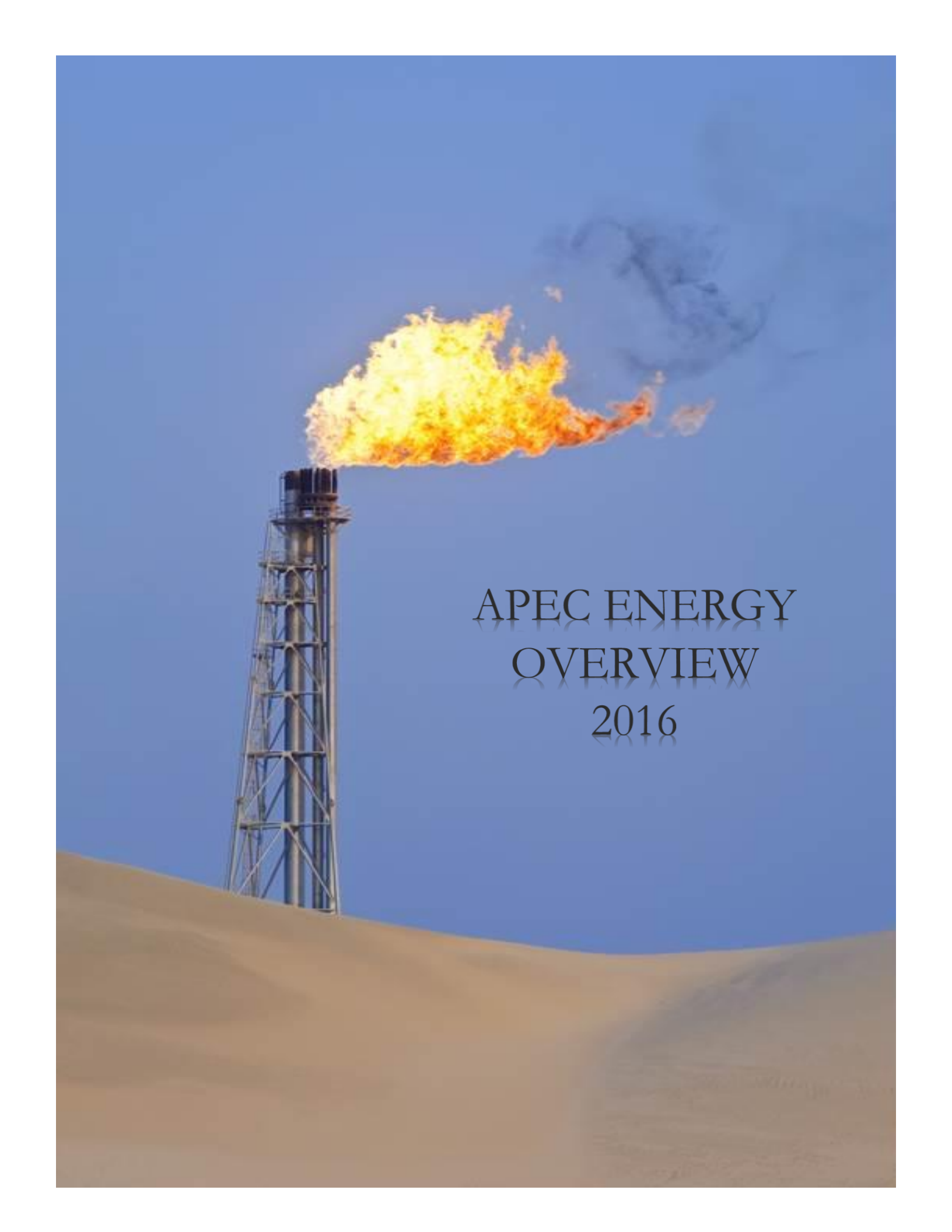


A tall, slender industrial flare stack stands on a sandy dune. A large, bright orange and yellow flame is being emitted from the top of the stack, rising into a clear blue sky. The foreground is filled with smooth, undulating sand dunes. The overall scene suggests an industrial facility in a desert environment.

APEC ENERGY OVERVIEW 2016

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FOREWORD

The APEC Overview is an annual APERC publication. Its main objectives are to compile the latest data of the Expert Group on Energy Data and Analysis (EGEDA) on energy use and recent energy developments in each APEC economy, promoting the use of EGEDA data and providing useful information and insights to policy makers in the region.

The APEC Overview gives a *bird's-eye view* of the energy situation of 21 APEC economies. It contains energy demand and supply data as well as energy policy information for each of the 21 APEC economies. It also contains information on notable energy developments, including those related to policy updates, upstream development, energy efficiency, low carbon energy, and environmental protection.

It gives a summary of the energy intensity improvement as well as renewable energy development in APEC. The summary indicates how APEC is progressing in achieving its aspirational goals of reducing energy intensity by at least 45% by 2035, using 2005 as a base year, and in doubling the share of renewables in the APEC energy mix, including in power generation from 2010 to 2030.

While the rates of improvement vary by economy for many reasons, most economies have followed-through on previously committed action plans to improve energy efficiency; embarked on efficiency awareness raising campaigns; increased use of renewables; promoted good energy management practices and facilitated investment in energy efficiency.

We hope that this report helps to deepen mutual understanding among APEC economies on energy issues in the region. We wish to express our deepest gratitude to the APEC-EWG and EGEDA members for their continued support to this undertaking.



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EXECUTIVE SUMMARY

In 2014, APEC population reached 2.8 billion, a sluggish growth of 0.7% from the 2013 levels. While population grew slowly, APEC economies showed significant increase of 3.8% (USD 54 811 billion, in 2010 USD purchasing power parity [PPP]) in 2014 from the 2013 GDP levels of USD 52 794 billion (2010 USD PPP). Total primary energy supply reached 7 926 million tonnes of oil equivalent (Mtoe) in 2014 which was a 0.6% expansion from the 2013 levels of 7 875 Mtoe. This rate was slower than the annual average growth rate (AAGR) of 2.7% observed between 2000 and 2014. Meanwhile, final energy consumption in APEC grew modestly by 1.1% to reach 5 244 Mtoe in 2014 from 5 188 in 2013.

Subsequent to APEC Leaders' setting the target to reduce energy intensity by 45% by 2035 (against the 2005 level), energy intensity in APEC continues to improve. Given differences in fuel mixes within APEC economies and different conversion factors from primary to final energy, the summary presented an analysis based on final energy and final energy excluding non-energy use. As regards the doubling goal, rough estimation on the possible growth rates of renewables in total final energy consumption and power generation were presented in this summary.

The final energy intensity in APEC has improved by 2.6% in 2014 from the 2013 final energy intensity level of 98.3 tonnes of oil equivalent (toe) per million USD (2010 USD PPP). The final energy excluding non-energy intensity fell to 88.5 toe per million USD (2010 USD PPP) in 2014 or 3.1% lower than the 2013 final energy excluding non-energy intensity levels. With 2005 as base year, final energy intensity and final energy excluding non-energy intensity was reduced by 14% and 14.9%, respectively in 2014. By interpolation, the energy intensity reduction goal of 45% is expected to be achieved in 2041 for final energy and 2038 for final energy excluding non-energy.

Total final energy consumption of renewables grew as fast as the total final energy consumption (TFEC) in 2010 by 9% to reach 410 Mtoe in 2014 from 377 Mtoe in 2010. Its share to TFEC however, was maintained at around 7% between 2010-14. In power generation, output from hydro and other renewables grew significantly by 30%, from 2 250 Twh in 2010 to 2 920 Twh in 2014. In terms of share, generation output from hydro and renewables accounted for 17% to 18% of the total power generation from 2010 to 2014, respectively. Assuming the annual average growth rate (AAGR) of renewables between 2010 and 2014 of around 2%, at this rate, the share of renewables in total final consumption will fall short of doubling its target share in 2030 as compared with 2010. Meanwhile, the trend to 2030 in power generation using the same estimation with 7% AAGR, will likely double the share of renewables in power generation from the 2010 levels.

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

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CONTENTS

Foreword.....	iii
Error! Not a valid bookmark self-reference.....	iv
Contents.....	v
Abbreviations and symbols	vi
Acronyms	vii
Australia.....	Error! Bookmark not defined.
Brunei Darussalam.....	Error! Bookmark not defined.5
Canada.....	Error! Bookmark not defined.5
Chile.....	Error! Bookmark not defined.3
China	Error! Bookmark not defined.8
Hong Kong, China	71
Indonesia	82
Japan.....	102
Republic Of Korea	112
Malaysia.....	Error! Bookmark not defined.21
Mexico.....	Error! Bookmark not defined.7
New Zealand.....	Error! Bookmark not defined.9
Papua New Guinea.....	Error! Bookmark not defined.9
Peru.....	Error! Bookmark not defined.59
The Philippines.....	Error! Bookmark not defined.
The Russian Federation	Error! Bookmark not defined.84
Singapore	Error! Bookmark not defined.8
Chinese Taipei	Error! Bookmark not defined.20
Thailand	Error! Bookmark not defined.30
United States.....	Error! Bookmark not defined.41
Viet Nam	Error! Bookmark not defined.

ABBREVIATIONS AND SYMBOLS

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

Tcf	trillion cubic feet
toe	tonnes of oil equivalent
tU	tonnes of uranium metal
TWh	terawatt-hours
W	watt

ACRONYMS

APEC	Asia–Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
APP	Asia–Pacific Partnership on Clean Development and Climate
ASEAN	Association of Southeast Asian Nations
CBM	coal-bed methane
CCS	carbon capture and storage
CCT	clean coal technology
CDM	clean development mechanism
CFL	compact fluorescent lamp
CME	coconut methyl ester
COP 15	15th Conference of the Parties to the United Nations Framework Convention on Climate Change
CSM	coal-seam methane
DUHF	depleted uranium hexafluoride
EAS	East Asia Summit
EGEDA	Expert Group on Energy Data and Analysis
ESTO	Energy Statistics and Training Office, The Institute of Energy Economics, Japan
EEZ	exclusive economic zone
FEC	final energy consumption
GDP	gross domestic product
GHG	greenhouse gas
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
IPP	independent power producer

JOA	joint operating agreement
JOB	joint operating body
LCD	liquid crystal display
LED	light-emitting diode
LEU	low-enriched uranium
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MDKB	measured depth below kelly
MOPS	Mean of Platts Singapore
NGL	natural gas liquids
NGO	non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PES	primary energy supply
PPP	purchasing power parity
PSA	production sharing agreement
PSC	production sharing contract
PV	photovoltaic
RE	renewable energy
TFEC	total final energy consumption
TPES	total primary energy supply
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VAT	value added tax

CURRENCY CODES

Code	Currency	Economy
AUD	Australian dollar	Australia
BND	Brunei dollar	Brunei Darussalam
CAD	Canadian dollar	Canada
CLP	Chilean peso	Chile
CNY	yuan renminbi	China

TWD	New Taiwan dollar	Chinese Taipei
HKD	Hong Kong dollar	Hong Kong, China
IDR	rupiah	Indonesia
JPY	yen	Japan
KRW	won	Korea
MYR	Malaysian ringgit	Malaysia
MXN	Mexican peso	Mexico
NZD	New Zealand dollar	New Zealand
PGK	kina	Papua New Guinea
PEN	nuevo sol	Peru
PHP	Philippine peso	Philippines
RUB	Russian ruble	Russia
SGD	Singapore dollar	Singapore
THB	baht	Thailand
USD	US dollar	United States
VND	dong	Viet Nam

AUSTRALIA

INTRODUCTION

Australia is the world's largest island economy and the world's sixth largest economy by land area. It lies in the Southern Hemisphere between the Indian and Pacific oceans. Its total land area of nearly 7.7 million square kilometres (km²) comprises six states and two territories. The population of around 24 million lives mostly in major cities or regional centres along the eastern and south-eastern seaboard. The economy has maintained robust economic growth for the last 24 years and has had an average annual growth rate (AAGR) of 3.4% from 1960 to 2016 (ABS, 2016). In 2014, gross domestic product (GDP) reached USD 961.4 billion (USD 2010 purchasing power parity [PPP]), a 2.5% increase from 2012 (EGEDA, 2016). Australia has the only developed economy in APEC to have recorded no annual recessions over the last 25 years (ATC, 2016).

Australia has abundant, high-quality energy resources that are likely to last for many decades at current rates of production. The Australian energy industry constituted 4% (AUD 66.8 billion) of the economy in 2014–15 (OCE, 2016c).

In 2014–15, Australia's primary energy production rose by 4.6% to 19 7651 petajoules (PJ) or 472 078 kilotonnes of oil equivalent (ktoe), compared with a 2.6% decrease in 2013–14 (OCE, 2016a), supported by growth in coal and gas production. Australia produces energy for both domestic consumption and export, but is becoming increasingly export-orientated. Energy exports grew by 5% compared with 2% in the previous year and accounted for 78% of domestic energy production in 2014–15 (OCE, 2016a).

Australia produces uranium for export only, while all other energy production supplies both domestic and international markets. The economy's energy production increased at an average annual rate of 1.1% from 2003–04 to 2013–14; however, it rose by 4.6% in 2014–15 (OCE, 2016c).

In 2014–15, coal accounted for 66% of Australia's primary energy production in terms of energy content, followed by uranium (15%) and gas (13%) (OCE, 2016c). Crude oil and liquefied petroleum gas (LPG) represented a further 4% of total energy production in energy content terms, and renewables represented 1.8% (OCE, 2016a). Relative to 2014–15, Australian export earnings from energy and mineral commodities decreased by 9.1% in 2015–16 to AUD 157 billion (OCE, 2016b).

As of 2013 Australia was the world's eighth-largest energy producer, accounting for around 2.4% of world energy production (OCE, 2016c). It is the world's largest exporter of metallurgical coal and the second-largest exporter of thermal coal (27% of total global coal exports in 2014) and a major exporter of uranium and liquefied natural gas (LNG) (10% of total global LNG exports) (OCE, 2016c). Given Australia's large energy resources and geographical proximity to burgeoning markets in the Asia-Pacific region, it is capable of meeting a significant proportion of the world's growing energy demand as well as its own domestic needs.

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves ^b	
Area (million km ²)	7.7	Oil (billion barrels)	3.8
Population (million)	24	Gas (billion cubic metres)	3 738
GDP (2010 USD billion PPP)	961	Coal (million tonnes)	105 246
GDP (2010 USD PPP per capita)	40 972	Uranium (kilotonnes U)	3 472

Note: Coal reserves are defined as recoverable economically demonstrated resources of black and brown coal.

Sources: a. EGEDA (2016); b. GA (2014).

¹ As of 2016, uranium is no longer included in total Australian energy production in the Australian Energy Statistics report. For comparability with previous versions of the APEC Overview, we have included uranium in total energy production (for uranium see Table S in OCE, 2016a).

BRUNEI DARUSSALAM

INTRODUCTION

Brunei Darussalam is a small monarchy state located on the northern coast of the island Borneo, where it shares its border with the state of Sarawak, Malaysia and faces the South China Sea in the North. With a total land area of around 5 765 square kilometres (km²), Brunei Darussalam consists of two unconnected parts and has four districts, namely Brunei Muara, Tutong, Belait and Temburong. With a small population of 417 thousand in 2014 and a gross domestic product (GDP) of USD 28 billion (2010 USD purchasing power parity [PPP]), Brunei ranks as one of the wealthiest economies in the APEC region, owing to its rich resources of crude oil and natural gas. Strategically located within a region with vast hydrocarbons wealth, Brunei Darussalam has been able to finance its development programs since the discovery of oil in 1929. Crude oil and natural gas has also dominated the economy's foreign trade, accounting for about 96% of total exports, while imports are heavily dominated by machinery, transport equipment, manufactured goods and food.

The dependency on crude oil and natural gas exports for revenue remains high, which accounts for more than 60% of the economy's GDP. This has generated a very high per capita GDP of USD 66 538 (2010 USD PPP per capita) in 2014, which has enabled the government to continue providing the citizens of Brunei Darussalam with a high standard of living, no income tax, free health and education among other services. As a heavily hydrocarbon-dependent economy, the government has put forth efforts to diversify the economic structure, but has not gained traction. This could be due to the proven reserves that are estimated to last up to 23 years in addition to new discoveries of oil and gas fields (BP, 2016). Nonetheless, a number of reforms focusing on new foreign direct investment (FDI), the growth of the private sector and other improvements have gradually been put into place for the economy's sustainable future.

Table 1: Key data and economic profile, 2014

Key data ^{a, b, c}		Energy reserves ^d	
Area (km ²)	5 765	Oil (billion barrels)	1.1
Population (thousand)	417.4	Gas (billion cubic metres)	300
GDP (2010 USD billion PPP)	28	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	66 538	Uranium (kilotonnes U)	–

Sources: a. DEPD (2015); b. EGEDA (2016); c. World Bank (2016); d. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Crude oil and natural gas are the main energy resources in Brunei Darussalam. In 2014, the economy's total primary energy supply of 3 906 kilotonnes of oil equivalent (ktoe) in 2014 represented a year-on-year growth of 18%. Natural gas accounted for the highest percentage share of the total primary energy supply with 84%, and the remaining 16% was supplied by oil.

The majority of natural gas is exported as liquefied natural gas (LNG) and a small percentage is used domestically to generate electricity and town gas. Oil produced is primarily used for petroleum products and mostly exported as term and spot cargoes. In 2014, APEC economies took a 78% share of the total crude oil and condensate exports, while the rest were to other Asian economies. Australia overtook the Republic of Korea as the biggest export destination in 2014 among APEC economies, at 18%.

CANADA

INTRODUCTION

In terms of land area, Canada ranks second only after Russia worldwide. The economy is a neighbour of the United States of America (the US) to the south and partly to the west (Alaska). The Canada-US border is the world's longest international border and extends from the Pacific Ocean to the west, the Atlantic Ocean to the east and the Arctic Ocean to the north. Canada is composed of ten provinces and three territories and has a population of 35.5 million (2014). Most Canadians reside near the southern borders. In 2014, Canada's gross domestic product (GDP) grew by 2.5% to USD 1 498 billion (2010 USD purchasing power parity [PPP]) and GDP per capita grew by 1.4% to USD 42 139 (EGEDA, 2016).

Canada is the fourth-largest energy producer in the APEC region and the fifth-largest in the world behind China, the US, Russia and Saudi Arabia. The energy sector directly contributed 7.3% to Canada's GDP in 2015 and indirectly contributed (through purchases of goods and services from non-energy industries) an additional 3.5% (NRCan, 2016c). In 2015, Canada exported CAD 102 billion worth of energy products and imported CAD 40 billion (NRCan, 2016a). Canada is one of the world's top four exporters of crude oil, natural gas, uranium and electricity (NRCan, 2016a).

The economy has extensive conventional and unconventional oil, natural gas and coal reserves as well as significant uranium deposits. It has the world's third-largest amount of proven oil reserves after Venezuela and Saudi Arabia. The reserves were estimated at 170 billion barrels, of which oil sands accounted for 98% (166 billion barrels) at the end of 2015 (CAPP, 2016b). The bulk of the oil sands reserves are in the province of Alberta, although the province of Saskatchewan is also rich in bitumen reserves. Conventional oil reserves exist in various amounts in six Canadian provinces and territories, namely British Columbia, Saskatchewan, Ontario, Manitoba, the North West Territories (NWT) and the Yukon. However, Alberta and Saskatchewan, and Newfoundland and Labrador have the largest onshore and offshore reserves, respectively (NEB, 2015).

Canada has substantial proven gas reserves, which are estimated at more than 70.2 trillion cubic feet (tcf) and equal to 1.1% of global reserves in 2015 (BP, 2016). The largest concentration of gas reserves is in Alberta and British Columbia; although Saskatchewan, Newfoundland and Labrador, New Brunswick, Nova Scotia, the NWT and the Yukon also have significantly smaller remaining established reserves (NEB, 2015).

Canada currently holds 8.7 billion tonnes of proven resources of coal-in-place, of which 6.6 billion tonnes are recoverable (Alberta Energy, 2016). More than 90% of Canada's coal deposits are located in western provinces, namely Alberta, British Columbia and Saskatchewan, while the rest are located in the eastern province of Nova Scotia (CAC, 2016).

Canada's uranium reserves, 486 399 tonnes as of 2016 (NEA, 2016), most of which are located in the Athabasca Basin of northern Saskatchewan, are the fourth-largest in the world after those of Australia, Kazakhstan and Russia. This basin has the world's largest high-grade deposits (NRCan, 2014a). These reserves are equal to 9% of the world's known resources, which are recoverable at a price of CAD 100 per kilogram. If the price of uranium were to increase in the future, new uranium deposits would become economically recoverable and, therefore, Canada's uranium resources would increase.

Table 1: Key Data and Economic Profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d, e, f}	
Area (million km ²)	9.9	Oil (billion barrels)	170
Population (million)	36	Gas (trillion cubic feet)	70
GDP (2010 USD billion PPP)	1 498	Coal (million tonnes)	6 600
GDP (2010 USD PPP per capita)	42 139	Uranium (kilotonnes U)	486

Sources: a. EGEDA (2016); b. StatCan (2015); c. CAPP (2016b); d. BP (2016); e. CAC (2016); f. NEA (2016).

CHILE

INTRODUCTION

Chile joined APEC in November 2004 and is one of the two South American member economies. It is located in the south-west of South America and shares borders with Peru to the north and Bolivia and Argentina to the west. Its coastline runs along the Pacific Ocean for 6 435 km, with an average width of 175 kilometres (km) and a land area of 756 102 square kilometres (km²). Administratively, Chile is divided into 54 provinces and 15 regions headed by regional governors (intendente) appointed by the President. In 2014, the economy's population was estimated at approximately 18 million, with 87% living in urban areas and 40% percent of the population residing in the Metropolitan Region (RM), (INE, 2016).

Chile's economic growth is based on solid macroeconomic fundamentals, such as fiscal responsibility, an independent central bank with an explicit inflation target and a floating exchange rate system. Chile has almost tripled its gross domestic product (GDP) per capita from USD 8 175 in 1990 to USD 19 438 in 2014 (2015 USD purchasing power parity [PPP]). It is one of the fastest growing economies in South America with an average annual growth rate (AAGR) of 4.9% between 1990 and 2014. In 2014, Chile's GDP reached USD 344 billion (2015 USD PPP), which represents an increase of 1.7% from 2013 levels. Foreign direct investments, closely related to mining investments, decreased by 35% to USD 17 billion in 2014 from 2013 levels owing to lower commodity prices (UNCTAD, 2015). Chile's economic activity is highly correlated with final energy consumption, where the mining and industry sectors accounted for 45% of final energy consumption in 2014 (IEA 2015) and represented around 24% of Chile's economic activity (INE, 2016). Almost 95% of the total exports were under trade agreements with 60 economies, including the European Union, Mercosur (a regional trade group comprising Argentina, Brazil, Paraguay, Uruguay and Venezuela), India, China, Japan, Korea, Mexico and the United States (DIRECON 2015).

Chile's economic activity shows a reduction in its final energy consumption, where the mining and industry sectors accounted for 35% of final energy consumption in 2015 and represented around 22% of Chile's economic activity (INE, 2016). The economy has shown a remarkable reduction in energy intensity.

Despite the diverse geography and abundant natural resources, the territory is very limited in fossil fuel resources, making Chile a net importer of fossil fuels; thus, one of its mainstay priorities revolves around a steady energy supply. Fossil fuel reserves are limited, so nearly the entire fossil fuel supply is imported (around 68% of total primary energy supply (TPES) in 2014). Chile imports around 96% of its oil, 81% of its gas and 67% of its coal, but despite high oil and gas import dependence, hydro and non-conventional¹ renewables contributed about 30% of TPES in 2014 (Energy Balance 2014 CNE – Chile – <http://datos.energiaabierta.cl/dataviews/111597/-/>).

Oil production declined from 15 million barrels in 1981 to 1.1 million barrels in 2015 (Agostini and Saavedra, 2009; ENAP (2016)), maintaining proven oil reserves of 1.9 million cubic metres (mcm) in 2013. The government is currently focusing on exploration investment through the National Petroleum Company (ENAP in Spanish). Exploration in natural gas during 2015 was around USD 290 million.

¹ Solar, Wind, Biomass and Biogas.

CHINA

INTRODUCTION

China is one of the world's most important emerging economies. It is located in north-east Asia and is bordered by the East China Sea, the Yellow Sea and the South China Sea. Its population of 1.4 billion is approximately one-fifth of the world's population. China has a land area of approximately 9.6 million square kilometres (km²) with diverse landscapes, which consist of mountains, plateaus, plains, deserts and river basins. Its total maritime area is 4.7 million km² and the length of its coastline is 32 000 km (NBS, 2016).

After reforming and opening up its economy in 1978, China entered a new period of high-speed growth. Its entry into the World Trade Organization (WTO) in 2001 contributed further to its prosperity in the first decade of the twenty-first century. In 2004, China overtook Japan as the leading Asian exporter and in 2009, surpassed Germany to become the world's leading exporter. By 2015, China's merchandise exports accounted for 13.8% of the world's trade exports (WTO, 2016). In 2015, China's gross domestic product (GDP) was 19 814 billion (USD purchasing power parity [PPP]), with the primary, secondary and tertiary industries accounting for 9%, 40.5% and 50.5% respectively (World Bank, 2016; NBS, 2016).

Because of its huge population and booming economy, China plays an increasingly important role in the world's energy markets. According to BP, China's energy consumption grew by 1.5% in 2015. This was less than one-third of the ten-year average growth rate of 5.3% and the slowest annual rate of growth since 1998 (BP, 2016). However, China remained the world's largest energy consumer and accounted for 23% of global energy consumption and 34% of net global energy growth in 2015 (BP, 2016). Its per capita primary energy supply, at 2.1 tonnes of oil equivalent in 2014, is far lower than that of many developed economies and below APEC's average of 2.9 tonnes of oil equivalent (toe) (EGEDA, 2016).

China is rich in energy resources, particularly coal. According to BP statistics published in June 2016, China had recoverable coal reserves of approximately 114.5 billion tonnes, proven oil reserves of 18.5 billion barrels and proven natural gas reserves of 3.7 trillion cubic metres (tcm) (BP, 2016). In addition, China has 400 gigawatts (GW) of economic hydropower potential, more than any other economy. Coal and oil resources have been utilised more extensively than natural gas and hydro for power generation and industrial development.

The reserves per capita of coal, oil and gas are all well below the worldwide average levels. The limitations of its energy reserves per capita force China to conserve its resources. From 2000 to 2014, the compound annual growth rate (CAGR) of final energy consumption was 8.7% and the CAGR of GDP was 9.8% (EGEDA, 2016).

Table 1: Key data and Economic Profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (million km ²)	9.6	Oil (billion barrels)	19
Population (million)	1 364	Gas (trillion cubic metres)	3.8
GDP (2010 USD billion PPP)	16 841	Coal (million tonnes)	114 500
GDP (2010 USD PPP per capita)	12 344	Uranium (kilotonnes U)	114 500

Sources: a. EGEDA (2016); b. NBS (2016); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

China's primary energy supply has expanded sharply since 2001. This expansion was driven mainly by rapid economic growth, especially in energy consumption by heavy industry. In 2014, the total primary energy supply increased 1.4% compared with 2013, reaching 2 895 million tonnes of oil equivalent (Mtoe), including net

HONG KONG, CHINA

INTRODUCTION

Hong Kong, China is a special administrative region of the People's Republic of China. It is a world class financial, trading and business centre of 7.2 million people located at the south-eastern tip of China. Hong Kong, China has no natural resources and thus all of its energy demand is imported. The energy sector consists of investor-owned electricity and gas utility services.

In 2014, the per capita gross domestic product (GDP) of Hong Kong, China was USD 51 545 (2010 USD purchasing power parity [PPP]), among the highest of the APEC economies. The GDP increased 13% in real terms after 2010 to USD 373 billion (2010 USD PPP). The service sector remained the dominant driving force of overall economic growth, accounting for 89% of the GDP in 2014 (ESTO APERC, 2016). Hong Kong, China is driven by its financial, higher value-added and knowledge-based services. To stay competitive and attain sustainable growth, Hong Kong, China needs to restructure and reposition itself not only in light of the challenges posed by globalisation, but also due to its closer integration with mainland China. The Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) is a manifestation of the advantages of 'one country, two systems'. As part of the liberalisation of trade in goods under CEPA, all products imported from Hong Kong, China to mainland China enjoy tariff-free treatment.

With the support of mainland China under CEPA and the Framework Agreement on Hong Kong/Guangdong Cooperation, Hong Kong, China is poised to reinforce and enhance its status as an international centre for financial services, trade and shipping, as well as an advanced global manufacturing and modern services base. The central government has announced that it will actively liaise with Guangdong to identify favourable treatment and implement opportunities for Hong Kong's people and enterprises in the planning and development of Nansha, Qianhai and Hengqui. It will also increase the number of Economic and Trade Offices in Asia to help business and investors tap Asian markets. Moreover, the government has invited the submission of proposals to complement the National 13th Five-Year Plan (Policy Address, 2015).

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves ^b	
Area (km ²)	1 104	Oil (million barrels)	—
Population (million)	7.2	Gas (billion cubic metres)	—
GDP (2010 USD billion PPP)	373	Coal (million tonnes)	—
GDP (2010 USD PPP per capita)	51 545	Uranium (kilotonnes U)	—

Source: EGEDA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Hong Kong, China has no domestic energy reserves or petroleum refineries; it imports all of its primary energy needs. A substantial share of imported energy is converted into secondary energy such as electricity and gas for final consumption. The total primary energy supply in Hong Kong, China was 14 million tonnes of oil equivalent (Mtoe) in 2014, 0.26 Mtoe higher than 2013. Coal maintained the highest share of the total primary energy supply (57%), followed by oil (22%), gas (16%) and other sources (6%) (EGEDA, 2016).

In 2015, the total installed electricity generating capacity in Hong Kong, China was 12 645 megawatts (MW) (EGEDA, 2016). All locally generated power is thermal fired. Electricity is supplied by CLP Power,

INDONESIA

INTRODUCTION

Indonesia is the world's largest archipelagic state located south-east of mainland South-East Asia, between the Pacific Ocean and the Indian Ocean. Indonesia's territory encompasses 17 504 large and small islands and large bodies of water at the equator over an area of 7.9 million square kilometres (km²). This constitutes Indonesia's exclusive economic zone. The economy's total land area (25% of its territory) is about 1.9 million square kilometres. The population was 254 million in 2014.

Indonesia had a gross domestic product (GDP) of around USD 2 500.88 billion and a per capita GDP of USD 9 828 in 2014 (2010 USD purchasing power parity [PPP]). Excluding the oil and gas sector, manufacturing industries accounted for the largest component of GDP in 2013 (22%), followed by agriculture, forestry and fishing with a combined share of about 14%. In terms of exports, the main export products of the economy are mineral fuels, lubricants and related materials, which together account for about 29% of total export value, followed by manufactured goods classified by materials at 13%. In 2014, Indonesia attained economic growth of 5.02%, a decrease of 0.54% from 2013 (BPS, 2016).

Domestic oil, gas and coal reserves have played an important role in Indonesia's economy as sources of energy, industrial raw materials and foreign exchange. In 2014, oil and gas exports contributed 11% and coal exports contributed 5% of Indonesia's total exports. Overall, tax and non-tax revenue from oil, gas and minerals including coal accounted for 19% of the Indonesian Government's budget in 2014 (ESDM, 2015a).

Indonesia's proven fossil energy reserves at the end of 2014 consisted of 7.6 billion barrels of oil, 4.3 trillion cubic metres of natural gas and 31 billion tonnes of coal.

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves ^{b, c}	
Area (million km ²)	1.9	Oil (billion barrels)	7.4
Population (million)	254	Gas (trillion cubic metres)	4.3
GDP (2010 USD billion PPP)	2 501	Coal (billion tonnes)	32
GDP (2010 USD PPP per capita)	9 828	Uranium (kilotonnes U)	6.3

Sources: a. EGEDA (2016); b. ESDM (2015b); c. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, Indonesia's total primary energy supply (TPES) was 227 117 kilotonnes of oil equivalent (ktoe) of commercial energy, consisting of oil (38%), coal (20%), natural gas (16%) and other energy (mainly hydropower, geothermal, and biomass) (27%). Indonesia is a net exporter of energy; overall energy exports of crude oil, condensates, natural gas, liquefied natural gas (LNG), petroleum products and coal totalled 220 920 ktoe in 2014. Total energy exports in 2014 slightly increased by 13% from 2013 (193 983 ktoe), a decrease driven primarily by a decrease in the price of exported coal.

OIL

In 2014, Indonesia produced 84 530 ktoe of crude oil and condensates; of this, 15 391 ktoe (38%) was exported, a decrease of 14% compared to 2013. Because oil production has declined significantly over the past decade (in 1997 Indonesia produced 72 474 ktoe of crude oil and condensates), the economy imported 17 079 ktoe of crude oil and 32 608 ktoe of petroleum products in 2014 in order to meet its domestic oil requirements. This represents an increase of 3% from a total of 31 660 ktoe in 2013 (EGEDA, 2016; ESDM, 2015b).

JAPAN

INTRODUCTION

Located in East Asia, Japan comprises several thousand islands, the largest of which are Honshu, Hokkaido, Kyushu and Shikoku. Most of its land area, approximately 377 800 square kilometres (km²), is mountainous and thickly forested. Japan is the third-largest economy in the world and among the APEC economies, after the United States and China. Its real GDP in 2014 was approximately USD 4 437 billion (2010 USD purchasing power parity [PPP]). In 2014, Japan's population of 127 million people had a per capita income of USD 34 902. The GDP decreased by 0.03% in 2014 compared to 2013. Since indigenous energy resources are modest, Japan imports nearly all of its fossil fuels to sustain economic activity. The proven energy reserves¹ included approximately 44 million barrels of oil, 21 billion cubic metres (bcm) of natural gas and 347 million tonnes (Mt) of coal.

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves	
Area (thousand km ²)	377.8	Oil (million barrels) ^b	44
Population (million)	127	Gas (billion cubic metres) ^b	21
GDP (2010 USD billion PPP)	4 437	Coal (million tonnes) ^c	347
GDP (2010 USD PPP per capita)	34 902	Uranium (kilotonnes U)	–

Sources: a. EGEDA (2016); b. C. Xu, et al. (2015); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, Japan's total primary energy supply was about 448 million tonnes of oil equivalent (Mtoe), 2.5% less than in 2013. By fuel type, oil contributed the largest share (43%), followed by coal (26%) and natural gas (24%). In 2014, the net imports of energy sources accounted for 95% of the total primary energy supply.

In 2014, Japan was the third-largest oil consumer of the world and among the APEC economies (4.3 million barrels per day [Mbbbl/D]), after the United States and China (BP, 2016), and almost all of the oil was imported. The bulk of the imports (73% in 2014) were from economies in the Middle East such as Saudi Arabia; the United Arab Emirates and Qatar (BP, 2015). In 2014, the primary oil supply was 205 Mtoe, a decrease of 6.4% from the previous year.

Japan is endowed with only limited coal reserves, 347 Mt, which is less than twice the consumption in fiscal year² (FY) 2014: 110 Mt of steam coal and 72 Mt of coking coal (METI, 2016a). It is one of the world's largest importers of coking coal for steel production and steam coal for power generation, as well as for pulp, paper, and cement production. Japan's main steam coal suppliers are Australia; Indonesia and Russia, while those for coking coal are Australia; Indonesia and Canada.

Natural gas resources are also scarce in Japan. Domestic reserves stand at 21 bcm, which is less than one-fifth of the annual consumption in 2014, and are located in the prefectures of Niigata, Chiba and Fukushima. In 2014, the domestic demand was met almost entirely by imports in the form of liquefied natural gas (LNG) (BP, 2016), from Australia (21%); Qatar (18%); Malaysia (17%); Russia (10%) and other economies. LNG imports to Japan comprised 36% of the total global LNG trade in 2014. Natural gas is mainly used for electricity generation, followed by reticulation as city gas and use as an industrial fuel. The primary natural gas supply was 107 Mtoe in 2014, an increase of 2% from the previous year.

¹ Oil and natural gas are as of January 2016. Coal is as of the end of 2015.

² The fiscal year starts in April in Japan.

REPUBLIC OF KOREA

INTRODUCTION

The Republic of Korea is located in north-east Asia between China and Japan. It has an area of 100 266 square kilometres (km²) and a population of 50 million people as of 2014. Korea's population density is very high, with an average of more than 500 people per km². Approximately 20% of the population lives in Seoul, Korea's capital and its largest city. The economy's geography consists of hills and mountains with wide coastal plains in the West and the South. The climate is relatively moderate with four distinct seasons. Air conditioning is commonly necessary during the tropical hot summers and heating is required during the bitterly cold winters.

During the last few decades, Korea has become one of Asia's fastest-growing and most dynamic economies. The gross domestic product (GDP) has increased at a rate of 6.4% per year from 1980 to 2014, reaching USD 1 698 billion (2010 USD purchasing power parity [PPP]) in 2014. GDP per capita (2010 USD PPP) income in 2014 was USD 33 667, more than six times higher than in 1980. Korea's major industries include the semiconductor, shipbuilding, automobile, petrochemical, digital electronic, steel, machinery and parts and materials industries.

Korea has few indigenous energy resources. It has no oil resources except a small amount of condensate, only 320 million tonnes of recoverable coal reserves and 5.7 billion cubic metres of natural gas. Thus, to sustain its high level of economic growth, Korea imports large quantities of energy products. Korea imported about 87% of its primary energy supply in 2014. In the same year, it was the world's fifth-largest importer of oil, seventh-largest importer of liquefied natural gas (LNG) and fourth-largest importer of coal.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	100 266	Oil (million barrels)	—
Population (million)	50	Gas (billion cubic metres)	5.7
GDP (2010 USD billion PPP)	1 698	Coal (million tonnes)	320
GDP (2010 USD PPP per capita)	33 667	Uranium (kilotonnes U)	—

Sources: a. UN (2016); b. EGEDA (2016); c. EIA (2016); d. KEEI (2015).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Korea's total primary energy supply increased almost sevenfold between 1980 and 2014 from 38 million tonnes of oil equivalent (Mtoe) in 1980 to 269 Mtoe in 2014. In particular, from 1990 to 2000, energy supply increased at an annual average rate of 7.3%, far exceeding the economic growth rate of 6.5% for the same period. Likewise, per capita primary energy supply grew from 1 tonne of oil equivalent (toe) in 1980 to 5.3 toe in 2014. This increase was similar to that of Japan and most European economies.

In 2014, Korea's total primary energy supply was 269 Mtoe, a 1.7% increase from the prior year. In terms of energy source, oil represented the largest share (36%), followed by coal (30%) and gas (16%). The remaining 17% of the primary energy supply came from nuclear and hydro energy sources. Energy imports accounted for about one-third of Korea's total import value in 2014.

The oil supply in 2014 was 96 Mtoe, a 0.2% decrease from the previous year. In 2014, the economy imported 84% of its crude oil from the Middle East. With regard to coal, the supply in 2014 totalled 82 Mtoe, a 4.9% increase from the prior year. Korea has modest reserves of low-quality, high-ash anthracite coal, which are insufficient to meet its domestic demand. Thus, almost all of Korea's coal demand is met by imports. Korea

MALAYSIA

INTRODUCTION

Malaysia is located in South-East Asia and lies entirely in the equatorial zone, with an average daily temperature varying between 21°C to 32°C. It has a total territory of approximately 330 323 square kilometres (km²), covering eleven states and two federal territories in Peninsular Malaysia as well as two states and one federal territory on the island of Borneo (EPU, 2016). In 2014, Malaysia's population stood at 29.9 million, an increase of 1.5% from the 2013 level of 29.5 million (EGEDA, 2016).

Malaysia's gross domestic product (GDP) reached USD 717 billion (2010 USD purchasing power parity [PPP]) in 2014, an improvement of 6% from USD 676 billion in 2013. This represented a 4.4% improvement in GDP per capita from USD 22 945 in 2013 to USD 23 965 (EGEDA, 2016). The largest contributions to GDP were from services (53%), manufacturing (23%), agriculture (9%) and mining (9%) (EPU, 2016). In 2015, the main export products were electrical and electronic (E&E) products (approximately 36% of total exports), chemicals and chemical products (7.1%) petroleum products (7%) and liquefied natural gas (LNG) (6%) (MATRADE, 2016).

When compared with other large economies in the Asia-Pacific Economic Cooperation (APEC), Malaysia's energy resources can be considered moderate in absolute terms. A 2016 data published by the Energy Commission of Malaysia shows that the East Malaysian states hold nearly two-thirds of Malaysia's energy reserves; the rest are located in Peninsular Malaysia. The economy's oil reserves (including condensate) were 5.8 billion barrels, 40% of which is found in Peninsular Malaysia (the Malay basin). The natural gas reserves of the economy are estimated at approximately 2.8 trillion cubic metres or 100 trillion cubic feet (Tcf) in 2014. More than half of the reserves are found in the Sarawak basin. The coal reserves, assessed at 1.9 billion tonnes, are located mostly in Sarawak and Sabah (EC, 2016).

Located near the equator, where sunshine is abundant, Malaysia has huge potential to develop solar power, despite the cloudy appearance that constantly manifests itself in the region. It also has vast potential for biomass as an energy source due to the presence of palm oil plantations and industries in the economy. As of 2016, Malaysia accounted for 30% of world's palm oil production and 37% of the world's palm oil exports (MPOC, 2016). This production creates abundant agricultural residue, particularly empty fruit bunches.¹

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	330 323	Oil (billion barrels)	5.8
Population (million)	30	Gas (trillion cubic metres)	2.8
GDP (2010 USD billion PPP)	717	Coal (million tonnes)	1 938
GDP (2010 USD PPP per capita)	23 965	Uranium (kilotonnes U)	—

Sources: a. EPU (2016); b. EGEDA (2016); c. EC (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 78 626 kilotonnes of oil equivalent (ktoe) in 2014, an increase of 1.4% from the 2013 level of 77 567 ktoe. Oil contributed the largest share at approximately 41% (32 532 ktoe), followed by natural gas with 37% share (29 213 ktoe) and coal with a 19% share (15 258 ktoe). Other resources include hydro, which in 2014 provided a minimal share of approximately 2% (1 625 ktoe) to the primary energy

¹The process of palm oil production generates large amounts of residue, such as empty fruit bunches (EFBs) of palm. EFBs are a type of woody biomass with a calorific value of 4 400 kilocalories per dry kilogram (kcal/kg-dry); they are regarded as a safe and promising biofuel resource because they have a very low chlorine content (Asia Biomass 2009).

MEXICO

INTRODUCTION

Mexico, officially known as the United Mexican States (*Estados Unidos Mexicanos* in Spanish), is a North American federal republic bordered by the United States to the north, Belize and Guatemala to the south, and the Atlantic and Pacific Oceans on the east and west, respectively. For cultural and historic reasons, Mexico has been commonly regarded as a Latin American economy, although its geographical location and economic integration are in North America.

Mexico is rich in biodiversity, with abundant fossil and renewable energy resources across its land area of approximately 2 million square kilometres (km²). There are diverse climatic conditions across the Mexican territory that range from very dry with high temperatures in the north, to very humid with high temperatures in the south, mild temperatures in the centre and a warm coast. The total population of Mexico by mid-2015 was more than 119 million (INEGI, 2015). Mexico City is the political capital of the economy and is one of the largest urban centres in the world. It is home to more than 20 million people, with nine million living in Mexico City proper and more than 11 million in the 60 surrounding municipalities in the states of Mexico and Hidalgo (INEGI, 2013). After Mexico City, the other most important cities of the economy are Guadalajara and Monterrey, which are located in the west-central and northeastern sides of the territory, respectively.

Several major reforms and free trade agreements introduced since the 1990s have resulted in macroeconomic stability and increased flows of foreign direct investment into Mexico, making it one of the largest developing economies with a robust manufacturing industry. Despite these milestones, the growth of the Mexican economy between 2000 and 2013 has been modest, rising little more than 2% annually, with the real GDP in 2014 reaching USD 1 942 billion (2010 USD purchasing power parity [PPP]) (EGEDA, 2016).

The accomplishment of significant political, economic and energy reforms, was expected to underpin a more robust economy, but despite the prevalent environment of low oil prices since 2014, the GDP grew by 2.3% from 2013 to 2014. Despite this growth and the efforts in the last decade to improve standards of living, the growth of Mexico's GDP on a per capita basis has been small, with an annual rate of 0.7% from 2000 to 2014 (EGEDA, 2016). In addition, by the end of 2014, around 46% of the Mexican population was deemed as living under poverty conditions, with this share being roughly the same as in 2010 and 2012 (CONEVAL, 2015).

Energy, particularly oil, is a significant component of the Mexican economy, and is poised to become more relevant through the energy reform of 2013. In 2014, the value of crude oil exports represented 13% of Mexico's total exports, yet they provided 31% of the government's total revenue, from which social development and other public services are funded (Banxico, 2017). However, in 2015 this contribution dropped to around 20% due to the low oil prices, highlighting the risks of such reliance on a single resource.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	2	Oil (billion barrels)	11
Population (million)	125	Gas (billion cubic metres)	348
GDP (2010 USD billion PPP)	1 943	Coal (million tonnes)	1.2
GDP (2010 USD PPP per capita)	15 493	Uranium (kilotonnes U)	2.9

Sources: a. World Bank (2016); b. EGEDA (2016); c. BP (2016); d. NEA (2014).

NEW ZEALAND

INTRODUCTION

New Zealand is an island economy in the South Pacific, comprised of two main islands, the North Island and South Island, and numerous outer islands. While its land area is between that of Japan and the United Kingdom, its low population of about 4.5 million is comparable to a medium-sized Asian city. Due to its remote location, New Zealand has no electricity or pipeline connections to other economies. The economy has a mature economy with a per capita gross domestic product (GDP) of about USD 33 356 (2010 USD purchasing power parity [PPP]) in 2014.

New Zealand is self-sufficient in all energy forms except oil. It has a vast renewable energy potential, which in 2014 accounted for 80% of electricity generation, largely from hydro with increasing support from geothermal and wind. For fossil energy resources, the proven and probable (2P) reserves are more modest, including: 128 million barrels (Mbbbl) of oil and liquefied petroleum gas (LPG), 56 billion cubic meters (bcm) of natural gas and the BP Statistical Review (2016) estimates coal reserves at 571 million tonnes at the end of 2014 (BP, 2016; MBIE, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	269 652	Oil (million barrels)	100
Population (million)	4.5	Gas (billion cubic metres)	51
GDP (2010 USD billion PPP)	150	Coal (million tonnes)	571
GDP (2010 USD PPP per capita)	33 356	Uranium (kilotonnes U)	–

Sources: a. World Bank (2016); b. EGEDA (2016); c. MBIE (2016); d. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

In 2014, New Zealand's total primary energy supply (TPES) was 20 500 kilotonnes of oil equivalent (ktOE), a 6.2% increase from the previous year. Geothermal, wind, solar, and others were the major contributors (40%) and the main cause for the increased geothermal capacity came online. This was followed by oil (32%), gas (21%) and coal (7%). It is worth noting that geothermal electricity generation has an efficiency of 13% in New Zealand (MBIE, 2016). As such, the geothermal share of the total final energy consumption (TFEC) is significantly smaller than its primary energy supply share. New Zealand's energy self-sufficiency (indigenous production/primary energy supply) in 2014 was 83%, remaining stable during the last two years, but significantly lower than in 2011 (88%) due to the waning of oil production. Since 2000, growth in New Zealand's primary energy supply has been modest, increasing at an average annual rate of 1.4% (EGEDA, 2016).

Coal is New Zealand's most abundant fossil energy resource, predominantly available in the form of lower value lignite. However, almost all coal production comprises sub-bituminous and bituminous coals. In 2014, coal production dropped 14% after the 5% decrease in 2013 on an energy-equivalent basis compared with 2012 as domestic producers struggle to compete with low coal prices (MBIE, 2016).

Oil is sourced from 19 fields in the Taranaki region in the North Island (MBIE, 2016). The production of crude oil, natural gas liquids and condensate increased by 12% on an energy-equivalent basis in 2014 compared with 2013 as the Maari field redevelopment increased production. Oil production peaked in 2008 underpinned by the coming onstream of the newest fields Pohokura, Kupe, Tui and Maari, and from the onshore fields such as Cheal and Sidewinder (MBIE, 2015). Most of New Zealand's oil is exported due to its high quality (it is 'sweet' and 'light'). The vast majority of domestic oil demand is met by importing heavier crudes and refining it at New Zealand's only refinery at Marsden Point and importing refined oil products. Indigenous production accounted for around 33% of the domestic oil demand in 2014.

PERU

INTRODUCTION

Peru is a constitutional republic located on the west central coast of South America, bordered by the Pacific Ocean, with Chile to the south, Ecuador and Colombia to the north, and Brazil and Bolivia to the east. With a land area of 1.3 million square kilometres (km²), Peru is divided into three main geographical regions: the Costa to the west, the mountain region (Andes Mountains) and the Amazon region (Selva) covered by the Amazon rainforest. The economy is divided into 25 political departments (administrative regions). In 2014, the economy had a total population of about 30.97 million, an increase of 1.3% from the previous year (EGEDA, 2016). In 2015, approximately 22% of Peru's population was considered poor and 4.1% extremely poor (INEI, 2015a). The major population centre of Peru is the Lima region, which represents 9 million people, nearly one-third of the total population (INEI, 2015b). The urbanisation rate of Peru is 76% (INEI, 2011).

Since 1990, the economy has been driven by its internal demand, mainly private investments, exports and domestic consumption. Peru has a market-oriented economy, and in 2015, its key segments were services (49%), manufacturing and construction (18%), and mining (12%) (BCRP, 2015). Between 2000 and 2015, the average annual growth rate (AAG) was 4.8% higher than the level reached in 2014 (2.4%) due to the deceleration of emerging economies and global uncertainty. This resulted in negative growth rates in private and public investments (-4.4% and -7.5%, respectively), and a reduction in the private consumption growth rate from 4.1% in 2014 to 3.4% in 2015 (BCRP, 2015). Mining is especially important, since Peru is a major global producer, ranking third in silver, third in zinc, third in copper and tin, fourth in lead, and sixth in gold (USGS, 2016). Consequently, mineral exports have consistently accounted for a significant share of the export revenue of the economy, contributing as much as 55% in 2015 (BCRP, 2015). During 2015, the energy, oil and transport sectors used around 20% of the USD 24 billion of foreign direct investments (Proinversion, 2015).

By 2014, the GDP of the economy reached USD 347 billion (2010 USD purchasing power parity [PPP]), with its GDP per capita growing at 1 to reach USD 11 220 (EGEDA, 2016). In addition, the foreign reserves reached a record USD 61 billion while the fiscal balance was 2.1% of the GDP (BCRP, 2015).

Owing to its scarce oil resources, Peru is a net importer of oil. Specifically, domestic production is insufficient to meet the economy's demands. However, since most crude oil produced is of extra-heavy quality and domestic refineries are unable to process it, a substantial share of the domestic production is exported. In contrast, the proven gas reserves in the economy were 0.4 trillion cubic metres (tcm) in 2014. The Camisea Gas Project is the largest energy project in Peru, which commenced operations in 2004 by supplying gas to the local market. By 2010, Peru started to export through the LNG port located in Pisco (south of Lima).

Table 1: Key data and economic profile, 2014

Key data ^a		Energy reserves ^{b, c, d}	
Area (million km ²)	1.3	Oil (million barrels)	1 400
Population (million)	30.97	Gas (trillion cubic metres)	0.4
GDP (2010 USD billion PPP)	348	Coal (million tonnes)	9.9
GDP (2010 USD PPP per capita)	11 220	Uranium (kilotonnes U)	1.4

Sources: a. EGEDA (2016); b. BP (2014); c. MEM (2014); d. NEA (2014).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Peru's total primary energy supply (TPES) in 2014 was 22 788 kilotonnes of oil equivalent (ktoe), increasing 5.9% from 2013, due to the increasing production of natural gas. By energy source, in 2014, almost half (10 027 ktoe) of the TPES was from oil, 32% from natural gas (7 225 ktoe) and 4% from coal (841 ktoe). Non-

THE PHILIPPINES

INTRODUCTION

The Philippines is an archipelago comprised of 7 107 islands with total land area of 300 000 square kilometres (km²) and coastline of about 36 289 kilometres. The economy is located in the south-eastern part of Asia and bordered by the Philippine Sea to the east and west, the Luzon Strait to the north and the Celebes Sea to the south. It has three major geographical divisions, namely: Luzon, Visayas and Mindanao islands. Manila City, located in Luzon, is the capital of the Philippines. In 2014, the economy's total population was 99.1 million, an increase of 1.6% from 2012 level (EGEDA, 2016). From the 2015 World Population ranking, it is the twelfth most populated economy in the world (WB, 2015).

The Philippines posted a 6.1% growth rate in its gross domestic product (GDP), USD 608.5 billion in 2013 to USD 645.8 billion in 2014 (2010 USD purchasing power parity [PPP]) (EGEDA, 2016), lower than the 7.1% growth achieved during the previous period. The economy was able to realise such growth despite several challenges such as a lower level of government spending (PIDS, 2015). Continuation of high growth in the past few years is necessary in the fight against poverty. Growth drivers in 2014 were household consumption and net exports on the demand side, and the industry and services sectors on the supply side. Household consumption increased by 5.4%, and exports exhibited 12% growth from 2013 levels. As for the supply side, the service sector contributed most to the growth, which accounted for almost 60% of the GDP. The industry sector had the second-highest contribution with manufacturing provided the largest share (overall industry growth) amidst the ongoing revival program of the government for the manufacturing sector. However, the agriculture sector showed slow growth in most of its sub-sectors with reductions in coconut and coffee production (Navarro, 2015). The GDP per capita also displayed a 4.5% growth, USD 6 514 in 2014 from USD 6 236 in 2013 (EGEDA, 2016).

With a better economic outlook, the government faces a great challenge on ensuring energy supply stability to meet growing domestic demand. Central to the policy of the government is the aggressive development and utilisation of indigenous energy resources for both fossil fuels and renewable energy. The government has continued the implementation of the Philippine Energy Contract Round (PECR) to attract investments in oil, gas and coal exploration. The economy has modest proven reserves of around 76 million barrels of oil (includes condensate), 24 billion cubic metres (834 billion cubic feet [Bcf]) of natural gas and 440 million tonnes (Mt) of coal (DOE, 2015a).

The passage of the Renewable Energy Act of 2008 (R.A. 9513) offered fiscal and non-fiscal incentives to promote and encourage more investments in renewable energy development and to expand its share in the energy mix. Under the National Renewable Energy Program (NREP), the government has set an aspirational target of more than doubling the RE-based installed capacity in power generation by 2030 from 2010 levels, or 15 299 MW (2030) from 5 542 MW (2010 level). The government likewise intends to increase RE contribution for non-power applications in the primary energy mix by 2030 (DOE, 2011).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (t km ²)	300	Oil (million barrels)	76
Population (million)	99	Gas (billion cubic metres)	24
GDP (2010 USD billion PPP)	646	Coal (million tonnes)	440
GDP (2010 USD PPP per capita)	6 514	Uranium (kilotonnes U)	—

Sources: a. WB (2015); b. EGEDA (2016); c. (DOE, 2015a).

PAPUA NEW GUINEA

INTRODUCTION

Papua New Guinea (PNG), officially the Independent State of Papua New Guinea, is a tropical country located in Oceania, South Pacific Ocean, land-bordered by Indonesia and to the north of Australia. The 600 small island economy is known as ‘the land of a million different journeys’. Achieving independence in 1975, PNG celebrated its fortieth year as an independent nation in 2015.

The mostly mountainous and covered in tropical rainforests Papua New Guinea is along the ‘Ring of Fire’ that frequently faces earthquakes, volcanic eruptions and even tsunamis. High temperatures and humidity throughout the year and wet and dry seasons are characteristics of its climate. Papua New Guinea is endowed with natural resources, such as gold, copper, rare earth elements, nickel, cobalt, chromium, molybdenum, iron and platinum (MRA website).

The population of approximately seven million is young and growing, strikingly diverse with the representation of ‘thousands of different tribes, dances, adventures, traditions and 800 indigenous languages’, more than anywhere else in the world. Population density is as low as about 16.8 thousand per km², ranked 184th in the world (World Bank, 2015).

PNG’s economy is characterised by two main sectors: the labour-intensive sector (agricultural, forestry, and fishing) and the export-earning sector (minerals and energy extraction). The country experienced strong economic growth with an annual average rate of nearly 7% between 2007 and 2010 (ADB, 2012), but due to the global economic crisis, especially in South-East Asia and the Pacific, it slowed down from 2011-2013, but has signs of regaining in 2014–2015 to 8-9%. In 2014, PNG’s real gross domestic product (GDP) was estimated at USD 19.92 billion (2010 USD purchasing power parity - PPP), an increase of 8.5% from 2013; the GDP from the previous year was 5.5% (EGEDA, 2016). PNG’s GDP per capita ranks last in the APEC economies and 180th of the world. Basic socio-economic data are provided in Table 1.

Papua New Guinea became a member of APEC in 1993, together with Mexico. Additionally, the economy is also a member of the African, Caribbean and Pacific Group of States, Non-Aligned Movement, Pacific Community, Pacific Islands Forum, United Nations and World Trade Organization (The Commonwealth, 2017).

Table 1: Key data and economic profile, 2014

Key data		Energy proved reserves (end 2015)	
Area (km ²)	462 840	Oil (million barrels)	200
Population (million)	7.5	Gas (billion cubic metres)	141
GDP (2010 USD billion PPP)	20	Coal (million tonnes)	—
GDP (2010 USD PPP per capita)	2 668	Uranium (kilotonnes U)	—

Sources: EGEDA (2016); The Commonwealth (2017); CIA (2016); WEC (2016).

ENERGY SUPPLY AND DEMAND

STAKEHOLDERS IN ENERGY SECTOR

Under Prime Minister Peter O’Neill’s government, the Department of Petroleum and Energy (DPE) is the ministerial regulatory body in charge of all energy-related issues, especially policy. Inside the department, the petroleum and energy divisions divide themselves to be respectively in charge of non-renewable and upstream activities (oil, gas); and renewable activities, concerning hydro, geothermal, solar and biomass power (Kone and Tai, 2010). The Mineral Resources Authority (MRA) is another governmental agency specialising in administration of mining activities, executed on behalf of the Government under the Ministry of Mining.

RUSSIA

INTRODUCTION

Russia is the world's largest economy, spanning over 17 million square kilometres (km²). It is the only APEC economy located in both Europe and Asia, surrounded by the Arctic and the North Pacific oceans. Its territory is characterised by broad plains west of the Urals, vast coniferous forests in Siberia, the tundra along the Arctic seaboard and uplands and mountains in the southern regions. Russia's vast natural resources include major deposits of coal, natural gas, oil and other minerals. Despite its land area advantage, two-thirds of the economy is a zone of high-risk agriculture, due primarily to its continental climate, which is either too cold or too dry.

From 1993 to 2008, the Russian population declined from 148 million to 143 million; however, from 2009 to 2014, there was an increase to 144 million (EGEDA, 2016). As of January 1, 2017, the population has reached 147 million, a 0.2% or 260 thousand increase compared to 2016. The share of urban and rural population has remained unchanged from 2009 at 74% and 26% respectively. Russia's average population density is 8.4 people per square kilometre, with the majority of the population living in the European part of the economy (Rosstat, 2016).

Russia's economic growth has slowed from the 2012 level of 3.5% to 0.7% in 2014 with an average growth rate of 4.8% for the period 2000–13. In 2009, the global economic and financial crisis affected the Russian economy, with the GDP declining by 7.8% in 2009 from the 2008 level. A period of recovery (2010–13) was followed by another economic slowdown due to international sanctions from the European Union.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{b, c}	
Area (million km ²)	17	Oil (billion barrels)	102
Population (million)	144	Gas (trillion cubic metres)	32
GDP (2010 USD billion PPP)	3 223	Coal (billion tonnes)	157
GDP (2010 USD PPP per capita)	22 413	Uranium (kilotonnes U)	342

Note: NEA data is for uranium reserves recoverable at a production cost of less than 260 USD per kg.

Sources: a. EGEDA (2016); b. BP (2016); c. NEA (2016).

Russia's major industries include oil and gas production, petroleum refining, mining, iron and steel, chemicals and machinery. The economy's energy sector accounts for 27% of the GDP, 63% of the total exports and 27% of the total capital investment.

In terms of proven reserves, as of 2016, Russia holds 17% of the world's gas, 6% oil, 18% coal (BP, 2016) and about 5.8% of its reasonably assured resources of uranium (NEA, 2016).

The proven natural gas reserves in Russia, estimated at 32 trillion cubic metres, should be adequate to meet both the domestic market and export demands for the near future.

As at 2014, over 80% of Russia's oil is produced from the fields discovered before 1990, and are in later stage of development. This highlights the importance of new fields. Since 2005 the share of Western Siberia, including Khanty-Mansi Autonomous Okrug, has declined from 71% to 63%. The second largest oil-producing region is Volga-Urals accounting for 24% of production (MNRE, 2016).

At the current rate of domestic coal consumption, the reserves should be sufficient for 800 years.

The refining industry in Russia includes about 30 major refineries with a total capacity for primary processing of about 277 million tonnes (Mt) of crude oil per year (ME, 2016).

Russia has the world's largest and oldest district heating system with centralised heat production and distribution networks in most major cities. The system has a high number of combined heat and power (CHP) installations. Given the obsolescence of this heating infrastructure, a considerable amount of energy

SINGAPORE

INTRODUCTION

Singapore is located south of the Malaysia Peninsula between the Strait of Malacca and the South China Sea. This South-East Asian economy's land area was 714 square kilometres (km²) in 2014 with a population of 5.5 million.

Singapore is completely urbanised and highly industrialised, with a robust and growing diversified economy despite its lack of domestic energy and mineral resources and small land size of which a significant part is reclaimed land. The economy's impressive economic success is due to certain factors including turning itself into a regional hub for tourism, financial activities, shipbuilding, petroleum and related equipment, biotechnology, high tech and solar energy, and its expanding role in international cargo and fuel shipping.

The economy's gross domestic product (GDP) of SGD 390 billion reflected growth of 3.2% from 2013. The service industry accounted for the largest GDP share (66%), with the biggest sub-sector represented by wholesale and retail trade (15%), followed by goods-producing industries (25%), with manufacturing and housing representing 19% and 5%, respectively (SingStat, 2015a).

Singapore's exports in 2013 amounted to USD 513 billion of which the respective shares of domestic exports (USD 274 billion) and re-exports (USD 239 billion) were 53% and 47%. Non-oil products accounted for the bulk of the exports (76%), with machinery and equipment representing the largest share (46%), followed by chemicals and chemical products (12%), miscellaneous manufactured articles (8.7%), manufactured goods (3.2%) and food, beverages and tobacco (2.2%), leaving the rest for miscellaneous transaction articles (1.2%), crude materials (0.7%) and animal and vegetable oils (0.1%). Oil exports (refined oil products and lubricants) accounted for 24% of the economy's exports.

Table 1: Key data and economic profile, 2014

Key data		Energy reserves	
Area (km ²)	714	Oil (million barrels)	—
Population (million)	5.5	Gas (billion cubic metres)	—
GDP (2010 USD billion PPP)	426	Coal (million tonnes)	—
GDP (2010 USD PPP per capita)	77 942	Uranium (kilotonnes U)	—

Source: EGEDA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Singapore imports all its crude fossil fuel requirements. The economy's total primary energy supply (TPES) in 2014 was 29 040 kilotonnes of oil equivalent (ktOE) (EGEDA, 2016). Oil constituted the largest share (over 60%) and experienced an increase of 7.3% over 2013, from 16 528 ktOE to 17 730 ktOE. Natural gas had a 35% share (10 219 ktOE), with a modest growth (3.5%) compared to the preceding year. Coal's share increased to 397 ktOE from 2013 maintaining only a small share (1.4%) of the total (EGEDA, 2016).

Singapore's total imports of energy (crude oil, petroleum products, gas and coal) in 2014 were 162 482 ktOE, which included supplies to meet its energy requirements as well as those to meet the needs of its oil refineries whose refined products are mainly exported (EGEDA, 2016). Of these imports and their produced refined products, about 53% (85 698 ktOE) were exported (EGEDA, 2016). Most of the remaining imports were used at home for marine bunkering (25%; 40 824 ktOE) and aviation bunkering (4.4%; 7 214 ktOE), signifying the role of Singapore in international shipping and aviation (EGEDA, 2016).

CHINESE TAIPEI

INTRODUCTION

Chinese Taipei is an archipelago consisting of Taiwan, Penghu, Kinmen and Matsu, located off the south-east coast of China and south-west coast of Japan. With an area of 36 193 square kilometres (km²) (Executive Yuan, R.O.C., 2016), Chinese Taipei represents a natural gateway to East Asia. Although only one-quarter of the land is arable, the subtropical climate permits multi-cropping of rice and the perennial growth of fruit and vegetables.

In 2014, Chinese Taipei's gross domestic product (GDP) was USD 1 020 billion, and its per capita income was USD 43 536 (2010 USD purchasing power parity [PPP]). Its GDP grew on average at a rate of 3.8% from 2000–14. Within the past few decades, Chinese Taipei's economic structure has changed substantially, shifting from industrial production to the services sector, wherein the latter constituted 64% of the GDP, followed by industry (35%) and agriculture (1.8%) in 2014 (BOE, 2016a). Chinese Taipei is one of the most densely populated areas in the world, but its population growth rate has been relatively flat; the economy's population of 23 million grew at a rate of 0.3% in 2014 compared with 2013 (EGEDA, 2016).

Lacking natural resources, Chinese Taipei is highly dependent on energy imports to meet domestic energy demand. According to the U.S. Energy Information Administration, Chinese Taipei holds only 2.4 million barrels of oil reserves (EIA, 2016). Coal reserves in the economy are rather scarce, and owing to the high mining cost, there has been no coal production in the economy since 2000.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	36 193	Oil (million barrels)	2.4
Population (million)	23	Gas (billion cubic metres)	N/A
GDP (2010 USD billion PPP)	1 020	Coal (million tonnes)	–
GDP (2010 USD PPP per capita)	43 536	Uranium (kilotonnes of U)	–

Sources: a. EGEDA (2016); b. Executive Yuan R.O.C. (2015); c. EIA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

As mentioned earlier, Chinese Taipei relies heavily on overseas energy resources for its needs. In 2014, energy imports accounted for 98% of the total primary energy supply (TPES) in Chinese Taipei (BOE, 2016b), indicating a low energy self-sufficiency rate as well as a fragile energy security.

The growth of the TPES in Chinese Taipei is stable and has largely remained unchanged over the past few years, rising from 108 280 kilotonnes of oil equivalent (ktoe) in 2013 to 110 854 ktoe in 2014, an increase of 2.4%. Regarding the composition of the TPES, fossil fuels continue to be the dominant fuel consisting of 88% of the total supply. By fuel type, oil contributes the largest share (39%), followed by coal (33%), natural gas (15%) and other fuels (12%) (EGEDA, 2016).

In 2014, Chinese Taipei imported 315 million barrels of crude oil, 6.5% higher than the 296 million barrels imported in 2013. The Middle East is the major supplier, accounting for 83% of total oil imports, followed by Angola (8.4%) (BOE, 2017). To prevent supply disruption, the Petroleum Administration Act 2001 requires Chinese Taipei's refiners to maintain stocks of more than 60 days of sale volumes.

THAILAND

INTRODUCTION

Thailand is known as ‘the window to South-East Asia’ as it is surrounded by fast growing economies such as Myanmar, the Lao People’s Democratic Republic and Cambodia to the north and east, and shares borders with Malaysia to the south. Thailand has an area of 513 120 square kilometres (km²) and a population of about 67.7 million in 2014. Its GDP that year reached USD 994 billion (2010 USD purchasing power parity [PPP]), a 0.8% increase from USD 986 billion in 2013. In the same period, the GDP per capita increased 0.4%, from USD 14 613 (2010 USD PPP) to USD 14 673 (2010 USD PPP). The largest contributors to its GDP were services (53%) and industries (37%) (UN, 2016).

Thailand has limited energy resources. At the end of 2013, Thailand had proven reserves of 405 million barrels of oil, 220 billion cubic metres of natural gas, and 1 239 million tonnes of coal. Based on its production rate in 2014, it will deplete its domestic supply very soon—oil resources within three years and natural gas in six years (BP, 2016). Most coal in Thailand is lignite, which is a low ranking coal with high emissions. Notwithstanding its resources, Thailand is highly dependent on energy imports, particularly oil, with about 82% of its oil and 22% of its gas supply coming from imported stock in 2013 (DEDE, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^c	
Area (km ²)	513 120	Oil (million barrels)	405
Population (million)	68	Gas (billion cubic metres)	220
GDP (2010 USD billion PPP)	994	Coal (million tonnes)	1 239
GDP (2010 USD PPP per capita)	14 673	Uranium (kilotonnes U)	—

Sources: a. UN (2016); b. EGEDA (2016); c. BP (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

Thailand’s total primary energy supply in 2014 was 133 727 kilotonnes of oil equivalent (ktoe), which represented a decrease of 0.7% from 2013. Oil accounted for 38% of the total primary supply, while gas, coal and others accounted for roughly 31%, 10% and 21%, respectively. As most of Thailand’s proven coal reserves are lignite coal with lower calorific values, imported stock is needed to meet the energy demand for both the power and industry sectors. In 2014, coal supply was 13 039 ktoe, down 15% from the previous year.

Natural gas supply in 2014 was 41 800 ktoe, a 13% decrease from 48 002 ktoe in 2013. Although natural gas is mostly used for power generation in Thailand, it is also promoted in the transport sector as a replacement for conventional petroleum products, such as diesel and gasoline. Thailand has increased its reliance on imported natural gas, both in the form of piped gas and liquefied natural gas (LNG).

In 2014, total electricity generation was 175 428 gigawatt-hours (GWh). Thermal generation, mostly from natural gas and coal, accounted for nearly all of its power generation (92%), with hydropower and others accounting for the rest. In addition to its domestic capacity, Thailand purchased power from the Lao People’s Democratic Republic and Malaysia.

UNITED STATES

INTRODUCTION

The United States (US) is the world's second largest economy with a GDP of USD 16 trillion (2010 USD purchasing power parity [PPP]) in 2014 (EGEDA, 2016). The US spans 9.9 million square kilometres (km²) and has a population of 318 million people. The economy's population growth rate has declined from a recent high of 1.2% in 1997 to 0.8% in 2014 (EGEDA, 2016).

The US enjoyed economic expansion from 1990 to 2000, recording growth of 3.4% in real terms, which then slowed to 1.7% from 2000–14. In 2014, economic growth increased, from 1.5% to 2.4%, compared with 2013 (EGEDA, 2016).

The US is the second-largest producer and consumer of energy in APEC. It is rich in energy resources. In 2014, the US had 55 billion barrels of proved oil reserves, 10.4 trillion cubic metres (tcm) of natural gas reserves and 237 billion tonnes of coal reserves (BP, 2016).

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	9.9	Oil (billion barrels)	55
Population (million)	319	Gas (trillion cubic metres)	10
GDP (2010 USD billion PPP)	16 157	Coal (billion tonnes)	237
GDP (2010 USD PPP per capita)	50 662	Uranium (kilotonnes U)	138

Sources: a. Census (2010); b. EGEDA (2016); c. BP (2016); d. NEA (2016).

ENERGY SUPPLY AND DEMAND

PRIMARY ENERGY SUPPLY

The total primary energy supply in the US in 2014 was 2 215 million tonnes of oil equivalent (Mtoe). In terms of fuel type, 35% of the supply came from crude oil and petroleum products, 28% from natural gas, 19% from coal and the rest from other sources such as nuclear energy, hydropower and geothermal energy. Only 12% of the economy's primary energy requirements in 2014 were from net imports. The share of net energy imports declined from a peak of 33% in 2005 (EGEDA, 2016).

The economy's total primary energy supply in 2013 increased by 1.4% compared with the 2012 level of 2 184 Mtoe. The increase resulted mainly from a 3% increase in gas supply, a 2% increase in other sources and an increase in the supply of oil of 1%. Likewise, a substantial reduction in the net imports, 17% from the previous year, was recorded in 2014. The United States has shown constant reduction in import dependency since 2005, recording an average annual decline of 11% over the last nine years (EGEDA, 2016), as crude oil production increased in North Dakota and onshore Texas, mainly from shale and other tight (having very low permeability) formations (EIA, 2016k). In 2014, the US was the world's largest crude oil, natural gas liquids and condensates producer, ahead of Saudi Arabia and the Russian Federation. Production averaged 11.7 million barrels per day (bbl/d), a 17% increase from the previous year (BP, 2016).

The US primary natural gas supply totalled 624 Mtoe in 2014. While the economy's natural gas supply has grown modestly from 1990 to 2014 with an annual growth rate of 1.5%, the primary natural gas supply (including net imports in 2014) grew by 2.9% from the 2013 level (EGEDA, 2016). In recent years, production of cheap unconventional gas reserves from shale formations has resulted in an abundant supply and low wellhead prices. Relatively low natural gas prices and the substitution of gas for coal by power producers have helped lower emissions from power generation (EIA, 2016c).

VIET NAM

INTRODUCTION

Viet Nam is an S-shaped country located in the centre of South-East Asia. It is bordered by China to the north, Laos and Cambodia to the west, and the East Sea (Bien Dong) and Pacific Ocean to the east and south. Viet Nam has a land area of 330 967 square kilometres (km²) with diverse geography and an exclusive economic zone stretching 200 nautical miles from its 3 260-km coastline (excluding islands). As it is in a tropical monsoon zone and profoundly affected by the East Sea, Viet Nam has warm weather, abundant solar radiation, high humidity and generous seasonal rainfall. The country joined APEC in 1998 as part of the last batch to become members of the 21-economy organisation.

Viet Nam is a dynamic, emerging economy with a population of about 91 million (34% live in cities and 66% in rural areas) (GSO, 2015) and a gross domestic product (GDP) of USD 447 billion (2010 USD at purchasing power parity [PPP]) in 2014 (See Table 1). Over the past 30 years, Viet Nam has transformed from a centrally planned economy in 1986 to its current open, socialist-oriented market economy and active international integration (especially, after the removal of US economic embargos in 1994).

Viet Nam's GDP grew continuously between 1990 and 2008, at an annual rate of over 7%. The GDP decreased to 5.8% during the global financial crisis and recession period of 2008–15. Its economic structure has gradually changed through contributions from the industry and service sectors, expanding from 62% of the economy in the early 1990s to 73% in 2015. Major exports have diversified with more manufactured products, such as electronics, machinery and vehicles (28% of total exports in 2014) as well as textiles, garments and footwear (21%), in contrast to traditional fishery products, coffee and rice (nearly 10%) and crude oil (nearly 5%) (Viet Nam Customs, 2015).

As of 2017, Viet Nam's business environment ranking has risen nine levels and is now the eighty-second in the world, in part due to improved possibility of electricity, trading across borders, and protecting minority investors (World Bank, 2017). The government has promoted 'green growth' since 2012 for Viet Nam's new phase of industrialisation and modernisation.

Table 1: Key data and economic profile, 2014

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	330 967	Oil (billion barrels)	4.4
Population (million)	91	Gas (billion cubic metres)	600
GDP (2010 USD billion PPP)	477	Coal (million tonnes)	150
GDP (2010 USD PPP per capita)	5 262	Uranium (kilotonnes U)	3 900

Sources: a. GSO (2015); b. EGEDA (2016); c. BP (2016); d. NEA-IAEA (2016).

Viet Nam is endowed with diverse energy resources, such as oil, gas and coal, as well as renewables. Fossil energy potential is moderate, although thorough resource assessments have yet to be carried out across the entire territory, especially in deep layers and deep-sea areas. As of the end of 2014, Viet Nam's proven fossil energy reserves were 4.4 billion barrels of oil, 600 billion cubic metres (bcm) of gas and 150 million tonnes (Mt) of coal. OECD estimates the identified recoverable resources of uranium at about 3 900 tonnes yet has not been produced. Surveys and assessment for renewable energy's potential are somewhat covered (APERC, 2016), especially for large hydropower. The economic and technical potential of large hydro is estimated at 95–100 terawatt-hours (TWh)/year or 25 gigawatts (GW), of which the technical potential of small hydropower (less than 30 megawatts [MW]) is about 7 GW (MOIT, 2015e). Other renewable sources under the government's consideration for deployment over the next 15 years include wind, solar, biomass and municipal solid wastes (MSW). Potential capacity for wind power developments is 6 GW, solar 12 GW (PMVN, 2016b), biomass 2 GW and municipal solid wastes (MSW) 320 MW (MOIT, 2015e). The energy sector is important in

attracting significant foreign investments and boosting industry growth, export earnings, and science and technology development.

ENERGY DEMAND AND SUPPLY

PRIMARY ENERGY SUPPLY

Viet Nam's total primary energy supply (TPES) in 2014 was 65 232 kilotonnes of oil equivalent (ktOE), which is a considerable increase of 9.5% from the 2013 level and almost triple the 2003 level (Table 2). By energy source, 31% of the supply came from coal, 28% from oil, 14% from natural gas and 28% from other sources (mostly biomass).

COAL

Viet Nam's coal production and exports had average annual growth rates of 21% and 39%, respectively, during 2000–07, and then slowed down to -0.6% and -11.9% per year, respectively, during 2008–13, reflecting changes in government policy prioritising coal conservation for long term domestic uses rather than boosting exports for generating foreign currencies. In 2013, Viet Nam produced about 22 985 ktOE of anthracite and semi-anthracite coals, which is 3.2% less than what it produced in 2012. With increasing domestic demand for coal, coal exports have steadily declined to 7 169 ktOE in 2013, about 31% of the economy's production and roughly 40% of its export peak in 2007.

Viet Nam had about 49 billion tons of potential coal resources as of 2010 (PMVN, 2012b). The sub-bituminous-rich coal basin of the Red River Delta (in the provinces of Thai Binh, Hung Yen and Nam Dinh) accounts for 81%. The anthracite-rich coal basin in the north-east (in the provinces of Quang Ninh, Bac Giang and Hai Duong) accounts for 18%. Additionally, the share of the other mines in the provinces of Hai Phong, Thai Nguyen, Lang Son, Nghe An and Quang Nam account for about 7%. Peat coal in the Mekong Delta accounts for about 1%. Until now, Viet Nam's domestic coal has been produced and supplied mainly by opencast and underground mines in the Quang Ninh province.

Vinacomin (Viet Nam National Coal and Mineral Industries Holding Corporation Ltd) is the dominant coal producer in Viet Nam with output accounting for about 95% of Viet Nam's total coal production. Exploration activities in the Red River Delta coal basin are still preliminary, and given its characteristics of complex geological conditions and its sensitive environmental and economic area, the exploitation of coal resources in this basin is predicted to take place only after 2020.

Coal imports are predicted to increase significantly beyond 2017 to meet fuel requirements for over 41 GW of new coal-fired power capacity that the government has planned to build during 2016–30 in central and southern parts of Viet Nam (PMVN, 2016b).

OIL

Oil reserves are mainly offshore and in the southern part of Viet Nam. Active and successful offshore exploration has continuously increased the number of oil reserves in recent years. Crude oil production grew 1.8% from 17 518 ktOE in 2012 to 17 834 ktOE in 2013 (15% down from a peak of 20 940 ktOE in 2004), 49% of which was exported. As of the end of 2013, there were 23 oil-producing fields in Viet Nam (PVN, 2014). According to the Viet Nam Oil and Gas Group (Petrovietnam or PVN) forecast and planning, oil production based on current proven reserves will be about 16–18 Mt/year through 2022 and then it will decline since major fields in the Cuu Long Basin will have matured.

Viet Nam is a net crude oil exporter but a net importer of petroleum products. There were 9 178 ktOE of imported petroleum products in 2013 and they continue to account for the majority (59%) of Viet Nam's total primary oil supply. Petroleum product imports have shown a downward trend since 2009 as the first refinery in Viet Nam, the 140 000 barrels per day Dung Quat refinery, began operation during that period.

NATURAL GAS

Viet Nam is self-sufficient in terms of natural gas supply. There are four offshore gas pipeline systems built to deliver gas from Viet Nam's oil and gas fields in the petroleum basins of Cuu Long, Nam Con Son, Malay-Tho Chu and Red River Delta to shores in the south-east and south-west regions of Viet Nam.

Viet Nam's natural gas supply in 2014 was about 10 bcm (PVGas, 2015). Growth in the electricity, fertiliser and petrochemical industries have driven demand for natural gas. Under the government's orientation, PVN and PVGas are preparing for the development of two major gas projects in order to have additional gas supplies of about 7–10 bcm per year from Block B, Ca Voi Xanh field and adjacent sources to southern and central markets beyond 2020 (PMVN, 2016b, PVN, 2014). Viet Nam also has plans to develop new infrastructure for importing LNG, first in the south, to diversify gas supply sources and ensure national energy supply security for the period beyond 2015 (PMVN, 2014; MOIT, 2015b).

POWER GENERATION

Vietnam Electricity (or EVN) is a state-owned company who has the control over the entire national power transmission and distribution. As of the beginning of 2016, EVN owned approximately 61% of the total 38 553 MW capacity of electricity in Viet Nam (EVN, 2016). Total power generation in 2014 was 143 216 gigawatt-hours (GWh), an increase of 12% from its 2013 level. Of this total electricity output, about 58% came from hydro and almost 42% from thermal energy (Table 2). Only a very small insignificant portion of is made up by other renewable sources such as wind and biomass. The installed hydropower capacity has tripled from 4.4 GW to 14 GW since 2005, reflecting an average annual growth rate (AAGR) of 13%. As a result, total renewables' share increased from 38% in 2005 to 42% in 2014.

Among thermal power sources which grow as high as 18%, gas-fired power plant contribution remained the largest in terms of capacity in absolute value (stable at 7.7 GW since 2009); however, coal-fired power plants recorded the fastest growth in development, averaging 24% per year from 2008–13. With an installed capacity of 7 GW, coal power's share increased considerably to 28% in 2014 from 4% in 2008. Growing deployment of hydropower and coal power led to relative reductions in the roles of gas and oil power plants in Viet Nam's electricity system. Gas power plants experienced a sharp decline in share, from a record level of 41% in 2008 down to 21% in 2014. The share of oil power plants decreased substantially, from 6% to 2.6% in the same period.

In order to optimise the electricity supply and cost-effectiveness in all regions in the economy, since 2004 Viet Nam has also relied on power sources from biomass and electricity imports from neighbouring economies and countries such as China and Laos. However, these sources were still marginal in its economy's power system during 2008–14.

Table 2: Energy supply and consumption, 2014¹

Total primary energy supply (ktoe)		Total final energy consumption (ktoe)		Power generation (GWh)	
Indigenous production	68 188	Industry sector	22 655	Total power generation	143 216
Net imports and others	-2 277	Transport sector	10 721	Thermal	83 217
Total primary energy supply	65 232	Other sectors	17 649	Hydro	59 841
Coal	19 957	Non-energy	1 224	Nuclear	0
Oil	18 316	Total final energy consumption	52 248	Others	158
Gas	8 937	Coal	11 456		

¹ Note: The numbers differ greatly from last year's report as the database were recalculated and updated for the whole time series so that biomass resources could be reflected in the 'others' section.

Others	18 022	Oil	15 592		
		Gas	1 458		
		Electricity and others	23 741		

Source: EGEDA (2016).

FINAL ENERGY CONSUMPTION

In 2014, Viet Nam's total commercial final energy consumption (TFEC) was 52 248 ktoe, up 3.3% from 2013 (Table 2). By fuel source, electricity and others contributed to the largest share (45%), followed by oil (30%), coal (22%) and gas (3%). Although the component 'others', referring to biomass (fuelwood and wood waste) decrease year by year, that electricity consumption increase in association with higher electrification rates makes this number rank on top. The consumption of coal substantially grew at 8.5% and oil at 4.2%, for the first time in five years since 2009. By contrast, during the same period, gas consumption shows the first signals of decline.

Industry is an important sector in GDP growth and represents the largest segment of TFEC at a constant 43%. This sector consumed coal at 44%, electricity at 26%, biomass at 16%, petroleum products at 7% and natural gas at 6%. The transport sector was also a big energy-consuming sector, accounting for 21% of TFEC. It remained the main consumer of petroleum products at up to 70% of the economy's total requirement. In the other sectors (residential, agricultural and commercial as a whole) consumption represented 34% of TFEC. In this sector, biomass accounted for the largest amount at 51%, electricity 29%, petroleum products 11% and coal 8.6%. All of the biomass and most of the coal volumes were consumed by the residential sector. Demand for electricity grew rapidly in the residential sector, reflecting improvements in household income and creating an increase in electric appliance use and power supply quality.

ENERGY INTENSITY ANALYSIS

In 2014, Viet Nam's energy intensity was about 137 tonnes of oil equivalent per USD million GDP (toe/million USD), which is an increase of 3.3% from 132 toe/million USD in 2013, yet still lower than all levels from 2005–2012. There were, however, slight improvements in energy efficiency from end-use sectors except industry, the sector with the highest level of energy intensity. The residential sector (in others) recorded a significant decline in energy intensity at 9.2% as a whole in 2014 while transport was at 3.9% decline.

Table 3: Energy intensity analysis, 2014

Energy	Energy intensity (toe/million USD)		Change (%)
	2013	2014	2013 vs 2014
Total primary energy supply	132	137	3.3
Total final energy consumption	112	109	-2.6
Total final energy consumption excl. non-energy	108	107	-1.1

Source: EGEDA (2016).

POLICY OVERVIEW

ENERGY POLICY FRAMEWORK

The Ministry of Industry and Trade (MOIT), which formed in 2007, oversees all energy industries. It drafts laws, policies, development strategies, master plans, economy-wide target programs, technical-economic programs and important projects for all energy sectors and submits to the government and the Prime Minister for issue or approval.

The Ministry administers the implementation of these laws, policies and plans. It takes responsibility for issuing technical regulations and standards, eco-technical norms, and guidelines on the implementation of approved law and policies. The Ministry carries out the state management of public services, state-owned

enterprises in energy sectors and is in charge of communicating the government's policies as well as reporting on sector development results.

Within the MOIT, the General Directorate of Energy (GDE) and the Energy Regulatory Authority of Vietnam (ERAV) are two key advisory and executive units assisting the MOIT's Minister with the management of the energy sectors. GDE (PMVN, 2011a) focuses on formulating law, policy and planning, and generally managing all energy sectors; while ERAV (PMVN, 2008) specialises in regulatory activities in the electricity sector in order to ensure a safe and high-quality supply of electricity for the economy.

PVN, the Viet Nam National Petroleum Group (Petrolimex), Viet Nam Electricity (EVN) and Vinacomin are the leading state-owned enterprises (SOEs) in the energy industries in Viet Nam. They actively contribute to formulating and implementing development strategies, master plans and annual plans issued by the government in energy sectors. The government has gradually restructured the SOEs to operate on a commercial basis and with transparency in terms of their business performance and financial information (GOV, 2013).

In 2007, Viet Nam issued the 'National Energy Development Strategy to 2020, with a Vision to 2050' (PMVN, 2007a), which addresses the Vietnamese Government's energy development viewpoints, key objectives, major policies and measures to be realised up to 2020 in the energy industries. In addition, through the formulation and subsequent issuance of development strategies and or master plans by energy subsectors, detailed sectoral targets and policies for each five-year planning period correspondingly adjust to updated assessments. During 2015–16, the Prime Minister approved a number of new or revised strategies and master plans for the development of oil and gas, renewable energy, coal and electricity sectors. They include Oil and Gas Development Strategy to 2025 and Orientations to 2035 (PMVN, 2015b); Renewable Energy Development Strategy to 2030, with a vision to 2050 (PMVN, 2015c); The Revised Coal Development Master Plan to 2020, with a perspective to 2030 (PMVN, 2016a); and the Revised Power Development Master Plan for the period 2010–20, with a perspective to 2030, also known as PDP7 revised (PMVN, 2016b).

These versions continue to confirm the persistent viewpoints of Viet Nam:

- To develop energy sectors in close association with the national socio-economic development strategy and planning;
- To establish national energy security in open market conditions, effectively entering into regional and global cooperation while ensuring to firmly preserve the national security;
- To synchronously and rationally develop an energy system with diversified sources, consisting of electricity, oil, gas, coal, and new and renewable energies; efficiently use and conserve domestic resources; pay attention to develop clean energies and prioritise the development of new and renewable energies;
- To, step by step, develop functioning energy markets, striving to put an end to the pursuit of social policies through energy prices;
- To apply achievements of the knowledge economy in order to enhance productivities and effectiveness in energy businesses. To attach importance to investment in energy conservation technologies, so as to reduce the wastage; and
- To develop energy in close association with preserving the ecological environment, ensuring sustainable energy development.

Below is the summary of some of the main targets for energy development in Viet Nam over the next 5–15 years:

- To ensure a sufficient and high quality supply of energy to meet the demands of socio-economic development, with average GDP growth rates expected to be 7%–7.5% per year during 2011–20 and 6%–6.5% during 2021–30 (PMVN, 2015c);
- To strive to increase petroleum reserves at 25–30 Mtoe per year during 2016–20 and 20–28 Mtoe per year during 2021–30, and to produce 11-14 million tons of crude oil and 11-14 bcm of gas

annually during 2016-20, and 5-12 million tons of crude oil and 15-21 bcm for the period 2021-30 (MOIT, 2015d);

- To expand oil refining and petrochemical capacities, aiming to satisfy demands of domestic markets and export of oil and petrochemical products. To ensure domestic production to meet 60–70% of Viet Nam’s demand for petroleum products and 50% of the economy’s demand for petrochemical products over the period 2020–30 (MOIT, 2015d);
- To ensure total oil stockpiling (including crude oil and petroleum products) adequate for 90 net-import days from 2015 (PMVN, 2009);
- To strive to reach coal production of 47–50 million tons by 2020 and 55–57 million tons by 2030. To start exploitation in the Red River Delta coal basin in the period 2021–30 with a targeted commercial coal yield of 0.5–1.0 million ton per year by 2030 (PMVN, 2016a);
- To achieve a share of renewable energy (including large hydropower) in the total primary energy supply of 31% (or 37 Mtoe) in 2020, 32% (62 Mtoe) in 2030 and 44% (138 Mtoe) in 2050. To develop renewable power (including large hydro and pumped-storage hydropower) of about 24 GW in 2020 and 49 GW in 2030 (PMVN, 2015c); and
- To complete the rural electrification program for rural, mountainous and remote island areas increasing the proportion of rural households with access to electricity to 100% in 2020 (PMVN, 2007a).

In a meeting between APERC and IE in 2016, the National Energy Master Plan through 2035 is thought to be under preparation and likely completed by mid-2017.

ENERGY SECURITY

The Government of Viet Nam’s energy security priorities include synchronously developing various energy sources; exploiting and using domestic energy sources in an economical and efficient manner; reducing dependence on imported petroleum products; exporting a rational quantity of coal (annual coal export limited to 2–3 million tons per year up to 2020); connecting to regional energy systems; expanding stockpiles of petroleum products; and combining energy security with the economy’s general defence and security assurance.

To lessen dependency on oil imports and to ensure energy security, the government has implemented the following detailed policies and measures:

- Strengthen domestic energy supply capacity through legislative reforms (specifically in terms of price, fiscal systems, equity among enterprises forms and information transparency) and the expansion of infrastructure;
- Apply preferential policies for financing and expanding international cooperation to strengthen the exploration and development of indigenous resources, thereby increasing reserves and the exploitability of oil, gas, coal and new and renewable energy;
- Improve energy efficiency, reduce energy losses and implement extensive measures for the conservation of energy;
- Encourage Viet Nam’s oil companies to invest in exploration and the development of oil and gas resources overseas;
- Intensify regional and international energy cooperation and diversify energy import sources; and
- Develop clean energy, especially new and renewable energy.

ENERGY MARKETS

ELECTRICITY MARKET

Viet Nam’s electricity market is characterised by the active participation of several SOEs and various private players who are involved in power generation and distribution on a BOT (build-operate-transfer) and IPP

(independent power producer) basis. As the leading SOE in Viet Nam's power sector, EVN is entrusted to manage the development and operation of the national power transmission system. In 2015, the electricity generation structure by ownership was as follows (EVN, 2016):

- EVN's power plants accounted for 61.2% of the total 38.5 GW installed capacity;
- PVN's power plants accounted for 11.5%;
- Vinacomin's power plants accounted for 4.6%; and
- BOT and other investors' power plants accounted for 22.7.

Since 2004, the Government of Viet Nam has established a vision for a competitive power market as part of a long-term development strategy for the electricity sector. The implementation of the competitive market is considered a means to create a new dynamic in Viet Nam's power sector. It aims to reinforce the effectiveness of production and business activities within the electricity sector, facilitate a decrease in electricity selling prices and enhance the transparency and efficiency of power generation and distribution activities to ensure the robust development of the electricity sector over time.

The Electricity Law of December 2004 (effective 2005 and amended 2012) outlines the major principles for establishing the power market in Viet Nam. The scheme and conditions for the power market are detailed in the Road Map (PMVN, 2013a), stating the three phases of a competitive market development:

- Phase 1 (up to 2014): Competitive Generation Power Market;
- Phase 2 (2015–21): Competitive Wholesale Power Market (the first two years are pilot); and
- Phase 3 (2021 forward): Competitive Retail Power Market (with a pilot period from 2021–23).

Each phase contains two steps: pilot and full operation. Additional regulations and guidelines are enacted to complement the Road Map. These cover licensing and technical concerns, market rules, tariffs and contract regulations.

On 1 July 2011, Viet Nam's competitive generation power market (VCGM) launched its pilot operation and commenced full operation on 1 July 2012. By the end of the third quarter of 2014, there were 55 power plants with a total capacity of 12.8 GW directly participating in selling electricity in the spot market. Those 55 power plants constitute 40% of total capacity of the power system. There were about 52 power plants with a total capacity of over 18 GW or 60% of the total capacity of the power system yet to participate at the time.

The first actual pilot year of the competitive wholesale power market started in January 2016, according to MOIT's conceptual and detailed design of the Viet Nam Wholesale Electricity Market (VWEM) issued during 2014–15 (MOIT, 2014c and 2015c). This year the market will process the simulation of wholesale transactions in paper only (or by notes), yet still with real payments. ERAV assessed the total number of power plants and installed capacity that are directly involved in the VCGM in 2016; this could increase to 79 power plants and 21 GW, of which 63 power plants with an installed capacity of 14.9 GW have their plans firmly in place (ERAV's Decision No. 79/QD-DTDL in 2015).

TARIFFS

Electricity prices are in accordance with the market and under the regulation of the government (Provision 29 of Electricity Law 2004 and amendments in 2012). The baseline of the average retail electricity tariff in Viet Nam is calculated annually by the MOIT and is based on the audited costs; the generation, transmission and distribution sectors investors' reasonable profits; and the costs of regulating, managing and supporting services in the electricity system.

The baseline is the threshold for the electricity retail tariff adjustments. Adjustments occur following changes in fundamental costs such as fuel costs, exchange rates and generated capacity. Any changes that occur within the tariff scope are approved by the Prime Minister.

EVN is allowed to increase retail tariffs only when (PMVN, 2013b):

- the fundamental costs change from 7% to under 10%;

- the Electricity Price Stabilisation Fund has been used; and
- the MOIT, through consultation with the Ministry of Finance (MOF), provides an endorsement.

Current application of retail electricity tariffs by user categories and wholesale prices for electricity retailers follows the MOIT's regulations (MOIT, 2014a and 2015a) of purchasing and selling prices of electricity from the national electricity system. The average retail tariff (exclusive of value added tax [VAT]) is VND 1 622.01 per kilowatt-hours (kWh).

CRUDE OIL MARKET

Players in the upstream oil sector in Viet Nam include PVN and its subsidiary PVEP, various international oil companies, and other foreign enterprises. According to the Petroleum Law 1993 and amendments in 2000 and 2008, the government reserves the right to be a priority buyer of oil production from contractors and in such cases, foreign contractors have the right to sell their profit oil at international prices.

The Dung Quat refinery built in Quang Ngai province has a refining capacity of 6.5 Mt of crude oil per year (or 148 000 barrels per day). It has been operated by the Binh Son Refining and Petrochemical Company Limited (BSR) since 2009 and is the only crude oil consumer in Viet Nam. Currently BSR is a 100%-owned PVN subsidiary; however, PVN announced in 2015 a plan for BSR's equitization, inviting domestic and foreign investors. Over the last seven years, BSR has bought crude oil mainly via the Petrovietnam Oil Corporation (PVOil), a subsidiary of PVN. The sweet crude oil supply to Dung Quat refinery has mainly come from domestic sources, including about 60% from Bach Ho field and 40% from others offshore Viet Nam; imports remain a negligent contribution.

Viet Nam's crude oil market and imports are anticipated to further increase together with existing expansion plans of refining capacity towards 2030. At present, a 10 Mt refinery and petrochemical complex—PVN's Nghi Son project is under construction; commercial operation is scheduled for 2017.

PETROLEUM ENGINE FUEL MARKET

'Petroleum engine fuel' (PEF) is the general term used in Viet Nam to refer to products of the crude oil refining process, which are used as fuel, including gasoline, diesel, jet fuel, kerosene, fuel oil, biofuels (E5 and E10) and other engine fuels, excluding liquefied petroleum gas (LPG) and natural gas products.

The government, represented by the MOIT, the Ministry of Planning and Investment (MPI) and the Ministry of Finance (MOF), controls the PEF market. The MOIT regulates all enterprises participating in the market, especially refineries, importer-wholesale enterprises and the development of petroleum trading infrastructures (import terminal, strategic stockpiles, commercial stockpiles and oil products pipelines) in order to ensure the supply of PEF for the economy (GOV, 2014).

The government regulates wholesale prices of fuel oil and retail prices of other PEFs based on the approval of a baseline selling price for PEF suppliers. The base price for PEFs (excluding E5, E10) is composed of a number of price elements including: CIF (cost, insurance, freight) price of importers; government taxes and levies (import tax, excise tax, VAT, environment tax); business expense norms; deductions for the Petroleum Price Stabilisation Fund; and profit norms. Exchange rates also affect the base price. In regard to the E5, E10 base price, the calculation takes into account not only the abovementioned price elements but also the monthly average price of fuel ethanol (E100) domestically produced and imported to Viet Nam and the blending percentage of fuel ethanol (5% for E5 and 10% for E10) by its volume with unleaded gasoline RON 92. The MOF takes the leading role in the calculation of each price element in the regulated base price.

NATURAL GAS AND LPG MARKET

The government reserves the right to be the first priority buyer of all natural gas exploited and produced in Viet Nam. PVN and PVGas are the authorised buyers of natural gas from oil and gas contractors and the sellers to consumers in the Vietnamese market. According to the price law, natural gas prices are not subject to government regulation; all upstream sellers and downstream buyers are free to negotiate the price and other terms in the Gas Purchase and Supply Agreement (GPSA) with PVN and PVGas. The natural gas prices and

levels are set considering the competitive position of natural gas against alternative fuels. This ensures a reasonable profit margin for investors in related upstream and midstream natural gas projects.

PVN submits the GPSA, including a price formula and level, to authorised organisations and the Prime Minister for approval before the GPSA goes into effect. PVGas is responsible for planning, developing and operating infrastructure projects to ensure a safe and reliable natural gas supply and support natural gas exploration and production in Viet Nam.

Business activities, especially trading and distribution of LPG, and natural gas products are, however, open for competition among all domestic and foreign investors. In 2016, the government promulgated regulations (GOV, 2016a,b) on detailed conditions and investment procedures for conducting LPG, CNG and LNG businesses. By the end of 2016, there were 7 LPG import-export trading companies and 23 LPG distribution companies operating in Viet Nam. PVGas (51%), Bitexco (39%) and TG Asia (10%) have jointly invested and created the first LNG company in Viet Nam, the LNG Viet Nam, operating since August 2016.

COAL MARKET

Vinacomin's production and sales account for 95% of the total coal market in Viet Nam. Recently, the North-East Coal Corporation separated from Vinacomin to become an independent company and operate under the oversight of the Ministry of Defence. In addition, PVN established PV Power Coal, which is in charge of coal imports, trading and ensuring coal supply for their five new coal power plants, namely, VungAng 1, Thai Binh 2, Long Phu 1, Song Hau 1 and Quang Trach 1. The forecast for total coal demand for these power plants is about 16 Mt in 2020 and 20 Mt in 2030. As a percentage of the total coal demand for power generation, PVN's share will represent about 24% as of 2019–20 and drop to 10% by 2030.

Since July 2009, Vinacomin has set the price for local customers at the market price, except for power generators. Recently, the government has been preparing a strategy to deregulate the price of coal used for power generation. As a first step, in 2012, the government allowed the coal price for power production to rise according to the latest electricity price adjustment. Any adjustments would be no less than the coal production cost in order to ensure funding for the renovation, expansion and improvement of the capacity of the existing mines and the building of new mines to meet coal demand and contribute to improvements in energy efficiency.

ENERGY EFFICIENCY

In April 2006, the Prime Minister approved the Viet Nam National Energy Efficiency Program (VNEEP) for 2006–15 (PMVN, 2006b). The program's overall objectives cover: community stimulation, motivation and advocacy; science and technology; and mandatory management measures for carrying out coordinated activities related to the economical and efficient use of energy in society as a whole. The aim of the program was to save 3% to 5% of the total energy consumption over the 2006–10 period and 5% to 8% in the 2011–15 period (PMVN, 2012c).

The MOIT is the focal coordinator of EE&C and is authorised to administer the implementation of the VNEEP. As part of this, the government established the Energy Efficiency and Conservation Office within the MOIT (MOIT, 2006). The main work of the office is to develop organisations and systems for improving EE&C at the government level, from the central government to local government. According to the MOIT's report at the 7th National Conference on Energy Savings held in Tien Giang Province on 17 October 2014, a network of 14 energy conservation centres and more than 40 industrial promotion centres, counselling centres and technology transfer centres have been established across the economy.

In order to realise targets in energy efficiency programs, the government encourages major energy-using establishments to improve their energy planning, management and auditing. Major energy-using establishments are those with the consumption of energy as follows:

- Industrial, agricultural production and transportation enterprises with a total yearly energy consumption of at least 1 000 toe; and
- Buildings used as headquarters, offices, accommodations, institutions of education, healthcare, recreation, fitness and sports, hotels, supermarkets, restaurants, and stores with a total yearly energy consumption of at least 500 toe.

The MOIT, in coordination with other ministries, related sectors and localities, organises and manages the operation of these establishments. In addition, it coordinates with related ministries and the Departments and People's Committees of Central Provinces and Cities, to set up a list of these energy-intensive consumers and annually update and submit that list to the Prime Minister for approval.

Phase one of the VNEEP for the period 2006–11 was successfully implemented, saving about 4 900 ktoe in total energy consumption in the period 2006–10, equivalent to 3.4% of total energy consumption. Key legal documents on EE&C were created and issued, including the Law (NAVN, 2010) and its regulations and guidelines by sector. By the end of 2014, the regulation and guidelines of concrete measures for enhancing energy savings and efficiency covered transport (2011), agricultural (2013) and industrial sectors (2014). In 2013, the National Technical Regulation on Energy Efficiency Buildings was revised in line with updated international trends of minimum standards for energy-efficient building exteriors and interior equipment.

These standards applied as of November 2013 to all new or renovated offices, hotels, hospitals, schools, department stores and residences of 2 500 square metres (m²) or more (MOC, 2013). In addition, minimum energy performance standards (MEPSs) were instituted from 1 January 2014 for basic household electric appliances (including tube and compact fluorescent lights, electrical and electronic ballasts for fluorescent lights, air conditioners, refrigerators, washing machines, rice cookers, fans and televisions). As of 1 January 2015 the list of equipment was expanded to include printers, photocopiers, computer monitors, storage water heaters, commercial refrigerators and freezers (PMVN, 2011e). The government has also issued clear regulations on vehicle life based on vehicle type, fuel quality standards and MEPSs for motorcycles and cars. Drafting guidelines on applications of economical and efficient use of energy for public means of transportation (buses) in big cities is ongoing.

Phase two's results for the period 2011–15 were discussed at a series of conferences on the five-year implementation of the National Target Program on Energy Efficiency–period 2011–15, held in the fourth quarter of 2015 by the MOIT in cooperation with the Vietnam Association of Science and Technology in Energy Saving and Efficiency (VNEEP, 2015b). MOIT reported the level of energy savings at 5.96% of Viet Nam's total energy consumption during 2011–15.

RENEWABLE ENERGY

In November 2015, the government first issued the national strategy of renewable energy for the period through 2030, with a vision towards 2050 (PMVN, 2015c). Renewable energy development in Viet Nam continues to integrate with the implementation of broader objectives of general socio-economic development, industrial and sectoral deployment. In particular, it contributes to modernisation and new rural development, fuel diversification, and implementation of Viet Nam's pledge to mitigate the increase in GHG emissions.

The ambitious targets set include: commercial renewable energy to reach 37 Mtoe (31% of TPES) by 2020 and 62 Mtoe (over 32%) by 2030; renewable power (including large hydropower) to account for 38% of total generation by 2020 and 32% by 2030; and biofuels to increase to about 5% of total transport fuel demand in 2020 (about 800 ktoe) and 13% (3.7 Mtoe) in 2030. The government expects that accelerated renewable energy growth will contribute to a mitigation of GHG emissions in energy activities of around 5% by 2020 and 25% by 2030, compared to the business as usual (BAU) plan. Additionally, a reduction of fossil fuel imports for energy purposes of about 40 million tons of coal (compared to the case established in the PDP7 in 2011) and 3.7 million tons of oil products by 2030 is expected. In March 2016, the Prime Minister approved the revised PDP7 to update and detail these new targets and policy measures for renewable power developments in Viet Nam to 2030.

Renewable energy (RE) remains a field with government investment incentives. Support mechanisms and policies for renewable energy development include:

- Prioritising investments and use of renewable energy in the development of the energy industry with a focus on building Viet Nam's renewable energy market;
- Supporting all organisations and individuals with a variety of ownership structures to participate in the development and use of renewable energy;

- Applying various fiscal incentives within import tax, corporate income tax and land taxes and fees, as well as credit incentives as specified in legislation, applicable to special preferential projects and preferential investment projects;
- Approved electricity prices (avoided-cost tariffs, feed-in tariff) for on-grid renewable energy consistent with the different locations and features of potential renewable energy projects to provide appropriate returns to investors;
- Standardised power purchase and sale contracts (20 years) for each renewable power type and an obligation for EVN/its regional electricity utilities to prioritise renewable energy in grid connection and dispatch and purchase electricity at approved tariffs;
- A renewable portfolio standard (RPS) obligation for major electricity generators and traders.

Table 4: Renewable portfolio standards

RPS obligation	2020	2030	2050
Electricity generation companies greater than 1 000 MW (excluding BOT projects)	RE not lower than 3%	RE not lower than 10%	RE not lower than 20%
Electricity distribution companies	RE not lower than 5%	RE not lower than 10%	RE not lower than 20%

Notes: RE = renewable power sources exclude large hydropower plants (>30 MW). Source: PMVN (2015c)

- Project specific arrangements for off-grid electricity systems;
- Net-metering for electricity consumers with simplified connection arrangements; and
- Environmental fees for organisations utilising fossil fuels for energy production.

Policies of RPS and net-metering are newly mentioned in renewable strategy but yet to be implemented by 2016. The specific regulation system for renewable energy is as follows:

SMALL HYDRO POWER

The MOIT's Circular No. 32/2014/TT-BCT on regulation on avoided-cost tariff and power purchase agreement for small hydropower plants (MOIT, 2014c) is the latest relevant policy document. The MOIT annually approves and issues avoided-cost tariffs for small hydropower. Tariff levels are detailed by regions and vary by season and daily dispatch periods.

WIND POWER

Enacted regulations include the the Mechanism for Supporting Wind Power Development (PMVN, 2011d); the Financial Mechanisms for Grid-connecting Wind Power Project (MOF, 2012); and the Regulation on Implementation of Wind Power Project Development, Power Purchase and Sale Contract Form for Wind Power Projects (MOIT, 2012).

The current level of the feed-in tariff (FiT) for wind power is equal to 7.8 US cents/kWh. The government subsidises the power price for EVN by 0.01 USD/kWh through the Viet Nam Environment Protection Fund. The FiT level for wind power is under review by the MOIT for revision.

BIOMASS POWER

Enacted regulations include the Prime Minister's Decision No. 24/2014/QĐ-TTg, dated 24 March 2014, 'Support Mechanism for Development of Biomass Power Projects in Viet Nam' and the MOIT's Circular No. 44/2015/TT-BCT dated 9 December 2015, 'Regulation on Project Development, Avoided-cost Tariff, and Power Purchase and Sale Contract Form for Biomass Power Projects'.

FiT for a biomass cogeneration (or CHP—combined heat and power) project is set equal to 0.058 USD/kWh (excluding VAT). Avoided-cost tariffs apply for other biomass power projects; MOIT annually

approves and issues these tariffs. Calculations are based on the generation cost of thermal coal power plants that use imported coal. The MOIT's Decision No. 942 dated 11 March 2016 promulgates the avoided-cost tariffs (excluding VAT) in 2016 for biomass power projects at 7.3–7.5 US cents/kWh.

SOLID-WASTE POWER

The Prime Minister's Decision No. 31/2014/QĐ-TTg, dated 5 May 2014, 'Support Mechanism for Development of Solid Waste Power Projects in Viet Nam', indicates FiT levels applied for landfill gas and MSW direct combustion power projects equal to 7.28 and 10.05 US cents/kWh, respectively.

SOLAR POWER

MOIT is drafting specific regulations for solar power projects in Viet Nam. It plans to submit these to the Prime Minister for approval by June 2016. MOIT has proposed FiT as a support mechanism for solar PV farm and solar PV rooftop projects (MOIT, 2016a).

BIOFUELS

Biofuels are encouraged in Viet Nam as an alternative to partially replace conventional fossil fuels, contributing to assuring energy security and environmental protection. The government classified investment in biofuel production as an area eligible for special investment incentives. According to biofuel development scheme for the period up to 2015, with a vision towards 2025 (PMVN, 2007b), by 2015, the output of ethanol and vegetable oil is expected to reach 250 000 tons (enough for blending 5 million tons of E5 and B5), satisfying 1% of the whole economy's gasoline and oil demand. Moving to 2025, the economy aims to build an advanced biofuel industry, applying biofuel production technology in Viet Nam that will eventually reach the world's most advanced level. The ethanol and vegetable oil output is targeted to increase to 1.8 million tons, satisfying some 5% of the entire economy's gasoline and oil demand.

In November 2012, the government announced the applicable ratio for mixing biofuels with conventional fuels for road-motorised vehicles using gasoline and diesel in Viet Nam and the road map for the implementation (PMVN, 2012d). Since 15 January 2013, Viet Nam has produced, traded and distributed biofuels for motorised road vehicles. The fuels include E5, E10, B5 and B10. As of 1 December 2014, the distribution and use of E5 for all motorised road vehicles has become mandatory in seven cities and provinces including Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, Can Tho, Quang Ngai and Ba Ria-Vung Tau. It will be mandatory for the whole economy as of 1 December 2015. E10 will be mandatory in the abovementioned seven cities and provinces as of 1 December 2016 and will then expand to the whole economy on 1 December 2017 (PMVN, 2015a). However, more efforts should be made to realize those targets.

Since the 2007 deployment of the Scheme on Development of Biofuels up to 2015 with a Vision to 2025 (PMVN, 2007b), investments in biofuel research and production have increased. Biofuel research focuses on biofuel technologies and applications in electricity generation and transportation use. About 58 R&D and pilot projects were implemented during 2007–15. In 2014, there were five bioethanol plants (E99.5 and above) built in Quang Nam (Dai Tan), Dong Nai (Tung Lam), Quang Ngai (Dung Quat), Binh Phuoc and Phu Tho (Tam Nong), with a total installed capacity of about 500 million litres per year, enough for mixing 10 billion litres of E5 (MOIT, 2016a). It is projected that in 2016–2017 the number is roughly about 16 plants nationwide.

NUCLEAR

In January 2006, the Prime Minister approved the Strategy for Peaceful Applications of Atomic Energy to 2020 with the overall objective to gradually build and develop the atomic technology industry to increasingly and effectively contribute to socioeconomic development and strengthen the economy's scientific and technological capacity (PMVN, 2006a).

The Viet Nam Power Development Master Plan for the period 2010–20, with a perspective to 2030 (PDP7) (for both approved versions in 2011 and its revision in 2016 by the Prime Minister) promotes nuclear power development to ensure Viet Nam's electricity supply security in the future when domestic primary resources becomes exhausted. According to the PDP7 issued in 2011, the first introduction of 2 GW of nuclear power was scheduled in 2020; the capacity would gradually increase to 10.7 GW in 2030, so that nuclear power source could produce annually about 70.5 TWh, accounting for 10.1% of total power generation.

In March 2016, the Prime Minister approved the MOIT's revised PDP7 (PMVN, 2016b), underlining that nuclear power programs must be implemented in a coherent way, in compliance with the provisions of law and ensure safety and efficiency as the primary objectives. The revised PDP7 has postponed the operation year of the first unit in 2028 and reduced total capacity to 4.6 GW in 2030; hence, the power generation from nuclear will be 32.5 TWh in 2030, accounting for 5.7% of total power production of the national system. The government entrusted EVN as the investor for the first two nuclear power plants built in Ninh Thuan province in central Viet Nam.

Ultimately, however, in November 2016, the National Assembly decided to halt the Ninh Thuan nuclear power plants based on updated assessments of capital requirements and general conditions of Viet Nam's economy.

CLIMATE CHANGE

Viet Nam submitted its new climate action plan Intended Nationally Determined Contributions (INDC) in 2015 including a mitigation and an adaptation component. In the early stages of industrialisation, and only recently recognised as a lower middle-income developing economy, Viet Nam contributes only 0.5% global CO₂ emissions (GOV, 2015). In the past 50 years, however, extreme climate events such as storms, floods, droughts and saline water intrusion have increased in both frequency and intensity. Viet Nam is one of the economies that may suffer the most severe impacts of climate change and rising sea levels, according to national and international analyses of climate change scenarios to 2100.

Viet Nam signed the UNFCCC in 1992 and ratified it in 1994 and signed the Kyoto Protocol (KP) in 1998 and ratified it in 2002. Viet Nam has fulfilled all requirements to be an Annex II economy for developing clean development mechanisms (CDMs) under the protocol.

Government agencies are progressively revising and completing the institutional framework and the system of legal documents to prevent and mitigate natural disasters due to climate change. In April 2003, the government established the CDM National Executive and Consultative Board, comprised of officials from MONRE and other ministries. In June 2003, the government designated the National Office for Climate Change and Ozone Protection (part of the International Cooperation Department of MONRE) as Viet Nam's CDM national authority.

On 5 December 2011, Prime Minister Nguyen Tan Dung issued the National Strategy on Climate Change (Decision 2139/QD-TTg). This strategy has a century-long vision and it is the foundation for all other ministerial, sectoral and local strategies, plans and programs.

Viet Nam has set a target to reduce 8–10% of its GHG emissions intensity from 2010 levels by 2020; and after 2020, to reduce GHG emissions intensity 1.5–2% per year on average (or 20% by 2030). These targets are Viet Nam's voluntary reduction. Additional international support is required for higher targets of 20% by 2020 and 30% by 2030 (PMVN, 2012a; GOV, 2015). Viet Nam's BAU scenario for GHG emissions was developed based on the assumption of economic growth in the absence of climate change policies. The BAU starts from 2010 (the latest year of the national GHG inventory) and includes the energy, agriculture, waste, and land use, land-use change and forestry (LULUCF) sectors.

- GHG emissions in 2010: 246.8 million tons carbon dioxide equivalent (tCO₂-e);
- Projections for 2020 and 2030 (not including industrial processes):
2020: 474.1 million tCO₂-e
2030: 787.4 million tCO₂-e

NOTABLE ENERGY DEVELOPMENTS

ELECTRICITY DEMAND AND SUPPLY OF 2015-2016

According to EVN (Electricity Vietnam, the largest state-owned power company in Viet Nam), Viet Nam is successfully maintaining energy self-sufficiency in line with the growth of the gross domestic products at 6.68%

in 2015. In terms of installed capacity, the Viet Nam power system stepped up to the second rank in ASEAN (from the third by the end of 2014) with approximately 38.5 GW, including newly added 3 314 MW at the beginning of 2016. Electricity coverage stays high at 99.85% in the communes and 98.88% in rural households. Export and import activities have slowed since 2014, while energy demand has not stopped growing for a single year since 2010.

This growing demand, contributed mostly by industry/construction and residential area, has been met by more prevalent use of coal-fired power whose share reached 33%, compared to 26% in 2014. In response to increasing sales, EVN is considering importing more primary fuel (coal) or LNG alongside with investing in more advanced technology for power project development. The World Bank (2017) in its most recent report credits Viet Nam for reducing the time required for getting electricity connection by reducing delays and increasing efficiency in approving connection applications and designs for connection works.

HALT TO NINH THUAN NUCLEAR POWER PLAN PROJECT

During the last quarter of 2016, the National Assembly decided to halt the Ninh Thuan Nuclear Power Plant project in southeast Viet Nam, which was approved seven years prior in cooperative projects with Japan and Russia. According to the announcement made by the Government Office at the government's press conference on 22 November, two main reasons were mentioned in addition to the need for nuclear power and technology safety. Firstly, the unfavourable economic situation and the need for a more modern infrastructure together with the challenges of climate change presented a hurdle to the continuity of the already doubled VND 400 trillion projects.

Secondly, during the seven years since the project began, many changes in energy prices and technology development have occurred. The supply shortage equal to anticipated combined capacity of 4 000 megawatts due to this halt can be filled up by purchasing power from neighbouring countries and exploitation of renewable energy, especially wind and solar power as well as enhancing thermal power deployment. From now until 2030, Viet Nam will consider replacing the Ninh Thuan nuclear with a thermal power plant; and from 2030 forward, it is assumed that coal-fired power and LNG as well as renewable energy will be the primary source (GOV, 2016c).

ACTIVE MOVES TOWARDS RENEWABLE ENERGY

The loss of 5.7% in electricity output caused by cancellation of nuclear projects is expected to be recovered by accumulating more coal and renewable resources. This will require great effort from the government, in spite of the economy's commitment to FFS reductions to restore fossil fuels to market prices during APEC EWG 51th meeting in Australia. Year 2015-2016 witnessed the launch of important key policy documents such as

- No. 2068/QĐ-TTg of the Prime Minister (November 2015): This is the first comprehensive strategic legal document on the development of renewable energy to 2030 with a vision toward 2050. The document regulates responsibility of power companies to purchase all renewable energy, the price of power as well as distributed sources that are not connected to the grid. Hydropower is emphasised as the main source, expected to increase to 96 billion kWh in 2030.
- No. 428/QĐ-TTg of the Prime Minister (March 2016), a revision to the national power development plan (PDP7) that attached more support to sustainable development. Under this decision, renewables as a percentage of the total generation capacity as well as renewables output will increase over time. By 2030, it is expected to account for 21.0% of the total generation capacity and RE output will account for 10.7% of the total power output.
- No. 403/QĐ-TTg, in which the Prime Minister approved the adjusted master plan for development of Vietnam's coal industry through 2020, with prospects towards 2030. The consecutive revisions started by oil and gas industry will continue in other sectors onwards.

Besides, The Ministry of Industry and Trade issued regulations related to feed-in tariffs for biomass power projects (March, 2016) after decisions on wind (2011), biomass (2014), solid waste (2014) power development support. Scheme of FiT support for solar power is now in the final draft stages.

The government's efforts in promoting renewable energy were also evident in international forums. The fifty-first meeting of the APEC Energy Working Group (EWG) was held in Canberra, Australia in May 2016.

Viet Nam delegates confirmed that the new power master plan was revised to strengthen energy security and sustainability, including a roadmap. The strategy for renewables was expanded to 2030–2050 with new goals established, revising supporting mechanisms that included wind and solar development with the aid of feed-in tariffs. In terms of energy efficiency, energy labelling and energy saving of electric equipment were stressed and state-owned companies will become more efficient by 2020.

As Viet Nam relies on coal and thus produces relatively high GHG emissions, it has established cooperation with Japan towards a wider adoption of super critical coal technology. The economy actively cooperated with APERC in the peer review on low-carbon energy policies endorsed by the APEC Energy Ministers at the 2010 Energy Ministerial Meeting to publish a thorough research on alternative energy sources as well as peer review to be held soon. By the end of October 2016, the government ratified the Paris Agreement of the United Nations Framework on Climate Change (Resolution No 93/NQ-CP) In the Marrakech Climate Change Conference in November, Viet Nam, as one of the 48 countries most exposed to the impact of climate change, announced the adoption of a 100% renewables target.

On the practical side, RE projects are actively been supported. On 17 January 2016, the Bac Lieu wind farm, Asia's first offshore wind farm, started operation at the full capacity of 99.2 MW, with the potential to supply 320 GWh/year to the national power system (MOIT, 2016a) and recognised to offset 151 331 tons of CO₂ emissions a year. The completion of this project construction increased Viet Nam's total wind power capacity to 135 MW. The Bac Lieu wind farm is also the first project to be developed under the US-Viet Nam private sector agreement, which is part of the US-Asia Pacific comprehensive energy partnership aimed at addressing energy access and energy poverty issues in the Asia-Pacific region. In early responses to policy of promoting solar energy, a number of small-scale grid-connected PV plants have recently been developed (ADB, 2015), including:

- 212 kW Big C Supermarket in Di An;
- 200 kW Intel factory in Saigon High-Tech Park; and
- 100 kW power project near Ho Chi Minh City.

Larger projects are expected in the near future, such as the ones in Quang Binh, Khanh Hoa, and Ninh Thuan.

Following these, Phu Lac 1 windrower (24MW) is scheduled for September 2016, and the new Phuoc Thai solar farm project (200MW) will follow. The year 2016 is also when biofuel E10 will be introduced in major cities after December, according to Decision 53/2012/QĐ-TTg. Additionally, in its annual report for 2016, EVN has committed itself to the feasibility study of several RE projects and strong investments in rural and remote islands electricity distribution network expansion.

In an effort to tackle climate change, Viet Nam identifies in its INDC the GHG reduction pathway for the 2021–2030 period, during which time GHG emissions will be reduced by 8% by 2030 compared to the BAU. The abovementioned contribution could be increased up to 25% with international support.

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