The 4th ASEAN Energy Outlook 2013 - 2035

ASEAN CENTRE FOR ENERGY
ACE

One Community
for Sustainable
Energy

The 4th ASEAN Energy Outlook

Edited by:

ASEAN Centre for Energy Team

Published by

ASEAN Centre for Energy
ACE Building, 6th Floor
Jl. H.R. Rasuna Said Block X-2, Kav. 07-08
Jakarta 12950, Indonesia
Tel: (62-21) 527 8027
Fax: (62-21) 529 6382
E-mail: secretariat@aseanenergy.org

2015
www.aseanenergy.org

Forewords

The ASEAN Centre for Energy (ACE)

Endorsed by the 30th ASEAN Ministers on Energy Meeting (AMEM) on 12 September 2012 in Phnom Penh, Cambodia, the ASEAN Centre for Energy (ACE) was tasked to develop the 4th ASEAN Energy Outlook (AEO4). This outlook is a continuation from the previous three, which were developed and published in 2006, 2009 and 2011. As there have been various developments effecting the energy sectors, AEO4 presents two scenarios of energy demand and supply for the region into 2035: Business as Usual (BaU) Scenario which reflects the continuous trend of the developments from the past and Advancing Policy Scenario (APS) that incorporates progressive policy and action plans from each ASEAN Member State (AMS/Member States) to achieve their official national target for energy efficiency (EE) and renewable energy (RE).

The findings of raised the concern in terms of energy security, as the region will continue to depend on fossil fuels, with coal as the main energy source to meet the rapid growth of electricity demand. However, AEO4 also outlines the potential to reduce energy intensity while highlighting the potential to increase the contribution from renewable energy

AEO4 not only aims to provide policy makers with an understanding of the energy trends and challenges being faced by the region up to the year 2035, but also to strongly involve all AMS in the process. AEO4 complements the implementation of the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025, thereby deriving strategies within ASEAN to address future energy needs. AEO4 is part of ACE's effort to fulfil its function as a regional centre of excellence that builds a coherent, coordinated, focused and robust energy policy agenda and strategy for ASEAN.

We are glad that the Executive Summary of AEO4 has provided key discussion points during the Ministers-CEO Dialogues on the occasion of the 33rd AMEM on 7 October 2015 in Kuala Lumpur, Malaysia, and received positive feedback. We hope this full report will continue to provide more details for all interested parties in enhancing cooperation towards energy security in the region.

Ir. Dr. Sanjayan Velautham
Executive Director
ASEAN Centre for Energy

**The Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH**

At the 33rd AMEM on 7 October 2015 in Kuala Lumpur, Malaysia, Ministers showed their strong commitment on renewable energy: The Ministers decided upon a renewable target to address the challenges of future energy security, containment of fossil fuel usage and sustainable economic growth. The APAEC 2016-2025 aspires to achieve 23% renewable energy in energy mix by 2025.

The 4th ASEAN Energy Outlook (AEO4) underlines the potential for the use of renewable energy (RE) by the ASEAN Member States as an important element in a diversified energy mix as well as contributior to the labour market and local manufacturing - as a catalyst for economic development. This potential, however, have to a large extent not been tapped effectively so far. Renewable energy sources, especially wind and photovoltaic, have low variable costs depending on their existent potential and, in the near future, will be direct competitors to conventional power plants in generating electricity. AEO4 also highlights the dynamic development of renewable energy technology types, for example hydro power and geothermal. Both technologies are already in use in the ASEAN region but could be combined more efficiently with other energy sources.

These vast experiences and potential for the use of renewable energy are the starting points for the Renewable Energy Support Programme for ASEAN (ASEAN-RESP) to encourage AMS to improve the framework conditions for renewable energy in the region. By providing technical and policy advice on renewable energy framework conditions, promoting good practices and capacity building, ASEAN-RESP contributes to enhance regional cooperation and integration. The programme is jointly implemented by the ASEAN Centre for Energy (ACE) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ).

Such publication requires a major research and development effort. To this end, we congratulate ACE and AMS for this published AEO4. We believe that the result of this joint effort will help to develop a sustainable energy market in the ASEAN region.

Maria-José Poddey
Principal Advisor for ASEAN-RESP, GIZ

Acknowledgements

This AEO4 was developed by ACE and AEO Working Group (WG) members, with the assistance of the Fraunhofer Institute for Systems and Innovation Research (ISI). It could not have been accomplished without the guidance of the Regional Energy Policy and Planning Sub-sector Network (REPP-SSN) Focal Points, the contributions of many individuals and organisations, and support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the Renewable Energy Support Programme for ASEAN (ASEAN-RESP).

Two WG meetings were held on 10-13 February 2015 and 11-13 May 2015, followed by a consultative meeting on 2-3 September 2015 - all taking place in Jakarta - to gather the inputs from national perspective as well as the consultant, in order to develop AEO4.

We would like to thank all those whose efforts made this AEO4 possible, in particular those named below:

AEO WG members: Dr. Andi Tabrani and Md. Rifdi Hj Sahari from the Energy Department at the Prime Minister's Office of Brunei Darussalam; Math Rofat from the Ministry of Mines and Energy of Cambodia; Sadmoko Hesti Pambudi from The National Energy Council of Indonesia; Litthanoulok Laspho from the Ministry of Energy and Mines, Lao PDR. Zaharin Zulkifli and Noor Aizah Abdul Karim from the Energy Commission; Edisham Mohd. Sukor from Sustainable Energy Development Authority of Malaysia; Inu Baizura Mohamad Zain, Aiza Mahani Mozi, and Ernny Erniati binti Mohd Sayuti from the Ministry of Energy, Green Technology and Water of Malaysia; Celedonio B. Mendoza, Jr. and Rowena Villanueva from the Department of Energy of the Philippines; Poh Wei Chian, Chia Kang Yang, Erica Liu, Ng Cuirong Lelia, and Xavier Lim from the Energy Market Authority of Singapore; Supit Padprem, Chirapaporn Laima, and Bubpha Kunathai from the Ministry of Energy of Thailand; and Dr. Nguyen Ngoc Hung from the Institute of Energy, Vietnam.

ASEAN-RESP team: Badariah Yosiyana, Nanda F. Moenandar, Susy M. Simorangkir and Lisa Tjandra.

GIZ team: Maria-José Poddey, Arne Schweinfurth, Dr. Hanna Yolanda and Intan Cinditiara.

Fraunhofer ISI team: Dr. Wolfgang Eichhammer, Dr. Martin Pudlik, and José Ordoñez.

And last but not least: Christopher Zamora (APAEC Programme Manager) and ACE staff: Endang Triani, Mutia Asriyani and Trudy Hardjowijono. Dr. Joni Jupesta (Manager of Policy Research and Analytics) and Gumilang Dewananta (Technical Officer for Policy Research and Analytics) provide substantial supports in finalising the content of the Report. Beni Suryadi, Research Analyst, is the Project Leader for the development of AEO4.

Disclaimer

This work is a joint effort by the ASEAN Centre for Energy (ACE) in collaboration with the National Working Group of the 10 ASEAN Member States under the directives of the Regional Energy Policy and Planning Sub-sector Network (REPP-SSN), with the support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, through the Renewable Energy Support Programme for ASEAN (ASEAN-RESP) and with expert consultancy from the Fraunhofer Institute for Systems and Innovation Research (FhG ISI).

However, the views expressed do not necessarily reflect the views or policies of individual AMS nor the individuals and organisations that contributed. The individuals and organisations that contributed to this study are not responsible for any opinions or judgements it contains. All errors and omissions are solely the responsibility of the ASEAN Centre for Energy (ACE).

Table of Contents

Index of Figures

Index of Tables

Bio Energy Resources
Photo Courtesy : GIZ Indonesia

Executive Summary

General Overview

In 2013, ASEAN accounted for about 8.5% of the world population, consumed about 4.5% of world's primary energy, yet is accountable for a remarkable 5.7% of total global energy production. As the region's economies continue to steadily expand, and its main energy indicators are below global averages, demand is expected to soon outstrip supply unless strong measures are taken to manage the growth. This inevitably creates a challenge for both energy security and sustainable development.

Methodology and Data

The research and analytic methods used in the 4th ASEAN Energy Outlook (AEO4) relied heavily on the active participation of the ASEAN Member States. All Member States' models have been fully, or for the most part, developed by the participating Member States. These models were based on, and evolved from national historical data on energy and socio-economic statistics. To estimate future demand, econometric approach was being used in top-down or bottom-up models for each AMS. AEO4 uses national GDP target and population growth forecasts within the period 2013-2035. Each Member State's results were then aggregated to obtain the regional outlook, and further validated by an independent regional forecast model. AEO4's final results are in-line with the Member States' expectations on their future energy landscape.

For AEO4, two scenarios have been considered:

- The Business as Usual (BAU) Scenario, which assumes that past developments will continue in absence of influential modifications while still taking into consideration future changes in activities driving the energy consumption, and
- The Advancing Policies Scenario (APS), which considers the successful implementation of stronger policies as defined by official targets for renewable energy and energy intensity in each AMS.

Findings

"In 2035, following the Business as Usual (BAU) scenario, ASEAN is expected to require more than 2.7 times its energy demand in 2013 to meet economic growth targets. Yet, during the same time frame, GDP is forecast to increase by a factor of 3.7, indicating future energy intensity reduction."

During the period 2013 to 2035, the aggregation of national targets will result in an economic growth of 6.1% on average every year, while the population keeps expanding at the yearly average growth rate 0.96%. In the BAU scenario, ASEAN is expected to require 1,685 Mtoe of Total Primary Energy Supply (TPES) in 2035, up from 619 Mtoe in 2013, corresponding to a compounded annual growth rate (CAGR) of 4.7%. Oil, which represents the largest share of energy supply in 2013 at 41.1%, will be significantly reduced to 27.2% by 2035. This is mainly caused by the projected rapid growth in electricity consumption that will be largely met by coal-fired power plants. Whereas coal only accounted for 20.1% of the TPES in 2013, coal supply is expected to have the highest increase among other fuel types with a

yearly average growth rate of 7.0%, thereby overshadowing oil in 2035 with a 33.0% share, equivalent to 556 Mtoe. Meanwhile, the share of natural gas is expected to also increase from 18.7% in 2013 to 22.6% in 2035 as the requirement will increase from 116 Mtoe 2013 to 374 Mtoe in 2035, equivalent to a yearly average increase of 5.5%.

Likewise, in the Advancing Policy Scenario (APS), ASEAN is expected to require more than 2.4 times of its current annual energy demand in order to maintain economic growth as targeted. Yet, if the implementation of policies which specifically target higher efficiency standards in the transformation sector (i.e. thermal efficiency in the electricity sector), demand-side management and deployments of renewable energy (RE) are successful, it will, in turn, lead to substantially lower primary energy demand. The TPES of the APS will grow at a slower yearly average rate of 4.0%, accounting for 1,468 Mtoe by 2035. This corresponds to primary energy savings of about 13% compared to the BAU scenario. In particular, the increase in energy efficiency technologies for coal-fired power plants will significantly contribute to a reduction of energy demand. Under the APS, the coal requirement in the total energy mix in 2035 is expected to grow at the slower rate of 5.3%, amounting to only 388 Mtoe or 30% lower than in the BAU scenario. With the planned installation of nuclear power plants in Vietnam, to be followed by other Member States including Indonesia, Malaysia, the Philippines and Thailand, it is expected that 0.5-0.6% of energy supply will be delivered from nuclear power by 2035.

As Growth Domestic Product based on Purchasing Power Parity (PPP GDP) is expected to reach 18,763 billons of constant 2005 USD in 2035, or equal to an average growth rate of 6.1% from the year 2013 to 2035, the region is expected to reduce its energy intensity. Based on the 2005 level with the reference figure of energy intensity of 133.1 toe/million constant 2005 USD, the region is expected to reduce it to 89.8 toe/million constant 2005 USD in 2035 in the BAU scenario, and 78.3 toe/million constant 2005 USD in the APS. These equate to 32.5% and 41.2% of reduction, respectively for each scenarios.

RE is expected to grow as the region diversifies its energy mix away from fossil fuels by tapping into the huge potential of RE across the region. In 2013, RE reached 56 Mtoe, equivalent to 9.1% share in TPES, or as high as 10.2% if the traditional biomass is excluded from the total demand. Within ASEAN, hydropower and geothermal are two major sources of RE. In the BAU scenario, the growth of geothermal is the second highest after coal, with a yearly average growth rate of 6.6%. Together with hydro and other sources such as solar, wind, non-traditional biomass, etc., RE will increase to 176 Mtoe in 2035. In the APS, the growth in RE is significantly higher where it will reach a total of 272 Mtoe by 2035. Meanwhile, with increasing access to non-traditional appliances in rural areas and a trend towards urbanisation, which greatly improves access to energy, ASEAN is able to drop the share of biomass that is traditionally used in households for cooking, from 11% in 2013 to only around 7% in 2035.

Free flow of investments, skilled labour and capital under the framework of the ASEAN Economic Community (AEC) will push further growth in the industrial sector, which will require more energy than ever. In the BAU scenario, the Total Final Energy Consumption (TFEC) is expected to grow at a yearly average rate of 4.3% from 2013 to 2035, resulting in an increase from 437 Mtoe to 1,107 Mtoe during the period. Yet various initiatives of the AMS, through their advancing policy scenarios on RE and EE, are expected to reduce TFEC growth to only 3.5% on average per year during the same period, resulting in an increase of only 932 Mtoe. The industrial sector was the top consuming sector in 2013 with

a share of 31.0% or 135 Mtoe. The sector's share is expected to increase to 37.4% in the BAU scenario and 34% in the APS. The transportation sector represents the second largest share. Increasing mobility, while still relying on a limited public transport infrastructure, is expected to lead growth at 4.5% in the BAU scenario, resulting in an increase from 118 Mtoe in 2013 to 309 Mtoe in 2035. However, the potential to introduce electric cars coupled with the development of massive public infrastructure in several Member States such as Indonesia and the Philippines, are key drivers in reducing the consumption to only 267 Mtoe by 2035, based on the APS. The residential sector, as the third largest consumer, is expected to reduce consumption to 127 Mtoe in the APS, as compared to 139 Mtoe in the BAU scenario. However, among all sectors, the rate of consumption in the commercial sector will grow fastest at 7.3% CAGR in the BAU scenario as rapid urbanisation turns on various economic growth opportunities. Yet, with better energy management systems in buildings as well as the deployment of high efficiency appliances such as energy-efficient air conditioning systems, energy demand in this sector is expected to grow at the slower pace of 6.7% CAGR, a drop from 101 Mtoe in the BAU scenario to only 88 Mtoe in the APS.

All sectors will consume more coal at a higher pace than in the past as industry keeps growing. Even so, oil will maintain its dominance at 44%-45% during the whole period because of the steady growth in transportation sector, which still heavily relies on oil. In absolute terms, 198 Mtoe of oil consumption in 2013 is expected to increase by the year 2035 to 494 Mtoe in the BAU scenario and 415 Mtoe in the APS, as regional efforts are undertaken to increase public transportation as well as fuel efficiency. Electricity consumption per capita is expected to grow from 0.13 toe per person in 2013 to 0.34 toe per person in 2035 in the BAU scenario and 0.29 toe per person in the APS. Introduction of market pricing and phasing out of subsidies, particularly on oil and electricity sectors, will also contribute to the reduction of consumption. While a number of households will still rely on traditional biomass, its share in the TFEC is expected to decrease from 14% in 2013 to around 3-4%, both in the BAU scenario and the APS in 2035. Nevertheless, as urbanisation is expected to increase with a greater number of people entering the middle class income range, the projected demand on electricity is expected to grow by 5.6% in the BAU scenario and 4.8% in the APS.

Natural gas, coal and oil are the three main fuel sources of electricity generation, accounting for 44%, 31.5%, and 4.16% share respectively of a total of 821 TWh of electricity generated in 2013. To meet growing demand, all existing and planned installed capacity are expected to generate electricity of 2,884 TWh in the BAU scenario and 2,473 TWh in the APS, or equal to average growth at 5.9% and 5.1% per year respectively. In the BAU scenario, coal is expected to take over as the major power source generating about 1,578 TWh of the total 2,889 TWh of electricity generated in 2035, a share of 55% or thereabouts. Even though there has been a decline in the oil price during 2015, in the longer term electricity from coal is expected to cost less for the region. This will result in a lower growth in natural gas, reaching a 30% share or about 860 TWh in 2035. In the APS, the share of coal is expected to be lower than the BAU scenario, but still account for 45% while the share of natural gas is expected to fall to 29%. Generation from both coal and natural gas will be partially reduced as a number of AMS are deploying RE through hydropower plants, geothermal power plants, wind and solar power plants, etc.

About 45.7 GW installed capacity of RE in 2013 generated 169 TWh or about 21% of the total 821 TWh electricity generated in 2013. This will evolve continuously generating 399 TWh with 149 GW in the BAU scenario and 548 TWh with 156 GW in the APS. Hydro power will continue to contribute – approximately 250 TWh in both scenarios – as the main source of RE

electricity generation in 2035, followed by geothermal with 63 TWh in the BAU scenario and 76 TWh in the APS. Wind and solar have in the BAU scenario a rather marginal contribution of 23 TWh and 21 GW installed capacity combined, while in the APS the projected wind generation increases to 64 TWh and solar generation to 14 TWh. This corresponds to an installed capacity of 18 GW and 11 GW. Taking the high solar and wind potential of the whole of ASEAN and the relatively high deployment flexibility into consideration, these technologies might prove effective to overtake additional generation shares in future.

Of note, fossil fuels still account for the biggest share of energy demand during the period 2013-2035, in both the BAU scenario and the APS. In this regard, energy security will remain as the major concern for the region. The potential and need for RE sources is pertinent in the context of diminishing fossil fuel reserves as coal production is redirected from exports to meet domestic demands. Based on the BAU scenario and the APS, natural gas reserves are expected to be depleted between 2020 and 2025 in the BAU scenario or between 2025 and 2035 in the APS. Even the large coal reserves will be reduced by approximately 60%, assuming that exports are reduced dramatically compared to current levels. At the same time the RE potential remain to a great extent untapped, even in 2035, as about two-thirds of ASEAN´s hydropower potential is left unexploited. Additional jobs in a RE-orientated industry could reduce the overall costs of RE-supported mechanisms, while efforts to push greater EE measures like harmonisation of standards and labelling for various electrical appliances could reduce the overall cost of EE, thereby bringing both energy security and sustainable developments to lead towards the region's welfare. The regional initiatives such as ASEAN Power Grid (APG) and Trans-ASEAN Gas Pipelines (TAGP) will ensure the vision towards regional energy security while promoting the efficient use and sharing of energy resources.

Through the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 document, which was endorsed at the 33rd ASEAN Ministers on Energy Meeting (AMEM) on 7 October 2015 in Kuala Lumpur, Malaysia, the Ministers decided upon specific energy intensity and RE targets to address the challenges of future containment of fossil fuel usage and environmental aspects. The APAEC targets a reduction of energy intensity (EI) in ASEAN by 20% in 2020 and 30% in 2025, based on the 2005 level, and aspires to achieve 23% RE in energy mix by 2025.

AEO4's findings show that there is a gap between the APAEC targets with the results of modelling works for both scenarios. This indicates that further efforts on both national and regional levels are needed, especially in regard to its policies on reducing EI and RE.

Solar PV, Koh Sla - Cambodia
Photo Courtesy : ACE

Chapter 1. Introduction

Geographic, Demographic and Economic Profiles

The Association of Southeast Asian Nations (ASEAN), which is composed of ten ASEAN Member States within the Southeast Asia region, is considered one of the fastest growing regions in the world. ASEAN has a combined total land area of 4,435,618 km^2 which is inhibited by more than 615 million people or 8.5% of the world's population. Having quickly recovered from the 1997 economic crisis, the region averaged GDP growth rates of 5.1% from 1990 to 2013, a very positive performance as a centre of growth. In 2013, ASEAN-wide GDP at current prices was USD2,395,252 million, equivalent to 5,080 billion PPP GDP at constant 2005 USD. In aggregate, in 2013 the GDP PPP per capita was USD8,252 at constant 2005 USD or 4,136 at current USD rates, however there is great disparity between the economic level and performance across the region (Table 1).

Table 1 Geographic, Demographic and Economic profiles of the AMS, 2013

Country	PPP GDP (million 2005 USD)1	Population ('1,000)[2]	PPP GDP/capita (2005 USD/capita)[1]	Urbanisation rate (%)[1]	Area ('1,000 km²)[3]
Brunei Darussalam	25,873	418	61,929	77	5.8
Cambodia	39,732	15,135	2,625	20	181.0
Indonesia	2,061,232	249,866	8,249	52	1,860.4
Lao PDR	28,114	6,770	4,153	36	236.8
Malaysia	597,494	29,717	20,106	73	330.3
Myanmar	164,260	53,259	3,084	33	676.6
the Philippines	554,714	98,394	5,638	45	300.0
Singapore	366,915	5,399	67,957	100	0.7
Thailand	832,188	67,011	12,419	48	513.1
Viet Nam	409,798	89,709	4,568	32	331.0
ASEAN	5,080,319	615,676	8,252	46	4,435.6

Energy Development

Energy resources and potential across AMS, as a whole, are rich in both their number and variety, ranging from oil, natural gas, and coal to renewable energy (RE), particularly solar, wind, hydro and geothermal, although they are distributed unevenly across the region. Together, all ten Member States are accountable for a remarkable 5.7% of the world's energy production. While the region's economy is on a steady expansion path, its main energy indicators are substantially under the world's average. Per capita electricity consumption, for instance, is about half of the world's average and the electrification rate is only 78.7% (Figure 1). Based on current growth levels, a dramatic development of energy demand is clearly foreseeable unless strong measures are taken to slow down the increase. This inevitably creates the challenge of meeting regional energy demand, while pursuing efforts to rein in greenhouse gas (GHG) emissions.

Source:
1 Enerdata, 2015.
2. Member States' Statistics and Enerdata, 2015.
3. ASEAN Statistics Table 1 Selected basic ASEAN indicators as of December 2014.

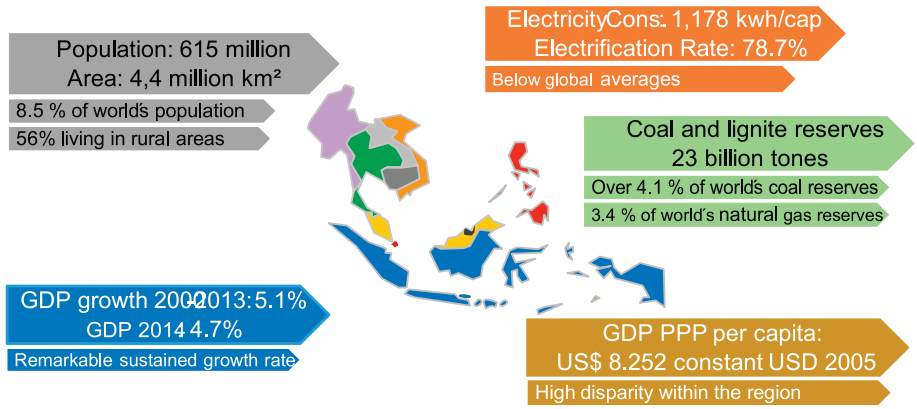


Figure 1 ASEAN Economy and Energy Brief in Number, as of 2013

Primary Energy Supply

The historical development of the ASEAN Total Primary Energy Supply (TPES) reflects the trend of steady economic growth and notable demographic development of the region. Between the year 1990 and the year 2000, the TPES grew at an average annual rate of 4.95%, reaching 386 million tonnes of oil equivalent (Mtoe) in 2000 from 238 Mtoe in the previous decade. The TPES reached 448 Mtoe in 2005, but between the year 2000 and the year 2013, the growth slowed down to an average yearly growth rate of 3.5% culminating in 619 Mtoe by 2013, an increase of 233 Mtoe from the year 2000. The five biggest contributors to energy consumption are Indonesia, Malaysia, the Philippines, Thailand and Vietnam. Together, they account for 88% (Figure 2) while the five remaining Member States contribute only 12% of the region's energy supply.

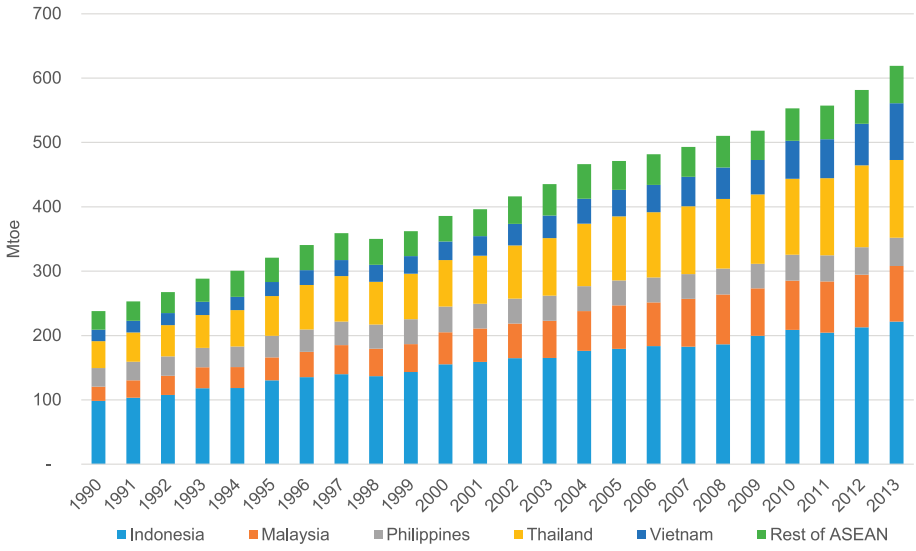


Figure 2 Total Primary Energy Supply in 1990-2013, Member States based

Among fuel types, the TPES or energy mix relies heavily on fossil fuels, namely; oil, coal and natural gas. In 2013, the share of fossil fuels accounted for about 80% of energy supply, with 9.1% supplied by different RE sources and the remainder supplied by traditional biomass (Figure 3). Between the year 1990 and the year 2013, oil was the major fuel type, increasing from 37.6% in 1990 to 40.0% in 2000 and rising to 41.1% share in 2013, equal to 4.7% growth on average per year. Crude oil and its derivate are predominantly utilized in the transportation sector with the remainder used to generate electricity. The increasing share of coal and natural gas power plants compensates the use of oil for electricity generation. In the transportation sector, however, reflecting the steady population and urbanisation growth combined with rising per capita GDP, the use of oil in the ASEAN region continues to remain pivotal. Yet the share of natural gas has also increased in many Member States such as Indonesia, Malaysia and Thailand, who have replaced their oil-fire power plants with gas-fired power plants and even constructed more new gas-fired power plants. With a share of only 12.5% in 1990, the supply of natural gas has grown faster than oil, at 6.1% on average per year, reaching a 18.7% share of the energy mix in 2013. Yet, among the three fossil fuels, coal was the fastest growing fuel in the period, with an average growth of 10.4% annually that contributed to coal's rising share in the energy mix. In the ten years up to 2000, most Member States installed natural gas-fired power plants which meant that coal's share only rose by 3% from a low 5.3% in 1990. However, since 2000, a large number of coal-fired power plants were put into operation, pushing coal's share of the energy mix to 20.1% by 2013.

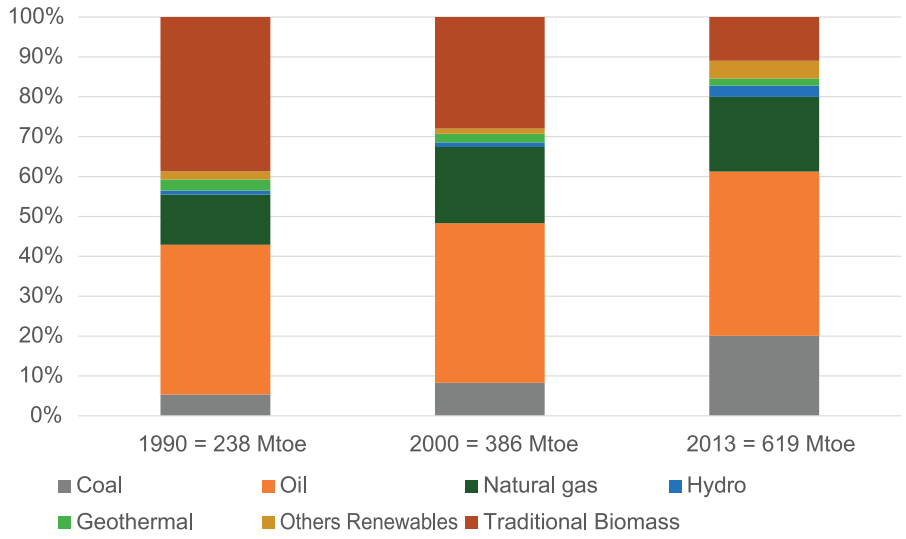


Figure 3 Total Primary Energy Supply in 1990, 2000 and 2013, fuel share

The share of traditional biomass in the TPES has seen a substantial decrease of almost fourfold from 1990 to 2013. This in turn reflects the reduced need for traditional biomass in the TPES as the regions spread more commercial energy. However, since still about 56% of ASEAN population living in rural areas and over 75 million inhabitants living under the poverty line of USD PPP 1.25 per day, the use of traditional biomass as an energy source for cooking remains essential in the region, accounted for about 11.0% in the energy mix in the year 2013. Renewable energy, which consists of hydro, geothermal and other sources

such as solar PV and wind gained the momentum and reached higher average growth rate per year, compared to that of total energy mix. While geothermal only increased 2.2% on average per year, hydro and other RE grew at 9.1% and 7.8% on average per year, resulted in the total 9.1% share of RE in the 2013 energy mix.

Reserves, Resources and Potential

ASEAN is rich in natural resources, with vast resources and reserves of hard coal, lignite, natural gas and oil (Figure 4) as well as sources of RE (Figure 5). The German Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe/BGR) recorded that as of 2013, ASEAN accounted for 4.1% of the world's proven recoverable coal reserves, 3.4% of world's proven recoverable natural gas reserves and 0.8% of world's oil reserves. Specifically, the hard coal reserves are as high as 17 billion tonnes of coal, with 80% being locked within the territory of Indonesia and 18% within Vietnam. These 17 billion tonnes of coal correspond to approximately 18% of total locked coal resources, meaning that 82% of the proven amount of coal in place is not - under current conditions - economically recoverable. The lignite reserves account for 11 billion metric tonnes, with 82% locked in Indonesia and 10% in Thailand. Similarly, these 11 billion tons represent a fraction of 5% of total lignite resources, with 95% classified as non-recoverable under current conditions. Indonesia's territory also holds about 43% of the 6.8 trillion cubic meters of natural gas reserves in the ASEAN region, followed by Malaysia with 35%. Meanwhile, the shares in crude oil reserves is locked in Malaysia's territory with 38%, followed by Vietnam and Indonesia with 28% and 23% respectively.

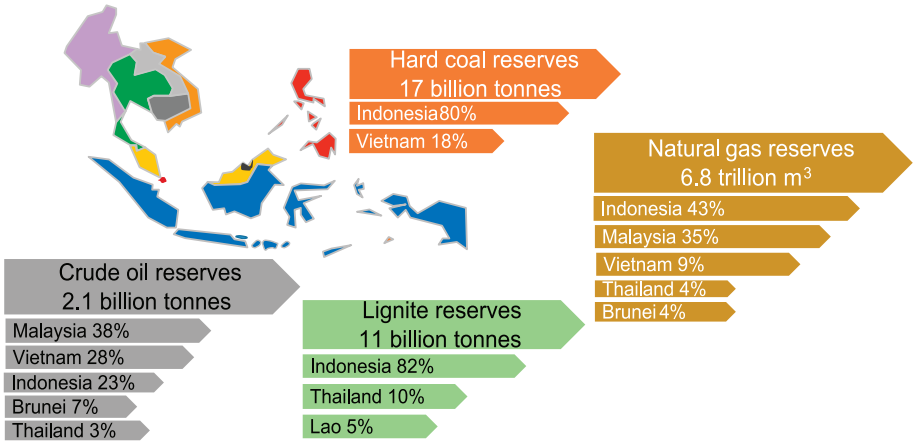


Figure 4 Fossil Fuel Reserves in ASEAN, as of 2013

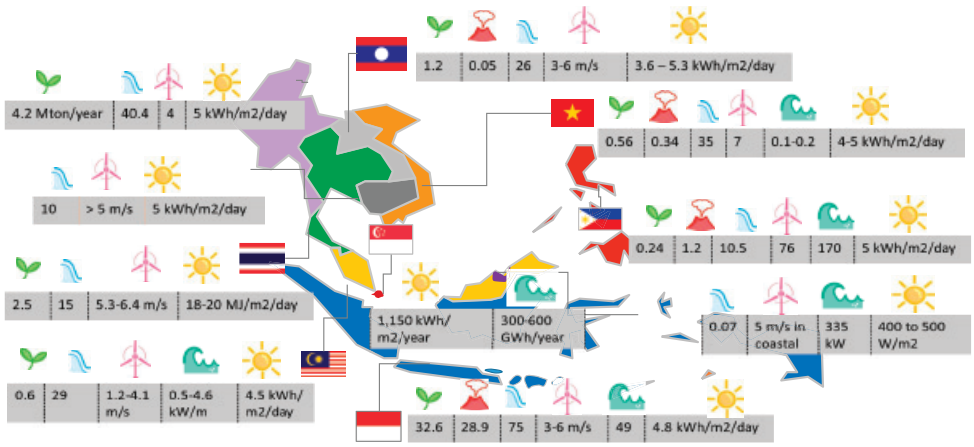


Figure 5 Renewable Energy Potential in ASEAN, as of 2013

Fossil Fuels Production and Consumption

ASEAN as a region is a net energy exporter of fossil fuels, given the fact that the production of coal and natural gas substantially exceeds the region's consumption even though it is a net importer of oil to meet supply requirements (Figure 6). ASEAN's consumption of crude oil amounted to 254.6 Mtoe in 2013, outmatching its production by approximately 134.6 Mtoe. The production and consumption of natural gas show a similar pattern. While the production still outweighs consumption by about 61.1 Mtoe, the higher average growth rate of consumption (6.1% between 1990-2013) compared to the growth rate of production (4%

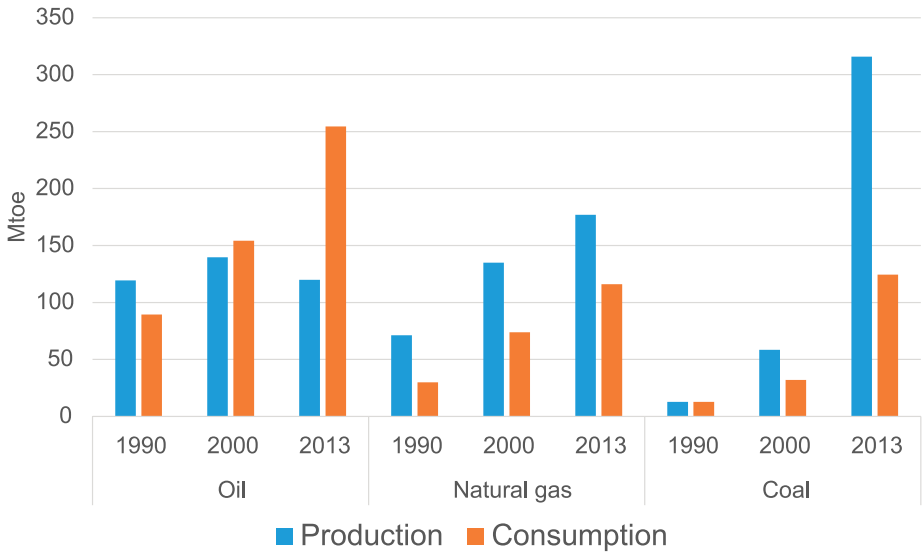


Figure 6 Fossil Fuels Production and Consumption in 1990, 2000 and 2013

across the same time period) will, if unchanged in the mid-term, shift the balance of the region's trade towards becoming a net natural gas importer. As for coal and lignite, a steady increase in production capacities delivered a remarkable expansion in the production path: with an average annual growth rate 15% between 1990 and 2013, the production of coal and lignite reached 316 Mtoe in 2013, outmatching the consumption by 191.5 Mtoe. About 90% of production takes place in Indonesia, given the vast reserves in Sumatera and Kalimantan, and to a minor extent, in Vietnam is about 7%.

Energy Trade

The level of production and consumption of fossil fuels affected the monetary value of the trade balance of primary fuels for the ASEAN region, both between extra- and intra-ASEAN shares (Figure 7). The importance of oil for the region is clear. With an extra-ASEAN import value of USD176 billion or about 72% of USD244 billion total imports and USD69 billion extra-ASEAN exports, the extra-ASEAN trade balance of oil results in a net deficit of USD107 billion. Coal (USD24 billion) and natural gas (USD47 billion) are domestically produced within ASEAN and correspondently exported mainly for extra-ASEAN demands.

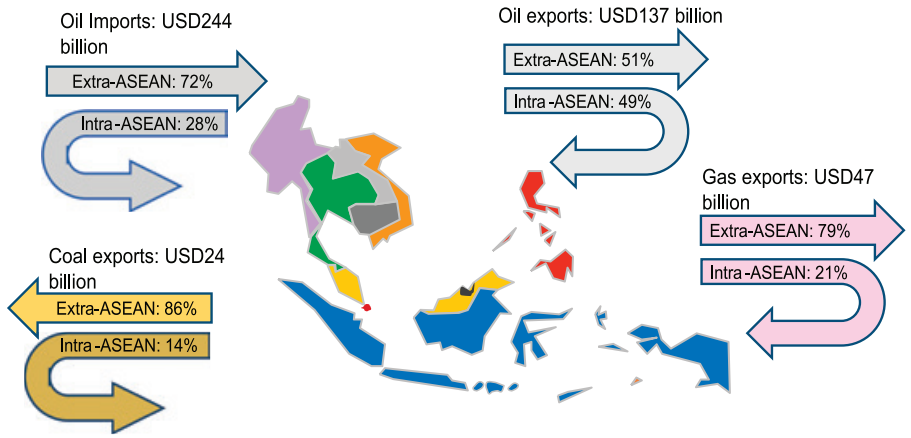


Figure 7 Intra- and Extra- ASEAN Trade on Fossil Fuels in 2013

Final Energy Consumption

ASEAN Total Final Energy Consumption (TFEC) and its share by each AMS is, in relative terms, no different than the TFES (Figure 8). In 2013, TFEC reached 436.8 Mtoe, as the result of an average growth rate of 4% per year between since 1990. Indonesia is the highest contributor, with a 38% share of TFEC in 2013, followed by Thailand with 21% and then Malaysia and Vietnam with 12% and 13% respectively.

Reflecting the structure of TPES, TFEC was dominated by fossil fuels where coal, oil and natural gas have 10%, 45.2% and 11.1% respective shares in 2013, with electricity share of 17.9%. This is a totally different share structure from the year 1990 when it was mostly dominated by the use of traditional biomass (Figure 9). In 1990, the region consumed 85.7 Mtoe of traditional biomass or about 48.6% of its TFEC. But as more people moved to urban areas and gained access to commercial energy, especially for their cooking, and increased

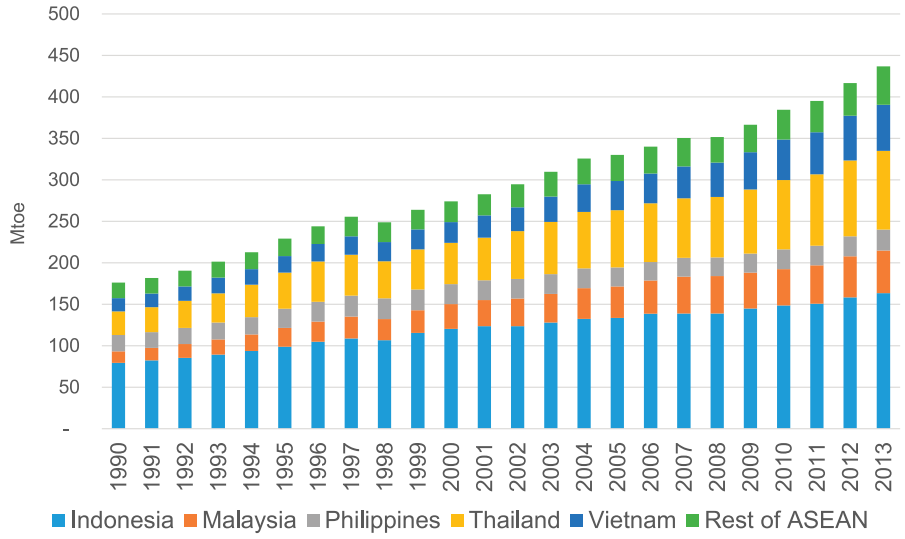


Figure 8 Total Final Energy Consumption in 1990-2013, Member States-based

their use on electricity, the use of traditional biomass as energy source felt to 59.3 Mtoe or only about 13.5% of its TFEC in 2013. During the period 1990-2013, TFEC grew at 4% on average every year, but the consumption of fuels in majority was higher. Coal's growth was the fastest at 9.2% on average per year, followed by electricity and natural gas at 8.8% and 8.4% each, while oil grew at a moderate 4.9% per year.

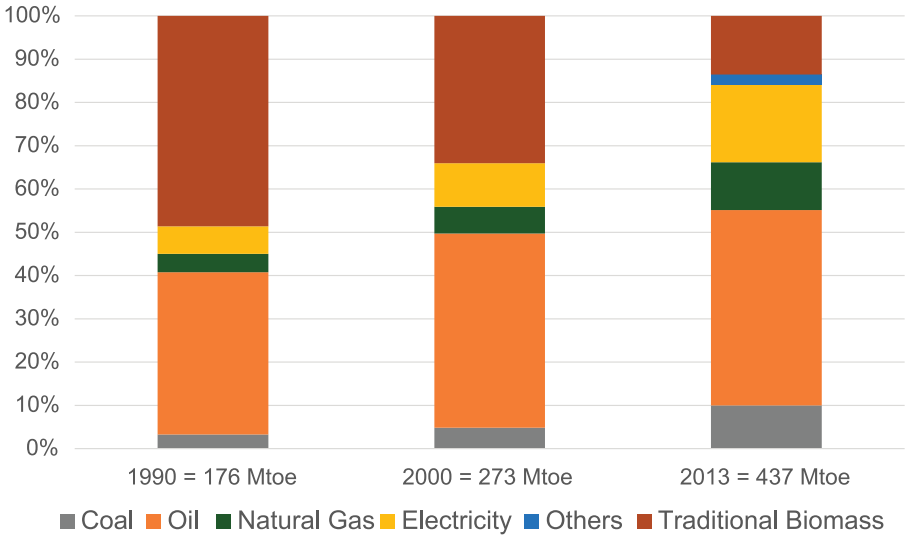


Figure 9 Total Final Energy Consumption in 1990, 2000 and 2013, fuel based

In sector terms, the industrial, transportation and residential sectors together account for 80% of TFEC in 2013, down from 89% in 1990. The pattern of TFEC's development from 1990 to 2013 by the various sectors show a clear reduction in the share by the residential sector from 46.8% to only 22.8%, compared to all the other sectors which show a steady increase in their respective shares of TFEC (Figure 10). Energy consumption by the residential sector grew at the lowest rate (only 0.8%) during the period 1990 to 2013, while the Others sector (which include fishing and agriculture) grew the fastest at 7.0% on average per year, followed by Non-energy use (including for feedstock on fertilizer industry) at 6.6% and commercial sector at 6.4% on average per year.

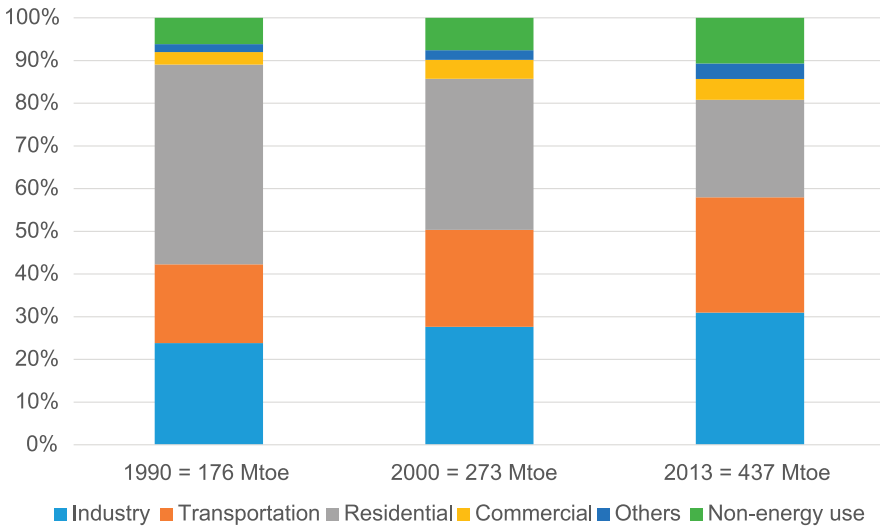


Figure 10 Total Final Energy Consumption in 1990, 2000 and 2013, sectoral based

Electricity Generation

Since 1990, electricity generation has increased dramatically, even faster than economic growth rates. During the 1990-2013 period, the economy grew by 5.1% on average per year, yet electricity generation grew at 7.5% on average per year. In 1990, as a whole, the region produced only 155.3 TWh, but in 2013 it has grown 5.3 times to reach 821.1 TWh. In share terms, six AMS (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) account for more than 90% of electricity generated during the period (Figure 11). Back in 1990, Thailand was the lead generator with its 28% share from total electricity generation, followed by Indonesia and the Philippines with 21% and 17% respectively. Even though Indonesia and Malaysia grew much faster (more than 8% on average per year) than the growth rate of total electricity generated by the region, Vietnam grew at an impressive rate of 12.6% on average per year during from 1990 to 2013. This has caused the big jump in Vietnam's share from only 5.6% in 1990 to 16.1% in 2013.

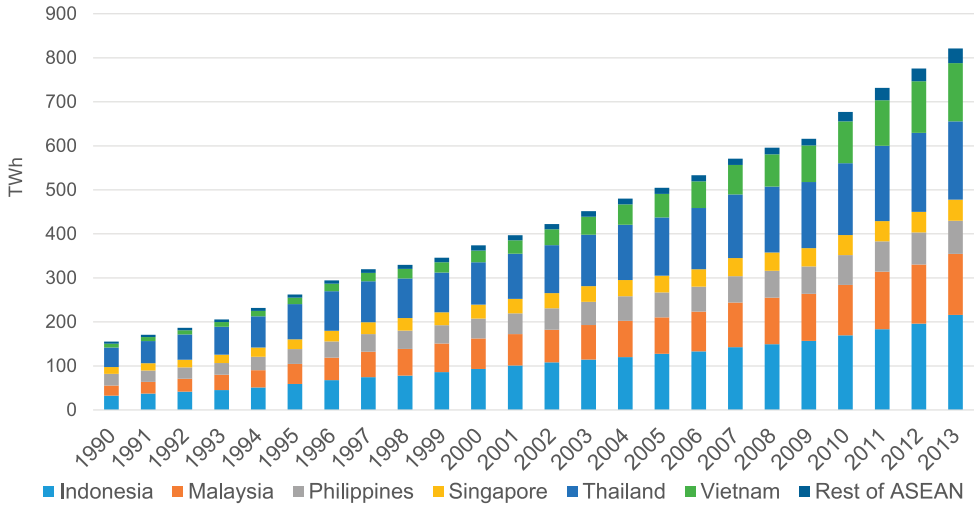


Figure 11 Electricity Generation 1990-2013, Member States based

In terms of the fuels used for electricity generation, the relative share and composition have also changed (Figure 12). In 1990, oil was the main fuel being used to produce 66.0 TWh or about 42.5% of total electricity generation, followed by coal and natural gas which had quite similar shares at 17.9% and 16.9% respectively. Because of massive programmes to construct gas-fired and coal-fired power plants in various ASEAN Member States, oil's share dropped drastically to only 4.2% in 2013, while the share of coal and natural gas jumped to 31.5% and 43.8% respectively. Relying on hydro and geothermal, RE has already contributed significantly, generating about 22.7% of all electricity generated in 1990, equivalent to 35.3 TWh. Even though RE's total absolute volume of electricity generated increased to 169.3 TWh in 2013, its share as a fuel dropped to 20.6%.

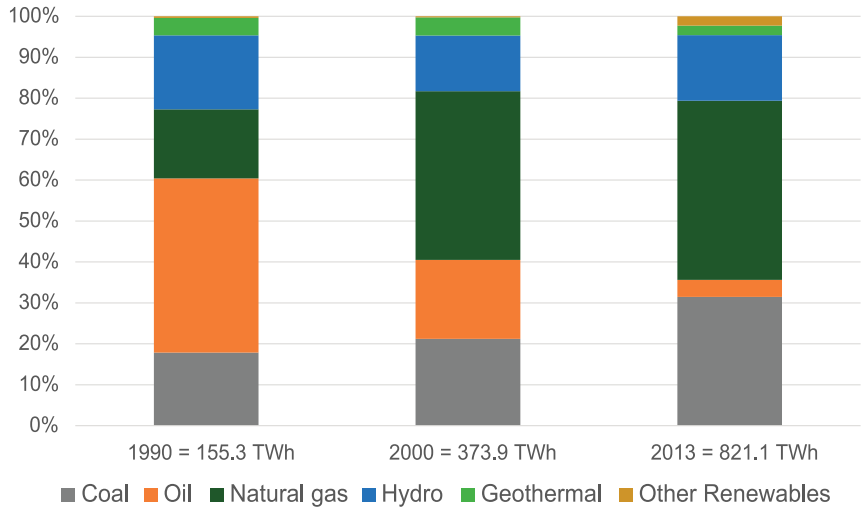


Figure 12 Electricity Generation in 1990, 2000 and 2013, fuel-based

Urbanisation and Electricity Consumption

In ASEAN, there was a clear relationship between per capita electricity consumption and the urbanisation rate of each Member State between 1990 and 2013 (Figure 13, - with the lowest data point for each set according to 1990 and the highest data point according to 2013). It becomes evident that each Member State is at a different development stage and encompasses a unique set of conditions. The rate of economic development also contributed to the increase in electricity consumption.

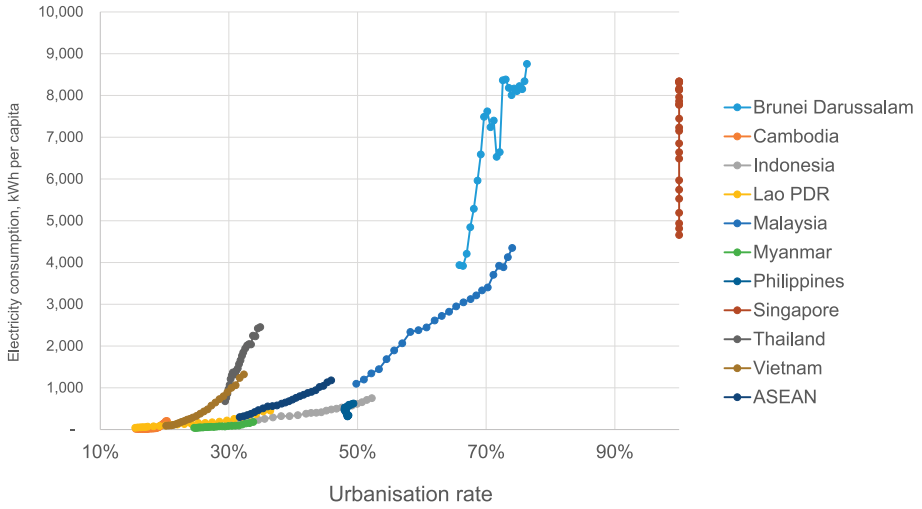


Figure 13 Correlation between urbanisation rate and electricity consumption

Scenario Cases

AEO4 tries to identify a long-term energy supply and demand outlook for the ASEAN up to 2035, and tries to answer the following key questions:

- How much energy is needed to support the economic growth targets of the AMS?
- How would the AMS choose the energy source to fulfil this demand?
- How far the current national EI and RE would targets support the regional targets aspired to in the APAEC document?

In doing this, AEO4 includes two scenarios, differing in the degree of success and implementation of the wider portfolio of energy policies among the AMS. Specifically, the two following scenarios are computed based on the same socio-economic assumptions:

- Business as Usual (BAU) Scenario assumes that past developments will continue without a strong additional policy effort and in the absence of further radical modifications. While taking into consideration future changes in activities that drive energy consumption, this scenario presumes that the policy landscape within the whole ASEAN region is not subject to influential modifications.

- Advancing Policies Scenario (APS) considers future changes in activities driving the energy consumption in an equal manner to the BAU scenario, while additionally presuming the successful implementation of stronger policies by the AMS.

In general terms, both the BAU scenario and the APS scenarios contain measures for the following sectors as defined by each AMS in their corresponding energy plans:

- Power sector: Policies target higher thermal efficiency processes such as state-of-the-art natural gas and combined cycle processes. Further policies including ASEAN targets on RE shares at national levels for the overall installed capacities are also included, with hydro playing the most important role.
- Industry: Policies target higher energy efficiency in the manufacturing processes, in particular in the energy intensive industry such as the primary ferrous and non-ferrous metals production, the pulp and paper production, the chemical industry, etc.
- Transport: The transport policies mainly target the implementation of a higher share for biofuels and, to a limited extent, public transportation policies such as rail development projects.
- Buildings and Service Sector: Policies target enhanced building efficiency measures.
- Residential: Policies target electrification programmes for rural areas, and energy efficiency household appliances.

Detailed overview on the AMS specific policies in the BAU scenario and the APS are provided in separated spreadsheets.

Results of the calculations in these two modelling scenarios were analysed with reference to the aspirational regional targets as stipulated under the ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase I, endorsed by the 33rd AMEM on 7 October 2015 in Kuala Lumpur, Malaysia:

- To reduce energy intensity by 20% in 2020 based on the 2005 level.

- Aspirational target to increase the component of renewable energy to 23% by 2025 in the ASEAN energy mix.

The scenario approach used to evaluate the future energy supply and demand, as well as the implication on realising specific APAEC targets are being analysed (Figure 14).

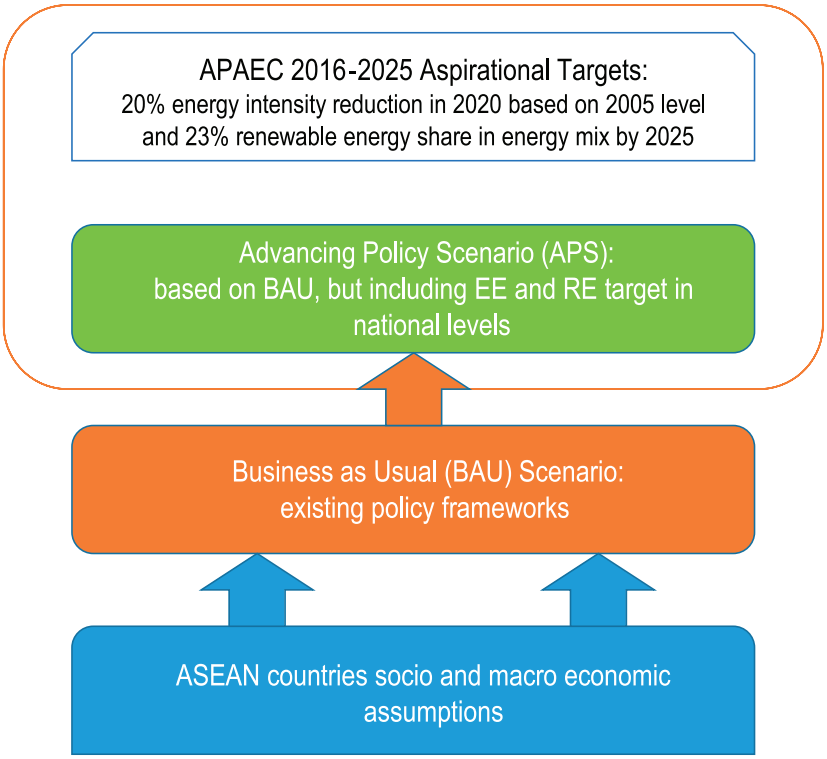


Figure 14 Scheme of Approach on Scenarios

Methodological Framework

One of the key conditions of AEO4 is that each AMS forecasts their future energy demand by creating each Member State-specific energy model. The two most widespread modelling approaches to forecasting future energy demand: top-down and bottom-up models were selected by the Member State, based on their national preferences. In a top-down approach, an econometric approach was applied to forecast energy demand where demand equations are econometrically estimated using historical data, while future values are projected using explanatory variables. Meanwhile, for a bottom up approach, forecasting relies on intensity and activity level for each sector. Both approaches were simulated using the Long-Range Energy Alternatives Planning System (LEAP) software. All modelling parameters and assumptions reflect data availability on a national level and Member State' expectations of their future energy development based on their in-depth knowledge of their energy landscapes (Figure 15).

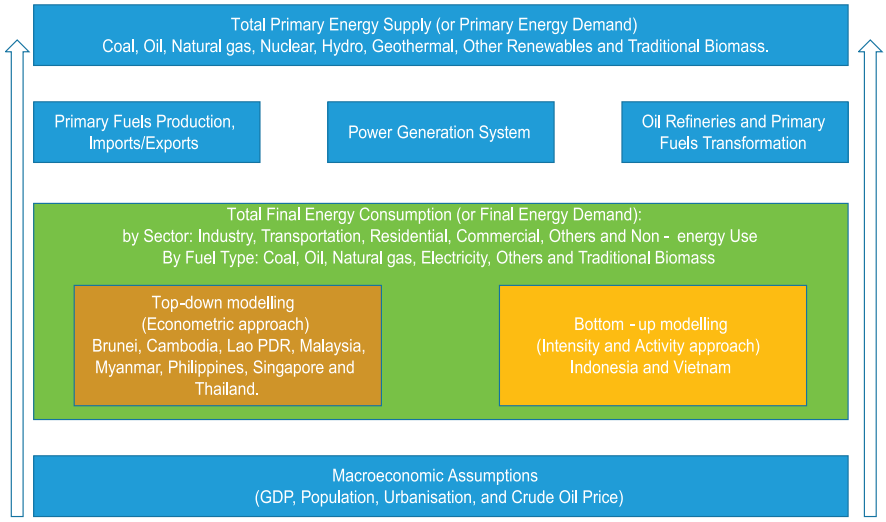


Figure 15 Modelling Scheme in Forecasting Final and Primary Energy Demand

Outlook Time Periods

The base year for AEO4 is set at 2013. The Outlook period is from 2013 to 2035.

Modelling Assumptions

Gross Domestic Product (GDP) Development

GDP assumptions were derived from national statistics and have been standardised as gross domestic product (GDP) based on purchasing power parity (PPP). The PPP approach converts currencies at a rate based on how much they can buy compared to a US dollar, rather than the rate that would be offered at a bank. It could be argued that, for the purpose of calculating energy intensities, PPP is the more appropriate method for converting currencies. The PPP approach was selected for calculating energy intensities because it reflected on how a Member State's energy use is fundamentally related to how much their GDP will buy, rather than how much it would be worth if it were converted to US dollars at a bank. In addition, market exchange rates can be subject to dramatic fluctuations, which could cause energy intensities to fluctuate dramatically if GDP were valued at market exchange rates, even though how an economy utilize that energy may not have changed. This selection has been agreed officially by the AMS.

For AEO4, aspired economic growth is defined by each AMS as their GDP growth between the year 2013 and the year 2035 (Table 2). AMS' representatives provided these data during a series of consultation workshops for the preparation of AEO4. The set of assumptions correspond to the development paths based on the official development strategies and economic projections of each ASEAN Member State. Based on Member State-specific development targets for the ASEAN region, the aspired GDP annual average growth rate between the year 2013 and the year 2035 is 6.1%, which will drive the growth of GDP PPP from 5,080 billion constant 2005 USD in 2013 to 18,763 billion constant 2005 USD in 2035.

Table 2 Macro Assumption on GDP and Population

Country	GDP Growth		Population Growth	
	Historical 1990-2013	Aspirational 2013-2035	Historical 1990-2013	Aspirational 2013-2035
Brunei Darussalam	1.20%	5.90%	2.1%	1.7%
Cambodia	7.80%	6.30%	2.3%	1.7%
Indonesia	5.40%	7.70%	1.5%	1.0%
Lao PDR	7.40%	7.00%	2.1%	1.5%
Malaysia	4.70%	3.20%	2.2%	1.1%
Myanmar	9.50%	8.30%	1.0%	1.0%
Philippines	5.00%	5.90%	2.0%	1.6%
Singapore	5.40%	2.00%	2.5%	1.4%
Thailand	4.00%	4.00%	0.7%	0.0%
Vietnam	6.40%	7.10%	1.3%	0.7%
ASEAN	5.20%	6.20%	1.5%	1.0%

Population Growth

Another key assumption used as a fundamental to forecast energy demand is population growth. These growth rates were also provided by each AMS and are in-line with their demographic expectations of population growth and urbanisation rates (Table 2). By 2035, ASEAN's total population is expected to reach 762 million inhabitants, where 420 million will live in the city, reflecting a yearly average growth rate of 0.96% and an annual urbanisation rate of 1.74% until 2035.

Crude Oil Price

Whereas the prices for all of the fossil fuels will have a crucial role in anticipating future energy demand, it is the price of oil, which is particular importance. Oil's development as a fuel is subject to high uncertainty as its price depends on the demand and supply patterns

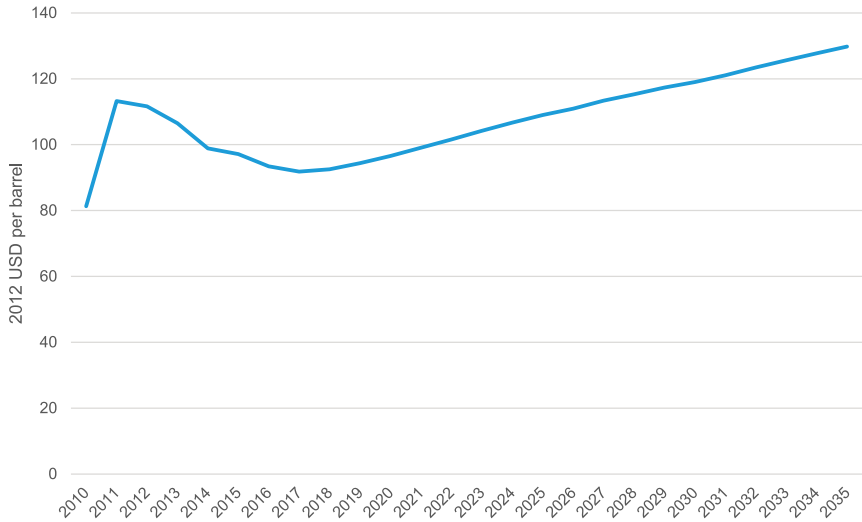


Figure 16 EIA Reference Oil Price Forecast

of major consumers and producers, as well as being battered by geopolitical shocks or by the strategic considerations of oil producing nations. For AEO4, the price development chosen is in-line with the Energy Information Agency's (EIA) reference scenario in 2014 for the development of North Sea Brent spot prices. In this scenario, the price is expected to be 130 constant 2012 USD per barrel in 2035 (Figure 16). Yet this forecast does not include the fall of oil price developments in 2014 and 2015.

Gas Energy Plant, Paka - Malaysia
Photo Courtesy : Siemens

Chapter 2 Energy Demand and Supply Outlook

This chapter presents the results of the cumulated and harmonised the AMS' models within the BAU scenario and the APS.

Business as Usual (BAU) Scenario

Total Primary Energy Supply (TPES)

In the BAU scenario, the TPES of ASEAN is projected to increase steadily from 619 Mtoe in 2013 to 1,685 Mtoe in 2035, growing at an annual rate of 4.7%. The projected growth is higher than trends observed between 1990 and 2013, which averaged 4.2% per year.

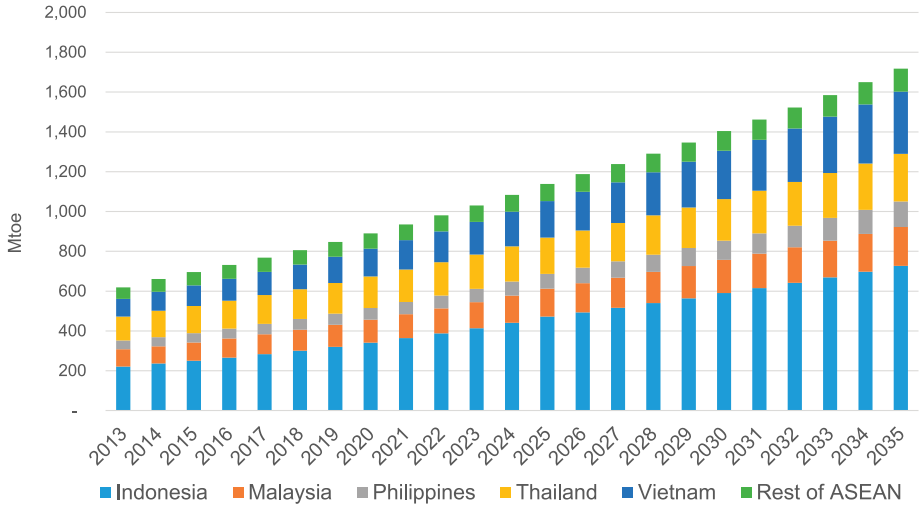


Figure 17 Forecast Total Primary Energy Supply in 2013-2035, Member States-based

Five major Member States, as shown in Figure 17, continue to dominate the supply of energy, with a combined share above 90%. In 2013, Thailand was the second biggest with 19% after Indonesia's 36%, while Vietnam's fast economic development has contributed to the growth of energy demand in the Member States. With energy demand growing at 5.9% on average every year, the TPES of Vietnam in 2035 is expected to reach 313 Mtoe or about 18% of the regional TPES, securing its position as the second biggest supplier. Although growing at the slower rate of 5.5% every year, Indonesia will maintain its top position with 727 Mtoe or 43% of the regional TPES in 2035.

By energy type (Figure 18, Figure 19), oil will only be able to maintain its primary position, with the largest share of TPES, until 2025, accounting for 31.1% in 2020 and falling slightly to 29.9% in 2025. During the period 2013 to 2035, oil's demand growth is projected to only register a very slow 2.7% per year, the lowest among all fossil fuels. This is mainly caused by the projected rapid growth in electricity consumption that will be largely met by coal-fired power plants and motorisation-led growth in demand for oil will not contribute much. It is predicted that oil's share of the TPES pot will fall to its lowest share, at 22.2% by 2035.

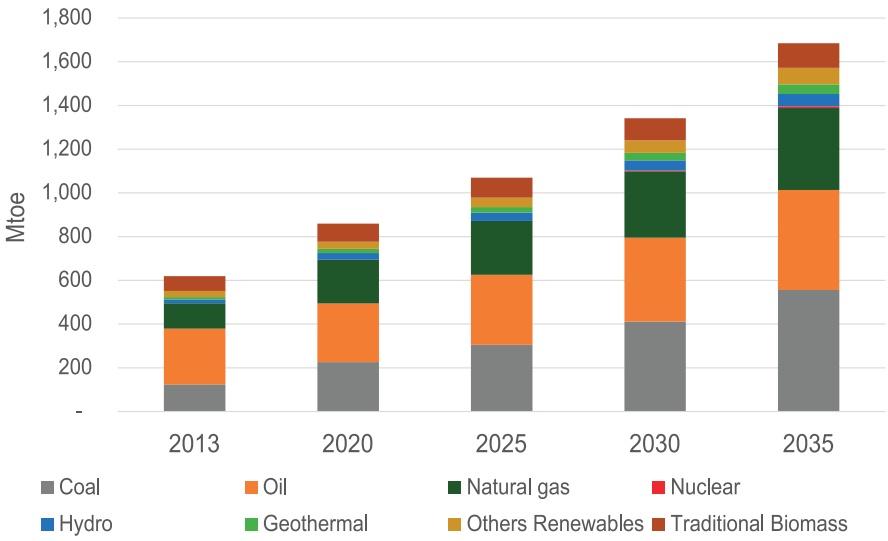


Figure 18 Forecast Total Primary Energy Supply in 2013-2035, fuel-based

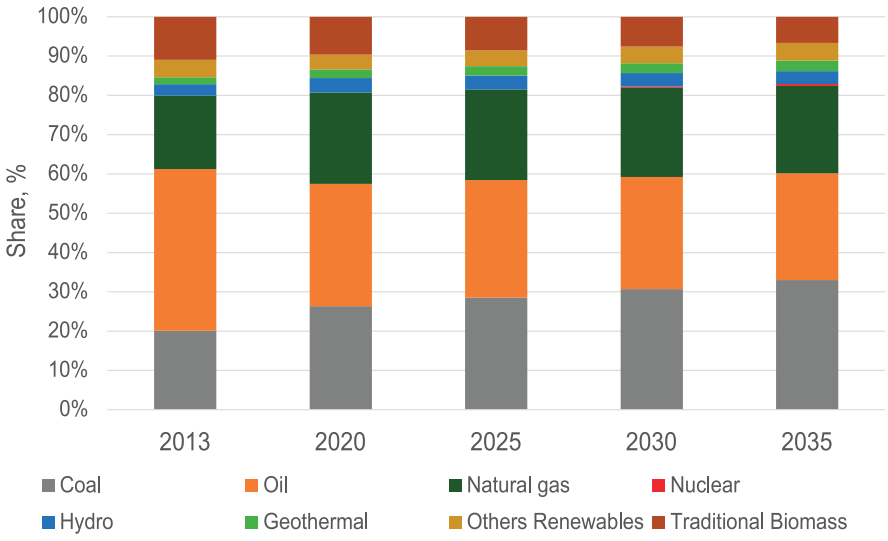


Figure 19 Forecast Total Primary Energy Supply in 2013-2035, fuel share

Whereas coal only accounted for 20.1% of the TPES in 2013, coal supply is expected to have the highest increase among other fuel types with a yearly average growth rate of 7%, thereby overshadowing oil in 2035 with a 33% share, equivalent to 556 Mtoe. Meanwhile, the share of natural gas is expected to increase from 18.7% in 2013 to 22.2% in 2035 as the requirement will increase from only 116 Mtoe 2013 to 374 Mtoe in 2035, equivalent to a yearly average growth rate of 5.5%.

Natural gas will register the second fastest growth rate among the fossil fuels at 8.1% per year during the period of 2013 to 2020, rising to 23.3% share of TPES or about 199.9 Mtoe. Lower environmental impact and ease of use are the key factors that drive the demand for natural gas to grow only 4.3% per year from 2020 to 2035, when coal takes up the slack. This will lead to a fall in its share of TPES in 2035, to only 22.2 % or about 374.3 Mtoe. Across the whole period 2013 to 2035, natural gas will grow at 5.5% per year.

Renewable energy is expected to grow as the region diversifies its energy mix away from fossil fuels by tapping into the huge potential of RE across the region. In 2013, the absolute value of RE was 56 Mtoe, accounting for the 9.1% of TPES, or as high as 10.2% if traditional biomass is excluded from the TPES. Within ASEAN, hydropower and geothermal are two major sources of RE. In the BAU scenario, the growth of geothermal is the second highest after coal, with yearly average growth rates predicted to hit 6.6%. Hydro will grow at 5.3% on average every year while other RE sources such as solar, wind and commercial biomass will grow at 4.7% on average every year. All commercial RE is expected to reach to 176 Mtoe by 2035. Meanwhile, the use of traditional biomass will only grow at a slower rate of 2.3%, decreasing its share from 11% in 2013 to only 6.7% in 2035.

Nuclear is projected to begin its contribution to TPES in 2030 with 4.7 Mtoe and to rise to 8.1 Mtoe as the region is expected to see the operationalization of nuclear power plants in Vietnam and followed by Thailand and Malaysia.

Total Final Energy Consumption (TFEC)

During the period 2013 and 2035, the TFEC in the region under the BAU scenario is projected to grow at an average annual rate of 4.3%, reflecting the assumed 6.1 % annual GDP growth and about 1% population growth. TFEC is projected to increase from 436.8 Mtoe in 2013 to 1,107 Mtoe in 2035. In the commercial sector demand is projected to grow most rapidly, increasing by 7.3% per year, as a result of increasing incomes as economies grow. However,

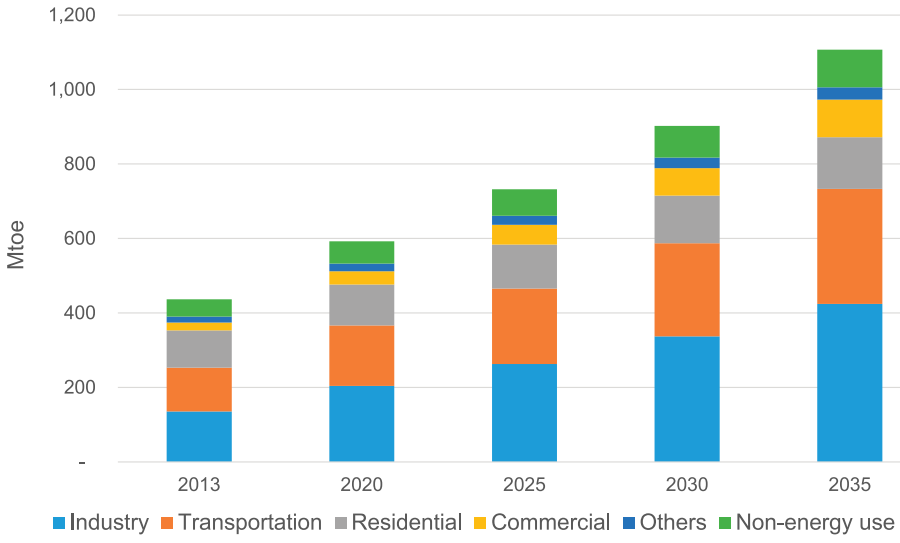


Figure 20 Projected TFEC in 2013-2035, sectoral-based

the industrial sector will consume the majority, with a 31% share of TPES in 2013, rising to 38.3% in 2035, an increase of 5.3% on average every year to reach an absolute value of 424.1 Mtoe in 2035. Demand from the residential sector will grow at only 1.5% per year during the years 2013 to 2035. However, this is already higher than the previous period of 1990-2013, in which growth averaged 0.8% per year. The share of non-energy use will remain constant during the period with a 3.6% growth rate. Even though there is a slight change in the sectors' shares in TFEC from 2013 to 2035, the position is expected to remain the same (Figure 20, Figure 21).

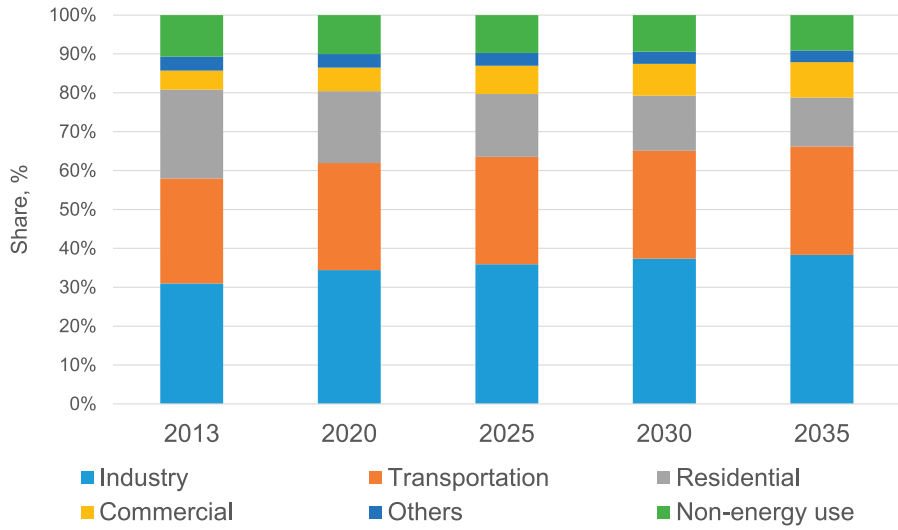


Figure 21 Projected TFEC in 2013-2035, sectoral share

As an energy source (Figure 22, Figure 23), demand for coal in the BAU scenario is projected to exhibit the fastest growth, increasing by 6% per year, from 43.7 Mtoe in 2013 to 156.2 Mtoe in 2035. Although oil will retain the largest share of TFEC, it is projected to grow at the slightly lower rate of 4.2% per year, reaching 483.5 Mtoe in 2035. This is a slower pace than its 4.9% annual growth over the period 1990-2013. However, oil's share will still remain the largest, with only a small dip from 45.2% in 2013 to 44.6% in 2034. Demand for electricity will grow at a rate of 5.6% per year, second only to coal. Its share will increase from 17.9% in 2013 to 23.2% in 2035, maintaining its position as the second most consumed fuel. Other fuels, such as solid and liquid biofuels, will experience a slow annual growth rate of 2.9% on average. Consequently, the share of other fuels will decline from 2.4% in 2013 to 1.8% in 2035.

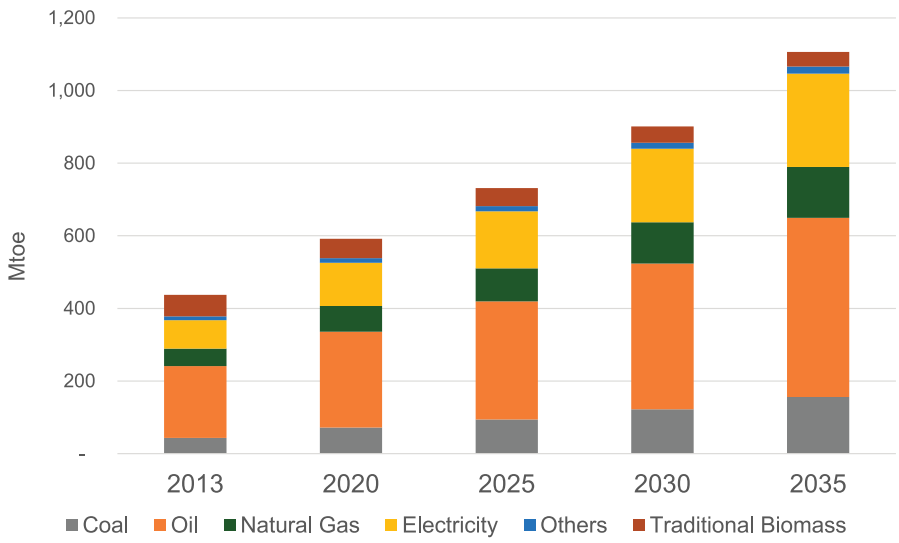


Figure 22 Projected TFEC in 2013-2035, fuel-based

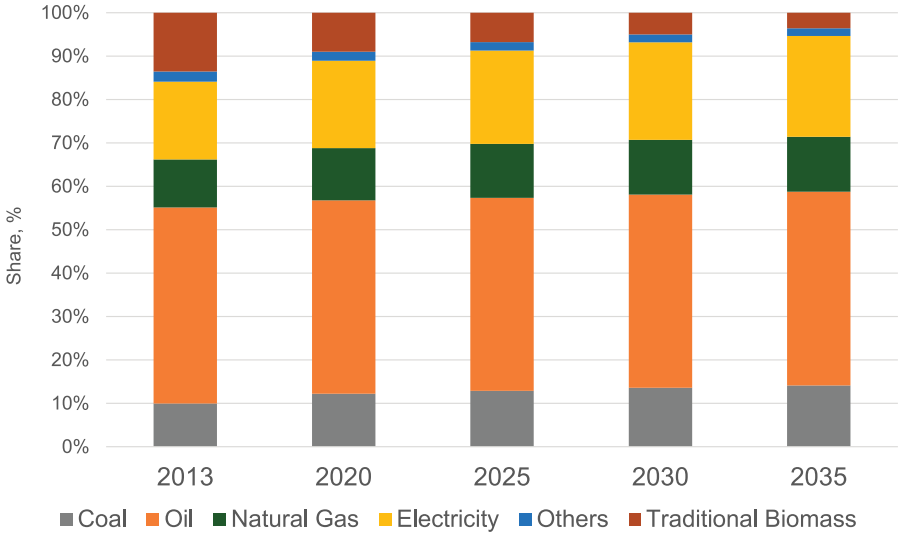


Figure 23 Projected TFEC in 2013-2035, fuel share

Electricity Generation

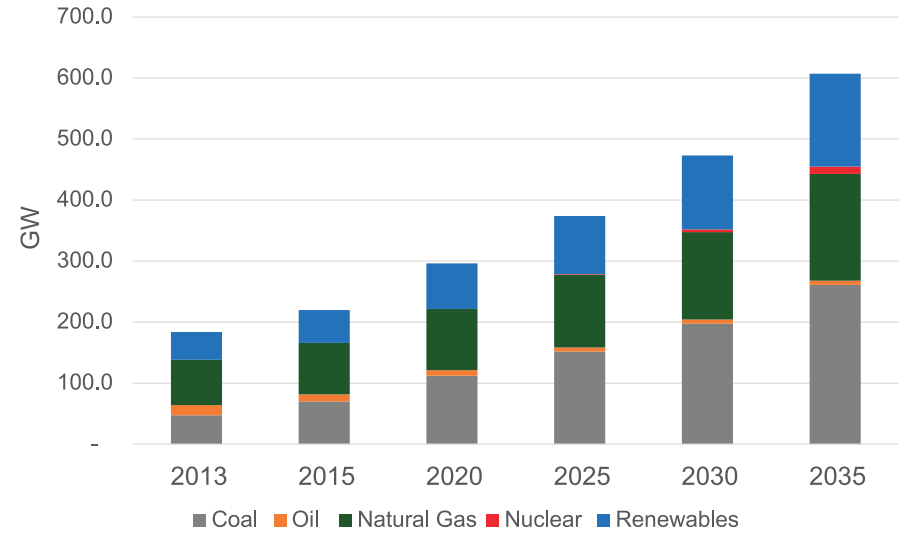


Figure 24 Projected Installed Power Capacity in 2013-2035, fuel-based

The installed power capacity in ASEAN increases rapidly based on the BAU scenario projection (Figure 24), showing that impressive efforts are required to cope with the increasing demand for electricity in ASEAN. In this scenario, the overall capacity increases from 184 GW in 2013, to 374 GW in 2025 and is predicted to reach 607 GW in 2035, at an average growth of 5.6%.

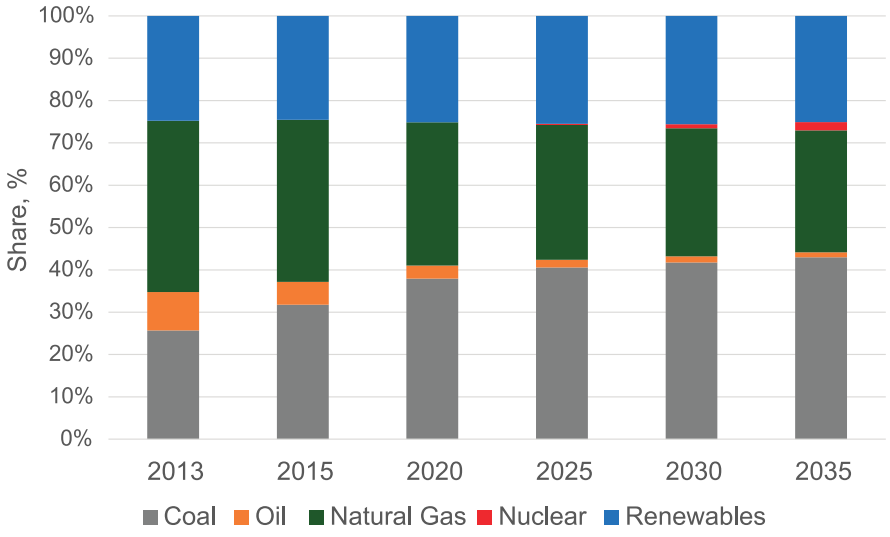


Figure 25 Projected Installed Power Capacity in 2013-2035, fuel share

Installed power capacity from coal-based plants will rise from a starting value of nearly 47 GW in 2013 to 152 GW in 2025, reaching 261 GW in 2035, based on an average growth of 8.1% per year. This is a fastest level of growth, which will have considerable implications for coal production, as demand for coal will rise too.

Natural gas-based plants had a historical capacity of 74.4 GW in 2013, which is expected to increase more than double, reaching 119 GW in 2025 and 175 GW by 2035. Although the average growth is at a rate of 4.0%, but it is below the average value of electricity generation annual growth at 5.6% on average during period 2013-2035. The share of natural gas-fuelled power plants will fall from 40% in 2013 to 29% in 2035 (Figure 25). Meanwhile, oil-fired power plants will also reduce their electricity contribution, declining from 16.7 GW to only around 6-7 GW from 2025 to 2035.

After coal, RE will have the largest average growth of 5.6% between 2013 and 2035. In the BAU scenario, the total installed capacity will reach a value of 95.4 GW in 2025 and 152 GW in 2035. Figure 26 shows the different generation types and the development of their shares within the renewable branch. The highest share is reached by hydro with 84% and a capacity of 37 GW in 2013. Growing by an average of 3.4% per annum, hydro will reach a capacity of 57.4 GW in 2025 and 77.6 GW in 2035. Although its share will fall to 52%, hydro remains the main RE source. Wind and solar remain in the nascent phase with low capacities, in 2013 they reached a combined value of 1.2 GW and a share of approximately 2.7%. It is expected that by 2035 both these technologies will reach around 10.8 GW and 9.9 GW respectively, equal to a share of 7.3% for wind and 6.6% for solar technologies. Geothermal is forecast to reach 8.4 GW in 2025 and 11.3 GW in 2035 when it will achieve a share of 7.6%.

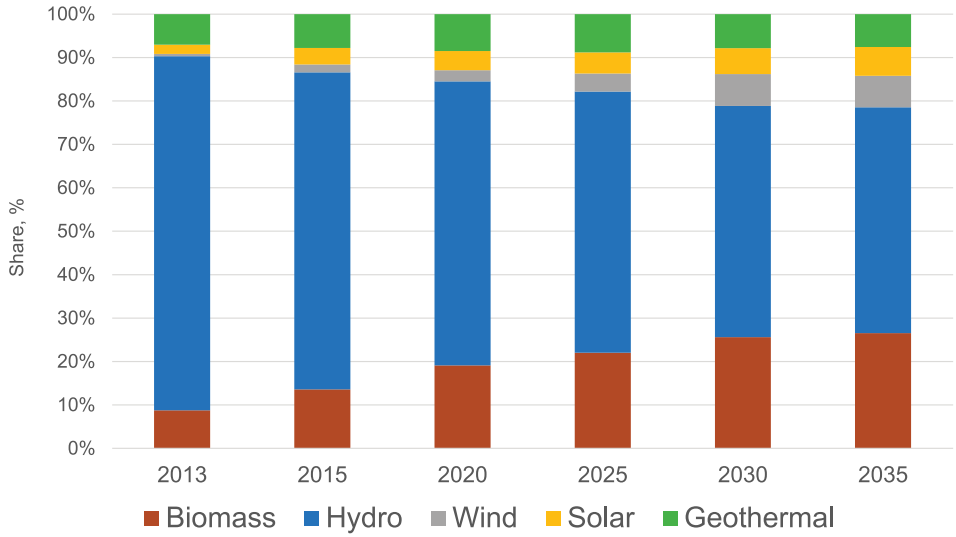


Figure 26 Projected Installed Power Capacity on Renewable in 2013-2035, fuel-based.

In term of fuel sources, it is forecasted to experience the change of the composition (Figure 27). In 2013 total generation was 821 TWh and was dominated by natural gas-based plants supplying 359.3 TWh (43.8%), coal-based plants supplying 258.3 TWh (31.5%), RE supplying 169 TWh (20.5%) and oil supplying the remainder. RE's primary source was large hydro which contributed 73% with 113 TWh followed by geothermal plants contributing 13%

with 19.8 TWh and biomass contributing 8.7% with 13.5 TWh. Solar and wind contributed only a small share of RE generation, respectively 4.3% and 0.1%.

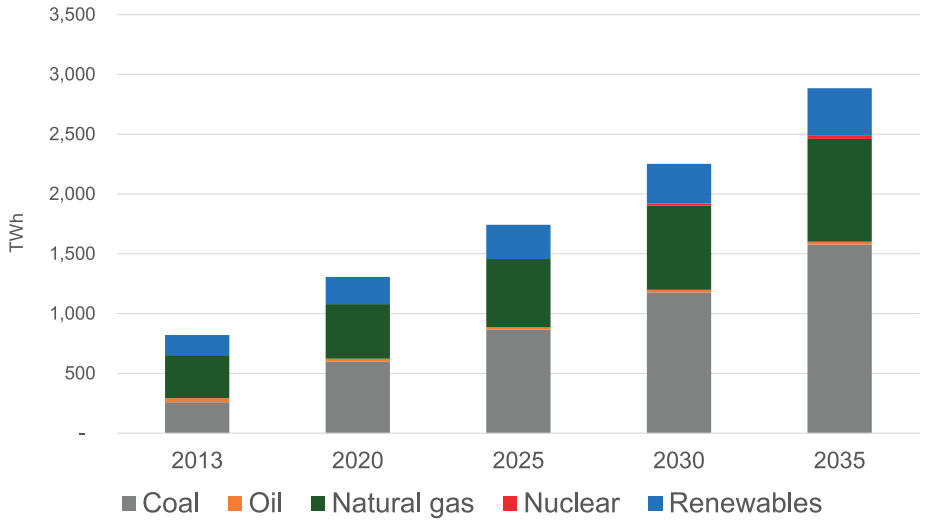


Figure 27 Projected Electricity Generation in 2013-2035, fuel-based

In the BAU scenario, coal-based generation increases to 867 TWh in 2025 and 1,577 TWh in 2035. At these levels, coal will replace natural gas as the most dominant generation fuel, reaching a 55% share in 2035 versus natural gas on 32% share. Coal-based generation growth is growing at 8.2%. As mentioned above, this level of growth is high, and will necessitate the installation of an additional 100 coal power plants, each with a capacity of 500 MW, between 2015 and 2025. The proportion of electricity generated by renewable energy generation will grow at an average rate of 4.4% from 2013 onwards. This proportion is only 153 TWh in 2013, but will reach 286 TWh in 2025 and 392 TWh in 2035. Although this represents considerable growth, RE's overall share will drop to 13% in 2035, due simply to coal's huge increase in its contribution to electricity generation.

Advancing Policy Scenario (APS)

Total Primary Energy Supply (TPES)

The TPES in the APS is projected to increase from the historic value of 619 Mtoe in 2013, to over 998.2 Mtoe in 2025 and 1,468 Mtoe in 2035. This is based on an average growth rate of 4% per annum. The difference with the BAU scenario shows approximately the potential saving on the TPES that could be achieved by ASEAN through the implementation of their advancing policies (Figure 28). While the TPES based on the APS in 2000 was only 3% lower than in the BAU scenario, by the end of 2035, these policies are expected to contribute to a reduction of energy demand of 13%.

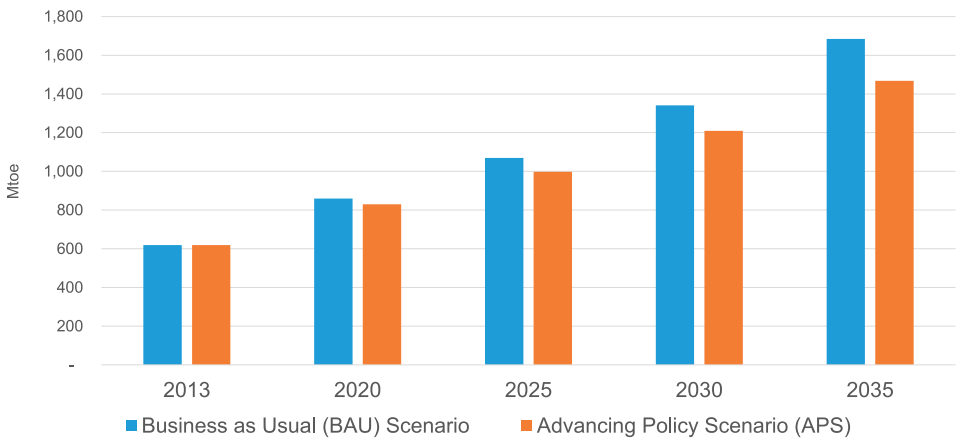


Figure 28 Potential Reduction for TPES with the APS

In terms of fuel types (Figure 29), the growth of coal and natural gas within the TPES is projected to be considerably lower than for the BAU scenario, although oil growth remains the same. Coal demand in the APS is expected to grow by only 5.3% on average per year, slower than the 7% in the BAU scenario, reaching only 388 Mtoe in 2035. This is 30% lower than the demand for coal in the BAU scenario. Natural gas will also grow at a slower rate of 3% per year in the APS, compared to 5.5% in the BAU scenario. In 2035, the demand for natural gas is expected to reach 239 Mtoe, almost 36% lower than demand in the BAU scenario. This will contribute to a declining share of coal and natural gas in the APS - to only 25.6% and 16.8%, respectively. In this scenario, oil will maintain its position as the major fuel source, with 454 Mtoe in 2035, or 30.9% of TPES. However, as the AMS actively push their policies on energy efficiency and renewable energy, the growth of RE under the APS will

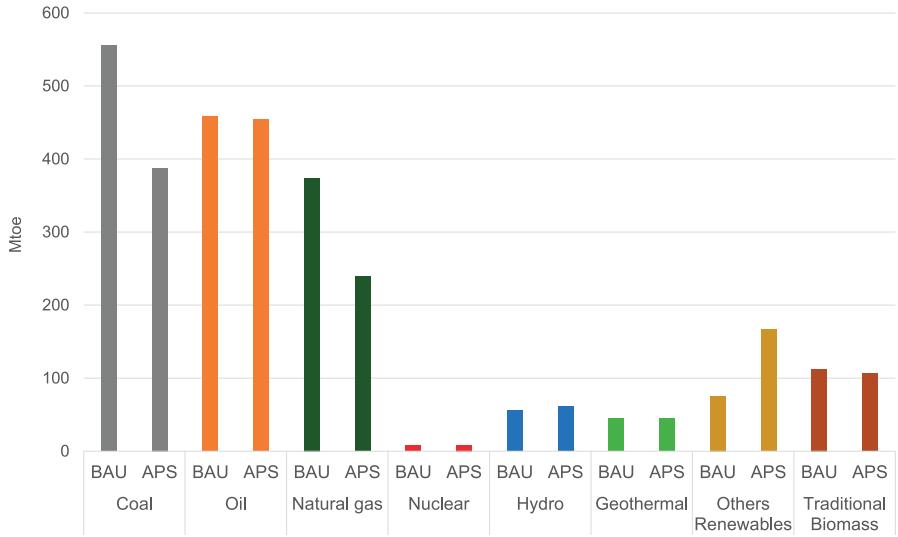


Figure 29 Potential Reduction of TPES for Each Fuel Type

be higher than the average growth trend. While the growth of hydro and geothermal is only slightly better under the APS compared to the BAU scenario, other renewables such as wind and solar have the potential to reach the highest growth, at 8.5% on average every year. This will contribute to RE's sharp rise, to 18.5% share of TPES by 2035, compared to only 10.5% share under the BAU scenario.

Total Final Energy Consumption

Under the APS, the TFEC will increase from 437 Mtoe in 2013, to over 658 Mtoe in 2025 and up to 932 Mtoe in 2035. This corresponds to an average growth rate of 3.5% every year, slower than under the BAU scenario, which reached an average growth of 4.3%, during period 2013-2035. This is due to the various energy efficiency plans and programmes and also influenced by the demand side initiatives that are to be implemented by the AMS. Based on the APS, the region will be able to reduce TPES by 16% by 2035 compared to the BAU scenario (Figure 30).

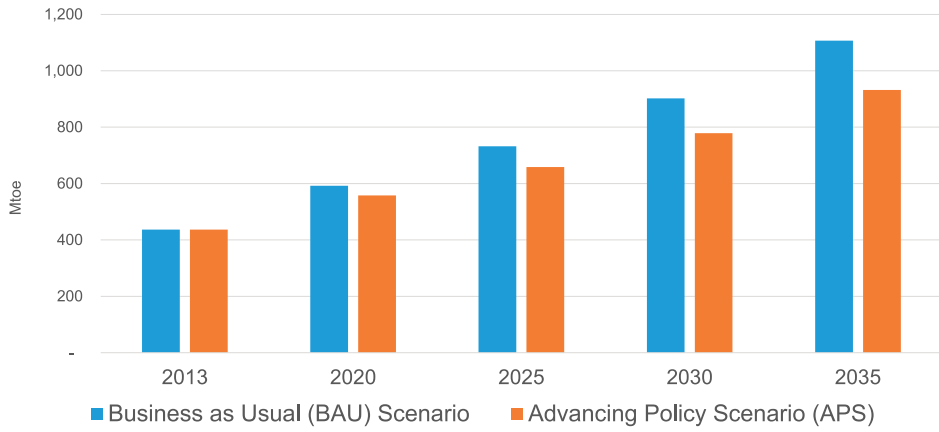


Figure 30 Potential Reduction for TFEC on the APS

Final energy consumption in most sectors is significantly reduced under the APS compared to the BAU scenario, except in non-energy use (Figure 31). In percentage terms, the largest reduction is in industry sector at 25.1%, followed by the transportation sector at 13.4% and commercial sector at 12.9% by the year 2035.

In terms of fuel sources, the consumption of nearly all types is lower under the APS, except for Others (Figure 32). Growth in TFEC for all fuels is lower under the APS compared to the BAU scenario. Demand for coal will experience the biggest drop in percentage and volume terms at 24.2% or 38 Mtoe, from 156.2 Mtoe under the BAU scenario to 118.4 Mtoe under the APS. However, in terms of absolute value, the advancing policy scenario is able to drive the largest reduction in the consumption of oil - 78 Mtoe lower under the APS compared to the BAU scenario, a decline of around 15.8%. Electricity and natural gas consumption will also follow this pattern, with reductions of 15.0% and 14.7% each by the year 2035 respectively. While traditional biomass also declines as more people migrate to commercial energy, the consumption for Others is predicted to increase by 8.8% under the APS compared to the BAU scenario.

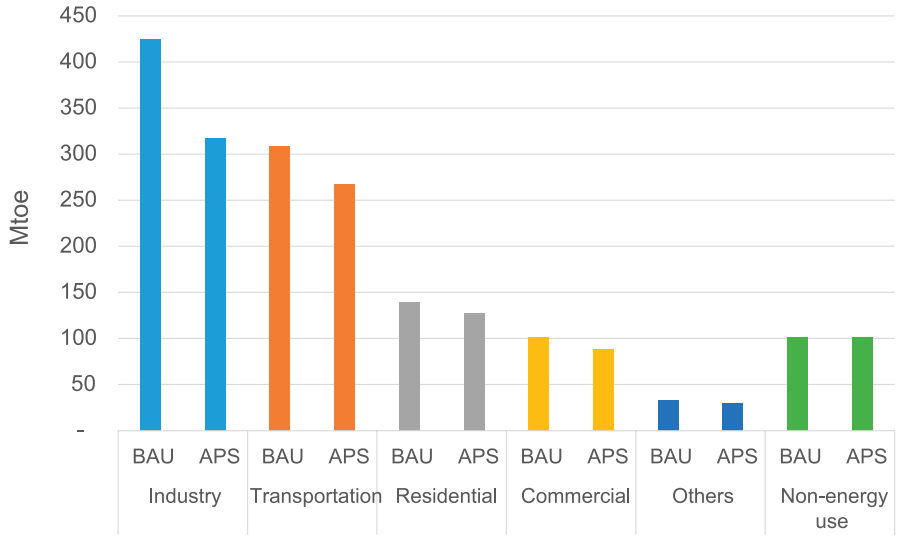


Figure 31 Potential Reduction of TFEC for Each Sectoral Type in 2035

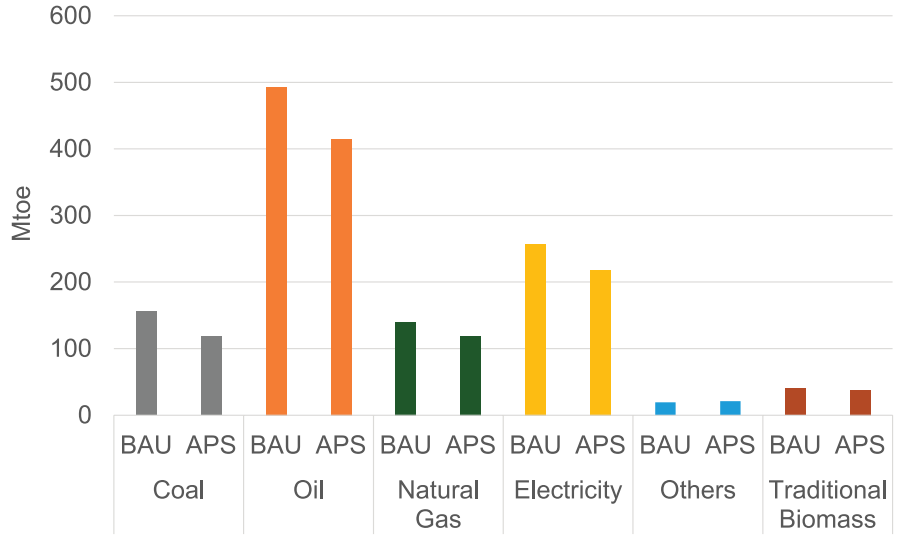


Figure 32 Potential Reduction of TFEC for Each Fuel Type in 2035

Electricity Generation

Under the APS, electricity generation in ASEAN is projected to grow at 5.1% per year on average from 2013 (821.1 TWh) to 2035 (2,473 TWh), slower than the 5.9% annual growth rate in the same period under the BAU scenario. As the region migrates towards more efficient power plants, it is expected to be able to reduce fuel demand by 14% by 2035, compared to the BAU scenario (Figure 33).

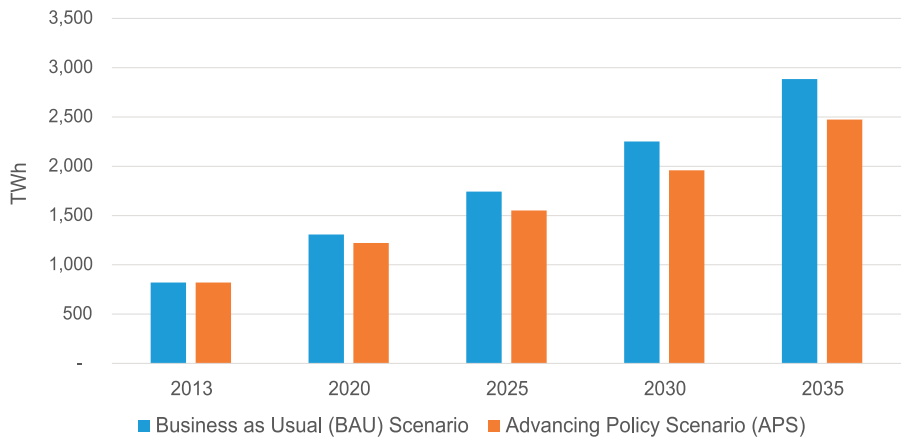


Figure 33 Potential Reduction for Electricity Generation on the APS

In terms of fuel sources for electricity generation, under the APS there will be a 30.3% decline in electricity that is generated from coal-fired power plants, and a 16.9% reduction from natural gas-fired power plants, compared to the BAU scenario. The AMS are implementing policies to generate 20.4% more electricity from geothermal compared to the one generated in the BAU scenario, and even as high as 189% more from other RE sources such as wind, solar and biomass. This will maintain RE's share of electricity generation above 20% during the period 2013 to 2035.

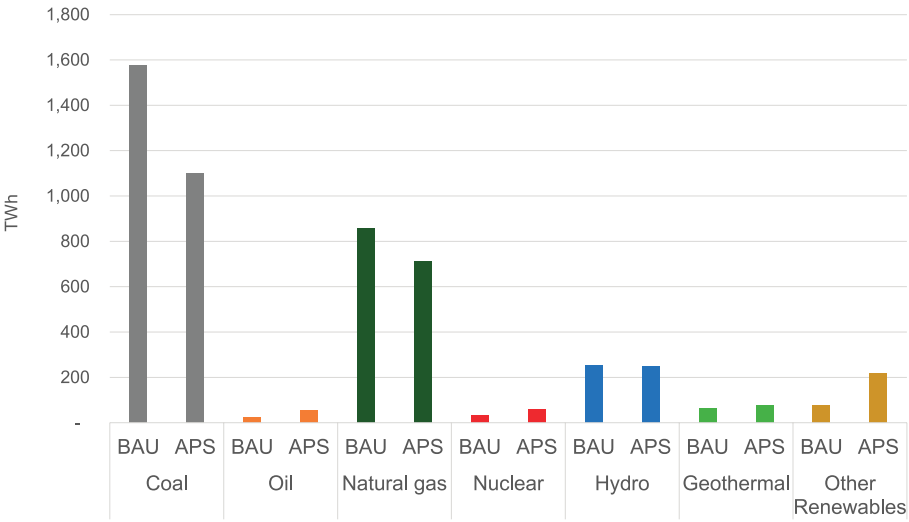


Figure 34 Potential Reduction of Electricity Generation for Each Fuel Type

Thai Global Energy - Thailand
Photo Courtesy : thaige.co.th

Chapter 3. Energy Indicators and APAEC Targets

This chapter analyses the energy indicators from both scenarios and examines their correlation with the APAEC targets. The APAEC 2016-2025 endorsed by the 33rd AMEM in Kuala Lumpur, Malaysia on 7 October 2015 set the collective targets for the region in terms of energy intensity and RE, as follows:

- Energy Efficiency & Conservation: to reduce energy intensity by 20% in 2020 based on the 2005 level.
- Renewable Energy: aspirational target to increase the component of renewable energy to 23% by 2025 in the ASEAN energy mix.

Both of these targets are stated as APAEC targets.

Energy Intensity

TPES per GDP PPP or known as Energy Intensity (EI) in ASEAN has decreased significantly during the period. In 1990, the EI figure was 146 toe per million at constant 2005 USD, and by the year 2005, in which the base year used by ASEAN in measuring its EI target, the EI number was 133.1 toe/million constant 2005 USD. In 2013, this value decreased to 121.8 toe/million constant 2005 USD. With the assumption of economic growth rate of 6.1% during the period 2013 to 2035, both the BAU scenario and the APS forecasted that the EI reduction trend would continue, reaching 89.8 toe/million constant 2005 USD under the BAU scenario, or falling even lower to 78 toe/million constant 2005 USD under the APS (Figure 35).

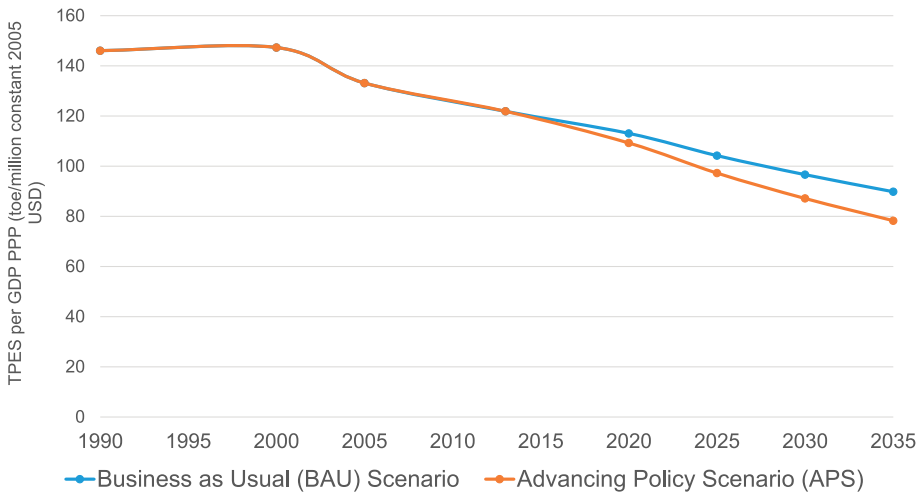


Figure 35 Energy Intensity (EI) Reduction on the BAU scenario and the APS

Indexing the benchmark point of EI's value in 2005 to 100%, it shows that by 2013 the EI had already decreased by 8.5% (Figure 35). This result surpassed the target set by the previous APAEC 2010-2015 to reduce EI by 8% in 2015, based on 2005 level. Using the modelling

under the two scenarios, it is forecasted that by 2020, the reduction of EI versus 2005 will be 15.1% in the BAU scenario and 18.0% in the APS (Figure 36). There is a gap of 4.9% to 2% from the targets compared to the modelling results.

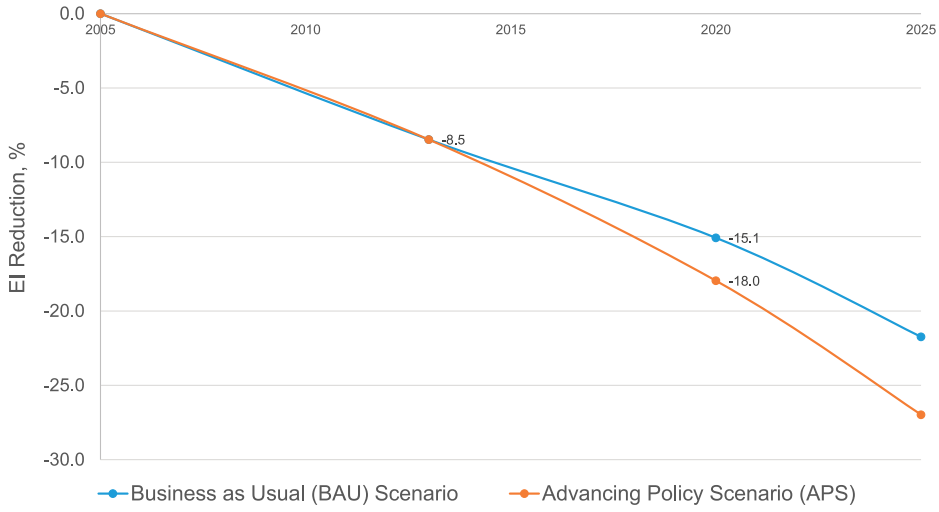


Figure 36 Potential Reduction of EI in Achieving APAEC Target

Renewable Energy Share

In both scenarios, the value of RE in TPES is constantly growing. However, its contribution is less significant compared to non-renewable sources (Figure 37).

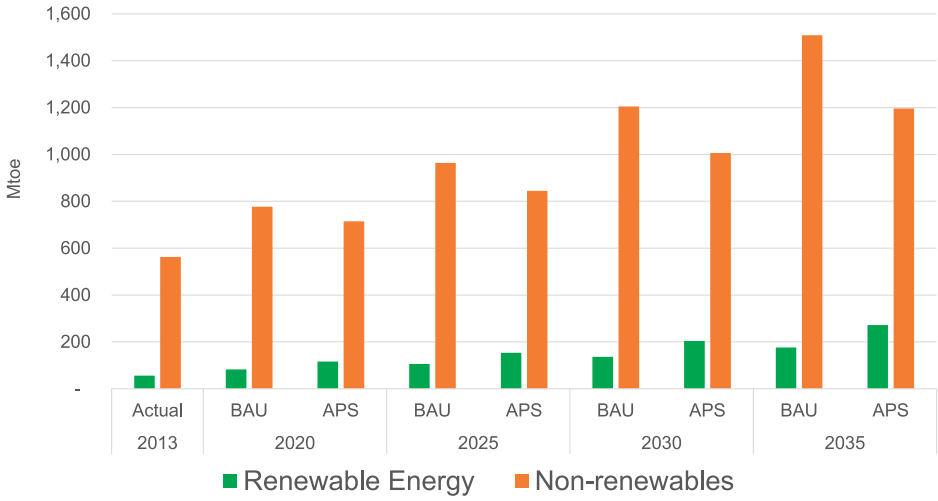


Figure 37 Contribution of RE and Non-renewables in TPES

As explained above, there is a potential for the bigger role of RE (Figure 38). Under the BAU scenario, contribution of RE has increased from 56 Mtoe in 2013 to reach 83 Mtoe in 2020 and 106 Mtoe in 2025, or double its contribution than in the year 2013. This is even higher under the APS, when RE (made up of hydro, geothermal and other RE sources) rises to 116 Mtoe in 2020 and 153 Mtoe in 2025, triple its 2013 level. Yet RE's share of TPES remains the same (around 10%) in the BAU scenario, while it reaches 15.4% under the APS in 2025. Nonetheless, this is still a big gap compared to ASEAN's aspirational goal to reach 23% in 2025.

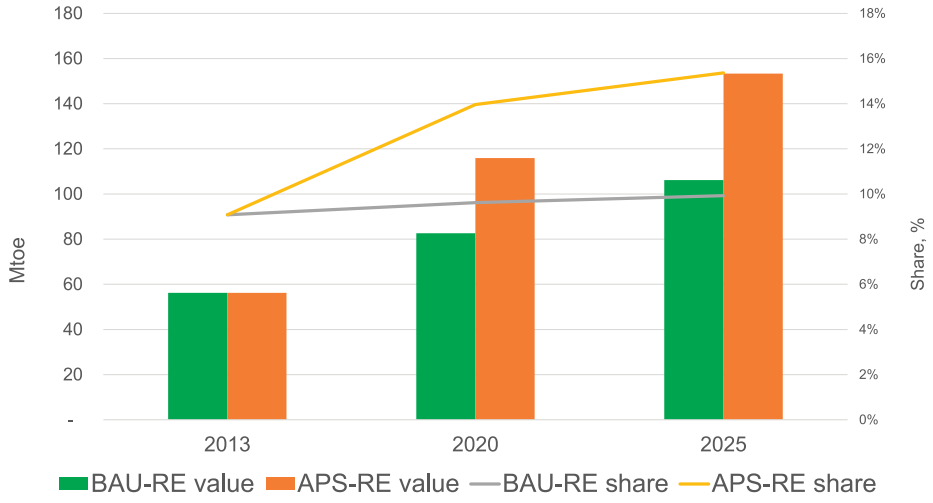


Figure 38 Potential Increase of RE in TPES in comparison with APAEC Target

PowerSeraya gas power plant - Singapore
Photo Courtesy : www.ytl.powerseraya.com.sg

Chapter 4 Challenges on Reserves Depletion

The following chapter describes the general reserves situation in ASEAN. It focuses on the main fossil fuels: coal, oil and gas. The perspective on fossil fuel reserves is important in ASEAN to better manage increased domestic use in the future, induced export reduction and depletion.

Coal

ASEAN is rich in fossil fuels, predominantly in coal reserves - both hard and brown coal - that are locked within its territory. As of the year 2013, according to the BGR, ASEAN had total coal reserves of approximately 27 billion metric tonnes, where around 40% of these resources are hard coal reserves, while the remaining 60% are brown coal reserves. Historically, Indonesia has experienced remarkable development in the production and exports of coal. With practically no production in 1990 or only about 8 million ton of coal equivalent (Mtce), Indonesia expanded its production to 65 Mtce in 2000, further rising to a remarkable 400 Mtce in 2013, corresponding to an annual average growth rate of 15% between 2000 and 2013. By 2013, 88% of Indonesia's coal production was exported. Vietnam shows more moderate numbers in its coal production and export patterns. From 2000 to 2013, Vietnam expanded its coal production from 9 Mtce to 33 Mtce, with a corresponding annual average growth rate of approximately 10%. Contrary to Indonesia, the majority (70% in 2013) of Vietnams' coal production was consumed domestically, while only 30% was exported.

Indonesia's coal production is predicted to increase to 588 Mtce by 2035. Exports will fall from 350 to 180 Mtce in 2013, while imports will grow to 60 Mtce by 2035. Although Indonesia shifts from increasing its net coal exports to reducing it since 2013, it will remain a net exporter according to the projection period until 2035. Sixty percent of its own coal reserves will be deployed during this period. Vietnam's coal production will expand from 33 in 2013 to 57 Mtce by 2035, while its domestic requirements increase to 160 Mtce. Imports will expand from 10 to 111 in 2035, thereby substantially increasing Vietnam's coal dependency. During this timeframe, Vietnam's coal resources will be depleted by 50%.

Through the modelling, the production and net trade of coal within ASEAN are clearly visible (Figure 39), and how the predictions for the depletion of total coal reserves in ASEAN under two scenarios can be seen (Figure 40). Within the APS, the enhanced energy efficiency measures in Indonesia lead to energy demand reduction for coal. Correspondingly, Indonesia's coal production increases less strongly than in the BAU scenario, rising to only 395 Mtce in 2035, while exports remain equal to the BAU scenario, falling to 180 Mtce in 2035. Indonesia's own resources are respectively deployed less strongly than in the BAU scenario. Similarly, under the APS, Vietnam´s coal requirements increase less strongly than in the BAU scenario, due to the stronger EE framework. Its primary requirements for coal reach 140 Mtce in 2035 as opposed to 160 Mtce in the BAU scenario. Contrary to Indonesia, Vietnam's production under the APS is not much different from the BAU scenario, which expands from 33 to 57 Mtce in 2035. The lower primary demand for coal thus lowers the import dependency, leading to a much smaller import expansion of only 10 Mtce from 2013 to 93.5 Mtce in 2035, as opposed to 111 Mtce in 2035 for the BAU scenario.

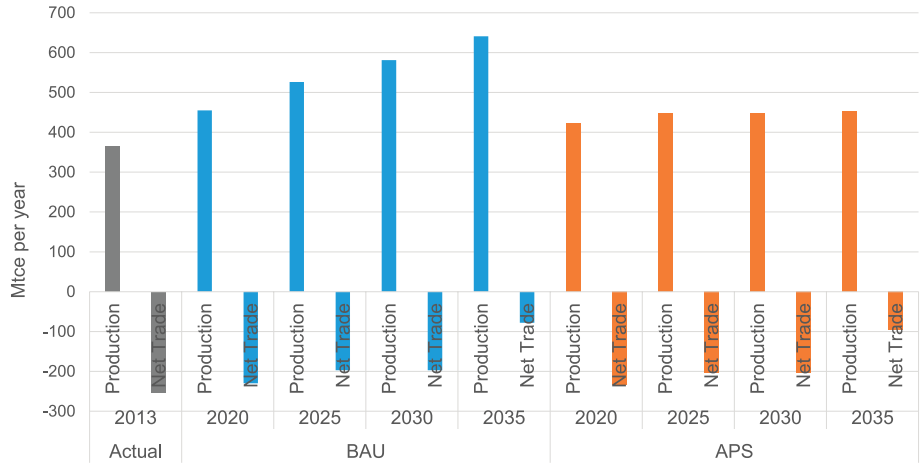


Figure 39 Projected ASEAN coal production and net trade

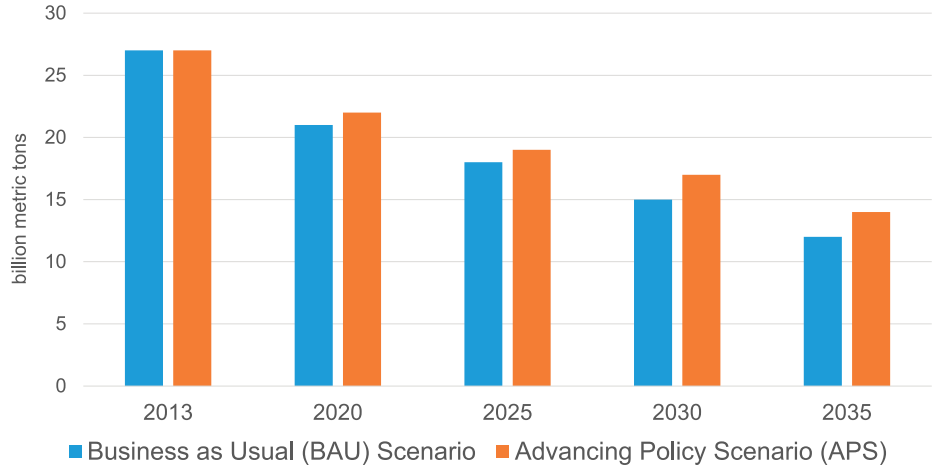


Figure 40 Projected ASEAN coal reserves depletion

Natural gas

The natural gas resources within ASEAN are more evenly distributed between the AMS than coal. According to BGR, Indonesia has 43% of total ASEAN natural gas reserves, followed by Malaysia (35%), Vietnam (9%) and Brunei Darussalam (4%). The development of ASEAN's gas resources will thus depend on the production of Indonesia, Malaysia and Vietnam, and to a minor extent, Brunei, Myanmar and Thailand. ASEAN's natural gas production and net trade development under both the BAU scenario and the APS is reflecting the expectations of the most important gas-producing AMS (Figure 41). Natural gas production is forecast to decrease under both scenarios from approximately 200 bcm in 2013 to 160 bcm in 2035. Given that domestic demand is expected to surpass gas production volumes within the

projection period, ASEAN as a region will become a net gas importer. This shift occurs between the year 2020 and the year 2025 under the BAU scenario and, with some delay, between the year 2025 and the year 2030 for the APS. In particular, Indonesia as the biggest producer in the region and Vietnam to a minor extent are expected to drive the shift from being net gas exporter to net importers between 2020 and 2025. Additionally, Thailand´s natural gas demand will continue to be supplied by imports within the projection period.

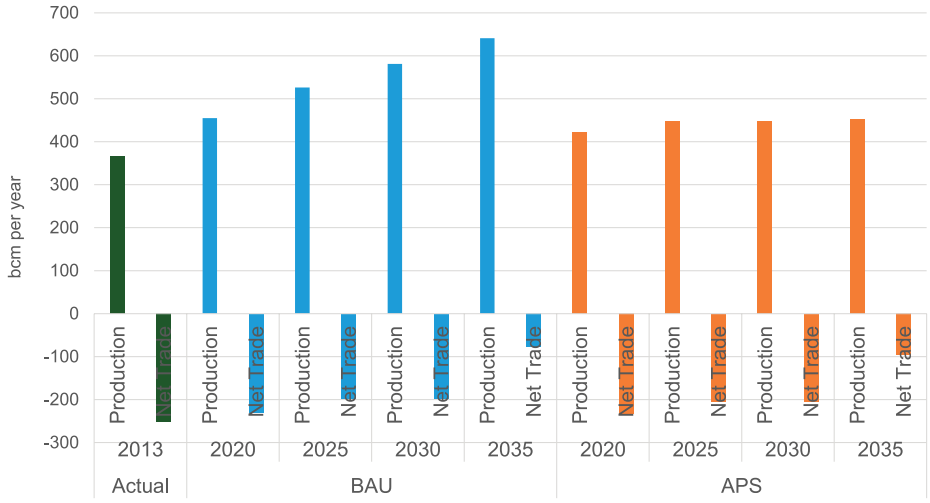


Figure 41 Projected ASEAN natural gas production and net trade

Accordingly, depletion of ASEAN's gas resources will continue rapidly, lowering the proven (technically and economically-viable) gas resources to approximately 2.8 bcm in 2035. This is the case for both the BAU scenario and the APS, given that production patterns are very similar in both scenarios (Figure 42).

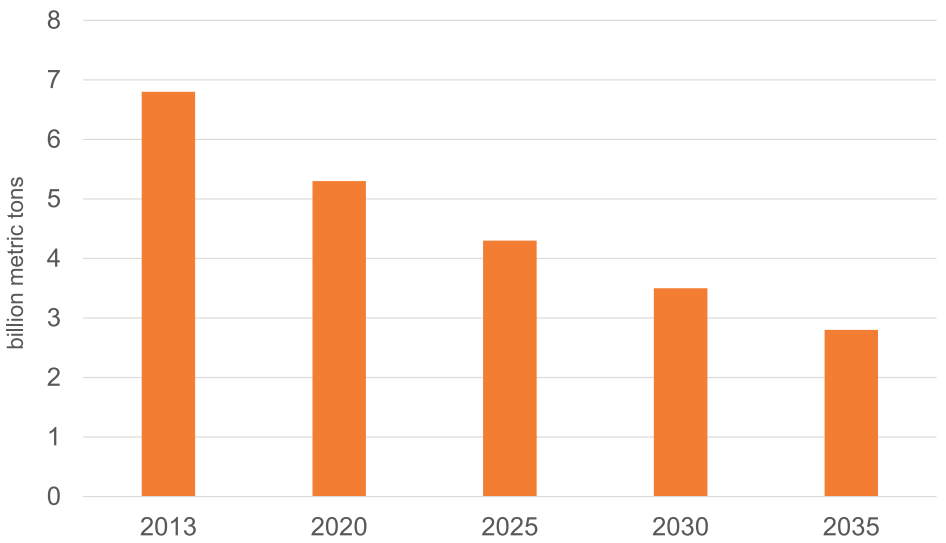


Figure 42 Projected ASEAN Natural gas reserves depletion

Oil

ASEAN's limited reserves in crude oil are locked under Malaysia's territory (38%), followed by Vietnam (29%), Indonesia (23%), Brunei Darussalam (7%) and Thailand (3%). In terms of oil production, in 2013, Indonesia had the highest share, representing 36% of ASEAN's total crude oil production, followed by Malaysia (26%), Thailand (17%), Vietnam (15%) and Brunei Darussalam (6%). While for the year 2013 it accounts for approximately 120 Mtoe, the production slightly decreases during the forecast period (Figure 43). The sharp demand for oil products is hence overcompensated by increasing imports.

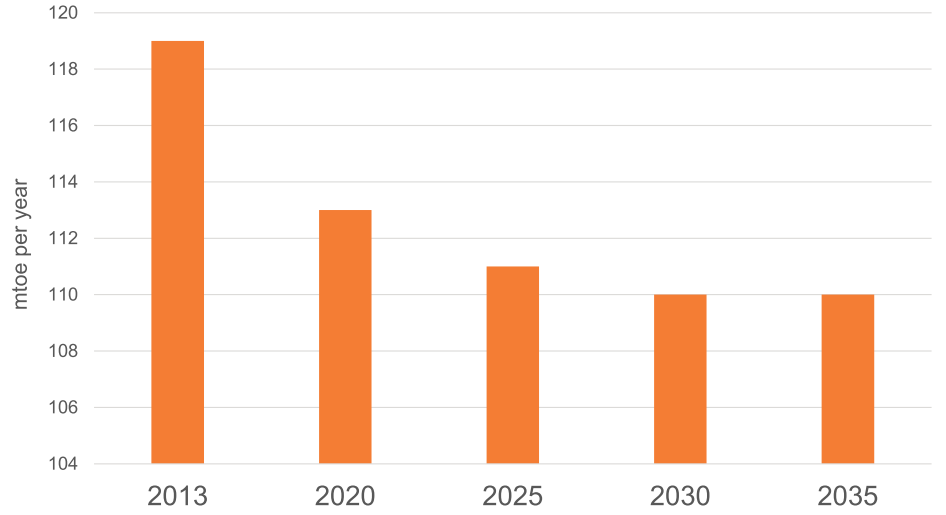


Figure 43 Projected ASEAN Oil Production

The production pattern for oil is very similar under both the BAU scenario and the APS. Hence, the lower demand for oil in the APS is compensated by lower imports. Yet the oil reserves depletion is respectively equal for both the BAU scenario and the APS (Figure 44). As presented in this figure, the oil reserves are reduced from 2.1 billion tonnes of oil equivalent (toe) in 2013 to less than 0.5 billion toe by 2035.

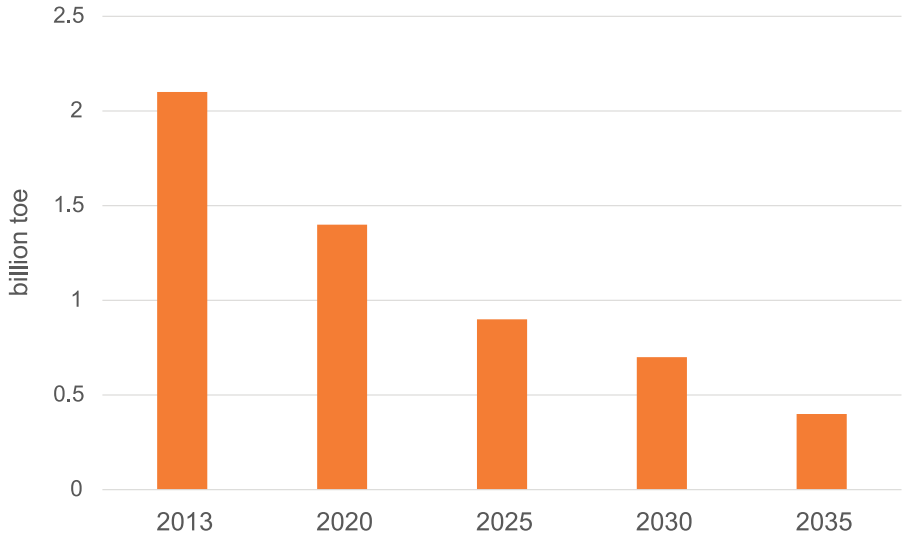


Figure 44 Projected ASEAN oil reserves depletion

PLTU Paiton - Indonesia
Photo Courtesy : blog.ub.ac.id

Chapter 5. Findings and Policy Recommendation

This chapter will present key messages from the findings on the forecast and ASEAN's solutions to the energy challenges, which the region will face in the next 20 years. The aim is to highlight the key strategies, those built to address the main energy challenges. In addition, a short overview on the general national policy structure is provided.

Key Messages of AEO4:
"Energy efficiency first": enhance national regulation in all sectors (including transport, electricity consumption). Synergies: Less energy used = higher RE shares.
Enhance RE diffusion and identify opportunities for high local manufacturing shares and requests on local manufacturing contents.
Mutual policy learning/coordination, regional market integration, interconnections help national EE/RE policies preventing system inefficiencies and reduce energy costs.
Strongly rising coal shares: Opportunities and challenges of clean coal technologies.
Continuation of successful energy subsidy reduction strategies: window of opportunity in times of low oil/gas prices (including to support regional market integration).

The main strategies of ASEAN in the context of cooperation on energy issues are, most importantly, the target definitions. On one side, ASEAN initiates negotiation and a process for discussion, which builds a common ground for the shared vision and ideas in the region. On the other hand, ASEAN also set firm and measurable boundaries for the region in terms of cooperation. This integrated approach (Figure 45) should be set up in order to manage the key messages of AEO4 as shown in the box above. In addition, ASEAN intends to support supranational interests and the sharing of projects. These include the Trans-ASEAN Energy Networks as part of the regional market integration. Both aspects are necessary to increase energy cooperation by the AMS, and will gain an even greater importance in the context of future energy demand and efficient energy system. The main challenge will be to meet the rapidly increasing demand while preventing system inefficiencies and reducing system costs. The increasing demand will make large capacity additions necessary. To reduce the costs of the overall energy system it is necessary to choose a sustainable and cost efficient system design. With an optimal supranational energy system design, e.g. peak generation, costs can be reduced. This reduction is an example of the benefits that could be realised with improved cooperation. Experiences from other regions show that regional market integration and interconnections are able to contribute significantly to achieve this objective.

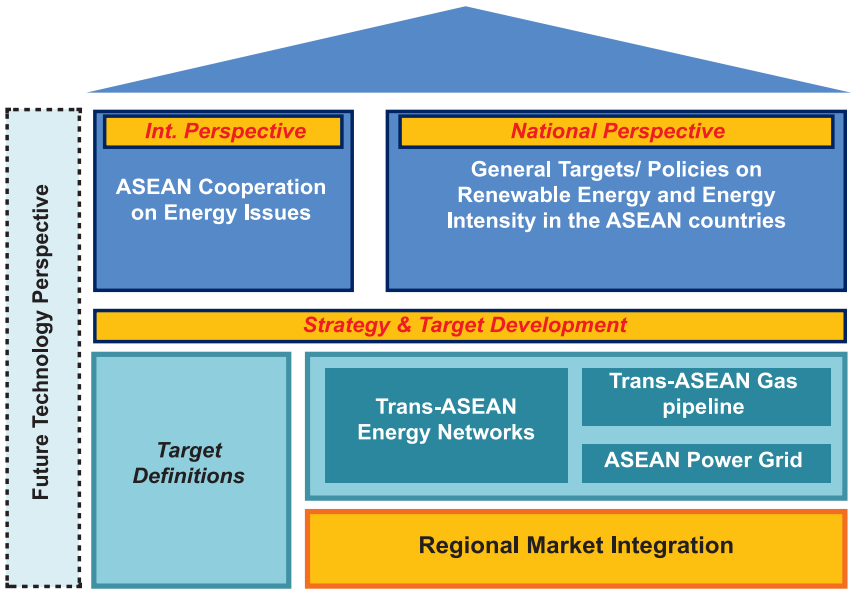


Figure 45 Comprehensive Approach in the ASEAN Energy Challenges

National Policy Situation

The AMS have already developed and implemented EE and RE policies. The projections show that implementation and further expansion are necessary to reach the targets. As the structure of these policies is not homogenous, the AMS could cooperate better in policy development and implementation. The main opportunities lie in an exchange of experiences between the Member States as some successful policies that have been proven successful in certain Member States might not necessarily work properly for others. However, a policy pioneer Member State can share its experiences in preventing other Member States from making similar mistakes or in increasing policy efficiency. While discussing its experiences, a policy pioneer gets the opportunity to have its policies reviewed by other AMS. Especially when an RE target is not reached, the potential of common policies should be developed and intensified. The exchange of experiences helps the AMS to understand each other's opportunities and needs. This is important to create a basis for large-scale projects like the ASEAN Power Grid (APG) or the Trans-ASEAN gas pipeline (TAGP).

Cooperation on Energy Issue

Since the signing of the 1986 Agreement on ASEAN Energy Cooperation, ASEAN Leaders have expressed their strong support to advance ASEAN energy connectivity, an important issue that ASEAN must address, especially given the growing demand for energy in the region. They demonstrated their support for regional energy connectivity projects such as the APG and the TAGP, by providing instructions to look into the next level of details and to seriously consider harmonising regulatory frameworks and standards to facilitate regional energy connectivity. The Ministers of Energy also emphasised the important role of the private sector in enhancing energy investments to support the ASEAN Economic Community (AEC).

The new endorsed ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 has been set as the guideline for energy cooperation in the region. The key initiatives under this APAEC include embarking on multilateral electricity trading to accelerating the realisation of the ASEAN Power Grid (APG), enhancing gas connectivity by expanding the focus of the Trans-ASEAN Gas Pipeline (TAGP), establishing Liquefied Natural Gas (LNG) regasification terminals as well as promoting clean coal technologies. It also includes strategies to achieve higher aspirational targets to improve EE and to increase the uptake of RE sources, in addition to building capacities on nuclear energy. Plans to broaden and deepen collaboration with ASEAN's Dialogue Partners (DPs), International Organisations (IOs), academic institutions and the business sector will be stepped up to benefit from their expertise and enhance capacity-building in the region.

Market Integration

The mid-term and long-term perspective is to foster market integration and market liberalisation within the ASEAN region. This could create an energy market with over 615 million inhabitants and an increasing tendency in national and per capita income (Figure 46). Market integration is often confronted with high expectations on benefits. Falling prices and supply increase are two of many benefits highlighted. However, regulative and legislative harmonisation and the reduction of regulative barriers are long processes with high risks. ASEAN is at the beginning of the process, which in other regions - like the internal electricity market of the European Union - took decades to be achieved to a specific extent and is still ongoing. One of the reasons is that greater market integration always requires a specific level of market liberalisation.

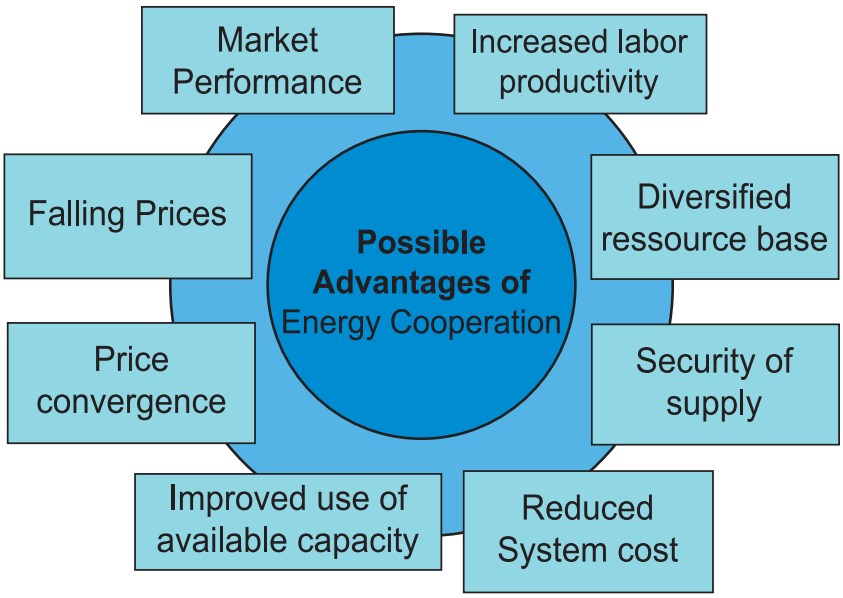


Figure 46 Advantages of market integration

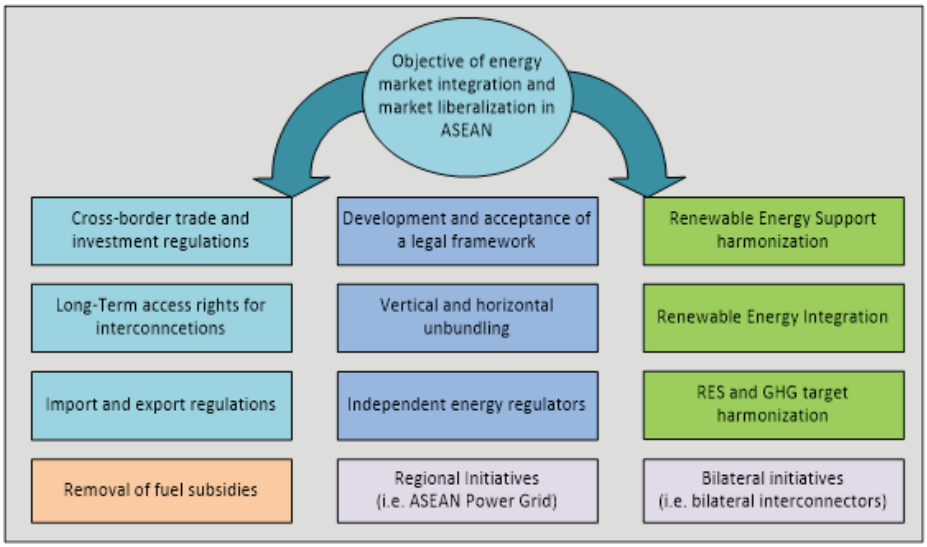


Figure 47 Objectives of Energy Market Integration

A number of necessary steps are required to foster market integration (Figure 47). While the legal framework and the import-export regulations are necessary to secure long-term perspectives for investors, the harmonisation of policies and the reduction of Member State-specific subsidies, e.g. fuel subsidies, are required to establish a non-discriminative market and therefore transparent price mechanics to establish energy trade. ASEAN has already started to work on regional and bilateral programmes. The latter in particular are adding even more experiences of market integration. Moreover, several AMS have started to decrease barriers at the national level, such as the fuel subsidies, which had been and are still very inconsistent across ASEAN. Although these reductions were often domestically motivated, they help to reduce barriers of market integration and to reduce price distortions, hence creating the latitude for policy developments and implementations. ASEAN has gained momentum in energy cooperation, mainly due to national initiatives and global developments, but also as first steps to harmonising region-wide approaches. This momentum can be used to further increase cooperation and market integration in the region.

Future Technology Perspectives and Opportunities

One of the major trends, mostly covered in the national model approach, is the integration of RE sources into the energy supply. RE sources, especially wind and photovoltaic, have low variable costs depending on the existent potentials and have become close competitors to conventional power plants run on fossil fuels. Furthermore, their investment costs will continue to fall in the short to medium term. RE's impact on the environment is much lower versus traditional energy sources. Even without subsidies or a strong support scheme, RE is able to deliver energy in a cost-efficient manner. This effect will strengthen further as cost reduction of RE continues. Although the steepest cost reductions for several technologies have been achieved in the last few years, the potential to further reduce the costs is still relatively high compared to conventional power plants.
This cost factor should be taken into account in future energy policy development as it allows

establishing an additional pillar in the energy mix. This would help the deployment of RE. Considering that APAEC's RE target is 23% by 2025, there is still some way to go. In order to reach this target, only fast deploying technologies like solar PV and wind can fill the gap quickly, with respect to the longer planning phases required for conventional power plants and large scale hydro.

Furthermore (Figure 48), RE sources can be used as a replacement for fossil fuels in electricity generation. The export revenues from the fossil fuels can then be partly used to finance support mechanism for RE in ASEAN. Furthermore, AMS without energy resources can profit from the savings made by not having to import fossil fuels.

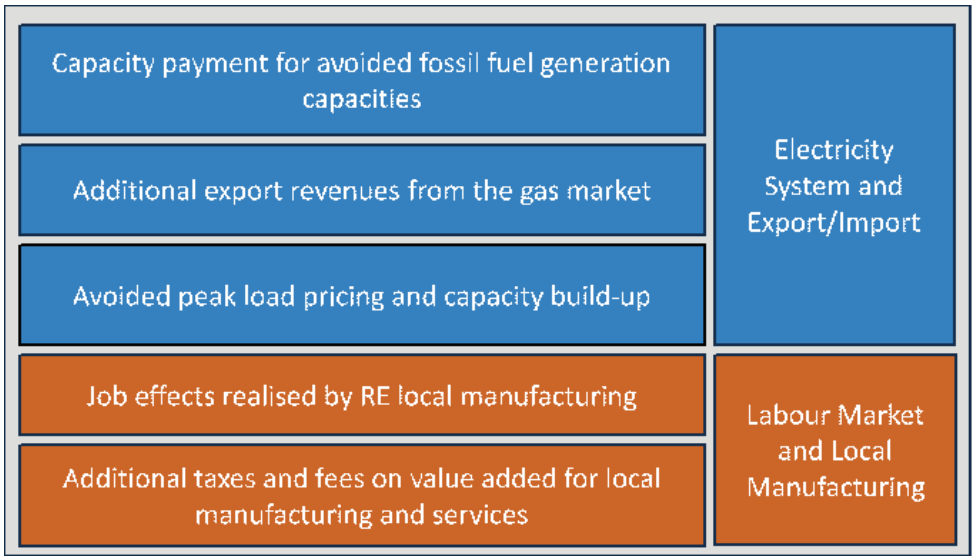


Figure 48 Possible economic effects and benefits of RE

In addition, the effects highlighted above are supported by the positive effect of local manufacturing of RE technologies. Although many components of RE systems are manufactured in only a few Member States or regions, e.g. PV modules, it is still possible to realise high local manufacturing shares of around 50% in PV or wind components. Egypt for example, has already imposed binding local manufacturing shares, not only to deploy RE, but also to profit from the additional job and welfare effects of RE local manufacturing.

The recommendation above is supported impressively by the IEA World Investment Outlook 2014 on the future RE capacity and investment flows (Figure 49). RE will reach a significant share of electricity generation but more importantly will be responsible for more than half of the investment until 2035.

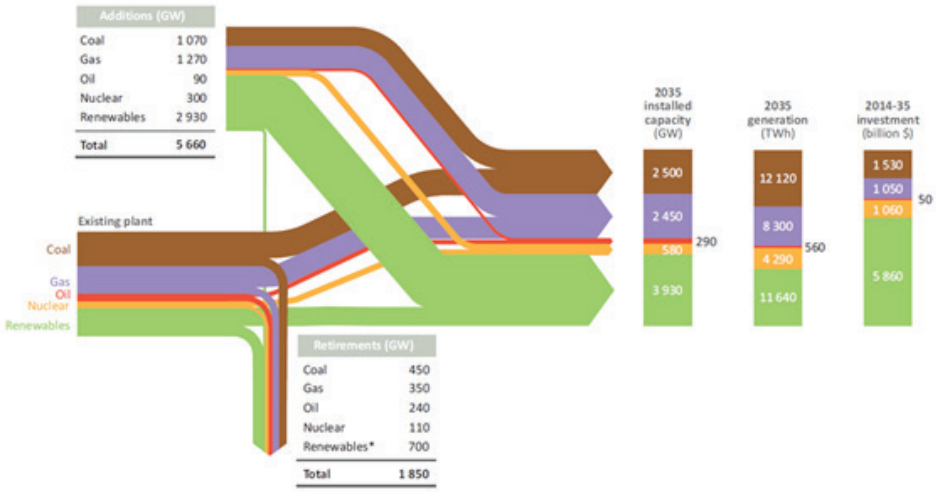


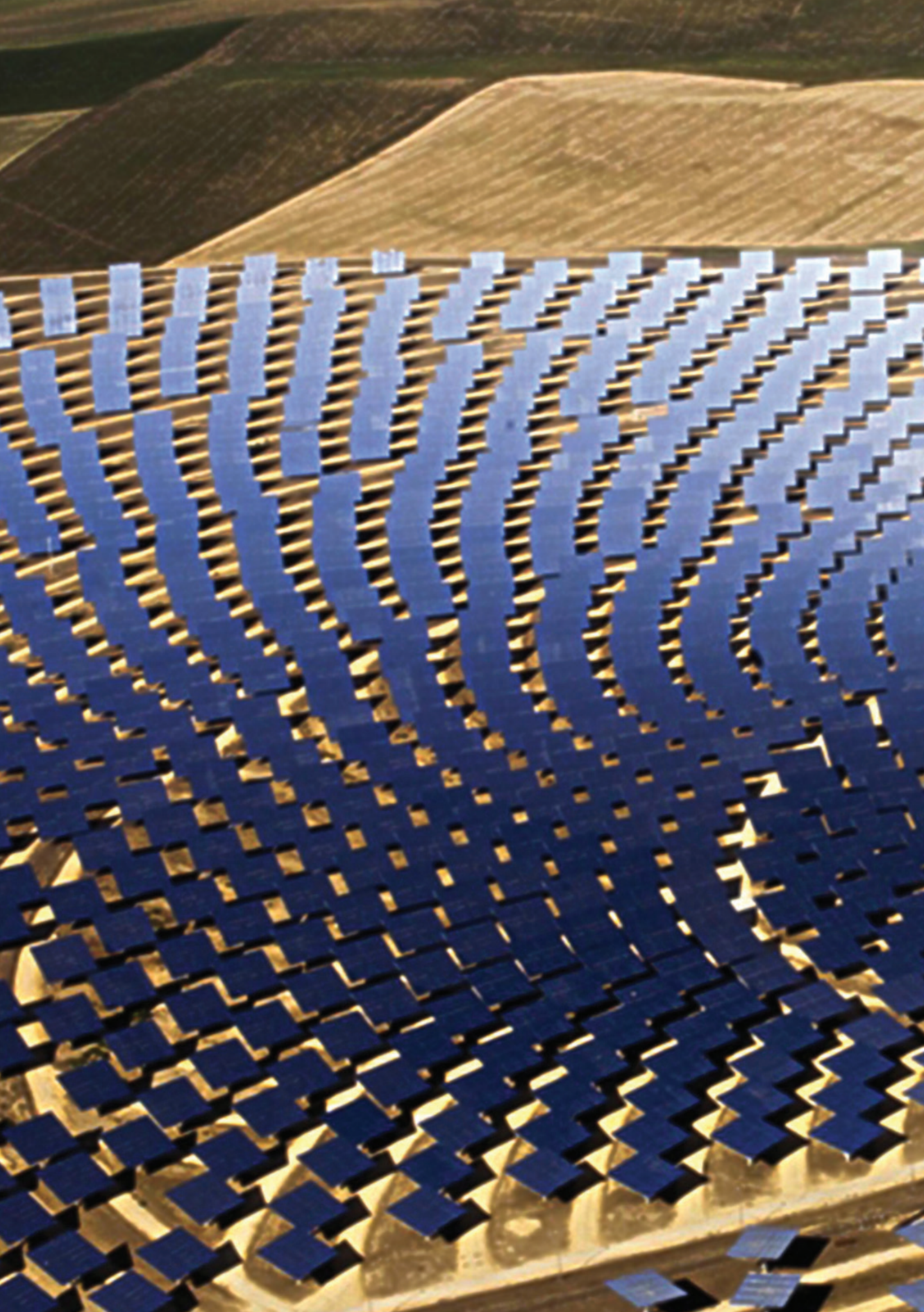
Figure 49 IEA Electricity generation global capacity flows and investment

This shows that the RE sector will have the most dynamic development of all technology types. For ASEAN, the consequence is that RE should be developed continuously. On the technology front, ASEAN has huge unused hydro power and geothermal potential. Both technologies are already used but could be combined with other RE for more efficient operations. For example, the combination of PV and hydro plants should be encouraged, to reduce the variability of water-levels in dry periods, and to help create further synergies. Several AMS have also started to develop onshore wind resources. ASEAN's wind energy potential is not as high as in other regions, but several hotspots have still be identified. Another perspective for the AMS is the more efficient use of gas within the energy grid. In particular, the existent capacities of LNG terminals could be used more efficiently in bilateral and regional pipelines, which would extend their catchment areas. The development might be further fostered by the continuing difference in gas prices between the US and Asia, as well as by the evolution of North America into a net exporter. What must be emphasized is that the recently falling and low gas price should not be considered as a permanent market phenomenon.

In any case, the successful utilization of both trends depends on two major factors. The first one is the successful implementation of national - and even more ASEAN-wide - policies, legal frameworks and their harmonization. This can create a regional policy environment with over 615 million consumers allowing efficient and secure investments for Member States and investors. The barriers to overcome are high (e.g. regional market creation, interconnection built-up), but a good start has been made to reduce fuel subsidies and to implement national efficiency policies. The APAEC targets for RE and EE are supporting the development regionally.

Another future perspective is the implementation of nuclear power plants in the ASEAN's electricity generation mix. Several Member States are planning to build nuclear power plants. However, the nuclear power plant technology should be revised carefully as several nuclear power plant projects have experienced difficulties and insecurities in the recent past.

One example is the unforeseen and rising investment costs due to technical problems as experienced at Hinkley Point in the UK. Studies support the development of nuclear power plants, indicating that a high variety often leads to a big increase in the investment costs (3,600 to 8,000 USD/kW). The uncertainty of nuclear power is further accentuated by the cost overruns. Based on an analysis of 75 nuclear power plants, the average cost overrun reached a value of 207%. Furthermore, it is important to factor in the uncertainties in price development, the monetary and administrative efforts of waste management and the high decommissioning costs of old plants, all of which have to be considered in the lifetime of the nuclear power plant. The uncertainty of nuclear power is also supported by the new LCOE study by the IEA, which indicates that for a discount rate of 10%, nuclear has the highest levelized cost of electricity compared to coal or CCGT, while it is equal with coal at a discount rate of 7%.



Vietnam solar power plant
Photo Courtesy : saigoneer.com

Annex 1

ASEAN, the Business as

Total Primary Energy Supply	Absolute, Mtoe						
	1990	2000	2013	2020	2025	2030	2035
Total	238	386	619	859	1,070	1,341	1,685
Coal	13	32	124	226	305	412	556
Oil	89	154	255	268	320	383	458
Natural gas	30	74	116	200	246	304	374
Nuclear	-	-	-			5	8
Hydro	2	4	18	31	38	46	56
Geothermal	7	8	11	19	25	34	45
Others Renewables	5	5	27	32	43	57	76
Traditional Biomass	92	108	68	83	92	101	112
Total Final Energy Consumption	Absolute, Mtoe						
	1990	2000	2013	2020	2025	2030	2035
Total	176	273	437	592	732	902	1,107
Industry	42	76	135	204	263	337	424
Transportation	32	62	118	163	202	250	309
Residential	82	97	100	109	118	128	139
Commercial	5	12	21	36	53	74	101
Others	3	6	16	21	24	28	33
Non-energy use	11	21	47	60	71	85	101
Total	176	274	437	592	731	901	1,106
Coal	6	13	44	72	94	122	156
Oil	66	123	198	264	325	401	493
Natural Gas	8	17	48	71	91	114	140
Electricity	11	28	78	119	157	202	257
Others			10	12	14	17	19
Traditional Biomass	86	93	59	53	50	45	40
Electricity Generation	Absolute, TWh						
	1990	2000	2013	2020	2025	2030	2035
Total	155	374	821	1,307	1,743	2,252	2,884
Coal	28	79	258	599	868	1,177	1,578
Oil	66	72	34	24	20	23	23
Natural gas	26	154	359	455	569	703	860
Nuclear			-	-	-	18	31
Hydro	28	51	131	159	192	214	254
Geothermal	7	16	19	36	50	55	63
Other Renewables	1	1	19	33	45	62	76
CO2 Emission	Absolute, Mt-C						
	1990	2000	2013	2020	2025	2030	2035
Total	383	738	1,199	1,835	2,412	3,046	3,813
Energy Economic Indicators							
GDP PPP (billions of constant 2005 USD)							
Population (millions of people)							
GDP PPP per capita (thousands of constant 2005 USD/person)							
TPES per capita (toe/person)							
TPES per GDP PPP (toe/million constant 2005 USD)							
CO2 Emissions per unit of GDP PPP (t-C/million constant 2005 USD)							
CO2 Emissions per unit of TPES (t-C/toe)							
Electricity Consumption per capita (toe/person)							

Usual (BAU) Scenario

Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.2%	4.8%	4.6%	4.7%
5.3%	8.3%	20.1%	26.4%	28.6%	30.7%	33.0%	10.4%	8.9%	6.2%	7.0%
37.6%	40.0%	41.1%	31.1%	29.9%	28.5%	27.2%	4.7%	0.7%	3.7%	2.7%
12.5%	19.1%	18.7%	23.3%	23.0%	22.6%	22.2%	6.1%	8.1%	4.3%	5.5%
0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.5%	-	-	-	-
1.0%	1.1%	2.9%	3.6%	3.5%	3.4%	3.3%	9.1%	8.3%	3.9%	5.3%
2.8%	2.2%	1.8%	2.2%	2.4%	2.5%	2.7%	2.2%	8.3%	5.8%	6.6%
2.0%	1.3%	4.4%	3.8%	4.0%	4.3%	4.5%	7.8%	2.4%	5.9%	4.7%
38.7%	28.0%	11.0%	9.6%	8.6%	7.6%	6.7%	-1.3%	2.9%	2.1%	2.3%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.0%	4.4%	4.3%	4.3%
23.8%	27.6%	31.0%	34.4%	35.9%	37.4%	38.3%	5.2%	6.0%	5.0%	5.3%
18.4%	22.7%	27.0%	27.5%	27.6%	27.7%	27.9%	5.8%	4.7%	4.4%	4.5%
46.8%	35.4%	22.8%	18.5%	16.1%	14.2%	12.6%	0.8%	1.3%	1.6%	1.5%
2.9%	4.5%	4.9%	6.1%	7.2%	8.2%	9.1%	6.4%	7.8%	7.1%	7.3%
1.9%	2.3%	3.6%	3.5%	3.3%	3.1%	3.0%	7.0%	3.7%	3.2%	3.4%
6.2%	7.6%	10.7%	10.1%	9.8%	9.4%	9.1%	6.6%	3.5%	3.6%	3.6%
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.0%	4.4%	4.3%	4.3%
3.3%	4.9%	10.0%	12.2%	12.9%	13.6%	14.1%	9.2%	7.4%	5.3%	6.0%
37.5%	44.8%	45.2%	44.5%	44.5%	44.5%	44.6%	4.9%	4.2%	4.3%	4.2%
4.3%	6.2%	11.1%	12.0%	12.4%	12.6%	12.6%	8.4%	5.7%	4.6%	4.9%
6.3%	10.1%	17.9%	20.1%	21.5%	22.5%	23.2%	8.8%	6.2%	5.3%	5.6%
0.0%	0.0%	2.4%	2.1%	1.9%	1.8%	1.8%	-	2.5%	3.1%	2.9%
48.6%	34.1%	13.5%	9.0%	6.8%	5.0%	3.6%	-1.6%	-1.5%	-1.9%	-1.8%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	7.5%	6.9%	5.4%	5.9%
17.9%	21.2%	31.5%	45.8%	49.8%	52.3%	54.7%	10.2%	12.8%	6.7%	8.6%
42.5%	19.3%	4.2%	1.8%	1.1%	1.0%	0.8%	-2.8%	-4.8%	-0.4%	-1.9%
16.9%	41.2%	43.8%	34.8%	32.6%	31.2%	29.8%	12.1%	3.4%	4.3%	4.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	1.1%	-	-	-	-
18.1%	13.6%	16.0%	12.2%	11.0%	9.5%	8.8%	6.9%	2.8%	3.2%	3.0%
4.2%	4.4%	2.3%	2.8%	2.9%	2.4%	2.2%	4.7%	9.5%	3.8%	5.6%
0.4%	0.3%	2.3%	2.5%	2.6%	2.8%	2.6%	16.2%	8.4%	5.6%	6.5%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
							5.1%	6.3%	5.0%	5.4%
Value, unit							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
1,629	2,619	5,080	7,601	10,268	13,888	18,763	5.1%	5.9%	6.2%	6.1%
440.1	520.4	615.7	658.5	691.2	725.8	762.6	1.5%	1.0%	1.0%	1.0%
3.7	5.0	8.3	11.5	14.9	19.1	24.6	3.5%	4.9%	5.2%	5.1%
0.5	0.7	1.0	1.3	1.5	1.8	2.2	2.7%	3.8%	3.6%	3.6%
146.0	147.3	121.8	113.0	104.2	96.6	89.8	-0.8%	-1.1%	-1.5%	-1.4%
235.1	281.8	236.0	241.4	234.9	219.3	203.2	0.0%	0.3%	-1.1%	-0.7%
1.6	1.9	1.9	2.1	2.3	2.3	2.3	0.8%	1.4%	0.4%	0.7%
0.03	0.05	0.13	0.18	0.23	0.28	0.34	7.3%	5.2%	4.2%	4.5%

Annex 2

ASEAN, the Advancing

Total Primary Energy Supply	Absolute, Mtoe						
	1990	2000	2013	2020	2025	2030	2035
Total	238	386	619	830	998	1,210	1,468
Coal	13	32	124	197	247	310	388
Oil	89	154	255	293	339	392	454
Natural gas	30	74	116	146	172	203	239
Nuclear	-	-	-			5	8
Hydro	2	4	18	37	44	52	62
Geothermal	7	8	11	17	24	32	44
Others Renewables	5	5	27	62	86	120	166
Traditional Biomass	92	108	68	78	87	96	107
Total Final Energy Consumption	Absolute, Mtoe						
	1990	2000	2013	2020	2025	2030	2035
Total	176	273	437	558	658	779	932
Industry	42	76	135	186	221	263	318
Transportation	32	62	118	154	186	222	267
Residential	82	97	100	106	112	119	127
Commercial	5	12	21	32	45	63	88
Others	3	6	16	20	23	26	30
Non-energy use	11	21	47	60	71	85	101
Total	176	274	437	557	658	778	931
Coal	6	13	44	67	81	99	118
Oil	66	123	198	245	290	345	415
Natural Gas	8	17	48	69	84	99	119
Electricity	11	28	78	111	139	174	218
Others	-	-	10	13	15	18	21
Traditional Biomass	86	93	59	52	48	43	38
Electricity Generation	Absolute, TWh						
	1990	2000	2013	2020	2025	2030	2035
Total	155	374	821	1,222	1,551	1,959	2,473
Coal	28	79	258	486	654	857	1,100
Oil	66	72	34	21	29	42	56
Natural gas	26	154	359	421	491	593	714
Nuclear	-	-	-	-	5	23	59
Hydro	28	51	131	153	183	205	249
Geothermal	7	16	19	43	58	64	76
Other Renewables	1	1	19	98	131	174	218
CO2 Emission	Absolute, Mt-C						
	1990	2000	2013	2020	2025	2030	2035
Total	383	738	1,199	1,628	1,961	2,332	2,760
Energy Economic Indicators							
GDP PPP (billions of constant 2005 USD)							
Population (millions of people)							
GDP PPP per capita (thousands of constant 2005 USD/person)							
TPES per capita (toe/person)							
TPES per GDP PPP (toe/million constant 2005 USD)							
CO2 Emissions per unit of GDP PPP (t-C/million constant 2005 USD)							
CO2 Emissions per unit of TPES (t-C/toe)							
Electricity Consumption per capita (toe/person)							

Policy Scenario (APS)

Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.2%	4.3%	3.9%	4.0%
5.3%	8.3%	20.1%	23.8%	24.8%	25.6%	26.4%	10.4%	6.8%	4.6%	5.3%
37.6%	40.0%	41.1%	35.3%	34.0%	32.4%	30.9%	4.7%	2.0%	3.0%	2.7%
12.5%	19.1%	18.7%	17.6%	17.2%	16.8%	16.3%	6.1%	3.3%	3.3%	3.3%
0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.6%	-	-	-	-
1.0%	1.1%	2.9%	4.4%	4.4%	4.3%	4.2%	9.1%	10.9%	3.5%	5.8%
2.8%	2.2%	1.8%	2.1%	2.4%	2.7%	3.0%	2.2%	6.7%	6.5%	6.6%
2.0%	1.3%	4.4%	7.5%	8.6%	9.9%	11.3%	7.8%	12.3%	6.8%	8.5%
38.7%	28.0%	11.0%	9.4%	8.7%	7.9%	7.3%	-1.3%	2.0%	2.1%	2.1%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.03%	3.55%	3.48%	3.50%
23.8%	27.6%	31.0%	33.4%	33.5%	33.8%	34.1%	5.2%	4.7%	3.6%	4.0%
18.4%	22.7%	27.0%	27.6%	28.2%	28.4%	28.7%	5.8%	3.9%	3.7%	3.8%
46.8%	35.4%	22.8%	19.0%	17.0%	15.3%	13.7%	0.8%	0.9%	1.2%	1.1%
2.9%	4.5%	4.9%	5.8%	6.9%	8.1%	9.5%	6.4%	6.1%	6.9%	6.7%
1.9%	2.3%	3.6%	3.6%	3.5%	3.4%	3.2%	7.0%	3.3%	2.7%	2.9%
6.2%	7.6%	10.7%	10.7%	10.8%	10.9%	10.9%	6.6%	3.5%	3.6%	3.6%
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	4.0%	3.5%	3.5%	3.5%
3.3%	4.9%	10.0%	12.1%	12.4%	12.7%	12.7%	9.2%	6.4%	3.8%	4.6%
37.5%	44.8%	45.2%	43.9%	44.2%	44.3%	44.6%	4.9%	3.1%	3.6%	3.4%
4.3%	6.2%	11.1%	12.4%	12.8%	12.8%	12.8%	8.4%	5.2%	3.7%	4.2%
6.3%	10.1%	17.9%	19.9%	21.2%	22.4%	23.5%	8.8%	5.1%	4.6%	4.8%
0.0%	0.0%	2.4%	2.3%	2.3%	2.3%	2.3%	-	3.0%	3.4%	3.3%
48.6%	34.1%	13.5%	9.4%	7.3%	5.5%	4.1%	-1.6%	-1.8%	-2.1%	-2.0%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	7.5%	5.8%	4.8%	5.1%
17.9%	21.2%	31.5%	39.8%	42.1%	43.8%	44.5%	10.2%	9.5%	5.6%	6.8%
42.5%	19.3%	4.2%	1.7%	1.9%	2.2%	2.3%	-2.8%	-6.9%	6.9%	2.3%
16.9%	41.2%	43.8%	34.5%	31.6%	30.3%	28.9%	12.1%	2.3%	3.6%	3.2%
0.0%	0.0%	0.0%	0.0%	0.3%	1.2%	2.4%	-	-	-	-
18.1%	13.6%	16.0%	12.5%	11.8%	10.5%	10.1%	6.9%	2.2%	3.3%	2.9%
4.2%	4.4%	2.3%	3.5%	3.7%	3.3%	3.1%	4.7%	12.4%	3.8%	6.5%
0.4%	0.3%	2.3%	8.0%	8.4%	8.9%	8.8%	16.2%	26.5%	5.5%	11.8%
Share, %							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
							5.1%	4.5%	3.6%	3.9%
Value, unit							CAGR, %			
							1990	2013	2020	2013
1990	2000	2013	2020	2025	2030	2035	2013	2020	2035	2035
1,629	2,619	5,080	7,601	10,268	13,888	18,763	5.1%	5.9%	6.2%	6.1%
440.1	520.4	615.7	658.5	691.2	725.8	762.6	1.5%	1.0%	1.0%	1.0%
3.7	5.0	8.3	11.5	14.9	19.1	24.6	3.5%	4.9%	5.2%	5.1%
0.5	0.7	1.0	1.3	1.4	1.7	1.9	2.7%	3.3%	2.9%	3.0%
146.0	147.3	121.8	109.2	97.2	87.1	78.3	-0.8%	-1.6%	-2.2%	-2.0%
235.1	281.8	236.0	214.2	191.0	167.9	147.1	0.0%	-1.4%	-2.5%	-2.1%
1.6	1.9	1.9	2.0	2.0	1.9	1.9	0.8%	0.2%	-0.3%	-0.1%
0.03	0.05	0.13	0.17	0.20	0.24	0.29	7.3%	4.1%	3.6%	3.8%

Member States Information

The ASEAN Member States Energy Profiles
Policies and Targets on Energy Efficiency and Renewable Energy
for AEO4 Modelling Scenarios

Brunei Darussalam

Towards a sustainable future, Brunei Darussalam supports the implementation of energy strategies related to energy security, diversification of supply and energy efficiency and conservation. Currently, Brunei Darussalam is actively exploring plans to diversify its energy mix through a concerted effort and promotion of alternative and renewable energy sources, particularly for power generation. It is align with Brunei Darussalam's aspiration to generate at least 10 percent of its total power generation mix from renewable energy sources by 2035.

As part of the Energy Efficiency and Conservation (EE&C) initiatives, Brunei Darussalam has set a target to achieve a 45 percent energy intensity reduction by 2035 (baseline 2005). In addition, Brunei Darussalam also announced at the United Nations Climate Change Summit 2014 to reduce the Total Primary Energy Supply (TPES) by 63 percent by 2035 with 2009 as the baseline (compare to the BAU scenario). To achieve these targets, relevant government agencies, industry and individuals are collaborating to evaluate legislative, financial and fiscal policy measures that promote energy efficiency and low-energy intensive industries. Industries' role include identification of technical levers that may assist the reduction of energy usage over time while individuals shift consumption behaviour towards energy efficiency that include making choices on high energy efficient appliances.

Key implemented policies in the BAU scenario:

To support the overall energy intensity reduction target of 45% by 2035 (baseline 2035) and power generation mix of 10% from RE sources by 2035:

1. Power Sector: (i) Increase efficiency in the power generation to more than 45% through the implementation of combined cycle turbine, improvement of transmission and distribution; and (ii) Introduce RE Policy and Regulatory Framework, scale-up market deployment of solar PV and promote Waste-to-Energy (10MW) and support research and technology transfer on RE.
2. Residential and Commercial: Application of high-energy efficient technologies in buildings and application of smart tariff.
3. Introduction of energy management process that comply with ISO 50001 and application of high-energy efficient technologies in buildings.
4. Transport: (i) Promotion of fuel efficient technologies; (ii) Promoting the use of hybrid cars for private transportation; and (iii) Introduction of fuel economy standards.

Additional key implemented policies in the APS:

Introduce RE Policy and Regulatory Framework, scale-up market deployment of solar PV and promote Waste-to-Energy (10MW), support research and technology transfer on RE, and potential of hydro-power plant development.

Cambodia

Energy security policy in Cambodia context forms part of the overall national energy policy that promotes not only energy sector growth and development but also overall economic growth and development. Cambodian government recognizes the paramount importance of energy security. On energy supply side, the policy is aimed at increasing indigenous energy reserves and resources and geared for their optimal utilization, to diversify fuel supply, to diversify the source of supply, to promote the increase in power supply, development of gas transport infrastructure and the investment in energy development. On the demand side, the government promotes energy efficiency to reduce energy demand, calls for the development of alternative transport systems to reduce the impact of the transport sector in the overall energy consumption, and integrate environmental concerns with development of energy.

Creating access to reliable electricity services in rural areas, at an affordable cost to the national communities, is thus an integral part of the governmental agenda of economic development and social upliftment. Electricity is very important for the improvement of living standards, for agricultural and small scale industrial development in rural areas. As a reflection of this commitment, Cambodia has set the goal to achieve 100% level of village electrification by the year 2020 including battery lighting, and raising the access rate to the reliable, grid-quality and affordable prices electricity services to 70% of the rural households by the year 2030. Rural Electrification comprises the provision of electricity services needed in rural areas for the basic household demand (lighting, television and fan) and the basic village demand (public lighting and electricity supply to community centres, health clinics, schools) and local businesses; its main objectives being the provision of electricity to a certain proportion of villages for more balanced development in each province by the techniques with the highest cost/benefit ratio. The government has also indicated that it intends to gradually integrate Cambodia's electric power system into the networks of the grid management system. Base on the development transmission line plan would increase to more than 2,100 km in 2020.

Additional key implemented policies in the APS:

1. Power Sector: Implementation of a 20% RE share for power generation in 2020, or about 3,123 MW Hydro in 2020 in addition to 1,448 MW coal-fired power plant and 400 MW natural gas-fired power plant.
2. Industry: In 2020, 70% energy saving for rice mills, 20-25% energy saving for garment industry, 80% energy saving for ice factory, 15%-20% energy saving for food industry, 80% energy saving for rubber factories, 70% energy saving for brick factories.
3. Residential: 79.71% of villages will access to electricity by 2014, 70% of the households will access to electricity by 2030, and 30%-50% energy saving from improved cook stove.

Indonesia

There are many forces shaping the energy policies of Indonesia. First of all, security of energy supply is crucial for the nation. Indonesia used to be an important oil exporter and has recently re-joined the Organization for Petroleum Exporting Countries (OPEC). However, with declining domestic production and booming demand, Indonesia became a net oil importer in 2004 and subsequently suspended its OPEC membership in January 2009. For this reason, the diversification of energy supply is necessary. Secondly, Indonesia has considerable renewable energy (RE) potential, which could be used to meet increasing energy demand, but also to ensure environmental sustainability. Indonesia announced its commitment to greenhouse gas (GHG) emission reduction during the G-20 Leaders' summit and UNFCCC's 15th Conference of the Parties (COP-15) in 2009. RE could play a vital role in fulfilling this pledge.

Indonesia's energy sector is supervised by the Ministry of Energy and Mineral Resources (ESDM). Moreover, the National Energy Council (DEN), established under the Energy Law 2007 (UU No. 40/2007), is assigned to develop a National Energy Policy (KEN). The Directorate General on New, Renewable Energy and Energy Conservation (EBTKE) supports DEN on the renewable energy and energy efficiency policies. The policy is implemented according to the National Energy General Plan (RUEN).

Key implemented policies: targeting 23% share of new and renewable energy on energy mix in 2025, equal to 87 Mtoe and 31% or 304 Mtoe in 2050.

1. Transport: (i) Aggressive use of Biofuel (20% mix starting 2016, and 30% in 2020), 20% Bio premium and 10% Bioavtur, (ii) 6% of transport is using natural gas, (iii) 10% improvement on efficiency of public transport, and (iv) Electric vehicle and hybrid, each 1% and 5% share in 2050.
2. Environmental: CO2 emission reduction 26% without international support and 41% with international support.

Lao PDR

Since the Ministry of Energy and Mines has been established in 2006, Energy Policy gained much public attention and supports. The policy gradually evolving from just power sector policy to broader energy policies towards a development of sustainable and environmentally friendly energy sector.

The Renewable Energy Development Strategy of Lao PDR (2011) sets a target for renewable energy's share within the national energy mix in 2025. The plan consists of three strategies: a short-term strategy (2010-2015) aimed at providing the necessary studies and capacity building, a mid-term strategy (2016-2020) to establish a clear renewable energy framework, and a long-term strategy (2021-2025) to develop a fully competitive renewable energy market. It aims to increase the share of renewable energy in total energy supply by 30% in 2020. This policy also targets a 10% blending of bio-fuels in the oil supply for the transportation sector. This policy is expected to help the Member State to reduce oil import. As part of the energy mix, although there is no nuclear power plant to be developed in the medium term, the Government is attempting to build its personal capacity to be ready to cooperate with other countries and develop nuclear power plants in the long term when it sees as necessary.

The policy for energy efficiency and conservation aims to reduce the final energy consumption 10% of all sectors in the whole Member State by 2030.

Household electrification is also an important aspect of Lao's energy policy. The Power Sector Policy and Targets for 2020 outlined a target of 90% electrification rate by 2020. With abundant hydropower resource, the development of hydropower constitutes another key area. The Law on Water and Water Resources (1996) sets the regulation for utilization of hydropower to ensure sustainability of hydropower projects and to prevent any adverse effect on the environment.

Malaysia

Malaysia has significant fossil fuel resources. The National Petroleum Policy, which was the very first energy policy introduced, focuses exclusively on the petroleum sector. The National Energy Policy was established in 1979 and outlines three primary objectives: energy supply, energy utilization, and environmental issues. The supply objectives are to ensure security of energy supply, to introduce renewable energy technologies, and to diversify supply of energy. The utilization objectives focus on improvement of energy efficiency by end-users. The environmental objectives aim to use renewable energy sources in order to minimize the adverse effects of the energy sector on the environment.

There are several major stakeholders involved in Malaysia's energy policy. The Economic Planning Unit (EPU) of the Prime Minister's Department focuses on petroleum energy and privatization of electricity supply. Ministry of Energy, Green Technology, and Water is responsible for supply of electricity, energy efficiency, and renewable energy, while the Ministry of Rural Development works on rural electrification. The Energy Commission (EC) is a regulatory body in the power and natural gas industry. In the electricity sector, the Act 447 "Electricity Supply Act" from 1990 (with later amendments) sets the ground rules i.e. licensing and control of electrical installations, efficient use of electricity etc.

The National Renewable Energy Policy and Action Plan (NREPAP) is the most recent development of energy policy that focuses directly on the renewable energy sector. It defines five strategic thrusts for the development of renewable energy: introduction of legal and regulatory framework, provision of conductive business environment, intensification of human capital development, enhancement of renewable energy research and development and the creation of public awareness and policy advocacy programmes.

The Renewable Energy Act (Act 725) was introduced in 2011 to set the framework for the feed-in tariff (FiT) and the RE grid integration. The Sustainable Energy Development Authority Malaysia (SEDA) was the implementing institution of this act. It defines the rules for: the eligibility criteria for feed in tariffs, conditions for renewable energy power purchase agreements, technical and operational requirements as well as the payment, duration and regression of the tariffs, etc.

Myanmar

Recognizing the critical importance of energy for sustainable economic development and the wellbeing of the people, the Government in 9th January 2013 established the National Energy Management Committee (NEMC), with Vice President of the Government of the Union of Republic of Myanmar as the Patron and the Union Minister for Energy as the Chairman. The implementation and the execution of the Myanmar Energy Policy will be under the guidance and coordination of the National Energy Management Committee and with the support of all concerned organizations/agencies as well as the civil society. The Government has also constituted an Energy Development Committee (EDC) to support the activities of NEMC.

There are nine Energy Policies to be implemented by National Energy Policy framework consistence with national energy plan.

1. To implement short term and long term comprehensive energy development plan based on systematically investigated data on the potential energy resources which are feasible and can be practically exploited, considering minimum impact on natural environment and social environment.
2. To institute laws, rules and regulations in order to promote private sector participation and to privatize State Energy Organizations in line with State Economic Reform Policy.
3. To compile systematic statistics on domestic demand and supply of various different kinds of energy resources of Myanmar.
4. To implement programmes by which local population could proportionally enjoy the benefit of energy reserve discovered in the areas.
5. To implement programmes on a wider scale, utilization renewable energy resources such as wind, solar, hydro, geothermal and bioenergy for the sustainable energy development in Myanmar.
6. To promote Energy Efficiency and Energy Conservation.
7. To establish R, D, D&D (Research, Development, Design & Dissemination) Institution in order to keep abreast with international practices in energy resources exploration and development works and to produce international quality products in order to manufacture quality products and in order to conduct energy resources exploration works in accordance with international standard.
8. To promote international collaboration in energy matters.
9. To formulate appropriate policy for energy product pricing meeting economic security of energy producers and energy consumers.

Myanmar identified four main drivers for its energy policy framework: to maintain energy independent, to promote utilization of renewable energy, to promote energy efficiency, and to promote use of alternative fuels.

There are several ministries working on energy in Myanmar. Ministry of Energy focuses primarily on exploration and production of oil and gas. Ministry of Forestry is responsible for biomass utilization planning. Parts of renewable energy development are within the scope of Ministry of Science and Technology. Coal mining is regulated by Ministry of Mines.

The Electricity Act of 1948 (with amendment in 1967), the Myanmar Electricity Law, and the Electricity Rules (1985) are major regulations for electricity sector in Myanmar. Two ministries are responsible for the power sector: Ministry of Electric Power No. 1 (MOEP1) and Ministry of Electric Power No. 2 (MOEP2). The main responsibility of MOEP1 is the development of hydropower, which is the main source for electricity generation in Myanmar. The MOEP2 focuses on the transmission and distribution of electricity.

the Philippines

The main driver within the Philippine energy sector is the goal of achieving energy self-sufficiency. In 2011, the proportion of imported energy amounted to 40%. Hence, the security of energy supply is the major concern in defining the national energy policy. The government plans to increase its investment into and the exploitation of domestic fossil fuel resources, while simultaneously introducing RE sources into the national energy mix.

The Philippine Energy Plan (2012-2030) defined several policy goals: to ensure security of energy supply, to increase energy access, to promote low-carbon and environmentally-friendly energy systems, to promote investment, and to implement energy sector reform. The plan also introduced an important energy efficiency target, aiming for 10% reduction in energy consumption across all economic sectors (residential, commercial, industrial, and transportation) by 2030. In the field of electricity regulation, the National Electricity Industry Reform Act from 2001 established a framework for a more competitive electricity market. The main goal is to separate the generation, transmission, distribution and supply of energy. Another important policy is the Renewable Energy Act of 2008 (R.A. No. 9513), which establishes a policy framework for RE development. For the on-grid RE systems, the act paves the way for feed-in tariffs, renewables portfolio standard (RPS), renewable energy market (REM) and net metering. On the off-grid side, RE is aimed to be used as a tool for rural electrification. The National Renewable Energy Board (NREB) was established by this act to support the Department of Energy (DOE) in the RE sector. Moreover, the Renewable Energy Trust Fund (RETF) was also established by the RE Act. The administration is executed by the DOE and the utilization of funds is monitored by the NREB. Moreover, in 2013 the Energy Regulatory Committee issued Resolution No. 7 adopting changes to the Philippine Grid Code, in order to accommodate Variable Renewable Energy Generating Facilities.

Singapore

The energy policy of Singapore sets the following objectives: (i) to promote competitive markets, (ii) to diversify energy supplies, (iii) to improve energy efficiency, (iv) to build-up the energy industry and promote research and development, as well as (v) to promote international cooperation.

Singapore aims to become a hub for research and development in renewable energy. With limited domestic resources, the country is dependent on its external energy supply. National The Climate Change Strategy Blueprint (2012) outlined a plan to reduce CO2 emissions by 7-11% by 2020.

The Energy Conservation Act (ECA) came into force in April 2013. The act collects and combines several conservation legislations from different sectors under one roof. It requires companies with high energy consumption levels (above 54 TJ energy use per annum) as well as companies from certain sectors (manufacturing, energy supply as well as water supply and waste management) to register with the National Environmental Agency (NEA) and to implement energy management. This includes the appointment of an energy manager and the requirement to produce annual reports on energy use and emissions. Among the topics to be covered in the Energy Use Report include types and quantities of energies used for consumption, production, or sale as well as evaluations of energy patterns from the previous years.

Thailand

Thailand relies significantly on energy imports, especially of crude oil and coal. Yet considerable natural gas resources are available domestically and these are the main source of power generation (providing 70% of electricity generation). However, as around 50% of natural gas demand is met with imports, it raises concerns about the security of supply.

The main driver for Thailand's energy policy is the need to diversify its energy mix to ensure the security of energy supply. The latest revision of Thailand's Power Development Plan 2010-2030 (PDP 2010), adopted in 2012, has brought two important plans into effect: the Renewable and Alternative Energy Development Plan (AEDP) for the period 2012-2021 and the 20-Year Energy Efficiency Development Plan (EEDP) for 2011-2030. The AEDP 2012-2021 is an important roadmap for Thailand's RE development. The plan aims for 25% share of renewable and alternative energy sources in national energy mix in 2021.

An important legislative document in the energy sector constitutes the Energy Industry Act (2007), which sets a regulatory framework for private sector involvement in power generation (e.g. encouraging local communities and the general public to manage and monitor energy-related operations). Moreover, this legislation established the Energy Regulatory Commission (ERC) – an independent regulatory agency, which is responsible for the electricity and natural gas industry. Every private sector player in the energy business is obliged to obtain a license from the ERC.

Other relevant bodies include: the National Energy Policy Committee (NEPC) that operates at ministerial level, the Energy Policy and Planning Office (EPPO) - a national agency responsible for policy formulation and the Department of Alternative Energy Development and Efficiency (DEDE) which works at promoting and supporting sustainable energy production and consumption. The Renewable Energy Act is currently being drafted. It is still subject to discussion and public hearing.

Vietnam

The key aim of Vietnam's energy policy is to attract foreign investment, especially in the electricity sector and to create a competitive market, as stated in the Law on Electricity from 2005 (last update: Decree 137/2013/ND-CP on 10th December 2013). Subsidization of electricity prices has put a huge burden onto the government budget, making investment in new infrastructure unattractive. Vietnam aims for diversification of its energy mix while minimizing its dependency on oil.

The main legislative body is the Ministry of Industry and Trade. The central document constitutes the Vietnam Power Development Plan for the 2011-2020 Period (with outlook to 2030) approved by the Prime Minister on 21st July 2011. It Member States that the general aim is the efficient use of energy sources, sustainable import, energy security, but also the stability of energy supply at socially and economically viable prices. The concrete goals include: (1) increase in electricity supply (through both domestic production and imports); (2) prioritisation of renewable energy sources, to reach 4.5% share of total electricity production in 2020 and 6.0% in 2030; (3) reduction of electricity elasticity coefficient / GDP from the current average 2.0 to 1.5 in 2015 and 1.0 in 2020; as well as (4) rural electrification of remote and rural areas.

Moreover, Vietnam has a separate policy on energy efficiency – the National Strategic Programme on Energy Saving and Effective Use (79/2006/ND-CP). There are several measures established to ensure energy efficiency on the consumer side such as regular mandatory energy reporting from large electricity consumers.

References

ADB (2014): ASEAN 2030. Toward a Borderless Economic Community.

ADB (2014): The ASEAN Economy in the Regional Context: Opportunities, Challenges, and Policy Options. ADB working paper series on regional economic growth, December 2014.

Anne-Sophie, Corbeau; Anne, Braaksma; Farid, Hussin; Yayoi, Yagoto; Takuro, Yamamot (2014): The Asian Quest for LNG in a Globalising Market. Hg. v. IEA. IEA.

Andrea Herbst, Felipe Toro, Felix Reitze, and Eberhard Jochem (2012): Introduction to Energy Systems Modelling -Swiss Journal of Economics and Statistics, 2012, Vol. 148 (2)

ACE (2010): The ASEAN Plan of Action for Energy Cooperation (APAEC) 2010-2015.

ASEAN (2015): ASEAN International Merchandise Trade Statistical Yearbook 2014 - Jakarta: ASEAN Secretariat, March 2015

BGR (2014): Energiestudie 2014. Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen (18). – 131 S., Hannover

Bonafe, Ernesto; Vanhay, Aurore (2015): The role of the energy Charter Treaty in fostering regional electricity market integration. Lessons learned from the EU and implications for Northeast Asia. ECT.

EIA (2015): Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2015. Hg. v. EIA.

EU Commission JRC (2015): EDGAR – Emission Database for Global Atmospheric Research. (Available at http://edgar.jrc.ec.europa.eu/overview.php)

Germanwatch (2014): Briefing Paper Global Climate Risk Index 20 15 - Who Suffers Most From Extreme Weather Events? Weather-related Loss Events in 2013 and 1994 to 2013, Bonn, November 2014. (Available at https://germanwatch.org/en/cri)

IEA (2014): World Energy Investment Outlook.

IRENA (2015): Renewable Power Generation Costs. Bonn.

Lee, Jae-Seung (2010): Energy Security and Cooperation in Northeast Asia. In: The Korean Journal of Defense Analysis, S. 217–233.

Lidula, N.W.A.; Mithulananthan, N.; Ongsakul, W.; Widjaya, C.; Henson, R. (2007): ASEAN towards clean and sustainable energy: Potentials, utilization and barriers. In: Renewable Energy 32 (9), S. 1441–1452. DOI: 10.1016/j.renene.2006.07.007.

OECD (2015): Economic Outlook for Economic Outlook for Southeast Asia, China and India 2015. Special Supplement, March 2015.

Ölz, Samantha; Beerepoot, Milou (2010): Deploying Renewables in Southeast Asia. Trends and potentials. Hg. v. IEA.

Peter, Engelmann (2005): The Asian Quest for LNG in a Globalising Market. GTZ.

Ponciano Intal, Jr., Yoshifumi Fukunaga, Fukunari Kimura, Phoumin Han, Philippa Dee, Dionisius Narjoko, Sothea Oum (2014): ASEAN RISING: ASEAN and AEC Beyond 2015.

Samuelson, Ralph D. (2012) The Unexpected Challenges of Using Energy Intensity as a Policy Objective: Examining the Debate over the APEC Energy Intensity Goal. Asia Pacific Energy Research Center (APERC). (Available at http://eneken.ieej.or.jp/3rd_IAEE_Asia/pdf/paper/092p.pdf)

Yale (2014): Global Metrics for the Environment – 2014 Environmental Performance Index EPI results. (Available at http://epi.yale.edu/)

ACE Building, 6th Floor
Jl. H.R. Rasuna Said Block X-2, Kav. 07-08
Jakarta 12950, Indonesia
Tel No: (62-21) 527 9332
Fax No: (62-21) 529 9350
www.aseanenergy.org

ISBN 978-979-8978-30-2

The publication is supported by:

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

In cooperation with:
Fraunhofer ISI