclear	- 31.3	- 34.4	- 39.3	- 55.9	- 102.6	1.0	2.7	3.6	4.1	3.9
	(7%)	(10%)	(11%)	(14%)	(22%)					
Input for Refineries and Other Energy Sector	**-141.3**	**-82.4**	**-101.5**	**-104.6**	**-117.1**	**- 5.3**	**4.3**	**0.3**	**0.8**	**0.6**
Coal	- 28.0	- 10.2	- 9.3	- 8.2	- 6.5	- 9.6	- 1.8	- 1.33	- 1.5	- 1.5
Oil	- 53.9	- 14.3	- 20.6	- 35.1	- 42.7	- 12.4	7.6	5.5	1.3	3.0
Gas	- 16.6	- 17.9	- 17.8	- 20.5	- 20.3	0.7	- 0.0	1.4	- 0.1	0.5
NRE	- 0.1	- 0.1	- 0.2			- 0.6	24.9			
Electricity	- 21.3	- 21.8	- 24.8	- 25.8	- 31.3	0.3	2.6	0.4	1.3	0.9
Heat	- 21.4	- 18.1	- 28.6	- 15.0	- 16.4	- 1.7	9.6	- 6.2	0.6	- 2.2

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**634.0**	**425.0**	**421.1**	**500.4**	**547.1**	**- 3.9**	**- 0.2**	**1.7**	**0.6**	**1.1**
Coal	54.9	20.7	17.2	20.4	16.2	- 9.3	- 3.6	1.7	- 1.5	- 0.2
	(9%)	(5%)	(4%)	(4%)	(3%)					
Oil	153.9	95.0	97.1	130.9	156.6	- 4.7	0.4	3.0	1.2	1.9
	(24%)	(22%)	(23%)	(26%)	(29%)					
Gas	143.1	117.1	128.0	156.5	166.0	- 2.0	1.8	2.0	0.4	1.0
	(23%)	(28%)	(30%)	(31%)	(30%)					
NRE	8.1	3.1	2.6	2.4	2.9	- 9.3	- 3.1	- 0.8	1.2	0.4
	(1%)	(1%)	(1%)	(0%)	(1%)					
Electricity	71.1	52.3	55.9	68.9	86.1	- 3.0	1.3	2.1	1.5	1.7
	(11%)	(12%)	(13%)	(14%)	(16%)					
Heat	203.0	136.8	120.3	121.4	119.4	- 3.9	- 2.5	0.1	- 0.1	- 0.0
	(32%)	(32%)	(29%)	(24%)	(22%)					
Industry	**209.8**	**131.0**	**127.3**	**148.4**	**157.4**	**- 4.6**	**- 0.6**	**1.5**	**0.4**	**0.9**
Coal	15.7	10.5	11.1	10.8	11.4	- 4.0	1.3	- 0.3	0.4	0.1
	(7%)	(8%)	(9%)	(7%)	(7%)					
Oil	24.6	17.0	10.3	11.1	8.6	- 3.6	- 9.6	0.8	- 1.7	- 0.7
	(12%)	(13%)	(8%)	(7%)	(5%)					
Gas	30.5	25.8	30.1	44.5	48.3	- 1.6	3.1	4.0	0.5	1.9
	(15%)	(20%)	(24%)	(30%)	(31%)					
NRE		0.6	0.6				- 0.2			
		(0%)	(0%)							
Electricity	41.4	26.9	28.4	36.0	45.2	- 4.2	1.1	2.4	1.5	1.9
	(20%)	(21%)	(22%)	(24%)	(29%)					
Heat	97.6	50.3	46.8	46.0	43.9	- 6.4	- 1.4	- 0.2	- 0.3	- 0.3
	(47%)	(38%)	(37%)	(31%)	(28%)					
Transportation	**124.8**	**79.0**	**93.7**	**119.2**	**138.5**	**- 4.5**	**3.5**	**2.4**	**1.0**	**1.6**
Coal										
Oil	81.8	46.8	52.7	74.4	89.0	- 5.4	2.4	3.5	1.2	2.1
	(66%)	(59%)	(56%)	(62%)	(64%)					
Gas	34.0	26.9	33.8	35.4	37.2	- 2.3	4.7	0.5	0.3	0.4
	(27%)	(34%)	(36%)	(30%)	(27%)					
NRE				0.2	0.7				8.0	
				(0%)	(0%)					
Electricity	8.9	5.2	7.2	9.2	11.6	- 5.2	6.4	2.5	1.6	2.0
	(7%)	(7%)	(8%)	(8%)	(8%)					
Other	**259.2**	**178.7**	**155.8**	**177.5**	**184.7**	**- 3.6**	**- 2.7**	**1.3**	**0.3**	**0.7**
Coal	39.1	9.5	5.4	4.8	3.7	- 13.2	- 10.6	- 1.2	- 1.7	- 1.5
	(15%)	(5%)	(3%)	(3%)	(2%)					
Oil	28.5	12.6	11.9	16.5	15.2	- 7.8	- 1.2	3.3	- 0.5	1.0
	(11%)	(7%)	(8%)	(9%)	(8%)					
Gas	57.4	47.5	42.7	54.8	58.8	- 1.9	- 2.1	2.5	0.5	1.3
	(22%)	(27%)	(27%)	(31%)	(32%)					
NRE	8.1	2.5	2.0	2.2	2.2	- 11.2	- 3.8	0.8	- 0.0	0.3
	(3%)	(1%)	(1%)	(1%)	(1%)					
Electricity	20.7	20.2	20.4	23.7	29.3	- 0.2	0.1	1.5	1.4	1.5
	(8%)	(11%)	(13%)	(13%)	(16%)					
Heat	105.4	86.5	73.5	75.4	75.4	- 2.0	- 3.2	0.3	- 0.0	0.1
	(41%)	(48%)	(47%)	(43%)	(41%)					
Non-Energy Use	**40.2**	**36.3**	**44.2**	**55.4**	**66.5**	**- 1.0**	**4.0**	**2.3**	**1.2**	**1.6**
Coal		0.7	0.7	4.8	1.1	41.2	- 1.7	21.8	- 9.5	1.9
		(2%)	(2%)	(9%)	(2%)					
Oil	19.1	18.7	22.2	28.9	43.8	- 0.2	3.5	2.7	2.8	2.8
	(47%)	(51%)	(50%)	(52%)	(66%)					
Gas	21.1	16.9	21.4	21.7	21.7	- 2.2	4.8	0.1	- 0.0	0.1
	(53%)	(47%)	(48%)	(39%)	(33%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**1,082.2**	**876.5**	**951.2**	**1,123.4**	**1,420.9**	**- 2.1**	**1.6**	**1.7**	**1.6**	**1.6**
Coal	157.0	175.6	165.7	194.2	243.5	1.1	- 1.2	1.6	1.5	1.6
	(15%)	(20%)	(17%)	(17%)	(17%)					
Oil	128.6	33.1	21.2	24.2	27.1	- 12.7	- 8.5	1.3	0.8	1.0
	(12%)	(4%)	(2%)	(2%)	(2%)					
Gas	512.2	370.4	439.0	493.1	513.3	- 3.2	3.5	1.2	0.3	0.6
	(47%)	(42%)	(46%)	(44%)	(36%)					
Hydro	165.9	164.1	172.7	200.0	250.0	- 0.1	1.0	1.5	1.5	1.5
	(15%)	(19%)	(18%)	(18%)	(18%)					
NRE	0.1	2.6	3.1	2.0	7.0	44.6	3.3	- 4.1	8.7	3.4
Nuclear	118.3	130.7	149.4	210.0	380.0	1.0	2.7	3.5	4.0	3.8
	(11%)	(15%)	(16%)	(19%)	(27%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**208,014**	**213,000**		**253,493**	**303,939**	**0.2**	**0.7**	**1.4**	**1.2**	**1.3**
Thermal	145 000	147 000		174 599	189 530	0.1	0.3	1.6	0.5	1.0
	(70%)	(69%)		(69%)	(62%)					
Coal		68 000		75 530	84 770		- 0.9	1.5	0.8	1.1
		(32%)		(30%)	(28%)					
Oil		15 000		87 837	94 168		- 4.4	22.0	0.5	8.6
		(7%)		(35%)	(31%)					
Gas		64 000		11 232	10 591		2.4	- 17.0	- 0.4	- 7.4
		(30%)		(4%)	(3%)					
Hydro	43 000	44 000		50 736	63 420	0.2			1.5	
	(21%)	(21%)		(20%)	(21%)					
NRE	14	1 000		1 522	5 327		1.9	3.3	8.7	6.5
				(1%)	(2%)					
Nuclear	20 000	21 000		26 636	45 662	0.5	2.4	1.2	3.7	2.7
	(10%)	(10%)		(11%)	(15%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	469	488	382	314	222	0.4	- 4.8	- 1.9	- 2.3	- 2.1
Primary Energy Supply per Capita (kgoe per capita)	5 927	4 201	4 525	5 743	7 100	- 3.4	1.5	2.4	1.4	1.8
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	339	337	248	202	139	- 0.0	- 6.0	- 2.1	- 2.5	- 2.3
Final Energy Demand per Capita (kgoe per capita)	4 275	2 905	2 942	3 688	4 441	- 3.8	0.3	2.3	1.2	1.7
CO_2 Emissions (million tonnes)	**2,180**	**1,514**	**1,458**	**1,557**	**1,590**	**- 3.6**	**- 0.7**	**0.7**	**0.1**	**0.3**
Sector										
Electricity and Heat Generation	1 162	858	827	899	910	- 3.0	- 0.7	0.8	0.1	0.4
Refineries and Other Energy Sector	57	59	88	138	140	0.4	8.3	4.6	0.1	1.9
Industry	292	224	146	180	183	- 2.6	- 8.2	2.2	0.1	0.9
Transport	296	188	241	143	160	- 4.5	5.2	- 5.1	0.7	- 1.6
Other	373	186	156	196	197	- 6.7	- 3.4	2.3	0.0	0.9
Fuel										
Coal			410	399	398			- 0.3	- 0.0	- 0.1
Oil	166	79	173	262	267	- 7.1	16.9	4.2	0.1	1.7
Gas	129	110	755	895	924	- 1.6	47.0	1.7	0.2	0.8
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	1 202	902	859. 2	627. 3	403. 3	- 2.8	- 1.0	- 3.1	- 2.9	- 3.0
CO_2 Emissions per Capita (tonnes per capita)	10	11	10. 2	11. 5	12. 9	0.3	- 1.0	1.2	0.8	0.9

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	142.5	468.7		515.7	14.9	39.3	7.3			1,188.3
Net Imports	(39.1)	(255.6)	(78.8)	(166.1)			(0.3)	(1.1)	8.8	(532.1)
Primary Energy Supply	**103.4**	**213.1**	**(78.8)**	**349.6**	**14.9**	**39.3**	**7.0**	**(1.1)**	**8.8**	**656.2**
Transfers and Statistical Diff.	0.0	0.0	0.1	0.0			0.0	0.0	0.0	0.1
Electricity and Heat Gen.	(76.9)		(16.8)	(203.7)	(14.9)	(39.3)	(4.4)	81.8	140.1	(134.0)
Petroleum Refineries		(213.1)	208.9							(4.3)
Other Energy Sector	(9.3)		(16.3)	(17.8)				(24.8)	(28.6)	(97.0)
Final Energy Demand	**17.2**		**97.1**	**128.0**			**2.6**	**55.9**	**120.3**	**421.1**
Industry	11.1		10.3	30.1			0.6	28.4	46.8	127.3
Transport	0.0		52.7	33.8			0.0	7.2		93.7
Other	5.4		11.9	42.7			2.0	20.4	73.5	155.8
Non-Energy Use	0.7		22.2	21.4			0.0			44.2

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	150.0	510.0	0.0	620.0	17.2	55.9	8.4			1,361.5
Net Imports	(45.5)	(260.0)	(65.8)	(209.0)			(2.2)	(2.0)		(584.5)
Primary Energy Supply	**104.5**	**250.0**	**(65.8)**	**411.0**	**17.2**	**55.9**	**6.2**	**(2.0)**	**0.0**	**777.0**
Electricity and Heat Gen.	(76.0)		(18.3)	(234.0)	(17.2)	(55.9)	(6.0)	96.7	136.4	(174.2)
Petroleum Refineries		(250.0)	233.8					(2.0)	(7.8)	(26.0)
Other Energy Sector	(8.2)		(18.8)	(20.5)				(23.8)	(7.3)	(78.6)
Final Energy Demand	**20.4**		**130.9**	**156.5**			**0.2**	**68.9**	**121.4**	**498.2**
Industry	10.8		11.1	44.5				36.0	46.0	148.4
Transport	0.0		74.4	35.4			0.2	9.2		119.2
Other	4.8		16.5	54.8				23.7	75.4	175.3
Non-Energy Use	4.8		28.9	21.7						55.4

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	180.0	520.0	0.0	655.0	21.5	102.6	15.4			1,494.5
Net Imports	(79.3)	(240.0)	(63.8)	(231.6)			(2.2)	(5.0)		(622.0)
Primary Energy Supply	**100.7**	**280.0**	**(63.8)**	**423.4**	**21.5**	**102.6**	**13.2**	**(5.0)**	**0.0**	**872.5**
Electricity and Heat Gen.	(78.0)		(17.0)	(237.0)	(21.5)	(102.6)	(12.5)	122.3	135.8	(210.5)
Petroleum Refineries		(280.0)	259.0					(2.4)	(9.8)	(33.2)
Other Energy Sector	(6.5)		(21.7)	(20.3)				(28.9)	(6.6)	(83.9)
Final Energy Demand	**16.2**		**156.6**	**166.0**			**0.7**	**86.1**	**119.4**	**544.9**
Industry	11.4		8.6	48.3				45.2	43.9	157.4
Transport	0.0		89.0	37.2			0.7	11.6		138.5
Other	3.7		15.2	58.8				29.3	75.4	182.5
Non-Energy Use	1.1		43.8	21.7						66.5

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
1912 - 2522	2.7 - 3.5	0.6 - 0.8	2.1 - 2.8

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
423 - 544	585 - 801	757 - 983	147 - 193

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
306 - 430	531 - 659	55 - 73	1020 - 1360

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
1020 - 1360	471 - 637	406 - 534	143 - 188

SINGAPORE

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	52	109	125	186	313	7.7	2.7	4.1	3.5	3.8
Population (million)	3	4	4	5	6	2.8	1.4	1.3	1.5	1.4
GDP per Capita (2005 US$ PPP per capita)	17 110	27 220	28 934	38 063	51 365	4.8	1.2	2.8	2.0	2.3

ENERGY PROJECTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
			Mtoe							
Production				**0.7**	**0.9**				**1.5**	
Coal										
Oil										
Gas										
Hydro										
NRE				0.7	0.9				1.5	
				(100%)	(100%)					
Nuclear										
Net Import	**13.4**	**22.2**	**31.0**	**37.9**	**51.6**	**5.2**	**6.9**	**2.0**	**2.1**	**2.1**
Coal										
Oil	13.3	21.1	25.0	28.4	35.2	4.7	3.5	1.3	1.5	1.4
Gas		1.2	5.9	9.4	16.2		38.1	4.7	3.7	4.1
Electricity				0.2	0.2				0.0	
Primary Energy Supply	**13.4**	**22.2**	**31.0**	**38.7**	**52.6**	**5.2**	**6.9**	**2.2**	**2.1**	**2.1**
Coal										
Oil	13.3	21.1	25.0	28.2	34.9	4.7	3.5	1.2	1.4	1.3
	(100%)	(95%)	(81%)	(73%)	(66%)					
Gas		1.2	5.9	9.4	16.2		38.1	4.7	3.7	4.1
		(5%)	(19%)	(24%)	(31%)					
Hydro										
NRE				0.9	1.3				2.3	
				(2%)	(2%)					
Nuclear										
Input for Electricity and Heat Generation	**-4.4**	**-6.9**	**-8.1**	**-12.1**	**-20.3**	**4.5**	**3.3**	**4.1**	**3.5**	**3.7**
Coal										
Oil	- 4.4	- 5.7	- 2.2	- 2.0	- 3.2	2.6	- 17.6	- 0.7	3.2	1.6
	(100%)	(83%)	(27%)	(17%)	(16%)					
Gas		- 1.2	- 5.9	- 9.3	- 16.1		38.1	4.6	3.7	4.1
		(17%)	(73%)	(77%)	(79%)					
Hydro										
NRE				- 0.7	- 0.9				1.5	
				(6%)	(5%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-3.5**	**-7.7**	**-10.4**	**-11.1**	**-14.1**	**8.3**	**6.1**	**0.7**	**1.6**	**1.2**
Coal										
Oil	- 3.2	- 7.4	- 10.0	- 10.5	- 12.8	8.6	6.0	0.5	1.3	1.0
Gas	0.1	0.1	0.1	0.1	0.1	5.5	0.0	0.0	- 0.0	0.0
NRE										
Electricity	- 0.3	- 0.4	- 0.5	- 0.8	- 1.4	3.4	6.0	4.3	4.0	4.1
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**6.9**	**10.4**	**15.8**	**20.3**	**27.2**	**4.2**	**8.8**	**2.6**	**2.0**	**2.2**
Coal										
Oil	5.7	7.9	12.9	15.7	18.9	3.3	10.3	2.0	1.2	1.5
	(83%)	(76%)	(82%)	(77%)	(69%)					
Gas	0.1	0.1	0.1	0.1	0.2	5.5	0.0	1.9	1.5	1.7
	(1%)	(1%)	(1%)	(1%)	(1%)					
NRE				0.2	0.3				5.3	
				(1%)	(1%)					
Electricity	1.1	2.3	2.8	4.3	7.9	8.1	3.5	4.5	4.0	4.2
	(16%)	(23%)	(18%)	(21%)	(29%)					
Heat										
Industry	**0.6**	**1.0**	**1.2**	**2.0**	**3.2**	**5.4**	**3.1**	**5.0**	**3.3**	**4.0**
Coal										
Oil	0.1	0.1	0.1	0.3	0.3	- 6.8	3.4	15.5	0.0	5.9
	(18%)	(5%)	(5%)	(14%)	(9%)					
Gas		0.1	0.1	0.1	0.1	7.5	- 1.2	2.7	2.0	2.3
		(6%)	(5%)	(4%)	(3%)					
NRE										
Electricity	0.5	0.9	1.1	1.6	2.8	6.9	3.4	4.0	3.8	3.9
	(77%)	(88%)	(90%)	(82%)	(88%)					
Heat										
Transportation	**3.3**	**4.9**	**5.5**	**6.7**	**7.2**	**4.2**	**2.2**	**2.1**	**0.4**	**1.1**
Coal										
Oil	3.2	4.9	5.4	6.5	6.8	4.2	2.2	1.8	0.3	0.9
	(100%)	(99%)	(99%)	(96%)	(94%)					
Gas										
NRE				0.2	0.3				5.3	
				(2%)	(5%)					
Electricity				0.1	0.1	4.6	3.7	10.0	0.0	3.9
				(1%)	(1%)					
Other	**0.7**	**1.4**	**1.7**	**2.7**	**5.0**	**8.0**	**3.5**	**4.6**	**4.2**	**4.4**
Coal										
Oil										
Gas					0.1	2.7	2.9	0.5	0.5	0.5
					(1%)					
NRE										
Electricity	0.6	1.4	1.7	2.6	5.0	9.0	3.5	4.7	4.3	4.5
	(89%)	(97%)	(97%)	(98%)	(99%)					
Heat										
Non-Energy Use	**2.3**	**3.0**	**7.4**	**8.9**	**11.8**	**2.6**	**19.9**	**1.9**	**1.9**	**1.9**
Coal										
Oil	2.3	3.0	7.4	8.9	11.8	2.6	19.9	1.9	1.9	1.9
	(100%)	(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**15.7**	**31.7**	**38.2**	**56.9**	**104.9**	**7.3**	**3.8**	**4.1**	**4.2**	**4.1**
Coal										
Oil	15.7	25.8	9.8	6.6	10.7	5.1	- 17.6	- 3.8	3.2	0.3
	(100%)	(82%)	(26%)	(12%)	(10%)					
Gas		5.9	28.4	47.3	90.4		37.2	5.2	4.4	4.7
		(18%)	(74%)	(83%)	(86%)					
Hydro										
NRE				3.1	3.8				1.5	
				(5%)	(4%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**2,301**	**5,848**	**10,026**	**13,223**	**23,773**	**9.8**	**11.4**	**2.8**	**4.0**	**3.5**
Thermal	2 237	5 597	9 676	12 823	23 273	9.6	11.6	2.9	4.1	3.6
	(97%)	(96%)	(97%)	(97%)	(98%)					
Coal										
Oil	1 950	4 460	4 460	4 153	6 697	8.6	0.0	- 0.7	3.2	1.6
	(85%)	(76%)	(44%)	(31%)	(28%)					
Gas	287	1 137	5 216	8 670	16 577	14.8	35.6	5.2	4.4	4.7
	(12%)	(19%)	(52%)	(66%)	(70%)					
Hydro										
NRE	64	251	350	400	500	14.7	6.9	1.3	1.5	1.4
	(3%)	(4%)	(3%)	(3%)	(2%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	256	203	248	207	168	- 2.3	4.1	- 1.8	- 1.4	- 1.6
Primary Energy Supply per Capita (kgoe per capita)	4 383	5 534	7 187	7 893	8 612	2.4	5.4	0.9	0.6	0.7
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	131	95	127	109	87	- 3.2	6.0	- 1.5	- 1.5	- 1.5
Final Energy Demand per Capita (kgoe per capita)	2 250	2 580	3 663	4 151	4 461	1.4	7.3	1.3	0.5	0.8
CO_2 Emissions (million tonnes)	**28**	**50**	**38**	**48**	**71**	**5.7**	**- 5.1**	**2.3**	**2.6**	**2.5**
Sector										
Electricity and Heat Generation	14	20	20	28	47	4.1	- 0.0	3.1	3.6	3.4
Refineries and Other Energy Sector	10	23	11	11	14	8.6	- 13.8	0.5	1.4	1.0
Industry	0	0	0	1	1	- 2.6	1.3	11.7	0.4	4.8
Transport	4	6	7	8	8	3.9	1.8	1.8	0.3	0.9
Other	0	0	0	0	0	- 7.8	2.9	0.5	0.5	0.5
Fuel										
Coal	0									
Oil	28	47	25	27	33	5.2	- 12.1	0.8	1.5	1.2
Gas		3	14	22	37		38.1	4.7	3.7	4.1
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	546	455	307	259	225	- 1.8	- 7.5	- 1.7	- 0.9	- 1.2
CO_2 Emissions per Capita (tonnes per capita)	9. 3	12. 4	8. 9	9. 8	11. 6	2.8	- 6.4	1.0	1.1	1.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.0			0.0
Net Imports	0.0	55.7	(30.7)	5.9			0.0	0.0	0.0	31.0
Primary Energy Supply	**0.0**	**55.7**	**(30.7)**	**5.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**31.0**
Transfers and Statistical Diff.	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0
Electricity and Heat Gen.	0.0		(2.2)	(5.9)	0.0	0.0	0.0	3.3	0.0	(4.8)
Petroleum Refineries		(55.7)	49.3							(6.4)
Other Energy Sector	(0.0)		(3.6)	0.1			0.0	(0.5)	0.0	(4.0)
Final Energy Demand	**0.0**		**12.9**	**0.1**			**0.0**	**2.8**	**0.0**	**15.8**
Industry	0.0		0.1	0.1			0.0	1.1	0.0	1.2
Transport	0.0		5.4	0.0			0.0	0.0		5.5
Other	0.0		0.0	0.0			0.0	1.7	0.0	1.7
Non-Energy Use	0.0		7.4	0.0			0.0			7.4

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.7			0.7
Net Imports	0.0	58.6	(30.3)	9.4			0.2	0.2	0.0	37.9
Primary Energy Supply	**0.0**	**58.6**	**(30.3)**	**9.4**	**0.0**	**0.0**	**0.9**	**0.2**	**0.0**	**38.7**
Electricity and Heat Gen.	0.0		(2.0)	(9.3)	0.0	0.0	(0.7)	4.9	0.0	(7.2)
Petroleum Refineries		(58.6)	51.8							(6.7)
Other Energy Sector	0.0		(3.8)	0.1			0.0	(0.8)	0.0	(4.4)
Final Energy Demand	**0.0**		**15.7**	**0.1**			**0.2**	**4.3**	**0.0**	**20.3**
Industry	0.0		0.3	0.1			0.0	1.6	0.0	2.0
Transport	0.0		6.5	0.0			0.2	0.1		6.7
Other	0.0		0.0	0.0			0.0	2.6	0.0	2.7
Non-Energy Use	0.0		8.9	0.0			0.0			8.9

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.0	0.0	0.9			0.9
Net Imports	0.0	71.4	(36.6)	16.2			0.3	0.2	0.0	51.6
Primary Energy Supply	**0.0**	**71.4**	**(36.6)**	**16.2**	**0.0**	**0.0**	**1.3**	**0.2**	**0.0**	**52.6**
Electricity and Heat Gen.	0.0		(3.2)	(16.1)	0.0	0.0	(0.9)	9.0	0.0	(11.3)
Petroleum Refineries		(71.4)	63.2							(8.2)
Other Energy Sector	0.0		(4.6)	0.1			0.0	(1.4)	0.0	(5.9)
Final Energy Demand	**0.0**		**18.9**	**0.2**			**0.3**	**7.9**	**0.0**	**27.2**
Industry	0.0		0.3	0.1			0.0	2.8	0.0	3.2
Transport	0.0		6.8	0.0			0.3	0.1		7.2
Other	0.0		0.0	0.1			0.0	5.0	0.0	5.0
Non-Energy Use	0.0		11.8	0.0			0.0			11.8

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
37 - 52	0.7 - 1.0	.. - ..	0.7 - 1.0

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
.. - ..	29 - 42	6.7 - 9.5	0.8 - 1.1

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
31 - 44	3.1 - 4.9	.. - ..	2.5 - 3.6

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
2.5 - 3.6	2.1 - 3.0	0.12 - 0.18	0.2 - 0.3

CHINESE TAIPEI

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	268	505	590	813	1 261	6.5	3.2	3.3	3.0	3.1
Population (million)	20	22	23	23	23	0.9	0.5	0.2	- 0.1	0.0
GDP per Capita (2005 US$ PPP per capita)	13 271	22 802	26 067	35 087	55 550	5.6	2.7	3.0	3.1	3.1

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**10.7**	**11.1**	**12.3**	**18.2**	**19.9**	**0.4**	**2.0**	**4.0**	**0.6**	**2.0**
Coal	0.3	0.1				- 16.0				
	(3%)	(0%)								
Oil	0.2					- 15.6	- 2.6			
	(2%)									
Gas	1.1	0.6	0.4			- 5.5	- 6.0			
	(10%)	(5%)	(4%)							
Hydro	0.5	0.4	0.4	0.3	0.3	- 3.3	- 2.2	- 1.1	- 0.4	- 0.7
	(5%)	(4%)	(3%)	(2%)	(1%)					
NRE			1.0	2.2	3.9	- 2.1		7.7	4.0	5.4
			(8%)	(12%)	(19%)					
Nuclear	8.6	10.0	10.4	15.7	15.7	1.6	0.8	4.2	0.0	1.7
	(80%)	(90%)	(85%)	(86%)	(79%)					
Net Import	**37.3**	**71.4**	**93.3**	**110.5**	**135.7**	**6.7**	**5.5**	**1.7**	**1.4**	**1.5**
Coal	10.9	29.4	38.8	45.0	48.9	10.4	5.7	1.5	0.6	0.9
Oil	25.7	37.2	46.3	53.3	67.3	3.8	4.5	1.4	1.6	1.5
Gas	0.7	4.9	8.2	12.2	19.4	21.7	10.9	4.1	3.1	3.5
Electricity										
Primary Energy Supply	**48.0**	**82.5**	**105.5**	**128.7**	**155.6**	**5.6**	**5.0**	**2.0**	**1.3**	**1.6**
Coal	11.2	29.4	38.8	45.0	48.9	10.1	5.7	1.5	0.56	0.9
	(23%)	(36%)	(37%)	(35%)	(31%)					
Oil	25.9	37.2	46.3	53.0	66.7	3.7	4.5	1.3	1.5	1.5
	(54%)	(45%)	(44%)	(41%)	(43%)					
Gas	1.7	5.5	8.6	12.2	19.4	12.1	9.5	3.6	3.1	3.3
	(4%)	(7%)	(8%)	(10%)	(12%)					
Hydro	0.5	0.4	0.4	0.3	0.3	- 3.3	- 2.2	- 1.1	- 0.4	- 0.7
	(1%)	(0%)	(0%)	(0%)	(0%)					
NRE			1.0	2.5	4.5	- 2.1		9.2	4.1	6.1
			(1%)	(2%)	(3%)					
Nuclear	8.6	10.0	10.4	15.7	15.7	1.6	0.8	4.2	0.0	1.7
	(18%)	(12%)	(10%)	(12%)	(10%)					
Input for Electricity and Heat Generation	**-20.3**	**-41.2**	**-51.3**	**-64.7**	**-74.1**	**7.3**	**4.5**	**2.3**	**0.9**	**1.5**
Coal	- 5.9	- 20.9	- 29.6	- 34.2	- 36.0	13.6	7.2	1.5	0.3	0.8
	(29%)	(51%)	(58%)	(53%)	(49%)					
Oil	- 5.1	- 6.4	- 3.8	- 2.4	- 1.8	2.5	- 9.9	- 4.5	- 2.0	- 3.0
	(25%)	(16%)	(7%)	(4%)	(2%)					
Gas	- 0.3	- 3.4	- 6.1	- 9.9	- 16.4	29.0	12.4	5.0	3.4	4.0
	(1%)	(8%)	(12%)	(15%)	(22%)					
Hydro	- 0.5	- 0.4	- 0.4	- 0.3	- 0.3	- 3.3	- 2.2	- 1.1	- 0.4	- 0.7
	(3%)	(1%)	(1%)	(0%)	(0%)					
NRE			- 1.0	- 2.2	- 3.9			7.8	4.0	5.5
			(2%)	(3%)	(5%)					
Nuclear	- 8.6	- 10.0	- 10.4	- 15.7	- 15.7	1.6	0.8	4.2	0.0	1.7
	(42%)	(24%)	(20%)	(24%)	(21%)					
Input for Refineries and Other Energy Sector	**-3.7**	**-6.0**	**-9.2**	**-9.3**	**-11.9**	**5.0**	**8.9**	**0.1**	**1.7**	**1.0**
Coal	- 1.2	- 1.8	- 1.6	- 1.6	- 1.6	4.1	- 3.2	- 0.01	0.0	- 0.0
Oil	- 0.9	- 1.8	- 4.8	- 4.9	- 7.0	7.9	21.4	0.2	2.4	1.5
Gas	- 0.5	- 0.6	- 0.7			0.8	3.5			
NRE										
Electricity	- 1.1	- 1.8	- 2.1	- 2.8	- 3.4	5.1	3.8	3.0	1.2	1.9
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**31.4**	**50.4**	**63.4**	**80.4**	**100.4**	**4.8**	**4.7**	**2.4**	**1.5**	**1.9**
Coal	4.0	6.1	6.8	9.2	11.3	4.3	2.1	3.1	1.4	2.1
	(13%)	(12%)	(11%)	(11%)	(11%)					
Oil	19.9	29.0	37.6	45.6	57.9	3.8	5.3	1.9	1.6	1.7
	(63%)	(58%)	(59%)	(57%)	(58%)					
Gas	0.9	1.5	1.8	2.4	3.0	4.8	4.3	2.5	1.7	2.0
	(3%)	(3%)	(3%)	(3%)	(3%)					
NRE				0.3	0.7	0.0	0.0	38.2	4.9	17.1
				(0%)	(1%)					
Electricity	6.5	13.8	17.1	22.9	27.4	7.7	4.4	2.9	1.2	1.9
	(21%)	(27%)	(27%)	(28%)	(27%)					
Heat										
Industry	**13.1**	**20.2**	**21.1**	**25.8**	**31.1**	**4.4**	**0.8**	**2.0**	**1.3**	**1.6**
Coal	4.0	6.1	6.7	9.1	11.2	4.2	2.0	3.1	1.4	2.1
	(31%)	(30%)	(32%)	(35%)	(36%)					
Oil	5.2	6.1	5.1	5.2	5.5	1.7	- 3.6	0.2	0.3	0.2
	(40%)	(30%)	(24%)	(20%)	(18%)					
Gas	0.2	0.6	0.7	1.0	1.2	10.1	3.9	3.5	1.0	2.0
	(2%)	(3%)	(3%)	(4%)	(4%)					
NRE										
Electricity	3.7	7.4	8.5	10.4	13.3	7.2	2.9	2.0	1.6	1.8
	(28%)	(37%)	(41%)	(41%)	(43%)					
Heat										
Transportation	**7.5**	**13.4**	**15.1**	**18.3**	**20.9**	**6.0**	**2.3**	**2.0**	**0.9**	**1.3**
Coal										
Oil	7.5	13.4	15.0	17.9	20.1	6.0	2.3	1.8	0.8	1.2
	(100%)	(100%)	(100%)	(98%)	(96%)					
Gas										
NRE				0.3	0.7				5.0	
				(2%)	(3%)					
Electricity		0.1	0.1	0.1	0.1	9.4	3.2	4.3	0.0	1.7
		(0%)	(0%)	(1%)	(1%)					
Other	**6.3**	**10.0**	**12.6**	**16.7**	**19.0**	**4.7**	**4.7**	**2.9**	**0.8**	**1.6**
Coal						- 16.4				
Oil	2.9	2.9	3.0	3.1	3.0	- 0.1	0.8	0.1	- 0.1	- 0.0
	(46%)	(29%)	(24%)	(18%)	(16%)					
Gas	0.5	0.8	1.1	1.4	1.9	4.1	6.0	2.3	2.2	2.2
	(9%)	(8%)	(9%)	(8%)	(10%)					
NRE						0.0	0.0	0.0	- 0.0	0.0
Electricity	2.8	6.3	8.5	12.3	14.1	8.3	6.1	3.8	0.9	2.0
	(45%)	(63%)	(67%)	(73%)	(74%)					
Heat										
Non-Energy Use	**4.5**	**6.7**	**14.6**	**19.5**	**29.4**	**4.2**	**16.8**	**2.9**	**2.8**	**2.8**
Coal		0.1	0.1	0.1	0.1		16.7	1.4	1.0	1.2
		(1%)	(1%)	(1%)	(0%)					
Oil	4.3	6.6	14.5	19.4	29.3	4.3	17.0	3.0	2.8	2.9
	(96%)	(98%)	(99%)	(99%)	(100%)					
Gas	0.2	0.1	0.1			- 5.0	- 12.4			
	(4%)	(1%)	(0%)							
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**88.4**	**180.5**	**223.6**	**298.8**	**358.6**	**7.4**	**4.4**	**2.9**	**1.2**	**1.9**
Coal	25.7	90.1	120.2	152.6	170.4	13.4	5.9	2.4	0.7	1.4
	(29%)	(50%)	(54%)	(51%)	(48%)					
Oil	22.3	29.6	17.1	10.6	8.5	2.9	- 10.5	- 4.6	- 1.5	- 2.8
	(25%)	(16%)	(8%)	(4%)	(2%)					
Gas	1.1	17.7	39.3	49.6	89.1	31.5	17.3	2.4	4.0	3.3
	(1%)	(10%)	(18%)	(17%)	(25%)					
Hydro	6.4	4.6	4.1	3.6	3.4	- 3.3	- 2.2	- 1.1	- 0.4	- 0.7
	(7%)	(3%)	(2%)	(1%)	(1%)					
NRE			3.0	21.2	26.1	- 10.4		21.5	1.4	9.0
			(1%)	(7%)	(7%)					
Nuclear	32.9	38.5	40.0	61.2	61.2	1.6	0.8	4.3	0.0	1.7
	(37%)	(21%)	(18%)	(20%)	(17%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**18,725**	**29,625**	**43,536**	**66,000**	**88,451**	**4.7**	**8.0**	**4.2**	**2.0**	**2.9**
Thermal	9 156	19 969	33 184	46 952	67 697	8.1	10.7	3.5	2.5	2.9
	(49%)	(67%)	(76%)	(71%)	(77%)					
Coal	3 657	9 800	17 258	23 224	29 921	10.4	12.0	3.0	1.7	2.2
	(20%)	(33%)	(40%)	(35%)	(34%)					
Oil	4 751	5 404	4 827	4 848	3 873	1.3	- 2.2	0.0	- 1.5	- 0.9
	(25%)	(18%)	(11%)	(7%)	(4%)					
Gas	748	4 764	11 099	18 880	33 903	20.3	18.4	5.5	4.0	4.6
	(4%)	(16%)	(25%)	(29%)	(38%)					
Hydro	4 422	4 512	2 602	2 602	2 602	0.2	- 10.4	0.0	0.0	0.0
	(24%)	(15%)	(6%)	(4%)	(3%)					
NRE	3		2 606	8 602	10 308			12.7	1.2	5.7
			(6%)	(13%)	(12%)					
Nuclear	5 144	5 144	5 144	7 844	7 844	0.0	0.0	4.3	0.0	1.7
	(27%)	(17%)	(12%)	(12%)	(9%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	179	164	179	158	123	- 0.9	1.8	- 1.2	- 1.6	- 1.5
Primary Energy Supply per Capita (kgoe per capita)	2 371	3 730	4 659	5 554	6 857	4.6	4.5	1.8	1.4	1.6
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	117	100	107	99	80	- 1.6	1.4	- 0.8	- 1.4	- 1.2
Final Energy Demand per Capita (kgoe per capita)	1 553	2 279	2 798	3 468	4 423	3.9	4.2	2.2	1.6	1.8
CO_2 Emissions (million tonnes)	**112**	**216**	**255**	**297**	**338**	**6.8**	**3.4**	**1.5**	**0.9**	**1.1**
Sector										
Electricity and Heat Generation	40	112	144	167	187	10.9	5.3	1.5	0.8	1.0
Refineries and Other Energy Sector	9	14	16	17	21	5.0	2.5	0.2	1.6	1.0
Industry	33	45	44	55	64	3.2	- 0.2	2.2	1.1	1.5
Transport	20	34	38	46	52	5.4	2.3	1.8	0.8	1.2
Other	10	11	12	13	14	0.5	1.8	0.6	0.5	0.6
Fuel										
Coal	44	115	152	179	195	10.0	5.6	1.7	0.6	1.0
Oil	64	88	84	89	98	3.3	- 0.9	0.6	0.6	0.6
Gas	4	12	20	28	45	13.1	9.8	3.6	3.1	3.3
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	416	428	432	365	268	0.3	0.2	- 1.7	- 2.0	- 1.9
CO_2 Emissions per Capita (tonnes per capita)	5. 5	9. 8	11. 3	12. 8	14. 9	5.8	2.9	1.3	1.0	1.1

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.4	0.4	10.4	1.0			12.3
Net Imports	38.8	54.5	(8.2)	8.2			0.0	0.0	0.0	93.3
Primary Energy Supply	**38.8**	**54.5**	**(8.2)**	**8.6**	**0.4**	**10.4**	**1.0**	**0.0**	**0.0**	**105.5**
Transfers and Statistical Diff.	(0.8)	7.6	(7.7)	0.0			0.0	0.0	0.0	(0.9)
Electricity and Heat Gen.	(29.6)		(3.8)	(6.1)	(0.4)	(10.4)	(1.0)	19.2	0.0	(32.1)
Petroleum Refineries		(62.2)	60.1							(2.1)
Other Energy Sector	(1.6)		(2.7)	(0.7)			0.0	(2.1)	0.0	(7.1)
Final Energy Demand	**6.8**		**37.6**	**1.8**			**0.0**	**17.1**	**0.0**	**63.4**
Industry	6.7		5.1	0.7			0.0	8.5	0.0	21.1
Transport	0.0		15.0	0.0			0.0	0.1		15.1
Other	0.0		3.0	1.1			0.0	8.5	0.0	12.6
Non-Energy Use	0.1		14.5	0.1			0.0			14.6

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.3	15.7	2.2			18.2
Net Imports	45.0	64.0	(11.0)	12.2			0.3	0.0	0.0	110.5
Primary Energy Supply	**45.0**	**64.0**	**(11.0)**	**12.2**	**0.3**	**15.7**	**2.5**	**0.0**	**0.0**	**128.7**
Electricity and Heat Gen.	(34.2)		(2.4)	(9.9)	(0.3)	(15.7)	(2.2)	25.7	0.0	(39.0)
Petroleum Refineries		(64.0)	62.4							(1.6)
Other Energy Sector	(1.6)		(3.3)	0.0			0.0	(2.8)	0.0	(7.7)
Final Energy Demand	**9.2**		**45.6**	**2.4**			**0.3**	**22.9**	**0.0**	**80.4**
Industry	9.1		5.2	1.0			0.0	10.4	0.0	25.8
Transport	0.0		17.9	0.0			0.3	0.1		18.3
Other	0.0		3.1	1.4			0.0	12.3	0.0	16.7
Non-Energy Use	0.1		19.4	0.0			0.0			19.5

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	0.0	0.0		0.0	0.3	15.7	3.9			19.9
Net Imports	48.9	91.0	(24.3)	19.4			0.7	0.0	0.0	135.7
Primary Energy Supply	**48.9**	**91.0**	**(24.3)**	**19.4**	**0.3**	**15.7**	**4.5**	**0.0**	**0.0**	**155.6**
Electricity and Heat Gen.	(36.0)		(1.8)	(16.4)	(0.3)	(15.7)	(3.9)	30.8	0.0	(43.3)
Petroleum Refineries		(91.0)	88.7							(2.3)
Other Energy Sector	(1.6)		(4.7)	0.0			0.0	(3.4)	0.0	(9.7)
Final Energy Demand	**11.3**		**57.9**	**3.0**			**0.7**	**27.4**	**0.0**	**100.4**
Industry	11.2		5.5	1.2			0.0	13.3	0.0	31.1
Transport	0.0		20.1	0.0			0.7	0.1		20.9
Other	0.0		3.0	1.9			0.0	14.1	0.0	19.0
Non-Energy Use	0.1		29.3	0.0			0.0			29.4

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
120 - 166	0.6 - 0.8	.. - ..	0.6 - 0.8

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
.. - ..	90 - 125	22 - 31	8 - 10

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
40 - 56	4.2 - 6.7	0.9 - 1.3	75 - 102

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
75 - 102	55 - 75	13 - 19	6.7 - 8.5

THAILAND

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	202	332	426	650	1 292	5.1	5.1	4.3	4.7	4.5
Population (million)	54	61	63	66	69	1.1	0.8	0.5	0.2	0.4
GDP per Capita (2005 US$ PPP per capita)	3 723	5 468	6 758	9 782	18 722	3.9	4.3	3.8	4.4	4.2

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**26.5**	**43.9**	**54.3**	**50.1**	**57.0**	**5.1**	**4.4**	**- 0.8**	**0.9**	**0.2**
Coal	3.6	5.1	6.1	7.0	6.0	3.6	3.4	1.5	- 1.0	- 0.0
	(14%)	(12%)	(11%)	(14%)	(11%)					
Oil	2.7	7.9	12.5	6.0	6.0	11.2	9.6	- 7.1	0.0	- 2.9
	(10%)	(18%)	(23%)	(12%)	(11%)					
Gas	5.1	15.8	18.5	20.0	16.5	12.0	3.2	0.8	- 1.3	- 0.5
	(19%)	(36%)	(34%)	(40%)	(29%)					
Hydro	0.4	0.5	0.5	0.8	0.8	1.9	- 0.7	4.5	0.1	1.9
	(2%)	(1%)	(1%)	(2%)	(1%)					
NRE	14.7	14.5	16.8	16.3	27.7	- 0.1	3.0	- 0.3	3.6	2.0
	(55%)	(33%)	(31%)	(33%)	(49%)					
Nuclear										
Net Import	**17.4**	**31.2**	**46.3**	**76.0**	**156.0**	**6.0**	**8.2**	**5.1**	**4.9**	**5.0**
Coal	0.2	2.5	5.4	9.6	27.4	27.9	16.5	5.8	7.2	6.7
Oil	17.1	26.7	33.1	49.3	81.1	4.5	4.4	4.1	3.4	3.6
Gas		1.7	7.4	14.4	43.6		33.8	6.8	7.7	7.3
Electricity	0.1	0.2	0.3	2.7	4.0	16.2	6.4	23.6	2.7	10.6
Primary Energy Supply	**43.9**	**75.0**	**100.6**	**126.1**	**213.0**	**5.5**	**6.1**	**2.3**	**3.6**	**3.0**
Coal	3.8	7.7	11.5	16.6	33.4	7.2	8.4	3.7	4.76	4.4
	(9%)	(10%)	(11%)	(13%)	(16%)					
Oil	19.8	34.5	45.6	50.2	79.6	5.7	5.7	1.0	3.1	2.3
	(45%)	(46%)	(45%)	(40%)	(37%)					
Gas	5.1	17.5	25.9	34.4	60.1	13.1	8.2	2.9	3.8	3.4
	(12%)	(23%)	(26%)	(27%)	(28%)					
Hydro	0.4	0.5	0.5	0.8	0.8	1.9	- 0.7	4.5	0.1	1.9
	(1%)	(1%)	(0%)	(1%)	(0%)					
NRE	14.7	14.5	16.8	21.5	35.2	- 0.1	3.0	2.5	3.3	3.0
	(33%)	(19%)	(17%)	(17%)	(17%)					
Nuclear										
Input for Electricity and Heat Generation	**-9.4**	**-20.1**	**-27.2**	**-37.8**	**-80.6**	**7.9**	**6.3**	**3.3**	**5.2**	**4.4**
Coal	- 2.5	- 4.1	- 4.8	- 8.8	- 25.0	4.8	3.4	6.1	7.2	6.8
	(27%)	(20%)	(18%)	(23%)	(31%)					
Oil	- 2.6	- 2.3	- 2.0	- 0.4	- 0.4	- 0.8	- 3.3	- 15.7	1.5	- 5.8
	(27%)	(12%)	(7%)	(1%)	(1%)					
Gas	- 3.8	- 12.7	- 19.0	- 26.6	- 52.5	12.8	8.4	3.4	4.6	4.1
	(41%)	(63%)	(70%)	(70%)	(65%)					
Hydro	- 0.4	- 0.5	- 0.5	- 0.8	- 0.8	1.9	- 0.7	4.5	0.1	1.9
	(5%)	(3%)	(2%)	(2%)	(1%)					
NRE		- 0.4	- 0.9	- 1.3	- 1.8		17.9	3.5	2.4	2.8
		(2%)	(3%)	(3%)	(2%)					
Nuclear										
Input for Refineries and Other Energy Sector	**-7.8**	**-11.4**	**-16.4**	**-16.5**	**-21.1**	**3.9**	**7.6**	**0.0**	**1.7**	**1.0**
Coal						1.2	- 3.3	1.46	- 1.0	- 0.0
Oil	- 0.7	- 2.1	- 5.3	- 3.8	- 5.2	12.4	20.0	- 3.2	2.1	- 0.1
Gas	- 1.0	- 3.5	- 5.1	- 5.5	- 4.5	13.1	7.5	0.8	- 1.3	- 0.5
NRE	- 5.5	- 4.8	- 4.8	- 5.1	- 7.4	- 1.4	0.2	0.6	2.5	1.7
Electricity	- 0.6	- 0.9	- 1.3	- 2.0	- 3.9	5.3	6.4	4.8	4.5	4.6
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**30.8**	**52.0**	**68.9**	**88.1**	**145.8**	**5.4**	**5.8**	**2.5**	**3.4**	**3.0**
Coal	1.3	3.6	6.8	7.8	8.3	10.7	13.4	1.4	0.4	0.8
	(4%)	(7%)	(10%)	(9%)	(6%)					
Oil	16.7	30.2	38.8	46.0	74.0	6.1	5.1	1.7	3.2	2.6
	(54%)	(58%)	(56%)	(52%)	(51%)					
Gas	0.2	1.3	1.9	2.3	3.1	17.9	8.1	2.3	1.9	2.0
	(1%)	(2%)	(3%)	(3%)	(2%)					
NRE	9.2	9.4	11.1	15.1	25.9	0.2	3.5	3.1	3.7	3.4
	(30%)	(18%)	(16%)	(17%)	(18%)					
Electricity	3.3	7.6	10.4	16.9	34.5	8.7	6.6	4.9	4.9	4.9
	(11%)	(15%)	(15%)	(19%)	(24%)					
Heat										
Industry	**8.6**	**16.9**	**22.7**	**27.7**	**43.4**	**6.9**	**6.2**	**2.0**	**3.1**	**2.6**
Coal	1.3	3.6	6.8	7.8	8.3	10.7	13.4	1.4	0.4	0.8
	(15%)	(21%)	(30%)	(28%)	(19%)					
Oil	2.8	4.4	4.1	3.0	2.4	4.8	- 1.4	- 3.1	- 1.4	- 2.1
	(32%)	(26%)	(18%)	(11%)	(6%)					
Gas	0.1	1.1	1.6	1.8	1.9	23.1	7.0	1.4	0.5	0.9
	(2%)	(7%)	(7%)	(6%)	(4%)					
NRE	2.9	4.3	5.4	6.7	12.1	4.0	4.8	2.2	4.0	3.2
	(34%)	(25%)	(24%)	(24%)	(28%)					
Electricity	1.5	3.5	4.9	8.3	18.7	8.4	7.2	5.5	5.5	5.5
	(18%)	(20%)	(22%)	(30%)	(43%)					
Heat										
Transportation	**10.9**	**17.4**	**22.1**	**28.8**	**43.8**	**4.8**	**4.8**	**2.7**	**2.8**	**2.8**
Coal										
Oil	10.9	17.4	22.0	25.4	34.8	4.8	4.8	1.5	2.1	1.9
	(100%)	(100%)	(100%)	(88%)	(80%)					
Gas				0.1	0.1			6.8	1.5	3.6
				(0%)	(0%)					
NRE				3.2	8.8				6.9	
				(11%)	(20%)					
Electricity							10.8	5.4	5.7	5.6
Other	**10.8**	**13.6**	**16.3**	**21.1**	**34.5**	**2.3**	**3.7**	**2.6**	**3.3**	**3.0**
Coal										
Oil	2.7	4.4	5.1	7.5	13.6	4.9	2.9	3.9	4.1	4.0
	(25%)	(33%)	(31%)	(35%)	(40%)					
Gas										
NRE	6.3	5.1	5.7	5.1	5.0	- 2.1	2.3	- 1.0	- 0.1	- 0.5
	(58%)	(37%)	(35%)	(24%)	(15%)					
Electricity	1.8	4.1	5.5	8.5	15.8	8.9	6.1	4.4	4.2	4.3
	(16%)	(30%)	(34%)	(40%)	(46%)					
Heat										
Non-Energy Use	**0.4**	**4.1**	**7.8**	**10.6**	**24.2**	**25.7**	**13.6**	**3.1**	**5.7**	**4.6**
Coal										
Oil	0.3	4.0	7.6	10.1	23.2	28.8	13.7	3.0	5.7	4.6
	(75%)	(96%)	(97%)	(96%)	(96%)					
Gas	0.1	0.2	0.3	0.4	1.0	3.7	11.5	5.6	5.7	5.6
	(25%)	(4%)	(3%)	(4%)	(4%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**44.2**	**96.0**	**132.2**	**188.6**	**400.5**	**8.1**	**6.6**	**3.6**	**5.1**	**4.5**
Coal	11.1	17.6	20.4	38.0	109.8	4.8	3.0	6.4	7.3	7.0
	(25%)	(18%)	(15%)	(20%)	(27%)					
Oil	10.4	10.0	8.7	1.6	2.0	- 0.3	- 2.8	- 15.7	1.5	- 5.8
	(23%)	(10%)	(7%)	(1%)						
Gas	17.8	60.8	94.1	134.2	271.2	13.1	9.1	3.6	4.8	4.3
	(40%)	(63%)	(71%)	(71%)	(68%)					
Hydro	5.0	6.0	5.8	9.0	9.2	1.9	- 0.8	4.5	0.1	1.9
	(11%)	(6%)	(4%)	(5%)	(2%)					
NRE		1.5	3.2	5.8	8.3		15.8	6.1	2.4	3.9
		(2%)	(2%)	(3%)	(2%)					
Nuclear										

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)			**27,722**	**36,804**	**72,865**			**2.9**	**4.7**	**3.9**
Thermal			22 185	29 880	64 365			3.0	5.2	4.4
			(80%)	(81%)	(88%)					
Coal			2 770	6 197	17 900			8.4	7.3	7.7
			(10%)	(17%)	(25%)					
Oil			1 646	1 800	2 236			0.9	1.5	1.2
			(6%)	(5%)	(3%)					
Gas			17 769	21 883	44 229			2.1	4.8	3.7
			(64%)	(59%)	(61%)					
Hydro			3 476	3 424	3 500			- 0.2	0.1	0.0
			(13%)	(9%)	(5%)					
NRE			2 061	3 500	5 000			5.4	2.4	3.6
			(7%)	(10%)	(7%)					
Nuclear										

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	217	226	236	194	165	0.4	0.9	- 2.0	- 1.1	- 1.4
Primary Energy Supply per Capita (kgoe per capita)	809	1 237	1 598	1 896	3 088	4.3	5.3	1.7	3.3	2.7
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	152	157	162	135	113	0.3	0.6	- 1.8	- 1.2	- 1.4
Final Energy Demand per Capita (kgoe per capita)	567	858	1 094	1 325	2 114	4.2	5.0	1.9	3.2	2.7
CO_2 Emissions (million tonnes)	**82**	**157**	**206**	**255**	**425**	**6.7**	**5.5**	**2.1**	**3.5**	**2.9**
Sector										
Electricity and Heat Generation	27	53	69	97	222	7.0	5.5	3.5	5.7	4.8
Refineries and Other Energy Sector	5	15	20	23	24	12.6	6.2	1.3	0.4	0.8
Industry	14	31	43	45	45	8.1	7.2	0.3	0.1	0.2
Transport	28	45	58	67	91	4.9	5.0	1.5	2.1	1.9
Other	9	14	16	23	42	4.9	2.9	3.9	4.1	4.0
Fuel										
Coal	16	31	47	66	134	7.1	8.5	3.6	4.8	4.3
Oil	55	87	101	110	156	4.6	3.0	0.9	2.3	1.8
Gas	11	40	59	78	136	13.3	8.1	2.8	3.8	3.4
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	406	474	484	391	329	1.6	0.4	- 2.1	- 1.1	- 1.5
CO_2 Emissions per Capita (tonnes per capita)	1. 5	2. 6	3. 3	3. 8	6. 2	5.6	4.7	1.6	3.2	2.6

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	6.1	12.5		18.5	0.5	0.0	16.8			54.3
Net Imports	5.4	35.9	(2.8)	7.4			0.0	0.3	0.0	46.3
Primary Energy Supply	**11.5**	**48.3**	**(2.8)**	**25.9**	**0.5**	**0.0**	**16.8**	**0.3**	**0.0**	**100.6**
Transfers and Statistical Diff.	0.1	(3.2)	3.7	0.0			0.0	0.0	0.0	0.6
Electricity and Heat Gen.	(4.8)		(2.0)	(19.0)	(0.5)	0.0	(0.9)	11.4	0.0	(15.9)
Petroleum Refineries		(45.1)	42.5							(2.6)
Other Energy Sector	(0.0)		(2.6)	(5.1)			(4.8)	(1.3)	0.0	(13.8)
Final Energy Demand	**6.8**		**38.8**	**1.9**			**11.1**	**10.4**	**0.0**	**68.9**
Industry	6.8		4.1	1.6			5.4	4.9	0.0	22.7
Transport	0.0		22.0	0.0			0.0	0.0		22.1
Other	0.0		5.1	0.0			5.7	5.5	0.0	16.3
Non-Energy Use	0.0		7.6	0.3			0.0			7.8

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	7.0	6.0		20.0	0.8	0.0	16.3			50.1
Net Imports	9.6	49.0	(4.8)	14.4			5.1	2.7	0.0	76.0
Primary Energy Supply	**16.6**	**55.0**	**(4.8)**	**34.4**	**0.8**	**0.0**	**21.5**	**2.7**	**0.0**	**126.1**
Electricity and Heat Gen.	(8.8)		(0.4)	(26.6)	(0.8)	0.0	(1.3)	16.2	0.0	(21.5)
Petroleum Refineries		(55.0)	54.4							(0.6)
Other Energy Sector	(0.0)		(3.2)	(5.5)			(5.1)	(2.0)	0.0	(15.9)
Final Energy Demand	**7.8**		**46.0**	**2.3**			**15.1**	**16.9**	**0.0**	**88.1**
Industry	7.8		3.0	1.8			6.7	8.3	0.0	27.7
Transport	0.0		25.4	0.1			3.2	0.0		28.8
Other	0.0		7.5	0.0			5.1	8.5	0.0	21.1
Non-Energy Use	0.0		10.1	0.4			0.0			10.6

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	6.0	6.0		16.5	0.8	0.0	27.7			57.0
Net Imports	27.4	69.0	4.6	43.6			7.4	4.0	0.0	156.0
Primary Energy Supply	**33.4**	**75.0**	**4.6**	**60.1**	**0.8**	**0.0**	**35.2**	**4.0**	**0.0**	**213.0**
Electricity and Heat Gen.	(25.0)		(0.4)	(52.5)	(0.8)	0.0	(1.8)	34.4	0.0	(46.1)
Petroleum Refineries		(75.0)	74.3							(0.8)
Other Energy Sector	(0.0)		(4.4)	(4.5)			(7.4)	(3.9)	0.0	(20.3)
Final Energy Demand	**8.3**		**74.0**	**3.1**			**25.9**	**34.5**	**0.0**	**145.8**
Industry	8.3		2.4	1.9			12.1	18.7	0.0	43.4
Transport	0.0		34.8	0.1			8.8	0.0		43.8
Other	0.0		13.6	0.0			5.0	15.8	0.0	34.5
Non-Energy Use	0.0		23.2	1.0			0.0			24.2

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
120 - 174	0.6 - 0.9	0.1 - 0.2	0.5 - 0.7

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
21 - 31	58 - 82	32 - 50	8 - 11

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
41 - 59	27 - 39	2.6 - 3.3	50 - 72

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
50 - 72	22 - 30	20 - 32	7.2 - 9.6

UNITED STATES

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	7 971	11 018	12 416	14 887	22 674	3.3	2.4	1.8	2.8	2.4
Population (million)	250	282	297	324	359	1.2	1.0	0.9	0.7	0.8
GDP per Capita (2005 US$ PPP per capita)	31 866	39 012	41 813	45 977	63 209	2.0	1.4	1.0	2.1	1.7

ENERGY PROJECTIONS

	1990	2000	Mtoe 2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**1,649.4**	**1,675.3**	**1,629.9**	**1,728.6**	**2,019.3**	**0.2**	**- 0.5**	**0.6**	**1.0**	**0.9**
Coal	539.2	544.8	564.2	584.9	632.8	0.1	0.7	0.4	0.5	0.5
	(33%)	(33%)	(35%)	(34%)	(31%)					
Oil	432.5	365.6	322.5	292.5	375.8	- 1.7	- 2.5	- 1.0	1.7	0.6
	(26%)	(22%)	(20%)	(17%)	(19%)					
Gas	418.1	446.8	421.4	472.4	550.6	0.7	- 1.2	1.1	1.0	1.1
	(25%)	(27%)	(26%)	(27%)	(27%)					
Hydro	23.5	21.8	23.4	26.4	28.0	- 0.8	1.5	1.2	0.4	0.7
	(1%)	(1%)	(1%)	(2%)	(1%)					
NRE	76.7	88.3	87.0	134.9	196.6	1.4	- 0.3	4.5	2.5	3.3
	(5%)	(5%)	(5%)	(8%)	(10%)					
Nuclear	159.4	207.9	211.3	217.5	235.5	2.7	0.3	0.3	0.5	0.4
	(10%)	(12%)	(13%)	(13%)	(12%)					
Net Import	**276.9**	**627.3**	**712.0**	**743.7**	**621.3**	**8.5**	**2.6**	**0.4**	**- 1.2**	**- 0.5**
Coal	- 80.8	- 1.3	- 5.7	- 11.0	- 11.0	- 34.1	35.4	6.8	0.0	2.7
Oil	337.4	524.8	629.6	673.6	554.2	4.5	3.7	0.7	- 1.3	- 0.5
Gas	20.1	100.8	85.6	77.8	72.9	17.5	- 3.2	- 1.0	- 0.4	- 0.6
Electricity	0.2	2.9	2.1	3.3	5.2	32.8	- 6.1	4.5	3.1	3.6
Primary Energy Supply	**1,926.3**	**2,302.6**	**2,341.9**	**2,472.3**	**2,640.6**	**1.8**	**0.3**	**0.5**	**0.4**	**0.5**
Coal	458.4	543.6	558.5	573.9	621.8	1.7	0.5	0.3	0.54	0.4
	(24%)	(24%)	(24%)	(23%)	(24%)					
Oil	769.9	890.4	952.2	965.7	919.7	1.5	1.4	0.1	- 0.3	- 0.1
	(40%)	(39%)	(41%)	(39%)	(35%)					
Gas	438.2	547.6	507.1	550.2	623.4	2.3	- 1.5	0.8	0.8	0.8
	(23%)	(24%)	(22%)	(22%)	(24%)					
Hydro	23.5	21.8	23.4	26.4	28.0	- 0.8	1.5	1.2	0.4	0.7
	(1%)	(1%)	(1%)	(1%)	(1%)					
NRE	76.7	88.4	87.3	135.3	206.9	1.4	- 0.2	4.5	2.9	3.5
	(4%)	(4%)	(4%)	(5%)	(8%)					
Nuclear	159.4	207.9	211.3	217.5	235.5	2.7	0.3	0.3	0.5	0.4
	(8%)	(9%)	(9%)	(9%)	(9%)					
Input for Electricity and Heat Generation	**-749.6**	**-932.2**	**-956.9**	**-1,044.3**	**-1,202.2**	**2.2**	**0.5**	**0.9**	**0.9**	**0.9**
Coal	- 396.0	- 501.6	- 503.1	- 538.3	- 589.2	2.4	0.1	0.7	0.6	0.6
	(53%)	(54%)	(53%)	(52%)	(49%)					
Oil	- 27.2	- 29.6	- 33.3	- 21.7	- 20.2	0.8	2.4	- 4.2	- 0.5	- 2.0
	(4%)	(3%)	(3%)	(2%)	(2%)					
Gas	- 89.7	- 136.9	- 154.6	- 193.0	- 256.3	4.3	2.5	2.2	1.9	2.0
	(12%)	(15%)	(16%)	(18%)	(21%)					
Hydro	- 23.5	- 21.8	- 23.4	- 26.4	- 28.0	- 0.8	1.5	1.2	0.4	0.7
	(3%)	(2%)	(2%)	(3%)	(2%)					
NRE	- 53.7	- 34.5	- 31.2	- 47.3	- 72.9	- 4.3	- 2.0	4.3	2.9	3.5
	(7%)	(4%)	(3%)	(5%)	(6%)					
Nuclear	- 159.4	- 207.9	- 211.3	- 217.5	- 235.5	2.7	0.3	0.3	0.5	0.4
	(21%)	(22%)	(22%)	(21%)	(20%)					
Input for Refineries and Other Energy Sector	**-164.0**	**-156.0**	**-141.0**	**-160.2**	**-181.4**	**- 0.5**	**- 2.0**	**1.3**	**0.8**	**1.0**
Coal	- 15.3	- 14.9	- 8.6	- 9.0	- 9.7	- 0.2	- 10.6	0.56	0.5	0.5
Oil	- 55.8	- 45.5	- 39.4	- 49.4	- 49.4	- 2.0	- 2.9	2.3	0.0	0.9
Gas	- 43.5	- 44.9	- 40.7	- 45.7	- 53.2	0.3	- 1.9	1.1	1.0	1.1
NRE										
Electricity	- 49.1	- 48.2	- 49.7	- 54.4	- 68.2	- 0.2	0.6	0.9	1.5	1.3
Heat	- 0.3	- 2.5	- 2.7	- 1.7	- 0.8	24.8	2.0	- 4.8	- 4.5	- 4.6

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**1,305.3**	**1,564.3**	**1,591.9**	**1,685.0**	**1,753.7**	**1.8**	**0.4**	**0.6**	**0.3**	**0.4**
Coal	54.4	31.3	30.5	26.5	22.8	- 5.4	- 0.5	- 1.4	- 1.0	- 1.2
	(4%)	(2%)	(2%)	(2%)	(1%)					
Oil	696.4	812.7	865.4	894.6	850.0	1.6	1.3	0.3	- 0.3	- 0.1
	(53%)	(52%)	(54%)	(53%)	(48%)					
Gas	303.0	359.9	317.0	311.6	313.9	1.7	- 2.5	- 0.2	0.1	- 0.0
	(23%)	(23%)	(20%)	(18%)	(18%)					
NRE	22.9	54.1	56.1	88.0	134.0	9.0	0.7	4.6	2.8	3.5
	(2%)	(3%)	(4%)	(5%)	(8%)					
Electricity	226.5	300.9	319.5	362.4	431.9	2.9	1.2	1.3	1.2	1.2
	(17%)	(19%)	(20%)	(22%)	(25%)					
Heat	2.2	5.3	3.3	2.0	1.0	9.4	- 9.2	- 4.8	- 4.5	- 4.6
	(0%)	(0%)	(0%)	(0%)	(0%)					
Industry	**282.6**	**331.0**	**284.2**	**277.2**	**279.1**	**1.6**	**- 3.0**	**- 0.2**	**0.0**	**- 0.1**
Coal	44.8	29.1	28.0	25.0	21.8	- 4.2	- 0.7	- 1.1	- 0.9	- 1.0
	(16%)	(9%)	(10%)	(9%)	(8%)					
Oil	44.3	25.7	35.2	31.4	27.1	- 5.3	6.5	- 1.1	- 1.0	- 1.0
	(16%)	(8%)	(12%)	(11%)	(10%)					
Gas	109.9	137.9	107.0	99.9	94.1	2.3	- 5.0	- 0.7	- 0.4	- 0.5
	(39%)	(42%)	(38%)	(36%)	(34%)					
NRE	9.1	36.0	32.1	32.0	32.0	14.8	- 2.3	- 0.0	0.0	- 0.0
	(3%)	(11%)	(11%)	(12%)	(11%)					
Electricity	74.5	98.2	79.4	87.0	103.1	2.8	- 4.2	0.9	1.1	1.0
	(26%)	(30%)	(28%)	(31%)	(37%)					
Heat		4.2	2.6	2.0	1.0		- 9.2	- 2.5	- 4.5	- 3.7
		(1%)	(1%)	(1%)	(0%)					
Transportation	**500.7**	**607.5**	**646.0**	**701.6**	**689.9**	**2.0**	**1.2**	**0.8**	**- 0.1**	**0.3**
Coal										
Oil	484.9	588.8	623.1	646.6	588.4	2.0	1.1	0.4	- 0.6	- 0.2
	(97%)	(97%)	(96%)	(92%)	(85%)					
Gas	15.4	15.2	14.2	14.3	14.5	- 0.2	- 1.4	0.1	0.1	0.1
	(3%)	(2%)	(2%)	(2%)	(2%)					
NRE		3.2	8.1	40.0	86.0		20.4	17.4	5.2	9.9
		(1%)	(1%)	(6%)	(12%)					
Electricity	0.4	0.4	0.6	0.7	0.9	0.7	11.2	0.2	2.5	1.5
	(0%)	(0%)	(0%)	(0%)	(0%)					
Other	**403.1**	**472.7**	**501.7**	**526.4**	**574.8**	**1.6**	**1.2**	**0.5**	**0.6**	**0.5**
Coal	9.5	2.3	2.5	1.6	1.0	- 13.4	2.1	- 4.7	- 3.0	- 3.6
	(2%)	(0%)	(1%)	(0%)	(0%)					
Oil	62.1	62.7	61.7	52.6	42.3	0.1	- 0.3	- 1.6	- 1.4	- 1.5
	(15%)	(13%)	(12%)	(10%)	(7%)					
Gas	163.8	189.4	181.5	181.4	187.6	1.5	- 0.9	- 0.0	0.2	0.1
	(41%)	(40%)	(36%)	(34%)	(33%)					
NRE	13.9	15.0	15.9	16.0	16.0	0.8	1.3	0.0	0.0	0.0
	(3%)	(3%)	(3%)	(3%)	(3%)					
Electricity	151.6	202.3	239.5	274.8	327.9	2.9	3.4	1.4	1.2	1.3
	(38%)	(43%)	(48%)	(52%)	(57%)					
Heat	2.2	1.1	0.7			- 6.4	- 9.2			
	(1%)	(0%)	(0%)							
Non-Energy Use	**119.0**	**153.0**	**159.9**	**179.9**	**209.9**	**2.5**	**0.9**	**1.2**	**1.0**	**1.1**
Coal										
Oil	105.2	135.6	145.5	163.9	192.2	2.6	1.4	1.2	1.1	1.1
	(88%)	(89%)	(91%)	(91%)	(92%)					
Gas	13.9	17.4	14.4	15.9	17.7	2.3	- 3.8	1.0	0.7	0.8
	(12%)	(11%)	(9%)	(9%)	(8%)					
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**3,202.8**	**4,025.7**	**4,268.4**	**4,809.3**	**5,755.8**	**2.3**	**1.2**	**1.2**	**1.2**	**1.2**
Coal	1 699.6	2 129.5	2 154.0	2 284.3	2 529.5	2.3	0.2	0.6	0.7	0.6
	(53%)	(53%)	(50%)	(47%)	(44%)					
Oil	130.6	118.5	141.3	91.0	85.3	- 1.0	3.6	- 4.3	- 0.4	- 2.0
	(4%)	(3%)	(3%)	(2%)	(1%)					
Gas	381.7	634.3	782.8	1 012.9	1 433.2	5.2	4.3	2.6	2.3	2.4
	(12%)	(16%)	(18%)	(21%)	(25%)					
Hydro	273.2	253.2	272.4	307.1	325.9	- 0.8	1.5	1.2	0.4	0.7
	(9%)	(6%)	(6%)	(6%)	(6%)					
NRE	106.1	92.5	107.1	253.7	450.6	- 1.4	3.0	9.0	3.9	5.9
	(3%)	(2%)	(3%)	(5%)	(8%)					
Nuclear	611.6	797.7	810.7	860.2	931.3	2.7	0.3	0.6	0.5	0.6
	(19%)	(20%)	(19%)	(18%)	(16%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)	**765,977**	**848,129**	**1,047,440**	**1,136,454**	**1,369,718**	**1.0**	**4.3**	**0.8**	**1.3**	**1.1**
Thermal	571 006	649 450	840 021	870 095	1030 626	1.3	5.3	0.4	1.1	0.8
	(75%)	(77%)	(80%)	(77%)	(75%)					
Coal	332 311	338 768	338 185	357 214	390 211	0.2	- 0.0	0.5	0.6	0.6
	(43%)	(40%)	(32%)	(31%)	(28%)					
Oil	86 178	68 080	64 845	59 845	56 095	- 2.3	- 1.0	- 0.8	- 0.4	- 0.6
	(11%)	(8%)	(6%)	(5%)	(4%)					
Gas	152 517	242 602	436 991	453 035	584 320	4.8	12.5	0.4	1.7	1.2
	(20%)	(29%)	(42%)	(40%)	(43%)					
Hydro	72 791	76 946	77 354	79 542	84 418	0.6	0.1	0.3	0.4	0.4
	(10%)	(9%)	(7%)	(7%)	(6%)					
NRE	14 200	16 999	24 480	77 818	136 674	1.8	7.6	12.3	3.8	7.1
	(2%)	(2%)	(2%)	(7%)	(10%)					
Nuclear	107 980	104 734	105 585	109 000	118 000	- 0.3	0.2	0.3	0.5	0.4
	(14%)	(12%)	(10%)	(10%)	(9%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	242	209	189	166	116	- 1.4	- 2.0	- 1.3	- 2.3	- 1.9
Primary Energy Supply per Capita (kgoe per capita)	7 701	8 153	7 887	7 636	7 361	0.6	- 0.7	- 0.3	- 0.2	- 0.3
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	164	142	128	113	77	- 1.4	- 2.0	- 1.2	- 2.5	- 2.0
Final Energy Demand per Capita (kgoe per capita)	5 219	5 539	5 361	5 204	4 889	0.6	- 0.7	- 0.3	- 0.4	- 0.4
CO_2 Emissions (million tonnes)	**4,884**	**5,669**	**5,744**	**5,953**	**6,084**	**1.5**	**0.3**	**0.4**	**0.1**	**0.2**
Sector										
Electricity and Heat Generation	1 875	2 413	2 471	2 664	3 009	2.6	0.5	0.8	0.8	0.8
Refineries and Other Energy Sector	334	304	278	294	315	- 0.9	- 1.8	0.6	0.4	0.5
Industry	569	513	467	427	388	- 1.0	- 1.9	- 0.9	- 0.6	- 0.7
Transport	1 498	1 800	1 910	1 981	1 806	1.9	1.2	0.4	- 0.6	- 0.2
Other	607	639	619	587	567	0.5	- 0.6	- 0.5	- 0.2	- 0.3
Fuel										
Coal	1 863	2 191	2 169	2 295	2 487	1.6	- 0.2	0.6	0.5	0.5
Oil	2 050	2 272	2 430	2 429	2 204	1.0	1.4	- 0.0	- 0.6	- 0.4
Gas	971	1 206	1 145	1 229	1 393	2.2	- 1.0	0.7	0.8	0.8
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	613	515	463	400	268	- 1.7	- 2.1	- 1.4	- 2.6	- 2.2
CO_2 Emissions per Capita (tonnes per capita)	19. 5	20. 1	19. 3	18. 4	17.	0.3	- 0.7	- 0.5	- 0.5	- 0.5

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	564.2	322.5		421.4	23.4	211.3	87.0			1,629.9
Net Imports	(5.7)	589.1	40.6	85.6			0.3	2.1	0.0	712.0
Primary Energy Supply	**558.5**	**911.6**	**40.6**	**507.1**	**23.4**	**211.3**	**87.3**	**2.1**	**0.0**	**2,341.9**
Transfers and Statistical Diff.	(16.3)	(59.2)	45.1	5.3			0.0	0.0	0.0	(25.2)
Electricity and Heat Gen.	(503.1)		(33.3)	(154.6)	(23.4)	(211.3)	(31.2)	367.1	6.0	(583.8)
Petroleum Refineries		(852.4)	861.4							9.0
Other Energy Sector	(8.6)		(48.3)	(40.7)			0.0	(49.7)	(2.7)	(150.0)
Final Energy Demand	**30.5**		**865.4**	**317.0**			**56.1**	**319.5**	**3.3**	**1,591.9**
Industry	28.0		35.2	107.0			32.1	79.4	2.6	284.2
Transport	0.0		623.1	14.2			8.1	0.6		646.0
Other	2.5		61.7	181.5			15.9	239.5	0.7	501.7
Non-Energy Use	0.0		145.5	14.4			0.0			159.9

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	584.9	292.5		472.4	26.4	217.5	134.9			1,728.6
Net Imports	(11.0)	579.0	94.2	77.8			0.4	3.3	0.0	743.7
Primary Energy Supply	**573.9**	**871.5**	**94.2**	**550.2**	**26.4**	**217.5**	**135.3**	**3.3**	**0.0**	**2,472.3**
Electricity and Heat Gen.	(538.3)		(21.7)	(193.0)	(26.4)	(217.5)	(47.3)	413.5	3.7	(627.1)
Petroleum Refineries		(871.5)	871.5							0.0
Other Energy Sector	(9.0)		(49.4)	(45.7)			0.0	(54.4)	(1.7)	(160.2)
Final Energy Demand	**26.5**		**894.6**	**311.6**			**88.0**	**362.4**	**2.0**	**1,685.0**
Industry	25.0		31.4	99.9			32.0	87.0	2.0	277.2
Transport	0.0		646.6	14.3			40.0	0.7		701.6
Other	1.6		52.6	181.4			16.0	274.8	0.0	526.4
Non-Energy Use	0.0		163.9	15.9			0.0			179.9

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	632.8	375.8		550.6	28.0	235.5	196.6			2,019.3
Net Imports	(11.0)	495.7	48.2	72.9			10.3	5.2	0.0	621.3
Primary Energy Supply	**621.8**	**871.5**	**48.2**	**623.4**	**28.0**	**235.5**	**206.9**	**5.2**	**0.0**	**2,640.6**
Electricity and Heat Gen.	(589.2)		(20.2)	(256.3)	(28.0)	(235.5)	(72.9)	494.9	1.8	(705.4)
Petroleum Refineries		(871.5)	871.5							0.0
Other Energy Sector	(9.7)		(49.4)	(53.2)			0.0	(68.2)	(0.8)	(181.4)
Final Energy Demand	**22.8**		**850.0**	**313.9**			**134.0**	**431.9**	**1.0**	**1,753.7**
Industry	21.8		27.1	94.1			32.0	103.1	1.0	279.1
Transport	0.0		588.4	14.5			86.0	0.9		689.9
Other	1.0		42.3	187.6			16.0	327.9	0.0	574.8
Non-Energy Use	0.0		192.2	17.7			0.0			209.9

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
2822 - 3647	0.7 - 0.9	0.1 - 0.2	0.5 - 0.7

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
567 - 748	1378 - 1770	793 - 1026	85 - 103

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
714 - 907	354 - 492	171 - 227	1582 - 2020

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
1582 - 2020	947 - 1230	570 - 712	65 - 78

VIET NAM

MACRO ASSUMPTIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Macro Assumptions										
GDP (2005 billion US$ PPP)	60	124	178	325	798	7.6	7.5	6.2	6.2	6.2
Population (million)	66	78	83	96	110	1.6	1.4	1.5	0.9	1.1
GDP per Capita (2005 US$ PPP per capita)	902	1 597	2 143	3 386	7 229	5.9	6.1	4.7	5.2	5.0

ENERGY PROJECTIONS

	Mtoe 1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Production	**24.7**	**48.1**	**69.5**	**77.5**	**99.4**	**6.9**	**7.6**	**1.1**	**1.7**	**1.4**
Coal	2.6	6.5	18.1	28.3	38.6	9.6	22.8	4.5	2.1	3.1
	(11%)	(14%)	(26%)	(37%)	(39%)					
Oil	2.8	16.9	19.4	16.2	15.7	19.9	2.8	- 1.8	- 0.2	- 0.8
	(11%)	(35%)	(28%)	(21%)	(16%)					
Gas		1.1	6.2	10.2	14.8		40.8	5.1	2.5	3.5
		(2%)	(9%)	(13%)	(15%)					
Hydro	0.5	1.3	1.8	2.7	4.5	10.5	8.1	3.9	3.5	3.6
	(2%)	(3%)	(3%)	(3%)	(5%)					
NRE	18.9	22.4	24.0	20.1	18.0	1.7	1.4	- 1.7	- 0.7	- 1.1
	(76%)	(47%)	(34%)	(26%)	(18%)					
Nuclear					7.8					
					(8%)					
Net Import	**-0.4**	**-10.9**	**-18.2**	**-8.9**	**32.1**	**39.6**	**10.8**	**- 6.9**		
Coal	- 0.4	- 2.1	- 10.0	- 14.7	- 10.6	19.0	36.3	3.9	- 2.2	0.2
Oil		- 8.8	- 6.9	6.6	40.4		- 4.7		12.8	
Gas			- 1.3	- 1.6	0.2			1.9		
Electricity				0.7	2.1				7.8	
Primary Energy Supply	**24.3**	**37.2**	**51.3**	**68.6**	**131.5**	**4.3**	**6.7**	**2.9**	**4.4**	**3.8**
Coal	2.2	4.4	8.1	13.6	28.0	7.0	13.2	5.3	4.93	5.1
	(9%)	(12%)	(16%)	(20%)	(21%)					
Oil	2.7	8.0	12.5	22.1	55.5	11.4	9.1	5.9	6.3	6.2
	(11%)	(22%)	(24%)	(32%)	(42%)					
Gas		1.1	4.9	8.6	15.0		34.4	5.8	3.7	4.6
		(3%)	(10%)	(13%)	(11%)					
Hydro	0.5	1.3	1.8	2.7	4.5	10.5	8.1	3.9	3.5	3.6
	(2%)	(3%)	(4%)	(4%)	(3%)					
NRE	18.9	22.4	24.0	20.8	18.6	1.7	1.4	- 1.4	- 0.7	- 1.0
	(78%)	(60%)	(47%)	(30%)	(14%)					
Nuclear					7.8					
					(6%)					
Input for Electricity and Heat Generation	**-1.7**	**-4.8**	**-9.5**	**-16.9**	**-44.5**	**10.7**	**14.5**	**6.0**	**6.7**	**6.4**
Coal	- 0.9	- 1.2	- 2.1	- 5.2	- 15.9	2.6	13.1	9.3	7.8	8.4
	(51%)	(24%)	(23%)	(31%)	(36%)					
Oil	- 0.4	- 1.3	- 0.7	- 0.4	- 0.5	13.1	- 12.3	- 4.4	0.4	- 1.5
	(22%)	(27%)	(7%)	(3%)	(1%)					
Gas		- 1.1	- 4.8	- 8.5	- 14.8		34.3	5.9	3.8	4.6
		(23%)	(51%)	(50%)	(33%)					
Hydro	- 0.5	- 1.3	- 1.8	- 2.7	- 4.5	10.5	8.1	3.9	3.5	3.6
	(27%)	(26%)	(19%)	(16%)	(10%)					
NRE				- 0.1	- 1.0				19.0	
				(0%)	(2%)					
Nuclear					- 7.8					
					(17%)					
Input for Refineries and Other Energy Sector	**-0.8**	**-1.1**	**-1.5**	**-2.0**	**-3.3**	**3.2**	**5.2**	**3.3**	**3.3**	**3.3**
Coal										
Oil				- 0.2	- 0.3				1.9	
Gas										
NRE	- 0.6	- 0.8	- 0.8	- 0.7	- 0.6	2.4	1.4	- 1.4	- 1.1	- 1.2
Electricity	- 0.2	- 0.4	- 0.6	- 1.1	- 2.4	5.2	12.0	5.5	5.4	5.4
Heat										

ENERGY PROJECTIONS – continued

	Mtoe					Growth Rates (% per annum)				
	1990	2000	2005	2015	2030	90-00	00-05	05-15	15-30	05-30
Final Energy Demand	**22.5**	**33.5**	**45.2**	**57.9**	**104.0**	**4.1**	**6.1**	**2.5**	**4.0**	**3.4**
Coal	1.3	3.2	6.0	8.4	12.1	9.3	13.2	3.5	2.4	2.8
	(6%)	(10%)	(13%)	(15%)	(12%)					
Oil	2.4	6.8	12.0	21.5	54.7	11.1	12.2	6.0	6.4	6.3
	(10%)	(20%)	(27%)	(37%)	(53%)					
Gas			0.1	0.1	0.2		40.9	2.9	2.3	2.5
			(0%)	(0%)	(0%)					
NRE	18.3	21.6	23.1	20.0	17.0	1.7	1.4	- 1.4	- 1.1	- 1.2
	(81%)	(64%)	(51%)	(35%)	(16%)					
Electricity	0.5	1.9	4.0	7.9	20.0	13.7	15.5	7.1	6.4	6.7
	(2%)	(6%)	(9%)	(14%)	(19%)					
Heat										
Industry	**1.7**	**4.7**	**9.2**	**16.1**	**37.3**	**10.5**	**14.7**	**5.7**	**5.8**	**5.7**
Coal	1.0	2.3	4.8	6.8	9.5	8.6	15.4	3.5	2.3	2.8
	(60%)	(50%)	(52%)	(42%)	(26%)					
Oil	0.4	1.5	2.5	4.9	13.9	12.9	10.5	6.9	7.2	7.1
	(26%)	(33%)	(27%)	(30%)	(37%)					
Gas			0.1	0.1	0.2		40.9	2.9	2.3	2.5
			(1%)	(1%)	(1%)					
NRE										
Electricity	0.2	0.8	1.9	4.3	13.7	12.3	19.0	8.8	8.0	8.3
	(14%)	(17%)	(20%)	(27%)	(37%)					
Heat										
Transportation	**1.4**	**3.8**	**7.1**	**12.0**	**29.1**	**10.3**	**13.4**	**5.4**	**6.1**	**5.8**
Coal										
Oil	1.4	3.7	7.0	11.9	28.9	10.4	13.4	5.4	6.1	5.8
	(99%)	(99%)	(100%)	(99%)	(99%)					
Gas										
NRE										
Electricity				0.1	0.2	15.4	10.8	7.5	6.9	7.1
				(1%)	(1%)					
Other	**19.4**	**25.0**	**28.6**	**29.5**	**36.7**	**2.6**	**2.7**	**0.3**	**1.5**	**1.0**
Coal	0.3	0.9	1.2	1.7	2.5	11.8	6.6	3.3	2.8	3.0
	(2%)	(4%)	(4%)	(6%)	(7%)					
Oil	0.5	1.4	2.2	4.3	11.1	10.9	9.6	7.2	6.5	6.8
	(3%)	(5%)	(8%)	(15%)	(30%)					
Gas										
NRE	18.3	21.6	23.1	20.0	17.0	1.7	1.4	- 1.4	- 1.1	- 1.2
	(95%)	(86%)	(81%)	(68%)	(46%)					
Electricity	0.3	1.1	2.1	3.5	6.1	14.8	12.9	5.3	3.8	4.4
	(1%)	(5%)	(7%)	(12%)	(17%)					
Heat										
Non-Energy Use		**0.1**	**0.3**	**0.4**	**0.8**	**16.8**	**17.8**	**1.9**	**5.9**	**4.3**
Coal										
Oil		0.1	0.3	0.4	0.8	16.8	17.8	1.9	5.9	4.3
		(100%)	(100%)	(100%)	(100%)					
Gas										
NRE										
Electricity										
Heat										

ELECTRICITY GENERATION

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Electricity Generation (TWh)	**8.7**	**26.6**	**53.5**	**96.1**	**234.8**	**11.8**	**15.0**	**6.0**	**6.1**	**6.1**
Coal	2.0	3.1	8.9	23.1	73.4	4.6	23.3	9.9	8.0	8.8
	(23%)	(12%)	(17%)	(24%)	(31%)					
Oil	1.3	4.5	2.5	1.6	1.8	13.2	- 11.3	- 4.0	0.7	- 1.2
	(15%)	(17%)	(5%)	(2%)	(1%)					
Gas		4.4	20.6	39.0	74.2		36.4	6.6	4.4	5.3
		(16%)	(39%)	(41%)	(32%)					
Hydro	5.4	14.6	21.5	31.5	52.6	10.5	8.1	3.9	3.5	3.6
	(62%)	(55%)	(40%)	(33%)	(22%)					
NRE				0.9	3.0				8.6	
				(1%)	(1%)					
Nuclear					29.8					
					(13%)					

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Installed Generation Capacity (MW)			**11,323**	**20,946**	**46,420**			**6.3**	**5.4**	**5.8**
Thermal			6 949	12 595	26 500			6.1	5.1	5.5
			(61%)	(60%)	(57%)					
Coal			1 495	3 870	12 324			10.0	8.0	8.8
			(13%)	(18%)	(27%)					
Oil			1 194	1 875	2 071			4.6	0.7	2.2
			(11%)	(9%)	(4%)					
Gas			4 260	6 849	12 105			4.9	3.9	4.3
			(38%)	(33%)	(26%)					
Hydro			4 374	8 000	15 000			6.2	4.3	5.1
			(39%)	(38%)	(32%)					
NRE				351	920				6.6	
				(2%)	(2%)					
Nuclear					4 000					
					(9%)					

ENERGY INTENSITY AND CO_2 EMISSIONS

	1990	2000	2005	2015	2030	Growth Rates (% per annum) 90-00	00-05	05-15	15-30	05-30
Energy Intensity Based on Primary Energy Supply										
Primary Energy Supply per GDP (toe per 2005 US$ million PPP)	407	300	288	211	165	- 3.0	- 0.8	- 3.1	- 1.6	- 2.2
Primary Energy Supply per Capita (kgoe per capita)	367	479	617	714	1 191	2.7	5.2	1.5	3.5	2.7
Energy Intensity Based on Final Energy Demand										
Final Energy Demand per GDP (toe per 2005 US$ million PPP)	377	270	254	178	130	- 3.3	- 1.3	- 3.5	- 2.1	- 2.6
Final Energy Demand per Capita (kgoe per capita)	340	432	544	603	941	2.4	4.7	1.0	3.0	2.2
CO_2 Emissions (million tonnes)	**17**	**44**	**81**	**140**	**312**	**9.9**	**12.9**	**5.6**	**5.5**	**5.5**
Sector										
Electricity and Heat Generation	5	11	22	42	99	9.0	14.2	6.7	6.0	6.3
Refineries and Other Energy Sector										
Industry	5	14	27	42	82	9.9	14.0	4.6	4.4	4.5
Transport	4	11	21	36	86	9.9	13.2	5.4	6.1	5.8
Other	3	8	12	20	45	11.3	8.3	5.7	5.4	5.5
Fuel										
Coal	9	17	33	54	112	7.0	13.2	5.3	4.9	5.1
Oil	8	24	38	65	165	11.2	9.1	5.7	6.4	6.1
Gas		3	11	20	34		34.4	5.8	3.7	4.6
CO_2 Emissions Intensity										
CO_2 Emissions per GDP (tonnes per 2005 US$ million PPP)	290	358	457	430	390	2.1	5.0	- 0.6	- 0.6	- 0.6
CO_2 Emissions per Capita (tonnes per capita)	. 3	. 6	1.	1. 5	2. 8	8.1	11.4	4.0	4.5	4.3

ENERGY BALANCE TABLES

2005

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	18.1	19.4		6.2	1.8	0.0	24.0			69.5
Net Imports	(10.0)	(18.9)	12.0	(1.3)			0.0	0.0	0.0	(18.2)
Primary Energy Supply	**8.1**	**0.5**	**12.0**	**4.9**	**1.8**	**0.0**	**24.0**	**0.0**	**0.0**	**51.3**
Transfers and Statistical Diff.	0.0	(0.5)	0.7	0.0			0.0	0.0	0.0	0.2
Electricity and Heat Gen.	(2.1)		(0.7)	(4.8)	(1.8)	0.0	0.0	4.6	0.0	(4.9)
Petroleum Refineries		0.0	0.0							0.0
Other Energy Sector	0.0		0.0	0.0			(0.8)	(0.6)	0.0	(1.5)
Final Energy Demand	**6.0**		**12.0**	**0.1**			**23.1**	**4.0**	**0.0**	**45.2**
Industry	4.8		2.5	0.1			0.0	1.9	0.0	9.2
Transport	0.0		7.0	0.0			0.0	0.0		7.1
Other	1.2		2.2	0.0			23.1	2.1	0.0	28.6
Non-Energy Use	0.0		0.3	0.0			0.0			0.3

2015

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	28.3	16.2		10.2	2.7	0.0	20.1			77.5
Net Imports	(14.7)	(1.6)	7.5	(1.6)			0.7	0.7	0.0	(8.9)
Primary Energy Supply	**13.6**	**14.6**	**7.5**	**8.6**	**2.7**	**0.0**	**20.8**	**0.7**	**0.0**	**68.6**
Electricity and Heat Gen.	(5.2)		(0.4)	(8.5)	(2.7)	0.0	(0.1)	8.3	0.0	(8.6)
Petroleum Refineries		(14.6)	14.4							(0.2)
Other Energy Sector	0.0		0.0	0.0			(0.7)	(1.1)	0.0	(1.8)
Final Energy Demand	**8.4**		**21.5**	**0.1**			**20.0**	**7.9**	**0.0**	**57.9**
Industry	6.8		4.9	0.1			0.0	4.3	0.0	16.1
Transport	0.0		11.9	0.0			0.0	0.1		12.0
Other	1.7		4.3	0.0			20.0	3.5	0.0	29.5
Non-Energy Use	0.0		0.4	0.0			0.0			0.4

2030

Units: Mtoe	Coal	Crude Oil	Petrol. Prod.	Gas	Hydro	Nuclear	NRE	Electricity	Heat	Total
Production	38.6	15.7		14.8	4.5	7.8	18.0			99.4
Net Imports	(10.6)	3.7	36.1	0.2			0.6	2.1	0.0	32.1
Primary Energy Supply	**28.0**	**19.4**	**36.1**	**15.0**	**4.5**	**7.8**	**18.6**	**2.1**	**0.0**	**131.5**
Electricity and Heat Gen.	(15.9)		(0.5)	(14.8)	(4.5)	(7.8)	(1.0)	20.2	0.0	(24.3)
Petroleum Refineries		(19.4)	19.1							(0.3)
Other Energy Sector	0.0		0.0	0.0			(0.6)	(2.4)	0.0	(3.0)
Final Energy Demand	**12.1**		**54.7**	**0.2**			**17.0**	**20.0**	**0.0**	**104.0**
Industry	9.5		13.9	0.2			0.0	13.7	0.0	37.3
Transport	0.0		28.9	0.0			0.0	0.2		29.1
Other	2.5		11.1	0.0			17.0	6.1	0.0	36.7
Non-Energy Use	0.0		0.8	0.0			0.0			0.8

ENERGY INVESTMENT REQUIREMENTS

Total Investment	Energy Investment	Production Investment	Supply Chain Investment
billion USD 2006	*Share of GDP, percent*	*Share of GDP, percent*	*Share of GDP, percent*
126 - 175	1.1 - 1.6	0.2 - 0.3	0.9 - 1.3

Extraction	Transformation	Transportation	Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
23 - 32	58 - 73	37.0 - 58.7	8 - 11

Crude Oil and Petroleum Products	Natural Gas	Coal	Electricity and Heat
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
15 - 22	13 - 16	7.2 - 9.2	91 - 127

Electricity and Heat Total	Electricity and Heat Generation	Electricity Transmission	Electricity and Heat Distribution
billion USD 2006	*billion USD 2006*	*billion USD 2006*	*billion USD 2006*
91 - 127	49 - 60	35 - 56	7 - 11

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APEC # 209-RE-01.6 ISBN 978-4-931482-42-5