Prospects for coal and clean coal technologies in the Philippines

John Kessels and Paul Baruya

CCC/217 ISBN 978-92-9029-537-2

March 2013

copyright © IEA Clean Coal Centre

Abstract

This report examines the current energy outlook for the Philippines in regard not only to coal but also other energy resources. The history of the power sector, current state of play and future plans to meet the increasing energy demand from a growing population are discussed. There is also analysis of the trends for coal demand and production, imports and exports of coal and the types of coal-fired power stations that have been built. This includes examination of the legislation involving coal and the promotion of clean coal technologies.

Acknowledgments

The information within this report has been gathered from several sources. The authors would like to thank several experts that made time to meet them and answer questions about the Philippines coal and energy sector. This includes government officials and members of the Philippine Chamber of Coal Mines (Philcoal). The authors would like to thank the valuable input and the contributions that were made through meetings and discussions with the individuals who are listed below:

Cito Gazo	CRL Energy Ltd, New Zealand
Ismael U Ocampo	Director of Energy Resource Development Bureau, Department of Energy, The Philippines
Arunlfo A Robles	Executive Director of Philippine Chamber of Coal Mines, The Philippines
Bobby M Calanog	The Philippines
Benjamin Austria	Philippines World Energy Council Committee, The Philippines

Acronyms and abbreviations

ADB	Asian Development Bank
AFBC	atmospheric fluidised bed combustion
APEC	Asia Pacific Economic Cooperation
APS	alternative policy scenario
ARMM	Autonomous Region of Muslim Mindanao
ASEAN	Association of Southeast Asian Nations
BAU	business as usual
bcm	billion cubic metres
BFOE	barrels fuel oil equivalent
BGR	German Geoscience Association
BIM	Business Insight Malaya
CAR	Cordillera Administrative Region
CCGT	combined gas cycle technology
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reduction (for CDM)
CFBC	circulating fluidised bed combustion
CFBC	circulating fluid bed combustion
CH4	methane
CHP	Combined heat and power
CIA	Central Intelligence Agency
CO	carbon monoxide
CO_2	carbon dioxide
COR	Cordillera Administrative Region
CPI	Corruption Perceptions Index
CTF	Clean Technology Investment Fund
DOE	Department of Energy
EC	European Commission
EEA	Energy and Environment analysis
EEAS	European Union External Action Service
EIA	Energy Information Agency
EIU	European Intelligence Unit
EO	Executive Order
EPIRA	Electric Power Industry Reform Act
ERC	Energy Regulatory Commission
ESP	electrostatic precipitators
EU-ETS	European Union Emissions Trading Scheme
EU	European Union
EUA	European Union Allowance (for EU-ETS)
FBC	fluidised bed combustion
FCO	Foreign and Commonwealth Office
FGD	flue gas desulphurisation
FIT	feed-in tariff
GCRDD	Geothermal and Coal Resources Development Division
GDP	Gross Domestic Product
GEF	global environment facility
GHG	greenhouse gases
Gt	gigatonne
GWh	gigawatt hour
HAP	hazardous air pollutants

HFCs	hydrofluorocarbons
IEA	International Energy Agency
IEE	Institute of Energy Economics
IMF	International Monetary Fund
IPP	independent power producer
KP	Kyoto Protocol
LHV	lower heating value
LNG	liquified natural gas
Meralco	Manila Electric Railroad and Light Company
MILF	Moro-Islamic Liberation Front
MMDA	Metropolitan Manila Development Authority
Mt	million tonnes
$MtCO_2$	million tonnes of CO_2
$MtCO_2$-e	million tonnes of CO_2 equivalent
Mtoe	million tonnes oil equivalent
MWe	megawatt electrical
N_2O	nitrous oxide
NAAQGV	National Ambient Air Quality Guideline Values
NEECP	National Energy Efficiency and Conservation Programme
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGO	non-governmental organisation
NPA	New People's Army
NPC	National Power Corporation
NREB	National Renewable Energy Board
NREL	National Renewable Energy Laboratory
NREP	National Renewable Energy Programme
PC	pulverised coal fired boilers
PD	Presidential Decree
PDOE	Philippine Department of Energy
PDR	People's Democratic Republic
PECR	Philippine Energy Contracting Round
PEDC	Panay Energy Development Corporation
PEP	Philippine Energy Plan
PFBC	pressurised fluidised bed combustion
PHILPRA	Philippine Petroleum Resource Assessment
PHP	Philippine Peso
PNOC-EC	Philippine National Oil Company Exploration Corporation
PPA	power purchase agreement
PSALM	Power Sector Assets and Liabilities Management Corporation
R&D	Research and Development
RE	renewable energy
RPS	renewable portfolio standard
SCPC	Sem-Calaca Power Corporation
SF_6	sulphur hexafluoride
SO_2	sulphur dioxide
tCO_2	tonnes of CO_2
tCO_2-e	tonnes of CO_2 equivalent
TPES	Total Primary Energy Supply
TSP	total suspended particulates
TWh	terawatt hour
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
USAID	United States Agency for International Development
USGS	United States Geological Survey

WB	World Bank
WEC	World Energy Council
WHO	World Health Organisation

Contents

1 Introduction

1.1 Country overview

Philippine population	*94 million (2010 est)*
Capital:	*Manila*
Currency: Philippine peso (rate to US)	*40-48 Pesos (2007-12)*
Total coal production (2010 estimate):	*7.3 Mt*
Total coal demand (2010 estimate):	*12.5 Mt*
Imports (2010 estimate):	*11 Mt*
Proven reserves (2010 estimate)	*316 Mt*

This report on the use and prospects for coal in the Philippines is part of a series examining coal and clean coal technology prospects in the *Association of Southeast Asian Nations* (ASEAN). The analysis draws on the published literature about the use of coal in the Philippines as well as a series of meetings with several of the companies and government officials involved in the development of coal within the Philippines. These included meetings with experts from the Philippines mining and power sector and government institutions involved in the regulation of the coal sector.

The Philippines is a tropical archipelago made up of about 7107 islands with a land area of 300,000 km² stretching over an area of 800,000 km² (EEAS, 2007). The country is split geographically into three island groups, Luzon (northern),Visyas (central and Palawan), and Mindanao (southern), *see* Figure 1. The Philippines are surrounded by the South China Sea to the north, and the Philippine Sea to the east. The capital Manila is located on the northern most group, Luzon. Much of the country is mountainous and the region is geologically active with 20 active volcanoes.

A major issue in the Philippines is the increasing energy demand coupled with a population growing at an annual rate of 2.3%. Electricity shortages remain a major problem. However, the government programme for energy development places more focus on renewable energy. Whether this will satisfy the growing demand for reliable electricity is questionable.

In 2005, the population was estimated at 81 million and by 2011 some estimates put it at around 101 million (European Commission, 2009; CIA, 2011). According to the Philippines Embassy in London the latest official estimate puts the population at 94 million in 2010, spread over 80 provinces. The population is more than 80% Roman Catholic, with a further 10% comprising other Christian denominations. Manila, the capital, is one of the world's 'megacities' with a population of 12 million, and one of the most densely populated cities on earth. There are two official languages in the Philippines, Filipino based on Tagalog and English (CIA, 2011).

The population is one of the fastest growing in Asia, and the resulting demand for energy and resources puts pressure on land, water, and food. Environmental issues such as deforestation are major problems; forested areas cover just 19% of the country's land area. Further to environmental land problems, 30 million people do not have access to potable water and water demand is expected to double. Other issues include soil degradation and loss of coral reefs and mangroves. Exacerbating the environmental issues, which need to be urgently addressed, is the lack of enforcement of environmental regulations (European Commission, 2009).

1.2 Constitutional background

Modern Philippines is a democratic republic with a presidential system. The Philippines became independent from the USA in 1946 after the Second World War through the Treaty of Manila. Prior to

Figure 1 Map of the Philippines

the Second World War the USA had been in the process of granting full independence to the Philippines. The USA supported the Philippine Revolution in 1896 against Spain, who had ruled since 1565. Although a proclamation of independence was declared in 1899 by the First Philippine Republic Government it was not recognised by the Treaty of Paris and sovereignty was ceded to the United States. As a result, a further Philippine-American war took place until 1902 at which time the USA took control of the Philippines.

The Philippines is a multiparty democracy modelled after the USA. The 1987 Constitution

reestablished a presidential system of government with a bicameral legislature and an independent judiciary. There are three branches with the executive being the President and the cabinet. The legislature is a two chamber Congress. There is a Senate or upper house with 24 members, and a lower house or House of Representatives that has 285 members of which 80% are directly elected and the remainder are selected from party lists. Senators have six-year terms and Representatives have three-year terms with a maximum of three consecutive terms.

The Philippine legislature is made up of wealthy families including the Aquinos and Cojuangcos of Tarlac, the Osmeñas of Cebu, the Romualdezes of Leyte, and the Marcoses of Ilocos Norte with some families having been represented for four generations. Once elected it is common for representatives to appoint family members in positions of power. As a result, these political dynasties with their clan networks maintain power and control (Chua and others, 2004).

Just ten families control 56% of the country's stock market listed corporate assets. This may be partly due to the lack of participation by the general population as shareholders since many are in poverty. Shareholding or shareholding pensions may not be possible for many in the country. The wealthy families also control the political system making it a family business. Many of these families have been represented in Parliament as senators or congressman for generations. This state of affairs is unlikely to change.

According to a World Bank report one of the major problems in the Philippines is corruption, reflected at a sector and agency level. Preferential treatment is practised through the appointments of officials who themselves appoint preferred individuals in decision making. Although in recent years there have been improvements with more oversight by the legislature, judiciary and new laws, corruption remains widespread. The World Bank suggested several remedies including giving officials less discretion in awarding contracts, budget allocation rules, improved public access to information, publicising trials of officials involved in corruption and improving the powers of oversight bodies (World Bank, 2009b).

The last elections were in 2010 in which Benigno Aquino III was elected president for six years. The next elections for the House of Representatives and half of the Senate are due to take place in 2013. The President's Liberal Party does not have a majority in either the House of Representatives or the Senate (EIU, 2012). The judiciary is made up of the Supreme Court, Court of Appeals and the trial courts. National political parties are supported at the local level. The Philippines is divided into 15 administrative regions. The political subdivisions of the nation state are:

- 80 provinces;
- 122 cities;
- 42,000 barangays.

A barangay is the smallest political division in the Philippines and in Filipino can be a village, ward or district. These political subdivisions are guaranteed by the Philippines Constitution. There are also several units that were created to manage specific areas and they are:

- Metropolitan Manila Development Authority (MMDA);
- Autonomous Region of Muslim Mindanao (ARMM);
- Cordillera Administrative Region (CAR).

The MMDA is the metropolitan government for Manila and covers eight cities and nine municipalities. The ARMM is a regional government in the Muslim Region of Southern Mindanao while the CAR is a special region for the highlanders in Northern Luzon and Cordillera.

Until 1986 the Philippines was relatively politically stable under President Marcos. Since 1986 there has been political turmoil with several coups. Terrorism is also a major problem with the *New People's Army* (NPA) waging a war over the last 40 years to establish a Maoist state. In addition, there is the Moro-Islamic Liberation Front (MILF), another terrorist group which also creates an unstable political environment, especially in the south of the Philippines on Mindanao.

1.3 Economic background

Historically, there were expectations of the Philippines becoming an advanced ASEAN economy. In the 1950s and 1960s, the Philippines had the highest per capita gross domestic product in the region. However, that growth did not continue and the economy can be characterised with several boom and bust cycles.

Between 1965 and 1983 there was political unrest, economic turmoil and several natural disasters which resulted in a substantial downturn in the economy (IMF, 2011). Coupled with the above problems there are also internal armed conflicts between communist and separatist Islamic guerrilla movements. A resolution to these conflicts would be beneficial for the Filipino people and reduce poverty by enabling more development in these areas (EEAS, 2007).

Today, the Philippines is one of ASEAN's less advanced economies. Despite it being an open and growing economy there is relatively low investment in comparison with other Asian economies in the region. There are three major sectors driving the economy: agriculture, industry and the service sectors. According to the European Union External Action Service (EEAS) the Philippines is classified as a lower middle-income country with a high rate of poverty.

Economic growth is modest by the standards of the industrialising Asian nations, and far behind countries such as China. The average economic growth of around 4% is enviable by OECD standards, but for the region, is fairly modest and has not kept pace with the rise in population (EEAS, 2007). In 2010, economic growth achieved a more creditable 7.6% due to consumer demand, a rebound in exports and investment, and government related spending, before falling back to 3.7% in 2011.

The Philippines managed to avoid the worst of the current global economic crisis by being less exposed to troubled international securities. The economy has a low dependence on exports, and a stronger dependence on domestic consumption. Based on purchasing power parity, GDP is estimated at almost $ 390 billion in 2011, considerably smaller than Thailand at $601 billion and Indonesia at $1.1 trillion (CIA, 2012). The service sector is strong, accounting for 54% of the nation's GDP, with 33% coming from industry and 13% from agriculture.

The average GDP per capita in the Philippines is approximately US$ 2000. Roughly 33% of the population is below the poverty line and 13% are living on less than US$ 1 a day. There is also substantial inequality with the wealthiest 20% of Filipino's receiving more that half of the national income and the poorest 20% only one twentieth (ADB, 2007a).

A key problem is weak governance which fails to result in sustained growth or any real progress towards poverty reduction (World Bank, 2009a). Tax collection is not strongly enforced, and so government funding for infrastructure is dependent on a smaller proportion of the economy. Politically, strengthening tax collection is sensitive. While poverty is rife, improving tax collection could itself weaken domestic consumption as household and business incomes are reduced, while those in poverty may need to shoulder some fiscal burden.

A mainstay of the Philippines economy is from cash-based remittances from overseas Filipino workers. According to a World Bank report in 2007, around 8.7 million Filipinos or 10% of the total population were working overseas and sending back annual remittances reaching US$14.4 billion, or over 10% of the country's GDP (World Bank, 2009). According to the Philippines embassy in London in 2010 this increased to almost US$19 billion. These remittances make a major impact in supporting the domestic economy and consumer spending.

Electricity prices are high in the Philippines. A study of power tariffs in ten Southeast Asian cities found businesses in Manila were paying 20–80% higher tariffs than the other nine cities in the region (Leung and Viseth, 2003).

2 Energy policy

The main focus on energy policy in the Philippines is achieving energy independence while enacting power market reforms. The key elements of the long term policy are increasing indigenous oil and gas reserves, developing renewable energy resources, increasing the use of alternative fuels (CNG for transport) and promoting a strong energy efficiency and conservation programme.

There are several public and private sector institutions that influence and regulate the energy sector. These have a direct impact on the development of coal resources and clean coal technologies. The key organisation is the *Department of Energy* (DOE) which defines the energy policy of the Philippines. The blueprint for planning the future is the *Philippine Energy Plan* (PEP) which outlines the plans and programmes of the energy sector in order to maintain the economic growth of the country for the period 2009-30.

The Philippines is facing a major challenge to increase its electricity supply to meet growing energy demand. The PEP has three key policy elements to help achieve this goal over the next twenty years:
1 Ensuring energy security.
2 Pursuing effective implementation of energy sector reforms.
3 Implementing social mobilisation and cross-sectoring monitoring mechanisms (DOE, 2011).

The Philippines' 20-year energy plan for the period to 2030 aims to ensure national energy security by making more use of the country's indigenous resources. This is being carried out by the encouragement of renewable energy, energy efficiency and identification of new fossil fuel reserves. The PEP has ambitious production targets for oil, gas and coal production which is expected to expand the fastest, with local coal production rising by 250% over a 20-year period.

An ambitious energy plan is needed to respond to blackouts in some parts of the Philippines. In particular, the island of Mindanao annually has rotational blackouts in summer of between three and six hours daily. The blackouts are due to a lack of power supply. The available power capacity in Mindanao is just 1180 MWe while peak demand is around 1300 MWe. There are several reasons for the lack of capacity including the sale of two power barges and the reduction of the available and actual capacity of the Pulangi power plants due to silt and the dilapidated state of the Agus hydroelectric plant turbines that need repair. In 2015 an additional 500 MWe of coal-fired power generation will begin operation (Asian Correspondent, 2012).

The policies of achieving power market reform have been under way for decades with varying degrees of success. The key legislation was the introduction of the 2001 *Electric Power Industry Reform Act* (EPIRA): The goal of the legislation was to promote better competition and efficiency by removing the state owned generator National Power Corporation's monopoly in generation (*see below*).

While it is important that the Philippines is able to deliver electricity to the rapidly expanding economy, one of the priorities remains the expansion of renewable-energy production, with installed capacity expected to reach 8637 MWe by 2030. Hydropower is expected to account for the bulk of this, while geothermal capacity is expected to reach 3447 MWe by 2030. The plan also aims to promote the use of alternative fuels, with bioethanol and biodiesel blends expected to account for 20% of total petrol and diesel demand by the end of the 20-year period (DOE, 2012).

2.1 Coal policy

The Presidential Decree No 972 of the Coal Development Act of 1976 aims to expand exploration and development of coal production and consumption. Coal mines would come under an operating

contract scheme, not too dissimilar to that in Indonesia, which also maintains a certain degree of autonomy for producers but with the rights issued by the Government.

Coal production also falls under a number of contractual and environmental regulations. The contract system encourages avoidance of pollution to air, ground and water, maximising cost effectiveness and ensuring health and safety measures are practised. Environmental Impact Assessments must also be carried out under the Environmental Policy Act of 1997 (PD 1151), which applies to mines, power plants and industrial users.

The Philippines appears to take environmental solutions seriously regarding the combustion of coal for power generation. Under the Environment code (PD 1152), tax exemptions are provided for the purchase and expenses associated with pollution control equipment, spare parts, devices and accessories. The Clean Air Act of 1999 (RA 8749) s19(2) requires all coal-fired power stations and industrial users of coal to mitigate SOx and NOx emissions, as well as ensure minimal CO_2 emissions. While the latter is more dependent on ensuring high efficiency and the deployment of the cleanest technology that is practicable, the DENR Administrative Order 14, s60(2) requires the sulphur content of the coal to not exceed 1%, unless appropriate emission control equipment is installed.

2.2 Electricity market policy

The Philippines power sector was conceived in the late 1880s by a private power company, La Electricista, supplying electricity to residential customers and street lighting in Manila. In the early 1900s, a distribution company *Manila Electric Railroad and Light Company* (Meralco) emerged supplying Manila, 30 other cities and 80 municipalities, which later merged with La Electricista.

By 1936, the National Power Corporation (NPC, now known as Napocor) was created, as part of a nationalisation plan of hydroelectric power and all potential hydro resources in the country. By 1960, the company moved from being a non-stock public corporation to a stock corporation, but wholly state-owned. By 1978, the NPC was authorised to operate as a monopoly, absorbing Meralco generating plant, and keeping the distribution companies.

The legislation that began the deregulation of the power sector was Executive Order 215 (EO 215) which in 1987 allowed private investors the option to build and operate power plants and sell the power to NPC. The motivation behind the legislation was blackouts in 1986 and the mothballing of a 625 MWe nuclear power plant which was to have been commissioned in 1985. The plant, a light-water reactor at Bataan, was built in response to the 1970s energy crisis. The plant was nearly completed but never fuelled. An international group of inspectors found the plant to be unsafe due to volcanic and earthquake risk. The Government responded by putting in place a constitutional ban on all nuclear power and mothballing the plant (Rein and Cruz, 2011).

The ending of the monopoly of NPC (in the generating sector) and lack of nuclear power resulted in a large gap between supply and demand in 1989-92. In response, the Government fast tracked 33 power projects between 1991 and 1998 with independent power producers (IPPs). As a result, by 1999 50% of total installed capacity was built and/or operated by IPPs (Ramesh and Howlett, 2006).

By 2001, the *Electric Power Industry Reform Act* (EPIRA) ensured 70% of NPC generating capacity in Luzon and the Visayas islands was developed by private companies. It also led to private sector participation in hydropower and geothermal energy but recognised energy security as a major theme of Philippines energy policy by promoting indigenous energy resources (USAID, 2007).

Supply-side constraints regarding electricity supply still blight many parts of the country. For example, the Mindanao power grid operates with a narrow reserve margin, even when hydropower is plentiful. The Luzon and Visayas grids are also exhibiting increasing signs of stress. One option to

increase electricity supply is to increase coal-fired power plant utilisation from the current 50% to 75%. This could add an additional 14% power to national generation. However, the growth in electricity demand is spread widely across many islands, and so increased utilisation of capacity in one region may not be sufficient to serve the needs of another region.

As a result of EPIRA 2001, the power sector has been restructured and the power-generation and power-transmission assets formerly owned by the government have been privatised. In 2008 the Senate approved a 25-year franchise contract to run National Power Corporation's transmission system, Transco. The franchise was awarded to the National Grid Corporation, a consortium of two Philippine companies and the State Grid of China. At the same time a key condition of the EPIRA – the introduction of open access and retail competition in the electricity market – was met as a result of the sale of two more power plants by the state-owned *P*ower Sector Assets and Liabilities Management Corporation (PSALM).

Satisfying the other condition of the reform act – the privatisation of at least 70% of the generating capacity came closer in April 2010 when PSALM sold the government's 1200 MWe contracted capacity in the Ilijan natural-gas-fired power plant in Batangas, to a subsidiary of one of the country's largest conglomerates, San Miguel. The sale of the first IPP contracts occurred in August 2009, with a San Miguel subsidiary winning the 1000 MWe contracted capacity of the Sual coal-fired plant and a subsidiary of the Aboitiz group, Therma Luzon, gaining the 700 MWe contracted capacity of the coal-fired Pagbilao plant.

By December 2010 another San Miguel subsidiary won the 345 MWe contracted capacity of the San Roque hydro plant, while Amlan Power won the 70 MWe Bakun and 30 MWe Benguet hydro plants, which were auctioned as a single package. The 70% target was almost achieved with the sale of the Ilijan contract, with 68% of the generating capacity that IPPs in Luzon and the Visayas are contracted to provide to the government now in private hands. However, the privatisation of two more IPP contracts, covering the 640 MWe contracted capacity of geothermal plants in Leyte province and the 110 MWe contracted capacity of coal- and diesel-fired plants in Cebu, were postponed in July-August 2010.

2.3 Climate change policy

The Philippines ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and the Kyoto Protocol in 2003 (USAID, 2007). The country is not a major contributor to global greenhouse gas emissions although this may change in the future with its growing population. As a signatory to the UNFCCC the Philippines is required to publish a National Communication or report on how it is going to achieve its obligations under the Convention. The national communications contain information on emissions and removal of greenhouse gases and details of the adaptation or mitigation activities a Party has undertaken to implement the Convention. The Philippines to date has published one national communication that was submitted in 2000, and at the time of writing, is finalising its second national communication.

In 2009, the Government enacted into law the Climate Change Act. A key requirement was the development and enactment of a National Framework Strategy on Climate Change. This was completed in 2010. The Strategy examined climate change impacts and vulnerabilities with a focus on adaptation and mitigation. The goal of the strategy is:

'*To build the adaptive capacity of communities and increase the resilience of natural ecosystems to climate change and optimize mitigation opportunities towards sustainable development*'.

The Government, as a signatory of the Kyoto Protocol, also encourages the use of the Clean Development Mechanism (CDM). There are approximately 23 CDM projects registered with the

CDM Executive Board and several more in the pipeline. The type of projects include agricultural waste as well as others that promote renewable energy. The total estimated reduction of CO_2e per annum is around 1 Mt. The Philippines currently emits 80 Mt of CO_2-e per annum excluding land-use changes (Esguerra and others, 2010).

2.4 Clean technology investment fund

Alongside the doubling of renewable capacity, the Government's long-term Energy Plan for 2009-30 could see indigenous coal production rise by 250%, and reduce gasoline and diesel imports by 20% by substituting with biofuels. To achieve these goals the Philippine Government received financial support from the *Clean Technology Investment Fund* (CTF) operated by several multilateral institutions including the Asian Development Bank.

The Philippines has ambitious plans to become the number one geothermal energy producer in the world, number one wind producer in Southeast Asia, double hydropower capacity with an additional 3GW, become the number one manufacturer of solar cells in Southeast Asia and finally to increase new contributions from ocean energy, solar and biomass by 100 MW. It is unclear to the authors how all of these goals can be achieved without major economic investment.

2.5 Energy efficiency policy

The Philippines Department of Energy manages the Philippine National Energy Efficiency and Conservation Programme (NEECP). The NEECP promotes energy conservation and energy efficient technology to effect higher energy savings for the consumer and producer. This is implemented through information, education and communication campaigns; collaboration with the private sector in implementing energy efficiency programmes through voluntary agreements; appliance and equipment energy standards and labelling implementation of building energy usage standards; integration of energy efficiency concepts in the procurement practices of the government; the provision of technical assistance in identifying, implementing and evaluating effective measures to improve energy use efficiency and the use of alternative fuel to reduce dependence on imported oil (DOE, 2011).

2.6 Comments

The Philippines faces a major challenge to secure a long-term sustainable energy supply to an ever increasing population demanding more electricity. The energy, coal and electricity market, climate change and energy efficiency policy are ongoing. The key policy is the Philippines Energy Plan (PEP) a blueprint for the energy sector up to 2030 with goals of achieving energy security through use of indigenous energy resources and energy sector reforms. The privatisation of the electricity sector in the Philippines is still an ongoing process. Since the 2001 *Electric Power Industry Reform Act* (EPIRA) there have been some setbacks in the privatisation process and currently around 73% of the generation sector is privatised.

Electricity prices are amongst the highest in South East Asia and likely to remain high and even increase if the government is to achieve several of its PEP aims, such as increasing renewable energy. Major economic investment is required in the energy sector and the clean technology investment fund will assist in this but more investment will be needed to achieve the ambitious goals the government has set, such as to double the current renewable energy capacity from 4500 MWe to 9000 MWe by 2030.

The Government has put in place legislation for market reform of the electricity sector as well as

encouraging clean coal technologies. The legislation for coal-fired power stations is strong with Environmental Impact Assessments required on all new stations. The government also supports pollution control technologies with tax exemptions and implemented the Climate Change Act of 2009, a key requirement of which was development and enactment of a National Framework Strategy on Climate Change.

3 Primary energy demand

Primary energy demand in the Philippines has averaged 55.7 Mtce (39 Mtoe) since 2001 and has shown almost no growth in eight years. Primary energy consumption was most dynamic in the period 1970-2000, seeing the emergence of geothermal power and coal power. This does not mean certain sectors of the energy economy are seeing no growth prospects. Figure 2 shows how natural gas has emerged as a major energy source since 2000.

In 2009, coal accounted for 15% of the country's primary energy supply, equivalent to 8454 Mtce (5918 Mtoe). Oil product consumption peaked in the late 1990s, but has since subsided, being displaced by coal with the building of new large power stations. Diesel/gas oil is still used as back-up fuel in power generation (9% of national consumption), but approximately 60% of oil products are consumed in the transportation sector (IEA, 2012).

Oil is still used widely across all sectors, contributing some 20–25% of the primary energy in the industrial, residential and commercial sector use in 2009. Unsurprisingly, oil contributes 98% of transportation fuels. Unless there is a major oil find in the Philippines it is likely that the country will increasingly rely on imports.

Renewable energy forms a significant proportion of the country's primary energy needs. The Philippines is the world's second largest producer of geothermal energy (behind Indonesia). In 2010, the country's geothermal plants produced 8.5 Mtce, generating 8.5 TWh out of a total generation of 67.7 TWh (IEA, 2012). Geothermal energy is relatively expensive to harness, but has benefits over wind, solar and tidal. Typically, renewable energy is a 'must-run' power source ahead of thermal sources, but with utilisation rates often within a range of 2–30% of the year. At best, renewable power such as solar and wind delivers relatively little electricity over a year compared with its maximum rated capacity. However, geothermal in the Philippines can run for more than 70% of the year (IEA, 2012).

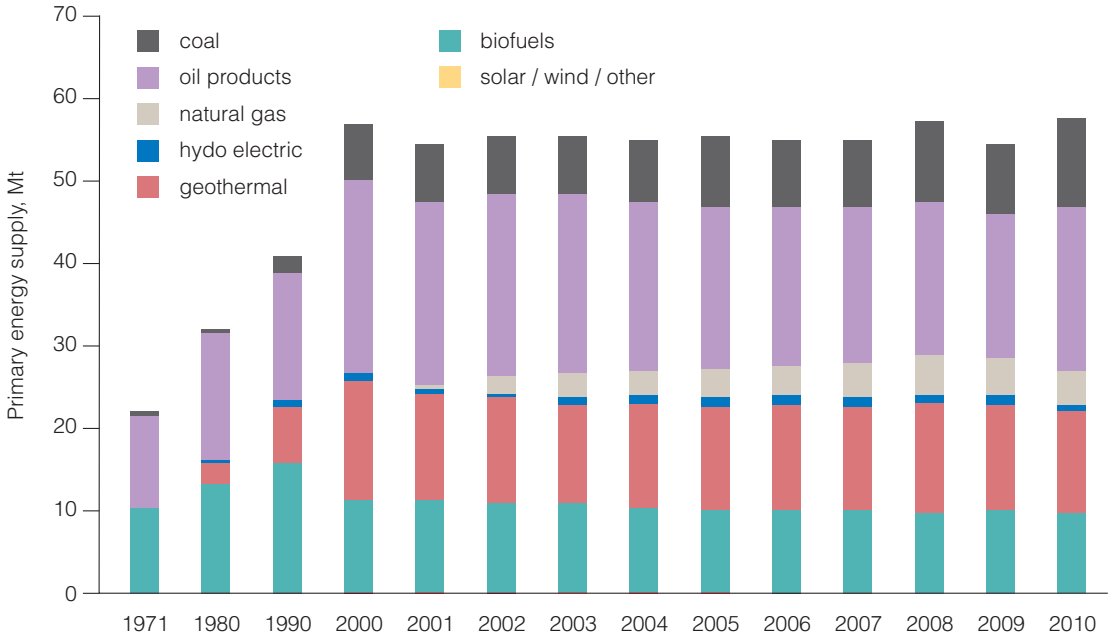

Figure 2 Total primary energy supply in the Philippines, Mtce

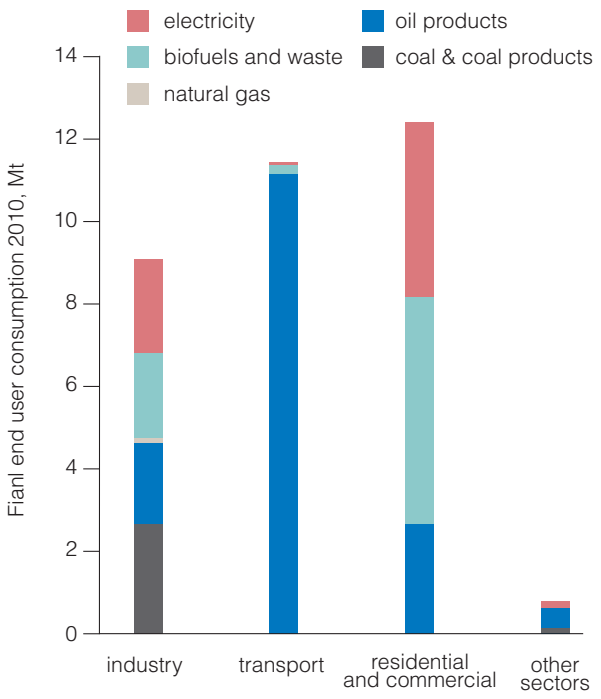

Figure 3 Final end user consumption by fuel in 2010, Mtce

Another source of energy is biomass waste which accounts for 18% of primary energy. In 2009, biomass provided 10 Mtce (7 Mtoe). Geothermal and biomass energy combined provide a massive 41% of primary energy supplies. The government have pledged further development of renewable energy. While solar and wind power will feature more, geothermal, hydroelectricity and biomass will still account for the bulk of most future developments.

In 2009, the Asian Development Bank estimated that the Philippines' final energy demand would rise from 37.9 Mtce in 2005 to 65.1 Mtce in 2030, a 72% increase. Most of this will be the transport sector which could account for 44% of energy demand in 2030; industry could be 25%, and according to the ADB, the remainder, 31%, could be power generation (ADB, 2009a).

IEA data suggest that final energy demand in 2005 was 32.9 Mtce, and applying the ADB growth rate this would yield a demand for energy in 2030 of 56.6 Mtce and a total primary energy supply of more than 85.7 Mtce. It is difficult to predict future growth, but the forecast could be much lower as a result of the global recession keeping energy demand flat between 2005 and 2009 (IEA, 2012).

As Figure 3 shows, the residential and commercial sectors consume 12.6 Mtce and are major markets for primary energy (8.7 Mtce and 3.8 Mtce respectively). A majority of the country's biomass is consumed by the residential sector in the form of fuel wood for applications such as cooking.

The industrial sector consumes a total of 9.2 Mtce of energy, and is also a major user of biomass in boiler systems for steam raising. The country has around 30 MWe of power generating capacity based on biomass. The sugar industry uses biomass for heat and steam raising, while other industrial applications include drying of agricultural crops, and combustion in kilns for ceramic and brick manufacture.

4 Energy resources and reserves

The Philippines is reasonably rich in energy resources relative to its needs. Exploration and exploitation of the country's reserves appears to be in its infancy and oil, gas and coal resources all appear to have a role to play in the future energy economy of the country.

4.1 Oil and gas

The country remains reliant on oil imports. Historically, the Philippines has been dependent on imported oil to meet its energy demand. In recent years the Government has undertaken several measures to encourage a greater understanding of the country's resources.

Between 2000 and 2002, the Norwegian funded *Philippine Petroleum Resource Assessment* (PHILPRA) Study was undertaken. The objective of the study was to develop a classification system to establish an inventory of the Philippine petroleum resources and improve the technical capability of the DOE oil and gas division in resource assessment. The study identified reserves of natural gas with exploration potential including:

- 16 sedimentary basins covering over 700,000 km^2;
- 12 basins with total recoverable of hydrocarbons estimated to be 8.9 billion barrels of fuel oil equivalent (BFOE) consisting of 57% gas deposits, 41% oil deposits and 2% condensate (Caluyong, 2003).

Between 2004 to 2009, 28 exploration licences were awarded. Before 2004 the government had only awarded six licences. Palawan, which contains the Malampaya gas project, is considered the main oil and gas province of the Philippines. The Malampaya gas project is the only commercially-producing gas well in the country. In 2011, the Malampaya Deep Water Gas-to-Power Project marked its tenth year since commencing natural gas production in October 2001. The operation of Malampaya involves deepwater sub-sea facilities, an offshore shallow water production platform, a 504 km underwater pipeline from Palawan to Batangas and an onshore gas plant in Batangas. These facilities use state-of-the-art technology to extract natural gas from the Malampaya gas field. The gas field is 80 km northwest of Palawan island, located some 3000 m below sea level and has been in operation since 2001 (Caluyong, 2003). The field has an estimated 64 billion cubic metres (BCM) of natural gas reserves and 85 million bbl of condensate (Shell, 2012). Malampaya gas fuels three combined-cycle gas turbine (CCGT) power stations on Luzon with a total capacity of 2700 MWe. A major benefit of the switch to Malampaya gas has been to reduce imports for oil-fired power generation by almost 30%, currently meeting 40–45% of Luzon's power requirements.

A key transnational issue facing the Philippines and related to natural resources is its claim to the Spratly Islands. The Spratly Islands area could be potentially rich in oil and gas resources. However, as well as the Philippines the Islands are also claimed by China, Taiwan, and Vietnam and partly by Malaysia and Brunei. There are around 45 islands with some occupied by small numbers of military forces from China, Malaysia, the Philippines, Taiwan and Vietnam.

4.2 Renewable resources

The hydropower resource potential of the Philippines is estimated at 13,097 MWe, of which 85% are considered large and small hydros (totalling 11.2 GWe), 14% (1.9 GWe) are classified as mini-hydros while less than 1% (27 MWe) are considered micro-hydros.

In 2000 the National Renewable Energy Laboratory (NREL) carried out a wind resource analysis and

mapping study of the Philippines to identify potential wind resource areas and to quantify the value of that resource (Elliot and others, 2001). According to Perez (2010) there is 750 MWe wind energy potential, however, to date there is only 33 MWe in operation.

4.3 Coal resources and reserves

Philippine coal is young and mostly formed in the Miocene age 23–25 million years ago. It occurs in moderately to highly geologically disturbed areas. It has developed in lagoonal to shallow marine environments. The heating value ranges from 2555 to 6666 kcal/kg (Morelos, 2009). Estimates for coal reserves vary widely ranging from 316 Mt to as much as 19 Gt. According to the German Geoscience Association BGR (2011), the Philippines has a reasonably substantial 19 Gt of reserves, with a potential 270 Gt of resources.

Other figures quoted by the Petroleum Economist (2011) suggest that the recoverable reserves are much smaller at just 0.35 Gt. This is close to the WEC (2010) estimate of 0.316 Gt (316 Mt) based on 2008 data. This reserve (economically recoverable) comprises of 170 Mt of subbituminous coal, 105 Mt of lignite, and just 41 Mt of bituminous coal and anthracite. Clearly, subbituminous coal is most prevalent in quantity as well as distribution.

Some of the more widely circulated numbers are those published by the Geothermal and Coal Resources Development Division (GCRDD) of the Department of Energy of the Philippines which estimates total coal resources to be a minimum of 2.27 Gt. Reyes (2010) and Jariel (2011) published resource data that broadly agrees with the DOE, but provides better detail on the reserves (*see* Table 1).

The United States Geological Survey (USGS) identified coal resources in 19 coal districts across the entire archipelago. The USGS (2006) probably used the GCRDD data, indicating that there are approximately 2.3 Gt of coal reserves of varying qualities. However, it appears that over the years there has been some confusion over the definition of resources and reserves. According to the Philippines Department of Energy, there is 2.3–2.4 Gt of coal but this refers to resources with only 0.3 Gt (324 Mt) as recoverable/mineable reserves (*see* Table 1). This latter figure is probably where the WEC and Petroleum Economist obtained their estimates from (*see above*).

Figure 4 shows a map of the Philippine islands with the locations of some of the major coal reserves, Assuming the official government figures, the largest total coal resource is estimated at 570 Mt of subbituminous coal, and is located in on the small island of Semirara (*see* Table 1).

With coal scattered over many islands, developing the infrastructure and mine facilities might prove difficult. For this reason, domestic coal production is concentrated in Semirara. The coal here comprises of subbituminous and bituminous rank coals.

The coal quality in some seams is good enough to export. In 2009, the Semirara Mining Corp exported 2.3 Mt, half of their production, to India, China, Thailand, Hong Kong, and Chinese Taipei. The island is located approximately 280 km south of Manila between the islands of Mindoro and Panay. Recoverable reserves are just 20% of the total resource, at closer to 115 Mt (using current economically recoverable methods), possibly accounting for half the recoverable reserves of subbituminous coal in the country.

Elsewhere across the country, other reserves have been identified in the Cagayan Valley (Luzon), Surigao (Mindanao), and South Catabato (Mindanao). With the exception of the Cagayan Valley most of the other coal areas have been earmarked for exploration or are under exploration for the potential to develop and produce coal (Reyes, 2010). The current status of reserves suggests that these figures may well be revised as exploration continues in the country.

Table 1 Potential and mineable coal reserves, Mt (PDOE, 2011)

Reserves as of 2010	Potential resource	Mineable reserve	Coal type
Cagayan Valley	336	70	Subbituminous/lignite
Cebu, of which:			
Central	*40*	*4*	*Subbituminous/bituminous*
Northern	*70*	*2*	*Subbituminous/bituminous*
Southern	*50*	*1*	*Subbituminous/bituminous*
Davao, of which:	100	0	Subbituminous
Masbata	*3*	*0*	*Subbituminous*
Mindoro	100	1	
Negros	5	1	Subbituminous
Polillo, Batan & Catandi	17	4	Subbituminous
Quezon	2	0	Subbituminous
Samar	27	7	Lignite
Semirara	570	115	Subbituminous/bituminous
Surigao	209	48	Subbituminous/lignite
Zamboanga	45	23	Subbituminous/bituminous
Bukidnon	50	0	Unknown
Magulndanao	108	0	Subbituminous/lignite
Sarangani	120	0	Subbituminous/lignite
South Cotabato	230	49	Subbituminous/lignite
Sultan Kudarat	300	0	Subbituminous/lignite
Total	2307	324	

4.4 Sovereignty of coal reserves

Like most areas of the country's energy business, the Philippines government has ownership of all coal resources. Presidential Decree (PD) 972, better known as the Coal Development act of 1976. PD 972 and the amendment PD 1174, governs all coal operations in the Philippines. The key elements are:

- It promotes the accelerated exploration, development, production and utilisation of coal.
- It introduced the coal operating contract system and established the appropriate guidelines for coal operations.
- The government retains the ownership of Philippine coal resources while the operator, as authorised by the government through the contract system, is assigned the right to explore, develop, produce and market the coal based on pre-agreed conditions for a specific period of time (Morelos, 2009).

The key organisation for development of coal and other indigenous energy resources is the state owned *Philippine National Oil Company Exploration Corporation* (PNOC-EC). The company was established in 1975 and aside from 0.21% shares held by public shareholders the remainder are owned by the Philippines government. The company has a mandate from the government to provide a stable

Figure 4 Major coal basins of the Philippines

energy supply for the Philippines through the development and utilisation of indigenous energy resources. In order to accomplish their mandate PNOC-EC has over the last 30 years been a catalyst for promoting onshore and offshore exploration for petroleum and coal resources. PNOC-EC has several coal operating contracts throughout the Philippines and operates coal terminals in Zamboanga Sibugay, Cebu, Batangas, and North Harbor in Manila, which serve as its handling facility for local as well as imported coal. The coal is supplied to power stations and cement factories. PNOC-EC is also engaged in a number of coal mine and power generation projects.

Exploration and development of many of these coal areas is under way; others have been allocated for further investigation under the contract system described above. The *Philippine Energy Contracting Round* (PECR) scheme started in 2003 for oil and gas, geothermal followed in 2004, and coal (and petroleum and geothermal) in 2005. The PECR offers the opportunity for companies to put in bids to explore, develop and produce indigenous energy resources. Proposals are evaluated on specific criteria. The key elements of the contract are:

- Contract term is initially for two years with the option of a two-year extension.
- Development and production for 10–20 years with a series of three-year extensions not to exceed 12 years.
- Cost recovery at 90% of gross income.
- Operations are exempted from national taxes with the exception of income tax.
- Profit share with the government. 30% of net proceeds goes to the government with the contractor receiving the remainder.
- Tax exemption for imported equipment, materials, spare parts and materials.

In 2007, there were 39 Coal Operating Contracts with 23 companies. Eleven of these were for exploration, the rest were for development and production (PDOE, 2012). Some of these contracts have been rescinded due to companies not being able to meet criteria to further develop the projects. By 2009, PECR awarded 16 Coal Operating Contracts across the whole country with two year commitments for exploration, and 20 other contracts for operation. In December 2011, the *4th Philippine Energy Contracting Round* (PECR4) for coal was announced, offering 30 coal areas in regions where mining is permitted, almost half of which are in the southern group of islands of Mindanao. The rest are mainly located in the central island Visayas.

5 Coal supply

The Philippines cannot meet the demand for coal from its domestic coal resources in Semirara, and exploration and exploitation elsewhere is limited. Increasingly, the country's large consumers of coal are relying on imports.

5.1 Coal imports

Before the 1990s, the Philippines' coal requirements were little more than 2 Mt/y, and half of this was produced domestically. In the 1990s, coal imports increased massively due to the building of a number of large coal-fired power stations such as the Pigbalao plant (*see below*) which were designed to burn imported coals. While domestic production increased steadily, imports remained below 8 Mt/y for many years. By 2000, the rise in IPPs led to a sharp rise in the demand for imported coal while domestic production was still at 1 Mt/y. By 2010, production rose to 7 Mt (although only 5 Mt is shown in Figure 5 as it is net of exports). At 7 Mt, domestic production was almost as much as the country was importing annually throughout the 1990s and 2000s. Imports jumped from roughly 7.5 Mt/y in 2009 to 11 Mt/y in 2010 (*see* Figure 5).

Coal imports account for up to three-quarters of coal consumption (Almendras, 2012). Around 10 Mt is imported from Indonesia (almost all steam coal); estimates show that for 2011, Indonesia supplied 99% of the country's imported supplies. The remainder come from Vietnam, Australia, China and the USA. In terms of consumption, 13 Mt of coal is used every year with around 9–10 Mt consumed by the power sector and the remainder by the cement industry.

5.2 Coal production

Coal production in the Philippines is dominated by subbituminous coal. Figure 6 illustrates how

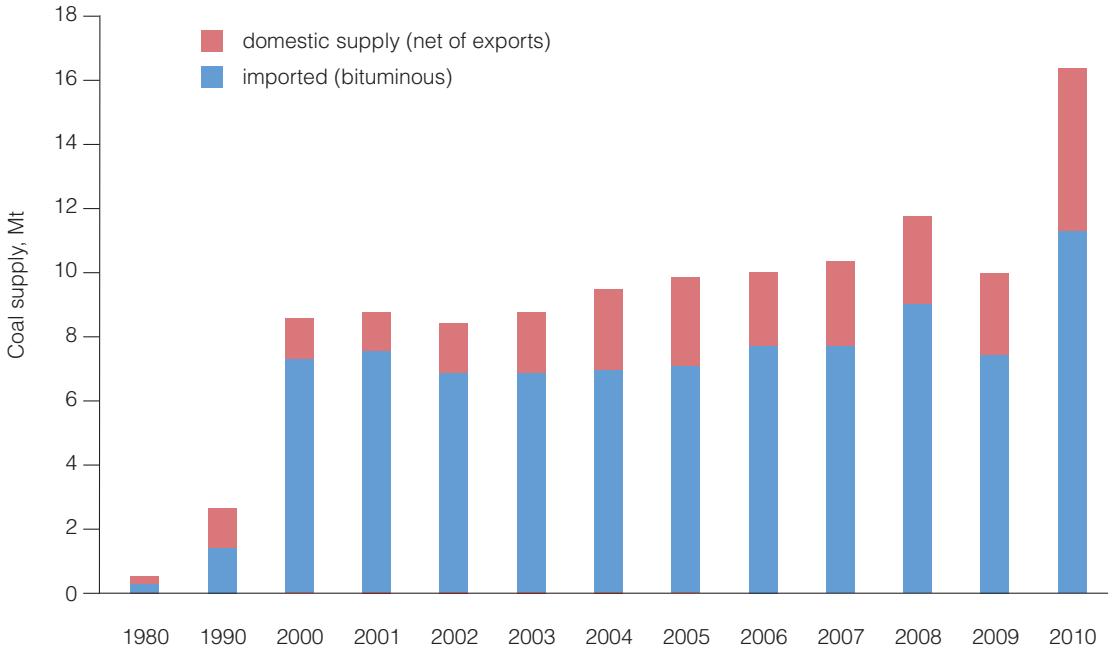

Figure 5 Philippine coal supply, 1980-2010 (IEA, 2012)

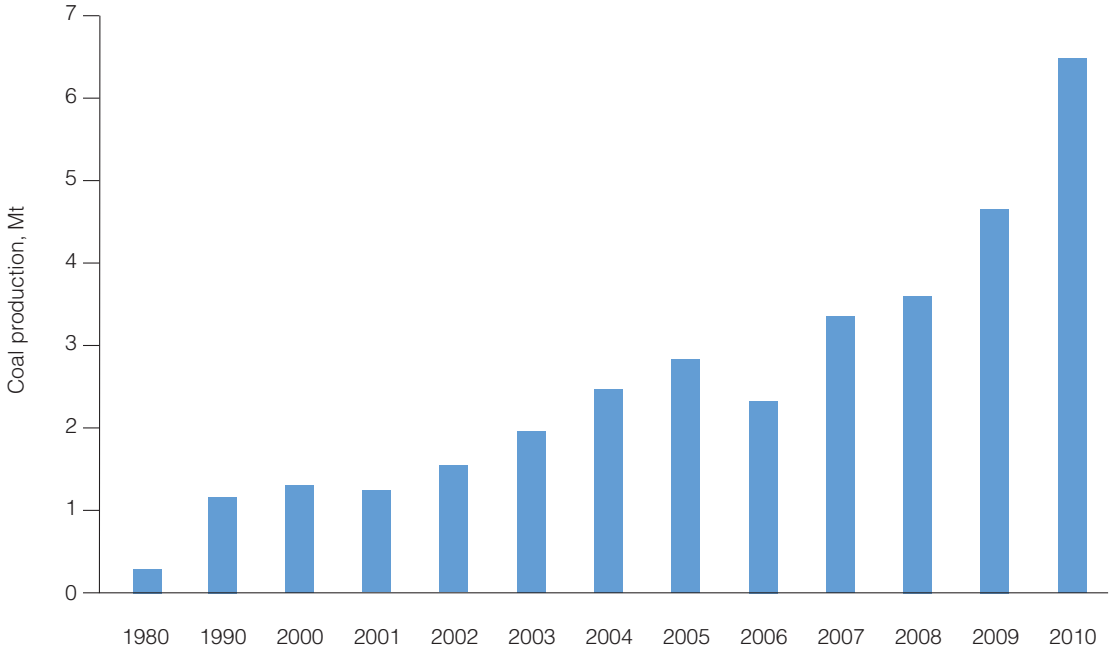

Figure 6 Coal production in the Philippines, 1980-2010 (IEA, 2012)

production has increased year on year with few exceptions. According to the DOE, in 2010, production increased 30% to reach 7.3 Mt, more than at any other time in the history of production in the country. 96% of coal production comes from the Semirara mine complex. Around 4 Mt of this coal is exported.

In 2010, the Semirara coal company invested US$ 32 million in new mining equipment including three new 16 m^3 excavators and a fleet of 100 t dump trucks, enabling a greater ability to shift earth overburden. The overburden removal in 2010 was 31% higher than in 2009. According to the company's annual report, production rose by 47% to 6.95 Mt (7.5 Mt ROM) in 2010, up from 4.8 Mt in 2009. In the same year, stock inventories were drawn down leading to sales of coal exceeding production. A decision by the DoE in 2009 to approve a 7000-ha enlargement of the concession area led to the expansion of the mine in 2010 (Semirara Annual Report, 2010).

In 2010, export sales accounted for 57% of total sales (4.1 Mt), with the remainder (3.1 Mt) sold locally. However, according to IEA data, exports from the Philippines were around 1.3 Mt. This is significantly lower than that declared by Semirara (4.1 Mt), and it seems unlikely that the entire difference is made up of stock drawdown. Revisions to IEA data are likely in the coming years. Even when considering the lower export estimates by the IEA, exports comprise of a large proportion of domestic production of subbituminous hard coal. Estimates for 2011 exports show that Semirara exported 2.7 Mt, 98% of which was destined for China, and a small amount for Thailand (54 kt) (Almandras, 2012).

According to the Semirara Annual Report 2010, the cost of production in 2010 was PHP 10.14 billion, or roughly ($225 million in 2010), which equates to roughly 30 $/t. At current market prices of some 80–110 US$/t FOB for internationally traded steam coals, subbituminous exports from the Philippines are currently extremely attractive. Not all of the production takes advantage of the profitability of export or local end-user business.

5.3 Promoting coal development

In December 2011, the government announced it would need $600 million in investment for its

Table 2 **Coal production in the Philippines in 2011, Mt** (Almendras, 2012)	
Semirara Island, Antique	7.19
Zamoanga Sibugay	0.17
Cebu	0.09
Batan Island, Albay	0.02
Surigao	0.03
Negros	<0.01
SSCM	0.12
Total	7.61

planned offering of 30 coal exploration projects, due for submission before April 2012 (International Business Times, 2011). Other mine operations are listed in Table 2. There are also underground mines operating in Cebu, Zamboanga Sibugay, Albay, Surigao del Norte, and Negros provinces (ASEAN, 2010). Smaller, underground operations exist, such as the Integrated Little Baguio colliery which is the Philippines' largest semi-mechanised underground mine located in Malangas, Zamboanga-Sibuguey (BIM, 2010).

In February 2010 a local company, Sultan Energy Philippines, began test production at the 7000 ha Daguma mine in South Cotabato, on Mindanao. The mine, which has since been acquired by a subsidiary of one of the country's largest conglomerates, San Miguel, is seen as a possible rival to Semirara's largest mine Panian.

6 Coal demand trends

This chapter looks at the trends in coal demand, but also introduces some of the forecast scenarios for coal demand based on increases in power generation and industrial growth. Economic and population growth have been rapid in the Philippines. As a result, electricity demand is outstripping supply resulting in shortages and blackouts. The Philippines has relatively small indigenous energy reserves and increasing consumption particularly in the residential sector. Therefore it is heavily reliant on importing energy, particularly coal, oil and natural gas.

In the 1980s, most of the coal demand came from the cement industry, with demand elsewhere from other industries for raising heat and steam (*see* Figure 7 and Table 3). Total demand in 1980 was just 0.3 Mt. By the 1990s, power station building activity had increased, and the demand for coal from the power sector equalled the demand from heavy industry.

As with coal supply, described in the previous section, coal demand in the Philippines increased sharply in the 1990s during the period of power station building, and from non-power sectors. Since 1995, coal demand in the power sector increased by 12.9%/y, while that in the industrial sector averaged 6.3%/y. By 2010, demand had risen to 12.5 Mt. In the last twenty years, demand has risen by 10.4 Mt; three quarters of the increase was attributed to the rise in power generation with the remainder from the industrial sectors.

Some of the coal that is produced domestically is earmarked for use by Semirara's two power generating units of the Sem-Calaca Power Corporation (SCPC). These 300 MW units currently operate at 50–60% utilisation. Consumption is roughly 1 Mt/y, but some coal is also imported and blended with local coals.

Industrial coal demand in 2010 was 3.7 Mt, most of which was from cement manufacturing. Other industrial facilities such as paper mills, phosphate production, and chemical industries also exist.

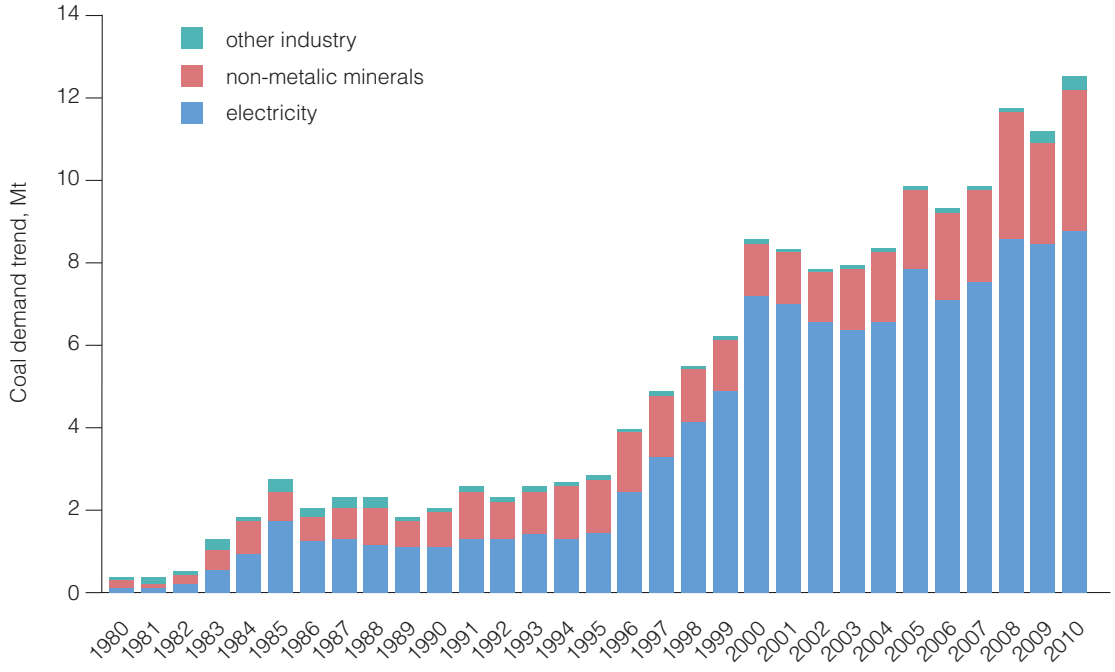

Figure 7 Coal demand in the Philippines, 1980-2010, Mt (IEA, 2012)

Table 3 Coal sector demand in the Philippines, kt (IEA, 2012)

	1980	1990	1995	2000	2005	2010
Electricity generation	102	1059	1421	7170	7832	8814
Non-metallic minerals	156	866	1342	1299	1925	3370
Other industry	31	133	50	31	77	321
Total	289	2058	2813	8500	9834	12505

Almost all the facilities make use of blends of domestic and imported coal. Industrial process plants are spread across Luzon, Visayas, and Mindanao.

While coal is set to have a greater role in the Philippines power market, natural gas is likely to lead all other forms of power by 2030. Nevertheless, many experts see the use of coal-fired power generation as a response to the potential power crisis that is expected in the next few years. Chapter 8 discusses in detail the level of coal-fired power in the Philippines today. Given the new projects for coal-fired power, demand for coal could rise from 8.8 Mt to 12–14 Mt by 2015.

7 Power generation

The Philippine power system is made up of three major grids: Luzon, Visayas, and Mindanao. In 2006, the Luzon grid had a total installed capacity of 12 GWe and is currently the largest of the three grids making up 73% of the demand. The largest load center in the country is the Metro Manila area with close to 65% of national electricity sales (ADB, 2007a). While the market is controlled by the NPC, private investment has had a great deal of involvement in the building of coal-fired capacity in past years (*see above*).

In 2009, the Philippines had 15.6 GWe of power generating capacity in operation. Renewable power capacity accounted for around 34% of capacity, while the share of coal was 20%. The government views coal as a dependable, reliable and cost effective power option and there are plans for several more coal-fired power stations. Small-scale CFBC plants are the technology of choice given the desire to utilise low quality indigenous coal in more isolated geographical locations which are poorly connected to the larger networks.

According to the Philippines Department of Energy, natural gas has been the main fuel used in power generation since 2005. In 2009, gas accounted for 32% of the total of 61 TWh of electricity generated nationwide, followed by coal (which accounted for 27% of total generation), geothermal energy (17%), hydropower (16%), oil (9%) and minor renewable sources (0.1%). By 2020 coal is expected to have increased its share in total generation to around 30%, while oil's share will have declined to around 5% (DOE, 2012a).

7.1 Oil

The Philippines used to operate several oil-fired power generation plants. However, in recent years these have been replaced with coal-fired power plants.

7.2 Natural gas

The discovery and development of the Malampaya gas field in offshore northwest Palawan provided a means to reduce gas imports. According to the ADB (2005) reserve estimates of the Malampaya gas field range from 64 bcm to 129 bcm. In 2002, the gas field started supplying gas to three power plants with an overall combined capacity of 2760 MWe of power in Batangas, South Luzon. The field could also provide fuel for another 300–1000 MWe of capacity for up to 20 years. There is ongoing exploration of other fields with some estimates putting the total gas resources, including undiscovered resources, at around 800 bcm. Ongoing use and any expanded capacity from natural gas will have to be supplied by new gas fields or from imported sources.

7.3 LNG

The Philippines is currently conducting feasibility studies on where to build a liquified natural gas (LNG) receiving terminal and a pipeline with the option of using floating vessels. The current areas being considered are Luzon and Manila Bay. According to the Energy Under Secretary, Jose Layug, the Philippines hopes to begin commercial activity with LNG to help meet the expected 5000 MW per day domestic demand for gas-fired power in 2016 up from the current 2700 MW. The Government is also in talks with potential US, Canadian and Australian suppliers (Business Mirror, 2012).

7.4 Nuclear

In the 1980s, the Philippines built a nuclear power plant that was never commissioned. Since then there has been no nuclear power development in the Philippines. The Aquino government decided to scrap the 620 MWe Bataan power plant, due to safety concerns identified by international experts. This led to a ban on any future nuclear power stations by the government (USAID, 2007).

7.5 Renewable energy sources

Renewable energy currently supplies 43% of total primary energy principally from biomass and geothermal. In 2008, the Visayas region had a total generating capacity of 1832 GWe, comprising of NPC plants and non-NPC plants. Of this total regional capacity, 964 MWe was geothermal and a bulk of the remainder was expensive diesel/fuel oil powered (604 MWe). Coal accounted for just 198 MWe (11%) of the generating capacity in Visayas.

For power generation, the government intended to double the then current 4500 MWe to 9000 MWe within 20 years (Climate Change Commission, 2010). However, in 2011, President Aquino increased the targets by launching the *National Renewable Energy Programme* (NREP) up to 2030. There are some impressive targets within the programme including a goal to treble renewable energy based capacity from 5400 MWe in 2010 to 15,300 MWe by 2030 (Philippine Star, 2011).

The NREP will include a *renewable portfolio standard* (RPS) as well as feed-in tariffs for different renewable energy technologies. In terms of installed capacity, geothermal and hydro power are the biggest contributors with 33% and this is likely to remain the case in 2030. Despite government incentives for renewable energy some technologies such as wind, biomass and solar currently only make up around 73 MWe. By 2030 the Government aims to increase this to 3050 MWe (FCO, 2011).

Geothermal power was first produced in the Philippines in 1979 with the development of the Tiwi and Mak-Ban fields in Southern Luzon by Philippine Geothermal Inc, a wholly-owned subsidiary of Union Oil Company of California. Other geothermal fields in Luzon, Mindanao, Leyte, and Southern Negros have subsequently been developed by the PNOCEDC. The Philippines is now the world's second largest producer of geothermal power, with an installed generation capacity of over 1930 MWe, of which almost 1200 MWe is owned and operated by the NPC. The DOE projects that between 2009 and 2014 geothermal capacity will increase by 820 MWe (USAID, 2007).

According to the DOE (2012a) the current installed capacity for hydro is 2518 MWe. There are plans to increase this by 2950 MWe in grid and off grid areas. This would increase hydropower to around 5468 MWe. 90% of this increase will be met by 18 large hydro power projects with the remainder supplied by mini-hydro and 490 kWe of micro-hydro power plants (DOE, 2012b).

The Philippines agricultural sector produces large crops of rice, coconut and sugarcane with a large proportion of residues that can be used as an energy fuel. There is also a substantial forestry and livestock industry that contributes to the potential biomass fuel available. According to NREL (2008) sugarcane is considered a key primary feedstock for ethanol production, due to its sustainability from well-established farming technologies and the high yield per hectare compared to other feedstock (corn, cassava, and sweet sorghum). The Biofuels Act is likely to result in an increase in sugarcane production. In addition, the use of sugarcane in cogeneration could potentially supply 540 MWe.

The Northwind Batanes 33 MWe wind farm in Bangui Bay, Ilocos Norte is located in the far north of the country and operated by Northwind Power Development Corporation. There are plans to expand wind power by 199 MWe by 2015 and up to 903 MWe by 2020, clearly exceeding the resource that Perez (2010) has estimated. The accuracy of the wind resource needs to be updated with a new assessment for both onshore and offshore. There are several constraints to the development of wind

energy in the Philippines. These include:

- no grid connection in rural areas.;
- lack of finance although the introduction of a feed-in tariff (FIT) will provide an incentive;
- lack of accurate wind data to identify wind sites both on and off shore;
- no manufacturing or distribution capacity.

With the introduction of the FIT there is now an incentive to develop more commercial-scale wind farms and in 2011 three wind power developers were given permission to build. All of these would be located in the same province as the Northwind Batanes wind farm project in Ilocos Norte.

In 2011, the NREB recommended a target of 830 MWe of renewable energy to be achieved within three years. The specific renewable energy targets are as follows: 250 MWe biomass, 220 MWe wind, 100 MWe solar, 50 MWe hydropower, 10 MWe tidal and wave. The NREB have recommended the FIT to be set high to encourage investment (Green Investor, 2011). The FIT rates are listed in Peso (P) and US cents:

- Biomass energy 6.5 P/kWh (14¢/kWh)
- Wind energy 10.0 P/kWh (22¢/kWh)
- Solar energy 6.5 P/kWh (37¢/kWh)
- Run-of-river hydro energy 6.0 P/kWh (13¢/kWh)

The Energy Regulatory Commission will make the final decision on the above FIT rates which will be implemented as a universal charge to energy consumers. An ocean energy FIT has also been recommended at 0.42 US$/kWh. The FITs are guaranteed to renewable-energy developers for 20 years. The Philippines has the most expensive electricity in Asia with an average retail price of 18.1 US c/kWh. Therefore the FIT scheme could face challenges from consumers with some analysts estimating that in the first three years the scheme would mean consumers paying an additional US$ 581 million (FCO, 2011).

Apart from the FIT, other incentives include a corporate income tax of 10% instead of the current 35%, seven year exemption from income taxes, duty free importation of RE machinery, equipment and material within the first ten years, any revenue generated from carbon credits tax exempt, a Renewable Portfolio Standard and a policy that requires electricity suppliers to source an agreed portion of their energy from RE sources.

8 Coal-fired power generation

Although coal-fired power plants continue to attract criticism from environmental campaigning groups, the government is unlikely to withdraw its support for fossil fuels which provide a more predictable supply of electricity. More coal is being produced and imported than ever before in the history of the Philippines.

As Figure 8 shows, electricity generation has grown from just 10 TWh in the 1970s to 67 TWh in 2010. Almost all forms of power generation have increased over the decades, although natural gas fired power has become a clear leader in growth terms since 2001. Coal has contributed around 17% of the power generation, although some later data suggest coal accounted for more than 20% in 2010. According to Almendras (2012), coal-fired power increased market share in 2011, accounting for 34% of total generation, while natural gas provided 29%, renewable (mainly geothermal and hydro) energy 27%.

In 2009, the Philippines had 15.6 GWe of power generating capacity in operation. Although there has been high growth in natural gas-fired power, coal still has the largest share of the generating capacity. Thermal power also provides more of the 'dependable' power that the Philippines requires.

Plant utilisation of the Philippine power stations was calculated based on what is termed 'dependable' capacity which is 5–10% below the installed figure, and the GWh generation published by the IEA. Figure 9 shows the power technology utilisations of plant operating in the Philippines in 2009. The variation across the plants is expected, with high utilisations from the combined cycle gas technology (CCGT) fleet, and low utilisation from renewable power. Oil plants are usually back up stations and so utilisation is typically lower than all other thermal stations.

For a country suffering from power shortages, coal-fired power stations in the Philippines run at unusually low utilisations, averaging less than 50%. The coal-fired fleet generated 16.5 TWh in 2009. If this fleet utilisation was increased to 75%, coal-fired power could be boosted by 52%, adding

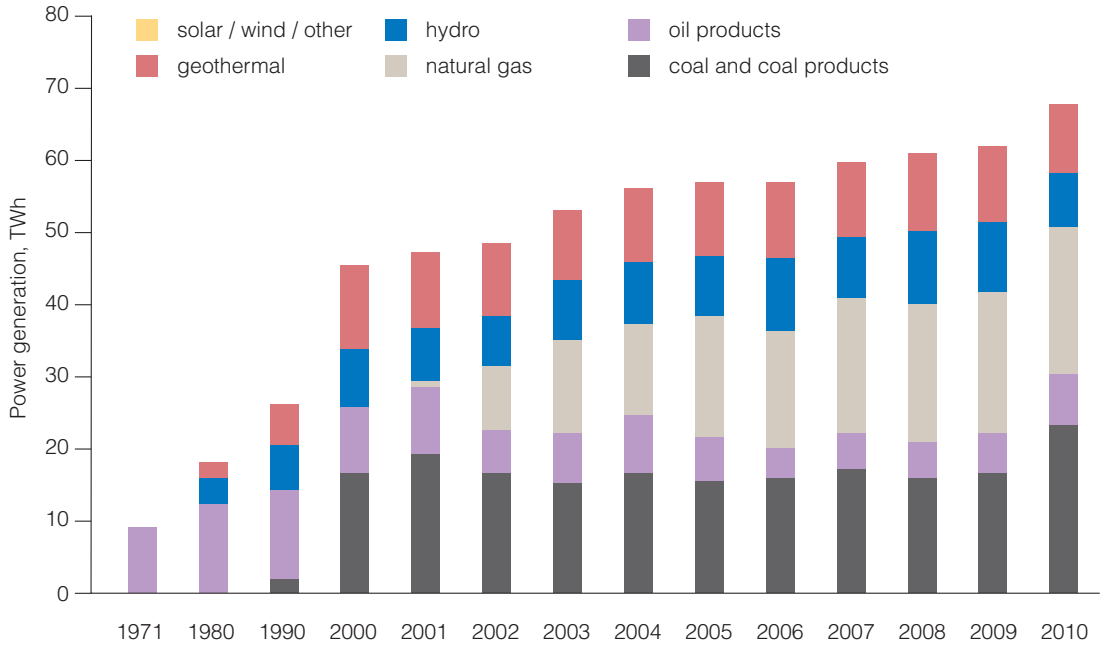

Figure 8 Electricity generation by fuel (IEA, 2012; Almendras, 2012)

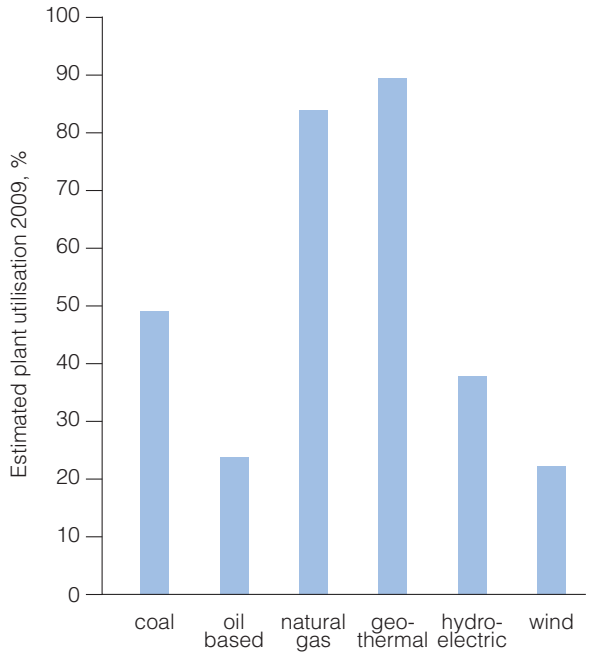

Figure 9 Average utilisation of the power station fleet in the Philippines by fuel

another 8.6 TWh to the wholesale power market (equivalent to 14% of national generation). However, whether the transmission system is capable of carrying this extra load is uncertain.

Several new coal-fired plants are expected to become operational in the period 2010 to 2020, and the government will have to make more use of domestic coal if it is to achieve its target of reducing the country's dependence on imports but this could be a considerable task.

A key obstacle to a sustainable energy supply in the Philippines will be to bring down the price of electricity. Currently, the Philippines has one of the highest electricity prices in the world. The drivers of the high electricity costs are PPAs. They were a result of the Government in the 1990s entering into contractual arrangements with IPPs to reduce the power capacity shortage.

8.1 Existing coal-fired power plants

According to Jcmiras.net (2009), there are nine operating coal-fired power plants with a combined capacity of **4213 MWe**. The plant list consists entirely of subcritical stations and there are no plans for new supercritical plants. Several small sized circulating fluid bed combustion (CFBC) plants have been built and more are proposed.

The coal-fired power plants are distributed across the country with five in Luzon Island, three in the Visayas in the central Philippines and one in Mindanao in the southern Philippines (*see* Figure 10). The largest coal-fired power plant is **Sual**, operated by Team Energy Corporation. The plant is located at Pangasinan on the coast at Bangayuo Point on a 142 ha site. It has a total capacity of 1218 MWe (2 x 609 MWe units) and has been in operation since 1999 using bituminous coal. This was the first plant to install wet limestone flue gas desulphurisation (FGD) scrubbers. It has a 226 m tall stack. The Pagbilao IPP plant, also operated by Team Energy Corporation has been online since 1996. The 734 MWe (2 x 367 MWe) plant is located 15 km from Manila on the southwestern tip of Pagbilao Grande island.

The **Mindanao** plant is 232 MW (2x116 MW) using bituminous coal. The plant is operated by Steag State Power Incorporation located at the Phivdec Industrial Estate near Cagayan de Oro City. The plant has a 25-year PPA. It imports and burns Indonesian coal.

The **Calaca** plant is 600 MWe (2x300 MWe) located at Batangas and operated by SEM-Calaca Power Corporation. It is designed to use bituminous and subbituminous coal. The first unit came online in 1984 and the second unit at the end of 1995. This was designed to use local low quality coal from the Semirara mine. It was the first 300 MWe plant to come online in the Philippines.

The **Masinloc** power plant is a pulverised coal fired power plant with a net capacity of 600 MWe. The plant is located in the town of Masinloc in the Zambales province. It is about 250 km northwest of Metro Manila. The configuration of the plant is 2 x 300 MWe generating units that were built by Mitsubishi Corporation of Japan. The plant has been operating since 1998. The plant was built to

Figure 10 Map of key coal-fired power stations in the Philippines

reduce power shortages. However, it was not well maintained and has been characterised up to when it was rehabilitated as operating at low capacity, poor availability, low reliability, with violations of environmental, health, and safety conditions (ADB, 2007b). These problems have been addressed in a two-year rehabilitation and there are plans to build two more 300 MWe units.

The **Quezon** power plant located in Mauban also came online in 1999 and is operated by the IPP

Quezon Power Limited. Its configuration is 490 MWe on a 100 ha site and has electrostatic precipitators, low-NOX burners and FGD scrubber. This power plant has a 25-year power purchase agreement (PPA) with Meralco. The plant negotiated a long-term coal supply contract with Indonesia's PT Adaro and Kaltim and burns approximately 1.65 Mt of coal annually. The plant has a port and coal handling facility to receive coal from the seaborne market.

8.2 New and planned coal-fired plants

In terms of future coal-fired power, the government expects a continued increase in power stations fuelled by domestic and imported coal. The rise in coal-fired power projects for the next few years could add some new capacity to the thermal fleet, much of it in the central region of Visayas, but there are plans for plants in Luzon also.

This section looks at some of the projects that were announced over the last few years, but the dynamism of power developments means that the status of some projects may change, while new projects that are not included here are announced. At the time of publication, some 3.8 GWe of coal-fired capacity were planned (0.8 GWe were under construction). 1.6 GWe of the new and planned stations are covered here since some plants remain speculative.

Since 2009, several power stations have been commissioned. In the period 2010-14, a further 1570 MWe will have been added to the grid (*see* Figure 11). Based on IEA CCC data, these new power stations will be small, each comprising of two units averaging roughly 80–100 MWe each. Although these plants are small, they are appropriate for local needs, and go a considerable way to alleviate uncertainty in capacity availability from renewable power and the high cost of diesel stations. All but one of the new coal-fired plant are based on atmospheric CFBC technology and all use a combination of domestic and imported coal.

All the new stations coming online in this period mainly serve the grid network in the Central and Northern regions of Visayas and Luzon. Visayane Electric Corp is the country's second largest power utility. The reason for this apparent spike in coal-fired power in the Philippines is the regions's heavy

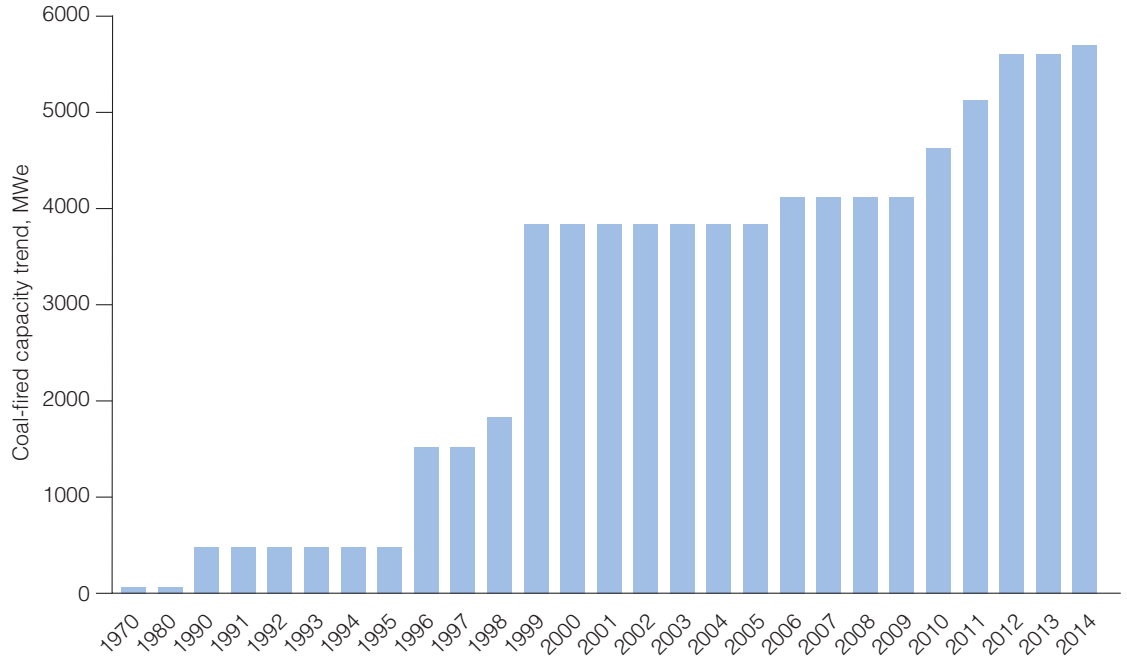

Figure 11 Capacity build of coal-fired capacity in Philippines since 1970

dependence on geothermal power and diesel generators which make up the bulk of supply in this group of islands.

One of the largest of these newer stations is the Toledo plant which came online in 2010. The Toledo coal-fired power plant operated by Mirant is 240 MWe comprising of 3x82 MWe units. By world standards this is a small station, but it is located on an island serving the Visayas grid and could help alleviate the 100–200 MWe deficit from which the island network suffers.

Also serving the regional Visayas grid is the new Cebu Salcon 200 MWe CFBC plant (also known as Naga City) operated by Kepco, located close to the existing Naga plant (100 MWe). The plant came online in 2011. The ADB (2009b) carried out a feasibility project, and concluded that there was a preference for a coal plant as other fuel sources were deemed either not easily or sufficiently available (hydro, biomass, geothermal, and natural gas) or relatively expensive (solar, wind, and oil). The configuration of two 100 MWe units was deemed optimal due to the small size and projected demand of the Visayas grid.

Subcritical technology was adopted because supercritical was considered technically more difficult to apply and not cost-effective for power plants below 500 MWe. However, the use of CFBC boilers allows the project to utilise a wide range of lower cost fuels, and achieve low NOx and SOx emissions, important when located close to a metropolitan area such as Cebu city. The ADB provided a US$ 100 million loan for the project (ADB, 2009b).

Other new coal-fired stations in Visayas include La Paz (Iloilo), another CFBC of 164 MWe capacity. State-owned Philippines National Oil Company Exploration Corp is to build a 30–100 MWe coal-fired power plant in Isabella which will begin operating by 2013 (Manila Standard, 2010). Panay Energy Development Corporation (PEDC) started operations of its 164 MWe CFBC plant in 2011. The plant is located on the island of Panay and was built to address the electric power shortfall in the Visayas region.

In terms of planned capacity, San Miguel Corp plans to build a 300 MWe coal-fired plant fuelled by coal from a mine in Mindanao. Early reports suggested that the plant would come online in 2012, but a date of 2015 is more likely (abs-cbnNEWS.com, 2012).

Construction is under way at Subic Bay (Luzon) of a 600 MWe CFBC power plant which is expected to come on stream in 2015 (Manila Times, 2011). The plant is being built by the Aboitiz group in partnership with Taiwan Cogeneration International Corp at a capital cost of $ 1 billion (Velasco, 2011). The new Mariveles 600 MWe PF plant built by Sithe Global and operated by GN Power in Luzon came online in 2012 and 2013.

More speculative plans include another project by Aboitiz at Davao (Mindanao) for a 300 MWe plant which could cost $500 million and consist of two 150 MWe units. Also, the shipbuilding company HHIC-Philippines plans to build a 200 MWe power plant to supply its own electricity requirements in Subic Bay (Luzon), with excess being sold to the Luzon grid. The plant is being built as part of a Philippine-Korean partnership, which also includes other projects in infrastructure, agriculture, tourism and climate change mitigation.

PNOC-EC company has much wider interests as well as facilitating coal imports. The company is developing a coal mine and a 50 MWe power station in Malangas, Zamboanga Sibuguey to supply power to the Mindanao power grid which suffers rotating blackouts. The Isabela Coal Mine and Power Plant Project is intended to be operational in the next 3–4 years is the 100 MW Malangas coal-fired power plant (PNOC Exploration Corporation, 2012).

Based on author's estimates, generation output from coal could rise from 16.5 TWh in 2011 to 25.7 TWh in 2014 (assuming new plants run at 75% utilisation). This could raise coal demand in the power sector to 12–14 Mt by 2014-15.

8.3 Coal and power scenarios

By 2030, the Japanese Institute of Energy Economics (IEE) suggest that coal-fired power generation could reach between 79 TWh and 104 TWh (*see* Table 4, IEE, 2011). Coal-fired power in the Philippines could generate more electricity than all the power generated from all sources in Greece and Hungary combined. In the Philippines, coal will increase its market share of the generating market to 48%. At the same time, growth in natural gas, hydropower, and geothermal power will occur at the expense of oil. In 2030, total Philippines generation could reach 200 TWh. The IEE expects nuclear power to contribute roughly 7% of the total, but the geological sensitivity of the Philippine islands will limit the locations suitable for siting a large civilian nuclear reactor. There would also need to be a change in the law to allow nuclear power to be built.

The 3rd ASEAN Energy Outlook published by the IEE expects growth in primary energy and coal to continue for some decades. Based on an assumption of population growth of 1.4%/y and GDP of 4.9%/y, the growth in total primary energy supply (TPES) between 2007 and 2030 could be 4.4%/y (IEE, 2011). The IEE projects primary coal consumption to increase at a rate of 6.9% to about 32 Mtce in 2030 under an alternative policy scenario (APS); under a business as usual (BAU) scenario, demand could be even higher.

This primary coal consumption comprises of non-power sectors such as industry, commerce and residential, which could increase demand modestly to 3.1 Mtce in 2030. Projected coal-fired power generation could increase to 79 TWh in 2030 (APS scenario). This translates to a coal demand equivalent to a minimum of 26.7 Mtce in 2030; under the BAU scenario, coal demand would be 35 Mtce.

The primary market for electricity is the region of Luzon, where the capital Manila is located. As an alternative projection to the IEE, Almandras (2012) reports that the Luzon electricity market is expected to see a doubling of generating capacity between 2011 and 2030, from approximately 10.8 GWe to more than 21 GWe to meet a forecast peak demand of 18.7 GWe based on an annual growth rate of 4.47%/y. It is not clear how much of this required capacity will be coal-fired power, but a doubling of demand for power could mean a doubling of coal-fired generation.

The adoption of high efficiency supercritical power technology could mean that the coal burn would be less for a given GWh compared with the current fleet. As mentioned in previous sections, a rise in generation need not require an expansion of capital investment, as an increase can come from a rise in the utilisation of the existing plants. Either way, coal demand from the power sector in the Luzon region could rise to 16–20 Mt (from 8–9 Mt in 2010), a lower estimate than that projected by the IEE, which is logical since the IEE calculates total national demand.

Table 4 Electricity generation to 2030 under BAU and APS scenarios in TWh (IEE, 2011)

	2005	2007	2030 (BAU)	2030 (APS)
Coal	15,257	16,837	104,305	79,267
Oil	6,051	4,495	5,076	4,682
Natural gas	16,952	19,442	66,113	53,499
Nuclear	0	0	0	15,768
Hydro	8,387	8,563	16,564	16,564
Geothermal	9,902	10,215	24,058	24,058
Others	19	59	2,658	3,161
Total	56,568	5,9611	218,775	196,999

8.4 Future coal supplies

Although domestic coal contributes a fair proportion it is unable to meet domestic demand. The Philippine coal mining industry is still under development and the Philippine Energy Development Plan (PEP) has a target of 250% growth in local coal production by 2030. However, as the development plan was set out in 2009, the plan probably considers growth from a base line of perhaps 2.5–2.7 Mt, the average production in 2005-08. A 250% increase would push production to 6.5 Mt. The Philippines' coal industry already achieved this in 2010 (and exported more than 1 Mt/y of this to other Asian countries).

By the end of the forecast period (2030), coal demand could reach 42 Mtce (estimated 48 Mt). If domestic production were to be maintained at 6.5 Mt/y, imports could be as high as 41.5 Mt/y, a considerable increase from the 11 Mt/y imported in 2010. Previous sections on coal production discuss the new round of permits to exploit further coal reserves, many of which are for small-scale mining, but may well add to production.

All these scenarios are subject to uncertainty, just some of which include:

- Future coal imports will depend on the level of local demand and the amount of new production capacity that comes online in the country; this is very much dependent on the international price of coal.
- If the Philippines commits to CO_2 reductions, demand for coal may well soften.
- In the absence of a massive new indigenous gas reserves find, supplies will depend more on foreign LNG imports and could prove expensive.
- A delay in or even halting of the introduction of nuclear power could favour coal and gas.
- There is currently no option of nuclear power so coal and gas will remain the mainstay for power generation.

Analysts expect major brownouts to occur around the years 2015-16 if demand keeps growing at the pace seen in recent years as the power station fleet fails to meet peak demand. Electricity tariffs are likely to increase. One of the major problems in the Philippines is ongoing opposition from environmental groups and local communities to the use and building of coal-fired power stations.

8.5 Emissions

The legislation that regulates and monitors air quality, The Philippine Clean Air Act, was signed into law on 23 June 1999. The Clean Air Act or Republic Act (RA) 8749 specifically regulates air quality management with the primary responsibility delegated to local government units to deal with environmental problems.

The National Ambient Air Quality Guideline Values (NAAQGV) set out in the CAA comprise of PM_{10}, total suspended particulates (TSP), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb). The Philippine air quality guidelines for PM_{10} (24-hour and annual) are three times the World Health Organisation (WHO) guidelines, while SO_2 (annual) limits are four times the WHO guidelines (Table 5). The eight-hour NAAQGV for O_3 is more stringent than the WHO Guideline whilst the CO and Pb NAAQGVs are comparable with the WHO.

Clearly efforts should be made to tackle every aspect of airborne emissions, from monitoring, to the enforcement of the standards since the forecast growth in coal demand from the possible rise in coal-fired power generation will be considerable. Ensuring a cleaner advancement of such generation growth should be encouraged strongly.

There also many coal-fired power stations that have installed technologies to reduce pollutants as listed below in Table 6

Table 5 NAAQGV versus WHO guidelines, µg/m³ (Clean Air Initiative for Asian Cities Center, 2010)

Pollutant	Average time	NAAQGV	WHO Guidelines
PM_{10}	24-hour	150	50
	Annual	60	20
TSP	24-hour	230	
	Annual	90	
NO_2	1-hour		200
	24-hour	150	
	Annual		40
SO_2	10-minute		500
	1-hour		
	24-hour	180	
	Annual	80	20
O_3	1-hour	140	
	8-hour	60	100
	24-hour		
CO	1-hour	35,000	30,000
	8-hour	10,000	10,000
Pb	3 month	1.5	
	Annual	1.0	0.5

Although the previous section strongly endorses the enforcement of emission controls, according to Table 6, all stations have PM control systems, but just two are fitted with FGD. This means that acquiring the lowest sulphur coal from the international market is probably the most desirable option for the present.

Table 6 Clean coal technologies in coal-fired power plants (Reyes, 2010)

	Com-bustion tech-nology	SO_2 control	PM control	PM control	Coal storage and handling	Coal storage and handling	Waste storage and handling
	CFB	FGD	ESP	Bag filter	Covered coal stockyard	Enclosed conveyor system	Ash pond with polyethylene liner
Calaca (2x300 MWe) PC			✔			✔	
Masinloc (2x300 MWe) PC			✔			✔	
Sual (2x609 MWe) PC		✔	✔			✔	✔
Pagbilao (2x350 MWe) PC			✔			✔	✔
Mauban (1x460 MWe) PC		✔	✔			✔	✔
Toledo (2x40 MWe) AFB				✔		✔	
Salcon (50 & 55 MWe) PC			✔			✔	✔
Steag (2x105 MWe) PC				✔	✔	✔	✔
APEC (50 MWe)	✔		✔		✔	✔	✔
UPPC (24 MWe)	✔		✔			✔	✔
Coral Bay (11 MWe) PC			✔			✔	
Semirara (2x7.5 MWe) PC			✔			✔	

CFB circulating fluidised bed
AFB atmospheric fluidised
PC pulverised coal
FGD flue gas desulpurisation
ESP electrostatic precipitator

9 Conclusions

The main driver for energy policy in the Philippines is achieving energy independence through use of indigenous energy resources while promoting reforms in the power market. However, the geographical nature of the Philippines with around 7100 islands covering 300,000 km^2 with 20 active volcanoes and mountainous terrain makes it difficult to provide the population of 94 million with electricity.

Estimates for coal reserves from several studies are wide ranging and contradictory. However, with estimates of 316 Mt to as much as 19,000 Mt, the potential is considerable. In addition, there is potentially up to 270 Gt of coal resources. The DOE estimates coal reserves at 316 Mt made up of 170 Mt of subbituminous coal, 105 Mt of lignite and 41 Mt of bituminous coal and anthracite. Although there are 19 coal districts, 96% of the coal produced comes from the Semirara district.

In 2010 demand for coal was 12.5 Mt. Three quarters of this increase can be attributed to the rise in power generation, but a considerable amount was also due to the rise in demand from the industrial sectors as well.

The Philippines has major renewable resources with large geothermal and hydro resources. However, coal is likely to play a key role in providing energy in the long term. In 2001 the Malampaya gas field began natural gas production. The gas field is 80 km northwest of Palawan island with an estimated 64 bcm of natural gas reserves and 85 million bbl of condensate. The gas field currently supplies three combined cycle gas plants totaling 2700 MWe on Luzon. There have been no further major natural gas discoveries. One of the key potential areas for exploration is the Spratley Islands. However, ownership of the islands and the surrounding sea area is currently being contested.

Although the energy sector has undergone deregulation and privatisation of generators this has yet to trickle down in benefits to energy consumers. The Philippines has one of the highest prices for electricity in Asia and is still heavily subsidised. The introduction of feed in tariffs for increasing renewables, while a laudable policy, is likely to meet widespread opposition if electricity prices increase further.

Since the 1970s the Philippines has suffered ongoing blackouts which continue today in some areas. With any system, investment in generating capacity must be carried out in parallel with investment in the distribution network.

It may be possible to boost thermal power generation output by increasing the utilisation of the current coal fleet from a low 50% to 75%. This could achieve an additional 8.6 TWh of generation using existing capacity, equivalent to 14% of the current national generation. This could be seen as a quick solution to increasing the output of the power generating fleet. The potential to adopt and retrofit current stations with high efficiency upgrades is good, given the fleet of subcritical stations. Either way, the prospects for coal demand appear positive providing this demand can be met from expanded indigenous production or from imports.

According to the DOE electricity demand will increase from around 55 GWh in 2010 to 87 GWh by 2018 and up to 149 GWh by 2030. However, based on past energy developments unless there is a major change in business practices and increased investor confidence these targets will not be achieved. Based on author's estimates, generation output from coal could rise from 16.5 TWh in 2011 to 25.7 TWh in 2014. This could raise coal demand in the power sector to 12–14 Mt by 2014–15. By 2030, the Institute of Energy Economics (IEE) scenarios suggest that coal-fired power generation could reach between 79 TWh and 104 TWh. This is considerably less than the DOE estimates and may indicate that the blackouts continue.

Coal demand from the power sector could increase 30–40 Mt by 2030. Other sectors are also forecasted to increase demand and could push overall demand up to 48 Mt. There is currently 6.5 Mt/y domestic production which means that imports could increase from the current 11 Mt/y to 41.5 Mt/y. There are incentives for developing coal mines. However, while permits are being issued, many of these are for small-scale mining. The production would add to current levels but there is still likely to be a major shortage of coal unless it is imported.

Based on current levels of usage and production the existing coal reserves would run out in 20 to 25 years. To address this issue the government has put in place several tax incentives to encourage further development of coal reserves and resources. However, unless new reserves are confirmed with full surveys there will be an increased reliance on imports of coal.

Policymakers, specialists, and scientists point out that the expansion of coal usage faces a number of environmental barriers. Simultaneously, it is recognised that the technical potential exists for large-scale emission reduction from coal-fired power plants through the use of CCTs.

The Philippines is increasing the use of CFBC with several stations either operating or being built. Future possibilities include improved power plant efficiencies and CCS technology. However, proposed and existing Philippine coal-fired power stations are small in size and this will make deployment of CCS technically and economically challenging.

The legislation for coal-fired power stations is stringent with newer coal-fired power stations equipped with FGD and ESP. Nearly all the planned coal-fired power stations are CFBC and small in size at up to 300 MWe. In 2009, the Philippines had 15.6 GWe of power generating capacity in operation. A major proportion was renewable energy with around 34% of capacity, compared to the share of coal-fired generating capacity of 20%.

The confirmed coal-fired power projects for the next few years could add a modest 1.6 GWe of new capacity, but more are planned, mainly in the central region of Visayas. A further option that could be investigated is the use of large supercritical coal-fired power on the island of Luzon where energy demand is highest.

The Philippines is potentially rich in energy resources. The energy sector reforms have had mixed success but are still ongoing. Coal imports are growing year by year. If the large coal resources can be reclassified as coal reserves then the government will improve the likelihood of achieving its goal of energy security by increasing use of indigenous energy resources.

10 References

Almendras, J (2012) *The Philippines energy sector.* Energy Forum, Manila, The Philippines. Available at: http://www.doe.gov.ph/Presentations/presentations.htm (Jan 2012)

Asian Correspondent (2012) *Southern comfort: No quick fix for Mindanao energy crisis.* Available at: http://asiancorrespondent.com/80477/mindanao-energy-crisis/ (Apr 2012)

abs-cbnNEWS.com (2012) *Power shortages, price swings dim energy sector outlook*. Available at: http://www.abs-cbnnews.com/business/07/29/12/power-shortages-price-swings-dim-energy-sector-outlook, The Philippine Star (Jul 2012)

ADB (2005) Philippines: Power sector profile and roadmap. Staff Consultant's report. Asian Development Bank, Manila, Philippines. (Dec, 2005)

ADB (2007a) *Philippines: critical development constraint.* Country Diagnostics Studies, Economics and Research Department, ISBN: 987-971-650-8, 83 pp Manila, The Philippines (Dec 2007)

ADB (2007b) *Proposed loan republic of the Philippines: acquisition and rehabilitation of the Masinloc coal-fired thermal power plant.* Available at: http://www.adb.org/Documents/RRPs/PHI/41936-PHI-RRP.pdf (Dec 2007)

ADB (2009a) *Energy outlook for Asia and the Pacific.* Asia Development Bank, Manila, The Philippines, 367 pp (Oct 2009)

ADB (2009b) *Report and recommendations of the president to the board of directors.* Project Number: 43906. Asia Development Bank, Manila, The Philippines(Jul 2009)

ASEAN (2010) *Final Summary Report of the Observation Tour.* Association of Southeast Asian Nations, April 13, 2010, http://www.aseanenergy.org/download/reports/energy_organisastion/afoc/Final%20Report%20of%20the%20Observation%20Tour%20in%20Japan%208-12.pdf

Asian Times (2004) *Philippines: More pain, no gain.* Available at: http://www.atimes.com/atimes/Southeast_Asia/FI30Ae04.html (Sep 2004)

BGR (2011) *Annual Report.* Deutsche Rohstoffagentur in der Bundesanstalt fur Geowissenschaften und Rohstoffe, Hannover, Germany; 92 pp (2011)

BIM (2010) *SMC-PNOC-EC talks on for mine-mouth plant in Isabela.* Business Insight Malaya, 2010, http://www.malaya.com.ph/06092010/index.html

Business Mirror (2012) *DOE to bid out LNG pipeline project in 2013.* Available from: http://businessmirror.com.ph/home/economy/25838-doe-to-bid-out-lng-pipeline-project-in-2013 (Apr 2012)

Caluyong S (2003) *The Philippine petroleum resource assessment (PhilPRA) project: Part 1 executive summary.* Department of Energy, The Philippines, available at: http://www.ccop.or.th/projects/PPM/Case_Study_Phillipines_files/First_workshop/doc%5CPhilPRA%20Executive%20Summary.PDF (Mar 2003)

CIA (2011) *The world factbook.* Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/rp.html (Jul 2011)

CIA (2012) *The world factbook..* Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/rp.html (Mar 2012)

Chua S, Rimban L, Cruz B (2004) *The Rulemakers; How the Wealthy and Well-born Dominate Congress.* Philippine Center for Investigative Journalism, Quezon City, The Philippines (2004).

Clean Air Initiative for Asian Cities Center (2010) *Clean air management profile: Philippines.* Available at: http://cleanairinitiative.org/portal/sites/default/files/documents/CAMP_Philippines_-_2010_Edition_0.pdf (2010)

Climate Change Commission (2010) *National framework strategy on climate change 2010-2022.* Available from: http://www.neda.gov.ph/references/Guidelines/DRR/nfscc_sgd.pdf (Apr 2010)

DOE (2011) National energy efficiency and conservation program website. Available at: http://www.doe.gov.ph/neecp/aboutus.htm (2012)

Department of Energy (2012a) *Highlights of the Philippine energy plan 2009-2030.* Available at:

http://www.doe.gov.ph/PEP/ accessed (Nov 2011)
DOE (2012b) Renewable energy DOE website. Available at: http://www.doe.gov.ph/ER/Hydropower.htm (accessed Jan 2012)
EIU (2012) *Philippines.* Economist Intelligence Unit. Available at: http://country.eiu.com/Philippines (2012)
Elliot D, Schwartz M, Scot G, Haymes S, Heimille D, George R (2001) *Wind energy resource atlas of the Philippines.* National Renewable Energy Laboratory, Colorado, USA, pp 206 (Feb 2001)
Esguerra, G, Tiangco C, Custodio S, Gabiola N (2010) *A strategic approach to climate change in the Philippines: An assessment of low-carbon interventions in the transport and power sectors.* Manila, The Philippines.
European Commission (2009) *European commission the Philippines: Country environmental profile.* Available at: http://eeas.europa.eu/delegations/philippines/documents/more_info/coop_news/cep_update_09_en (Jun 2009)
EEAS (2007) *The EC-Philippines strategy paper 2007-2013.* European Union External Action Service. Available at: http://www.eeas.europa.eu/philippines/csp/07_13_en.pdf (Accessed in Jan 2012)
FCO (2011) *Philippines: renewable energy:future, strengths and challenges.* FCO Country Updates for Businesses, British Manila Embassy, Available at: http://www.ukti.gov.uk/download/file/176840.html (Aug 2011)
Green Investor (2011) Renewable energy in Philippines – NREB sets ambitious 830 MW in 3 Years with high feed in tariffs subsidies. Available from: http://www.greenworldinvestor.com/2011/04/06/renewable-energy-in-philippines-nreb-sets-ambitious-830-mw-in-3-years-with-high-feed-in-tariffs-subsidies/ (Apr 2011)
International Business Times (2011) Philippines needs $600 million to fund 30 coal mining projects. Available at: http://au.ibtimes.com/articles/259881/20111201/philippines-needs-600-million-fund-30-coal.htm (Dec 2011)
IEE (2011) *The 3rd ASEAN Energy Outlook.* The Energy Data and Modeling Center, Institute of Energy Economics, Japan. Available at: http://www.energycommunity.org/documents/ThirdASEANEnergyOutlook.pdf. 157pp (Feb 2011)
IEA (2012) *Data service.* International Energy Agency, Paris, France. Available at: http://data.iea.org/IEASTORE/DEFAULT.ASP (2012)
IMF (2011) *The determinants of economic growth in the Philippines: A new look*. International Monetary Fund Working Paper 11/28. Available at: http://www.imf.org/external/pubs/ft/wp/2011/wp11288.pdf pp 25, Manila, The Philippines (Dec 2011)
Jariel N C Jnr (2011) *Overview of Philippine Coal Mining Industry.* ERDB, Philippine Department of Energy, 29pp (2011)
Jcmiras.net (2009) Coal-fired power plants in the Philippines. Available at: http://www.jcmiras.net/surge/p160.htm (Jan 2009)
Kaufmann D, Kraay A, Mastruzzi M (2008) *Governance Matters VII: Governance indicators for 1996-2007.* World Bank Policy Research Working Paper No. 4654. Available from, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1148386
Leung T, Viseth K (2003) *Integration and transition: Vietnam, Cambodia and Lao PDR.* International and Development Economics Working Paper 05-1, Asia Pacific School of Economics and Government. Australian National University, Canberra, Australia (2003)
Manila Times (2011) *Cleaner coal plants answer to looming power crisis.* Available from: http://www.manilatimes.net/index.php/opinion/editorials/10693-cleaner-coal-plants-answer-to-looming-power-crisis-meralco (Nov 2011)
Manila Standard (2010) *Filipino coal-fired power plant goes ahead*. Available at: http://www.upi.com/Business_News/Energy-Resources/2010/04/28/Filipino-coal-fired-power-plant-goes-ahead/UPI-58241272485589/, Manila Standard, Manila, The Philippines (Apr 2010)
Morelos R T (2009) *Coal supply and demand outlook in the Philippines.* APEC Clean Fossil Energy Technical and Policy Seminar, Incheon, South Korea (Oct 2009)
NREL (2008) *Survey of biomass resource assessments and assessment capabilities in APEC*

economies. Available at: http://www.nrel.gov/docs/fy09osti/43710.pdf, National Renewable Energy Laboratory, pp 146, Colorado, USA (Nov 2008)
Pérez V (2009) *Status of renewable energy in the Philippines*. Asian Development Bank. Available at: http://www.adb.org/documents/events/2009/CCEWeek/Presentation-Vincent-Perez-Energy-PHI.pdf (2009)
Perez V (2010) *Status of wind development in the Philippines and drafting of the Philippines wind development map: next steps.* Asia Clean Energy Forum, pre-event workshop presentation. Available at: http://www.sari-energy.org/PageFiles/What_We_Do/activities/Quantum_Leap_in_Wind_Power_in_Asia-Manila_Conference/presentations/(b)_Vince_Perez_ADB_Wind_Power_Roadmap_20_june_2010. pdf (Jun 2010)
Petroleum Economist (2011) Philippines counts on upstream revival. *Petroleum Economist.* Volume 78, Issue 7, 4 pp (Sep 2011)
PDOE (2007) *Philippine Development Plan.* Luzon Public Consultation Series. Philippine Department of Energy, 2007 available at: http://www.doe.gov.ph/PEP/consultations/PLENARY%20%28A.M.%29/Power/Power%20-%20Luzon.pdf
PDOE (2012) *List of Coal Operating Contract holders.* Philippines Department of Energy. Available at: http://www.doe.gov.ph/ER/Coal%20Statistics.htm
PNOC Exploration Corporation (2012) *Coal exploration and production.* Available at: http://www.pnoc-ec.com.ph/business.php?id=3 (Feb 2012)
Philippine Star (2011) *P-Noy launches renewable energy program.* Available from: http://www.philstar.com/Article.aspx?articleId=696271&publicationSubCategoryId=63 (Jun 2011)
Ramesh M, Howlett M (eds) (2006) Deregulation and its discontents: rewriting the rules in Asia. Edward Elgar Publishing pp 250 (2006)
Rein A, Cruz K (2011) Philippines energy policy and development. The Journal of Energy and Development. Vol 34, No 1
Reuters (2011a) *Philippines aims to begin importing LNG in 4 to 5 years.* Available at: http://www.abs-cbnnews.com/business/09/20/11/philippines-aims-begin-importing-lng-4-5-yrs (Sep 2011)
Reuters (2011b) *Philippines set to offer 30 coal projects in quarter 1.* Available from: http://af.reuters.com/article/commoditiesNews/idAFL4E7N118X20111201 (Dec 2011)
Reyes A N (2010) *Philippine Coal Policy.* Available at: http://www.egcfe.ewg.apec.org/publications/proceedings/CFE/Japan_2010/Session1A_S2_Philippines.pdf. The Philippines Department of Energy, presented at the APEC Clean Fossil Energy Technical and Policy Seminar, Fukuoka, Japan, 27-29 Oct 2010 (Oct 2010)
Schirmer D, Shalom S (eds) (1987) *The philippines reader: a history of colonialism, neocolonialism, dictatorship, and resistance.* South End Press. Cambridge, USA. pp 428 (Jan 1987)
Semirara Annual Report (2010) *Semirara annual report.* Available at: http://www.semiraramining.com/uploads/files/Blurb-14_File-560_2010SemiraraAR2010websitel.pdf
Shell (2012) Malampaya celebrates 10 years of powering a nation. Shell Philippines Exploration B.V. Available from: http://www.malampaya.com (2012)
Tolo W (2011)*The determinants of economic growth in the Philippines: a new look.* IMF Working Paper, WP/11/288, Manila, The Philippines, International Monetary Fund, pp 23 (Dec 2011)
Transparency International (2011) *Corruption perceptions index 2011 report.* Available from: http://cpi.transparency.org/cpi2011/results/ Transparency International, Berlin, Germany, pp 7 (Dec 2011)
USAID (2007) *From ideas to action: Clean energy solutions for Asia to address climate change*. Available from: http://usaid.eco-asia.org/programs/cdcp/IdeasToAction.html (Jun 2007)
USGS (2006) *The republic of the Philippines coalbed methane assessment: based on seventeen high pressure methane adsorption isotherms.* U. S Geological Survey and Philippine Department of Energy. Open File Report 2006-1063, 2006, available at: http://www.usgs.gov/of/2006/1063
Velasco M M (2011) Aboitiz Power scales up investment for Subic power plant project to $1B. Available at: http://www.mb.com.ph/node/304758/aboitiz-power (17 Feb 2011)
WEC (2010) *2010 survey of energy resources.* Available at:

http://www.worldenergy.org/documents/ser_2010_report_1.pdf London, UK (2010)
World Bank (2009a) *Country assistance strategy for the republic of the Philippines for the period financial year 2010-2012.* Report No. 47916-PH. P Available from, http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/05/19/000112742_20090519114325/Rendered/PDF/479160R200910077130REPLACEMENT0FILE.pdf (Apr 2009)
World Bank (2009b) *Philippines transport for growth: An institutional assessment of transport infrastructure.* Report No. 47281-PH, Available from: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2009/03/26/000334955_20090326035730/Rendered/PDF/472810ESW0PH0G10Disclosed0031251091.pdf, pp 130 (Feb 2009)
WHO (2007) Climate change country profile: Philippines. World Health Organisation. Available from: http://www.wpro.who.int/NR/rdonlyres/92EC0A38-6EA7-4BDA-B19E-C2E398D4724D/0/PHL.pdf (2007)