Annex 1

Energy Outlook Results of Total ASEAN

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March 2021

This chapter should be cited as:
Purwanto, A.J. (2021), 'Energy Outlook Results of Total ASEAN', in Han, P. and S. Kimura (eds.), *Energy Outlook and Energy Saving Potential in East Asia 2020*, Jakarta: ERIA, pp.313-327.

Annex 1

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1. Background

TheAccording to the World Bank World Development Indicators (WDI) databank[1], the 10 (ten) Member States of the Association of South East Asian Nations (ASEANS) reached a total Gross Domestic Products (GDP) of around US$[2] 3.1 trillion by 2017. According to the ASEAN Secretariat (2019)[3], by 2018, ASEAN as a region is fifth largest economy in the world, only behind the United States (US$20.5 trillion), China (US$13.4 trillion), Japan (US$5.0 trillion), and Germany (US$4.0 trillion).

Figure A1-1. Gross Domestic Product (GDP) and Population of ASEAN

[1] Available at https://databank.worldbank.org/source/world-development-indicators as accessed 5 November 2020
[2] Constant 2010 US$ is used in this report
[3] The ASEAN Secretariat (2019), ASEAN Key Figures 2019, Jakarta, ASEAN Secretariat, October, available in https://www.aseanstats.org/wp-content/uploads/2019/11/ASEAN_Key_Figures_2019.pdf as accessed 23 October 2020

The total 10 ASEAN Member States' GDP would rise from around US$ 3.1 trillion in 2017 to around 12250 billion US$ in 2050, i.e. an average yearly growth of around 4.3%. At the same time, the total ASEAN population would increase from around 636 million of inhabitants in 2017 to around 810 million of inhabitants in 2050, i.e. an average growth rate of 0.7% per year. The GDP per capita would increase then from around US$ 4875 in 2017 to US$ 15150 in 2050.

ASEAN Member States are taking individual actions to address climate change issues as stated in their Intended Nationally Determined Contributions (INDCs) as shown in the Table A1-1. Individual measures range from energy efficiency improvements to increase in renewable energy use in energy intensive consuming sectors, for instance household, transport, industry, buildings, etc., which are explained in detail in country chapters of this report.

Table A1-1 ASEAN Member States Individual Intended Nationally Determined Contributions (INDCs)

Table A1-1. ASEAN Member States Individual Intended Nationally Determined Contributions (INDCs)

Country	Reduction Target
Brunei Darussalam	Brunei Darussalam has a commitment to reduce 63% of its total energy consumption by 2035
Cambodia	Cambodia has a commitment to reduce 27% of its greenhouse gas emissions conditionally, taken from aggregate reductions from energy, transport, manufacturing and others and additional contribution from the LULUCF sector
Indonesia	Indonesia has a commitment to unconditionally reduce 26% of its greenhouse gas emissions by 2020 and 29% by 2030 compared to its Business-as-Usual (BAU) scenario. Reduction target would be increased to 41% by 2030 if support is provided from international cooperation.
Lao PDR	Lao PDR has set policies and measures to reduce greenhouse gas emissions in multiple sectors, to be implemented by 2030.
Malaysia	Malaysia intends to reduce its greenhouse gas emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. This reduction consists of 35% on an unconditional basis and a further 10% upon receipt of climate finance, technology transfer and capacity building from developed countries
Myanmar	Myanmar has set policies and measures to reduce greenhouse gas emissions in multiple sectors, to be implemented by 2030
Philippines	Philippines has a commitment to reduce 70 % of its greenhouse gas emissions by 2030 relative to its BAU Scenario. The mitigation contribution is conditioned on the extent of financial resources, including technology development and transfer, and capacity building
Singapore	Compared to the 2005 base year, Singapore intends to reduce its emissions intensity by 36% by 2030, and stabilize its emissions with the aim of peaking around 2030
Thailand	Thailand has a commitment to reduce its greenhouse gas emissions by 20 % from the BAU level by 2030. The target could increase up to 25 percent, subject to adequate and enhanced access to technology development and transfer, financial resources, and capacity building support through a balanced and ambitious global agreement under the (UNFCCC).
Viet Nam	Viet Nam intends to reduce its greenhouse gas emissions by 8% unconditionally by 2030. The target could be increased to 25% if international support is received through bilateral and multilateral cooperation, as well as through the implementation of new mechanisms under the Global Climate Agreement, in which emission intensity per unit of GDP will be reduced by 30% compared to 2010 levels.

Source: Summarized of ASEAN Member States information in the INDC Portal available at https://www4.unfccc.int/sites/submissions/INDC/Submission%20Pages/submissions.aspx as accessed on 29 October 2020

Collective actions are also taken at ASEAN level which are represented by the Joint Declarations on Climate Change which have been issued since 2007. In their most recent Joint Declaration on Climate Change, signed in Kuala Lumpur, 21 November 2015[4] , ASEAN Leaders called upon Member States to work effectively and in good faith for an agreed outcome with legal force under the Convention and submit Intended Nationally Determined Contributions (INDCs) in advance of the 21st UNFCCC Conference of Parties (COP-21) in Paris in December 2015.

ASEAN Plan of Action for Energy Cooperation (APAEC) as the regional blueprint for the energy sector in the framework of the ASEAN Economic Community (AEC) implementation might be the most important measure taken at the ASEAN level that concerns energy infrastructures development. With its seven program areas , APAEC is the blueprint of the energy cooperation in the region that plays a vital role in setting a sustainable future of ASEAN energy landscape.

In this chapter we present the energy outlook of the aggregation of 10 ASEAN Member States results. We provide first the outlook results of the business-as-usual (BAU) scenario and then the outlook results of the alternative scenario (APS5 or simply APS) scenario. In the country chapters, alternative scenarios (APS) have been developed based on the energy efficiency and renewable energy penetration targets in each country which are set without any direct relationship with the country's INDC as described in the Table A1-1.

In each scenario we show the development of the final energy demand, primary energy consumption, power generation sector, and several energy indicators that synthesize the region's performance on the improvements of energy efficiency and reduction of energy intensity and CO2 emissions.

2. Outlook Results

2.1. Business-as-Usual Scenario

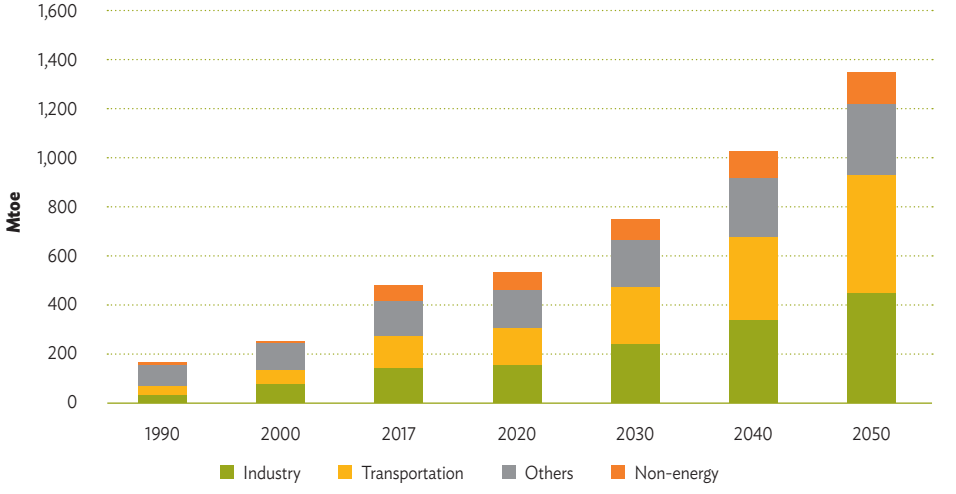
2.1.1. Final Energy Demand

ASEANS's final energy demand grew at an annual rate of 4.0% % from 165 Mtoe in 1990 to 480 Mtoe in 2017. During the same period, the "Others" sector, i.e. residential and commercial,

[4] ASEAN Joint Statement on Climate Change to the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) (Adopted). Available at http://environment.asean.org/wp-content/uploads/2018/11/ASEAN-Joint-Statement-on-Climate-Change-Adopted-2015.pdf as accessed 29 October 2020.

was the dominant energy use share, with 81 Mtoe and 141 Mtoe consumed in 1990 and 2017, respectively, i.e. an annual growth at 2.1%. With an annual growth of around 5.5%, transport sector was the second fast growing sector in that period followed by industry sector with 4.6% yearly growth rate. In 2017, with around 148 Mtoe, industry sector has the lion share of the energy consumption (31%), followed closely by the "Others" sectors (141 Mtoe or 29% share) and then transport sector (129 Mtoe or 27% share). Approximately only around 7% of the region's final energy is consumed for non-energy uses in 2017, particularly as feedstock for petrochemical production.

Figure A1-2. Final Energy Demand by Sector, BAU



Source: Author's compilation

Under the BAU scenario, final energy demand is projected to grow by 3.2% a year between 2017 and 2050. The fastest average annual grow can be expected to happen in the transport sector (4.1%), followed by the industry sector (3.4%). The "others" and Non-energy sectors demand are projected to grow yearly by 2.2% each. The slow growth in the "others" sector is caused by the shift from traditional biomass use especially in residential to other commercial and more efficient energy sources such as oil and electricity.

Under the BAU, transport sector consumption will become the highest share in the total final energy demand in ASEAN followed by the industry sector and then the "Others" sector. By 2050, transport sector energy use share would reach around 36% whilst those of industry and the "Others" sectors would reach 33% and 22% consecutively.

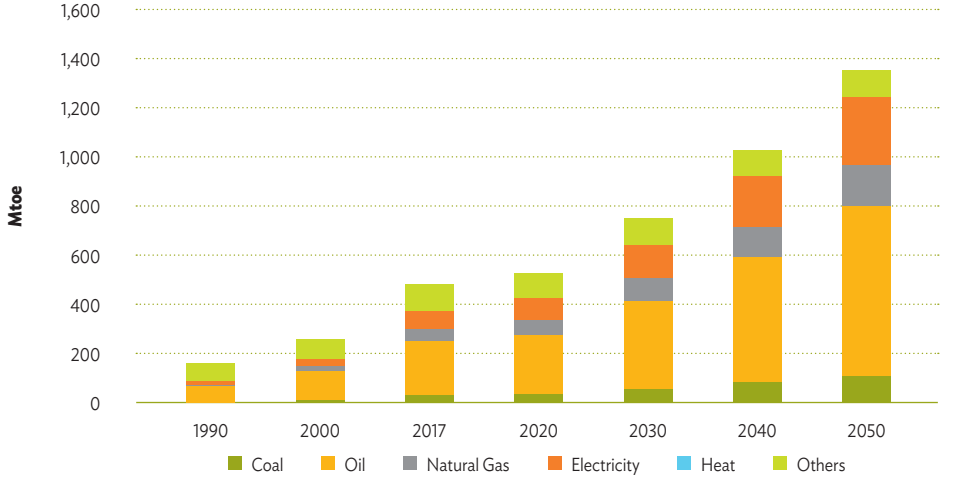
By fuel type, natural gas experienced the fastest growth over the 1990 to 2017 period, at an average rate of 7.3% per year mainly caused by the rapidly expanding industry sector. Coal and electricity demand grew annually at similar rate of 7.2% during the period 1990 to 2017. Demand for oil grew at an average annual growth of 4.6% percent while the "Others" sources, mostly consisted of traditional biomass, grew annually at 1.1%.

In term of fuel share, it is interesting to observe that the "Others" with 75 Mtoe and 45% of share, was the dominant fuel in 1990. This share dropped sharply to 21% (101 Mtoe) in 2017. In 2017, with 45%, oil had the lion share of fuel use followed by electricity (16%), natural gas (10%) and coal (7%).

Under the BAU, the demand for natural gas and electricity is expected to continue expanding but at a slower average growth of around 3.9 and 3.8 % annually until 2050. Meanwhile, coal and oil demand will only be growing at an average of of about 3.6% and 3.6% per year, respectively. Demand for the "Others" fuel, mostly composed by the use of traditional biomass would decrease by around 0.1% per year.

With a share of around 51% in 2050, oil is still expected to play a major role in the ASEAN's final energy demand. For the past two decades, that is, periods 1990 to 2017, the share of oil increased from 40% to around 45%. Under the BAU, oil's share to the final energy demand will increase slightly to 46% in 2020 then further to 51% in 2050. Meanwhile, the share of electricity in the final energy demand will increase to around 17% starting 2020 and before rising further to 21% until 2050. Figure 3 shows the final energy demand by fuel.

Figure A1-3. Final Energy Demand by Fuel, BAU



Source: Author's compilation

2.1.2 Primary Energy Consumption

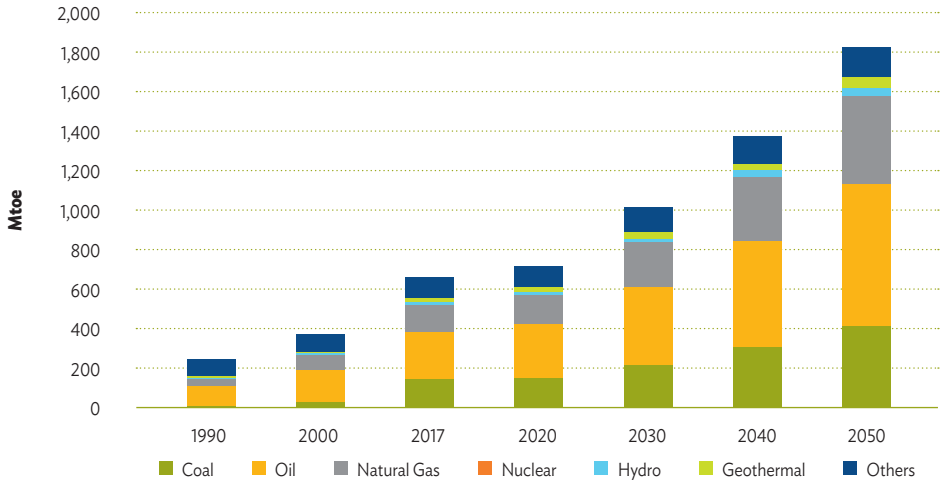
Primary energy consumption grew by 3.9 % per year, from 238 Mtoe in 1990 to 662 Mtoe in 2017. ASEAN region's dominant source of energy in 1990 was oil which made 42 % of the total primary energy consumption share, of which consumption increased yearly by 3.4 % from 99 Mtoe in 1990 to 244 Mtoe in 2017. The second dominant source of commercial energy was natural gas. In 1990 natural gas made 14% share of the total primary energy consumption in the region and in 2017 this share reached 20%, i.e. a yearly increase of 5.2% from 33 Mtoe in 1990 to 129 Mtoe in 2017. Nevertheless, with an annual growth rate of 9.3%, coal is the fastest growing energy source who increased from 13 Mtoe to 143 Mtoe between 1990 and 2017. During the same period, hydro and geothermal increased with annual growth rates of 7.3% and 4.7% respectively. "Others" sources of energy, consisted mainly by traditional biomass in made 36% of the total final energy consumption in 1990 which is the second biggest after oil. However, in 2017 its share was only 17% as its consumption increased only by around 1% per year from 85 Mtoe to 110 Mtoe between 1990 and 2017.

As shown in the Figure 4, Primary energy consumption in the BAU is projected to grow by 3.1% per year between 2017 and 2050. Among the energy sources, natural gas is expected to grow the fastest at 3.9 % a year, followed by coal and oil, at 3.2% and 3.3% per year, respectively. Geothermal and hydro are expected to increase at consecutively 3.6% and 2.0% per year. By 2050, with around 40% of the total primary energy consumption share, oil would remain as the dominant energy sources followed by natural gas (25%) and coal (22%) whilst, hydro and geothermal shares would remain limited at 2% and 3% respectively. The share of the "others" sources of energy in 2050 would be 8% as it is expected to grow by only 0.9% during the period of 2017 – 2050.

2.1.3 Power Generation

Electricity generation grew by 7.9% per year from 170 TWh to 1040 TWh over the period 1990 to 2017. The power generation mix has changed significantly over the past decade which marked principally by the shift from oil to natural gas, coal, and hydro. Natural gas and coal, which each accounted for respectively 17% (around 28 TWh) of electricity generation in ASEAN in 1990, grew rapidly to supply respectively 40% (415 TWh) and 37% (380 TWh) of the region's electricity in 2017. Hydro share grew from 16% (27 Mtoe) in 1990 to 18% (183 TWh) in 2017 whilst fuel oil share for thermal power generation drop from 46% (80 TWh) in 1990 to merely around 3% (25 TWh) in 2017. In the same period, "Others" sources of energy that

Figure A1-4. Primary Energy Consumption, BAU

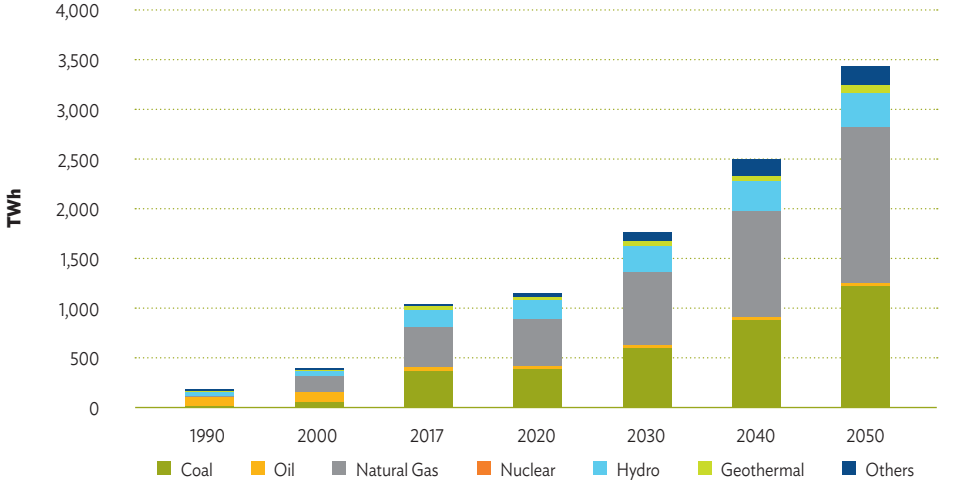


Source: Author's compilation

includes biomass and solar, took up only a small proportion of the mix, nearly zero in 1990 to totaling to around 1% in 2017.

In the BAU scenario, power generation is projected to increase at 3.7% per year over the period 2017 – 2050, reaching 3440 TWh in 2050. Natural gas is expected to take the lion share of the power generation mix, i.e. 46% of the total energy output in power generation in 2050, followed by coal (36%) and hydro (10%). Generation from "Others", which comprises of biomass and solar power, will have the fastest growth at an average rate of almost 8% per year. "Others" power generation is expected to increase its share from a minimal share of 1% (14 TWh) in 2017 to 5 % (184 TWh) in 2050.

Figure A1-5. Electricity Generation, BAU



Source: Author's compilation

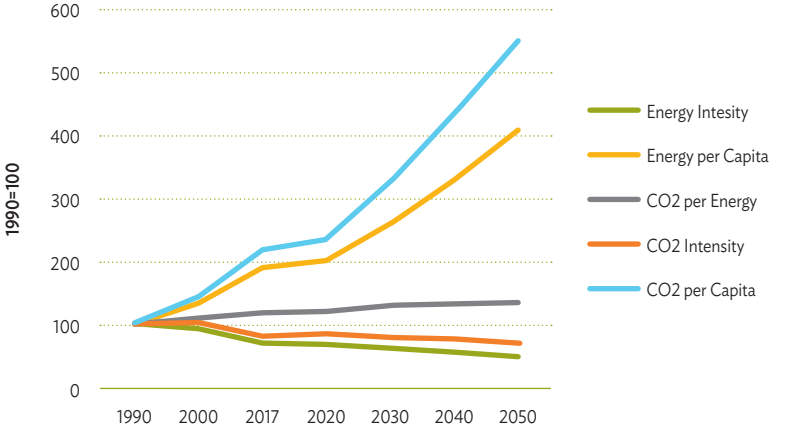
The average thermal efficiency of the whole ASEAN's fossil-fueled power plants was around 33% in 1990 and improved to 37% in 2017 as more natural gas fired power plants (especially CCGT) were in operation. In the BAU scenario, thermal efficiency of fossil plants is expected to improve further to around 43% in 2050.

By fuel, natural gas plants thermal efficiency will be 51% in 2050 while oil and gas will be at 35% and 36% respectively.

2.1.4 Energy Indicators

As shown in the Figure 6, primary energy intensity, which is computed as the ratio of primary energy consumption over GDP, is expected to decrease. Energy intensity continues to decrease as TPES will grow at a slower rate compared to economic growth. CO2 intensity, defined as CO2 emissions per unit of GDP, is projected to have similar declining trends compared to energy intensity. Energy and CO2 per capita increases due to several factors, i.e. rapid industrialization, life style change toward more energy intensive way of live and slower population growth than fossil fuel demand growth.

Figure A1-6. Energy Indicators, BAU



Source: Author's compilation

2.2 Energy Saving and CO2 Reduction Potential in the Alternative Policy Scenario (APS)

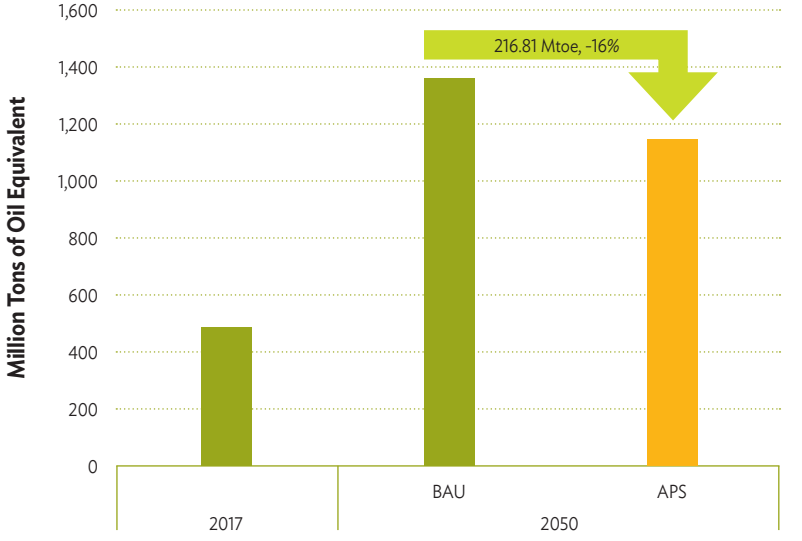
The Alternative Policy Scenario (APS) applies same GDP and population assumptions as assumed for the BAU scenario. The APS assumes the implementation of improved efficiency of final energy consumption in the end-use sectors. The APS will see more efficient thermal power generation, and higher contribution of renewable energy to the total supply with no nuclear power plants.

By comparing the APS results with the BAU scenario results, this section provides a basis for determining the impacts of promoting energy efficiency and increased use of renewable energy on energy saving and CO2 emissions reductions in ASEAN.

2.2.1 Final Energy Demand

Final energy demand under the APS is projected to increase by 2.7% annually from 2017 to 2050 which is slower than BAU's yearly growth rate, i.e. 3.2%. As shown in the Figure 7, by 2050, the total final energy demand of APS should reach around 1140 Mtoe which is 16% less than that of BAU scenario. Between 2017 and 2050, transportation sector grows annually at 3.3%, followed by the industry sector at 2.9% and the other (residential and commercial) sector at 1.8 %. Similar to the BAU case, the non-energy sector grows at 2.2 % per year.

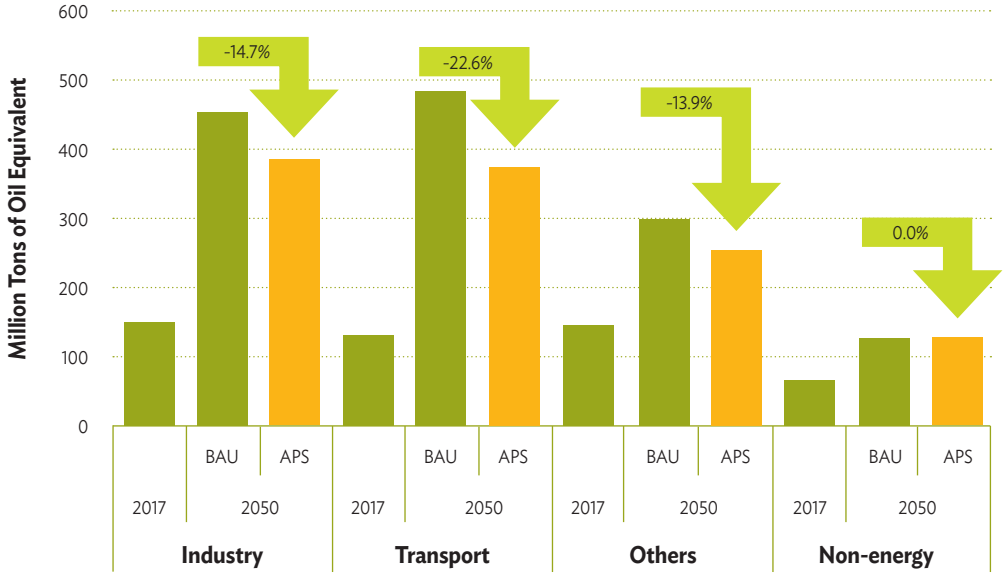
Figure A1-7. Total Final Energy Demand in 2050, BAU and APS



Source: Author's compilation

Transportation sector can be expected to be the sector that shall experience the most reduction of energy use in the APS. Figure 8 shows that in 2050 transport energy consumption would decrease by more than 22% in the APS compared to BAU scenario. By 2050, energy consumption the industry sector of APS should be 14.7% lower than BAU whilst consumption of the "others" sectors of the APS would be nearly 14% lower than of BAU.

Figure A1-8. Total Final Energy Demand by Sector in 2050, BAU and APS



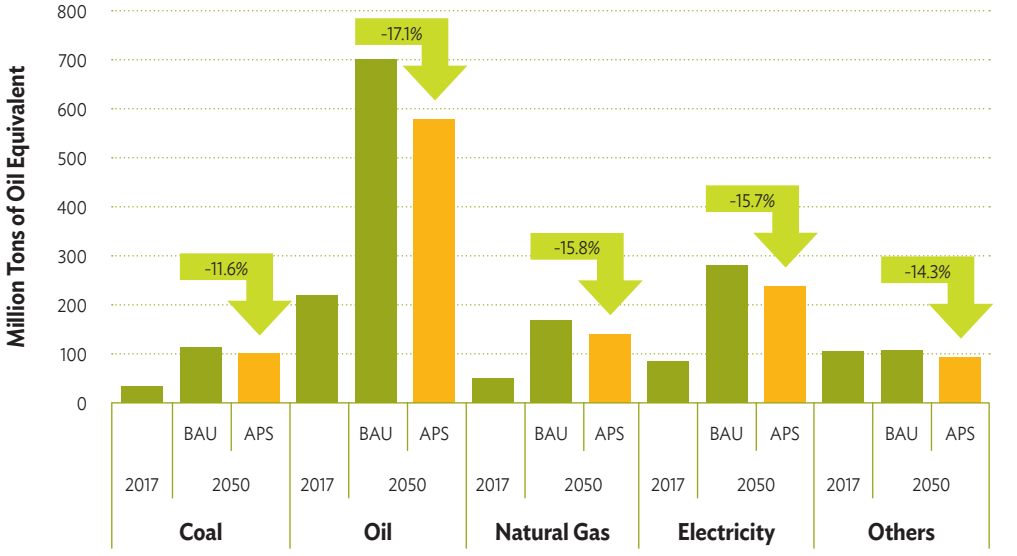
Source: Author's compilation

As given in the Figure 9, from the fuel type point of view, in 2050 in comparison to BAU, APS is expected to reduce oil consumption by more than 17% and natural gas and electricity consumption by around 15.7% each. Coal demand in APS would be 11.6% lower than in BAU whilst the "others" types of fuel consumption would be 14.3% lower.

2.2.2 Primary Energy Consumption

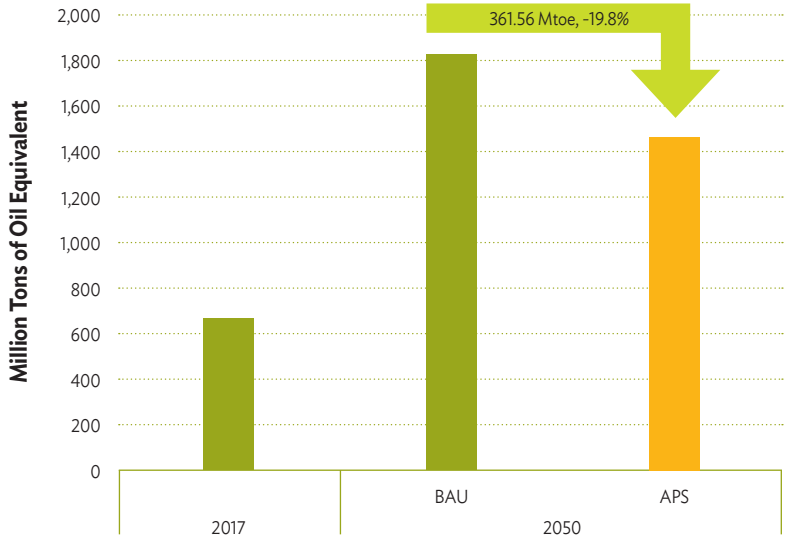
In 2050, with regards to BAU scenario, measures in APS would decrease the total primary energy consumption by around 360 Mtoe or nearly 20% (Figure 10). Most of the reduction in primary energy consumption will come from coal at 159 Mtoe, which is a drop of around 39% from BAU (Figure 12). Natural gas and oil consumption would decrease by 24% and 16.5% consecutively. In APS scenario, nuclear power plants would penetrate whilst geothermal power generation as well as solar, wind, ocean and biofuel would increase stronger than in BAU. Biomass' consumption will remain relatively constant. Altogether this should lead to an increase in consumption of "others" by 10%.

Figure A1-9. Total Final Energy Demand by Fuel in 2050, BAU and APS



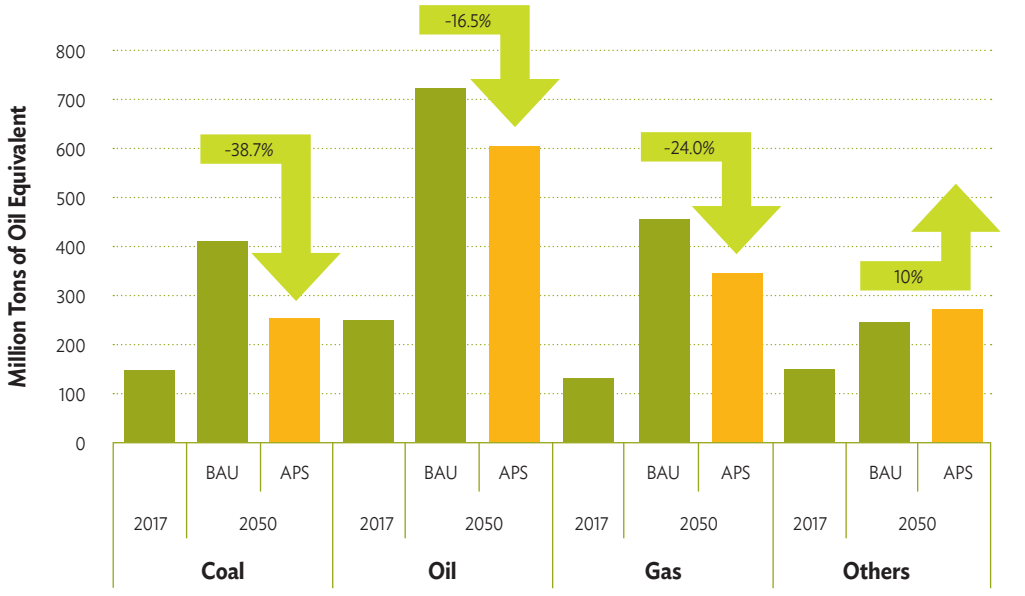
Source: Author's compilation

Figure A1-10. Total Primary Energy Consumption in 2050, BAU and APS



Source: Author's compilation

Figure A1-11. Total Primary Energy Consumption by Fuel in 2050, BAU and APS



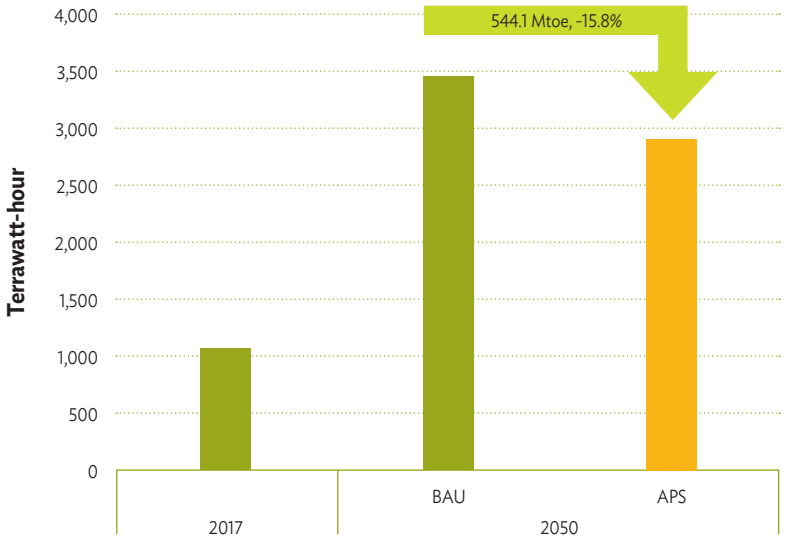
Source: Author's compilation

2.2.3 Power Generation

APS shows a decrease in electricity generation, registering a drop of around 544 TWh or nearly 16% from BAU (Figure 12). In 2050, with regards to BAU scenario, policy measures in APS should reduce the coal-fired electricity production by more than 37% and the gas-fired electricity production by 17.6%. The use of "others" energy sources, mainly from solar, to generate electricity would almost double in APS (356 TWh) with regards to BAU scenario (185 TWh). In 2050, electricity generated in geothermal plants would increase by nearly 17% from BAU to APS. In APS nuclear plants can be expected to generate up to 21 TWh in 2050 while in BAU no nuclear based power generation will occur.

Figure A1-12. Electricity Generation in 2050

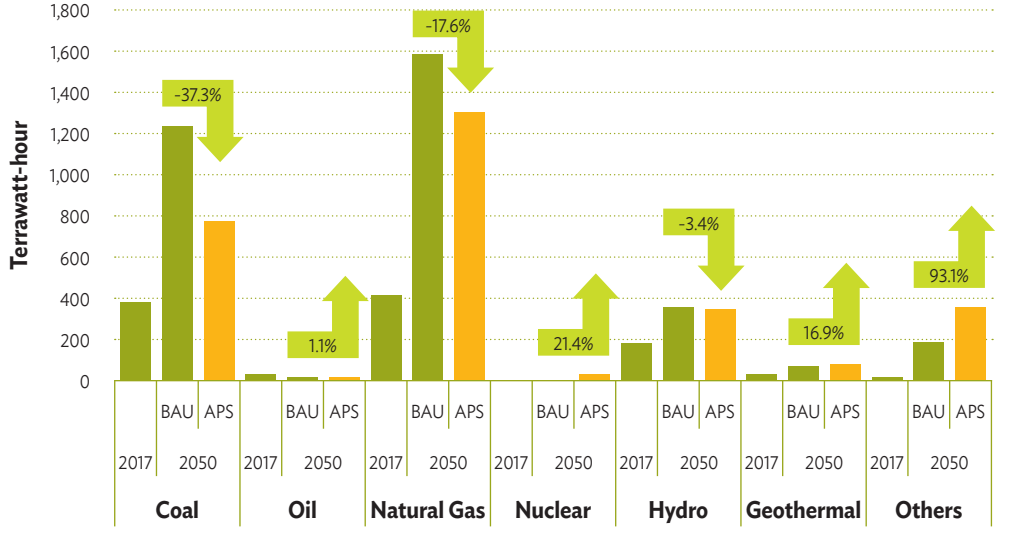
(TWh)



Source: Author's compilation

Figure A1-13. Electricity Generation in 2050 by sources

(TWh)

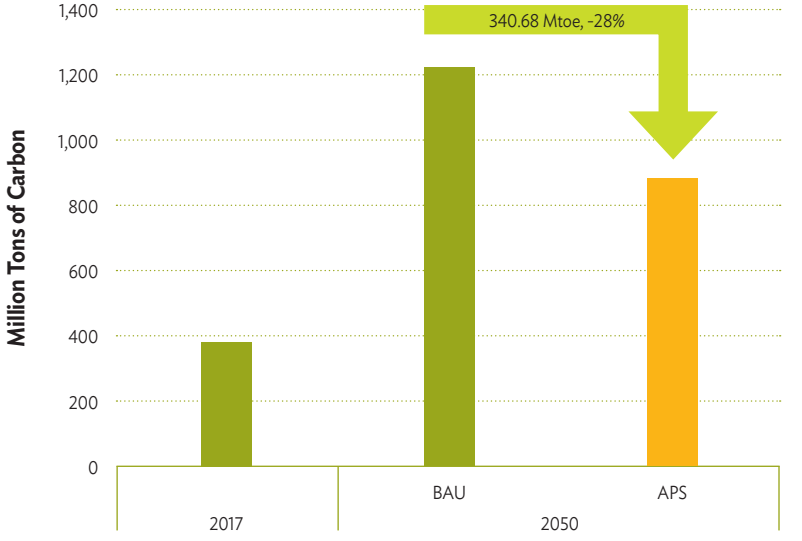


Source: Author's compilation

2.2.4. CO2 Reduction Potential

Under BAU, carbon dioxide (CO2) emissions from energy demand are projected to increase at an average annual rate of 3.6%, from 376 Mt-C in 2017 to around 1217 Mt-C in 2050 (Figure 14). During the same period, in APS, emission would grow yearly by an annual growth rate of 2.6% to reach 876 Mt-C only in 2050. Therefore, CO2 emissions reduction potential in APS would save around 341 Mt-C in 2050, equivalent to around 28% decrease from BAU.

Figure A1-14. CO_2 Emissions from Energy Consumption, BAU and APS



Source: Author's compilation

3. Implications and Policy Recommnedations

At least four main conclusions can be derived based on the outlook results:

First, energy consumption in ASEAN will continuously increase due to stable economic growth up to 2050.

Second, Individual Member States' governments have been implementing diversified sectoral measures to promote and advocate the adoption of clean energy technologies and sources,

and emissions reduction. If by implementing those measures ASEAN Member States could accomplish their energy efficiency and renewable energy penetration targets during next 3 decades, then ASEAN as a region would reduce energy consumption significantly as well as CO2 emissions.

Three, at the regional level, ASEAN has also put forward several initiatives and programs mainly through the ASEAN Plan of Action for Energy Cooperation (APAEC) as the regional blueprint. ASEAN should implement APAEC by increasing reginal collaboration as well as international cooperation regarding energy efficiency and renewable energy.

Fourth, energy efficiency promotion measures in transport fuel and electric generation will be essential. For RE, affordable and stable use of RE will be also crucial. For RE promotion, parallel use of natural gas will be a key but pay attention to use of affordable natural gas. LNG hub in Asia is an option to secure stable and affordable natural gas supply to ASEAN.

ASEAN as the current fifth largest economy in the world also plays an important role in the world in term of energy consumption and greenhouse gas emissions. Continuous monitoring and observation of the energy saving and emission reduction situation at ASEAN level including regular updating of the regional energy outlook as in this chapter is therefore among the most essential activities needed to prepare a suitable energy policy making at ASEAN level.

Several further in-depth studies need to perform to answer the following two important research questions: what are the effects of ASEAN energy initiatives and programs to the individual Member States' energy outlook? How can individual Member States' energy measures be synchronized at regional level to increase their effectiveness at country level as well as at ASEAN level?

Elements of answers to those questions would serve as on the basis for developing ASEAN energy strategy in energy saving and emission reduction potential in the future.