CHAPTER 14

Philippines Country Report

Magnolida B. Olvido and Lilibeth T. Morales

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CHAPTER 14
Philippines Country Report

S. Magnolia, B. Olvido, and Lilibeth T. Morales

1. Background

1.1 Socio-economic

The Philippines, officially known as the Republic of the Philippines, consists of more than 7,000 islands in three main geographical archipelagoes or divisions such as Luzon, Visayas, and Mindanao. The country's capital, officially known as the National Capital Region (NCR) or commonly known as Metro Manila or Manila, is located in Luzon.

In 2017, the country's population was roughly 105.2 million.[1] Gross domestic product (GDP) per capita was recorded at US$2,884.40, with the NCR accounting for the largest share of the economy (36.4%)[2].

In total, the Philippines' economy grew 6.7% over the preceding year, slightly below the 6.9% GDP growth recorded in 2016. While GDP dipped a few notches, the Philippines was still considered one of the fastest-growing economies in Asia during the period. Manufacturing, trade, and real estate, renting and business activities were the main drivers of overall growth[3]. Government spending also grew by 14.3% in the last quarter of the year, a significant increase compared to the same period in 2016. However, the greatest growth rates during this period were in the industrial and services sectors, which posted annual growth rates of 7.2% and 6.8%,

[1] https://data.worldbank.org/indicator/SP.POP.TOTL?locations=PH (accessed 1 August 2020).

[2] Gross Domestic Product of the Philippines (2018) Highlights for 2017. Manila: Philippine Statistics Authority (PSA). https://psa.gov.ph/grdp/highlights-id/131382 (accessed 1 August 2020

[3] Gross Domestic Product of the Philippines (2018) Highlights for 2017. Manila: Philippine Statistics Authority (PSA). https://psa.gov.ph/grdp/highlights-id/131382 (accessed 1 August 2020).

respectively. The growth of the industrial sector can be attributed to the manufacturing sub-sector, which grew by 8.4%. The services sector accounted for about 57.5% of the GDP, which can be attributed to the robust domestic trade and a boom in real estate. Meanwhile, agriculture, hunting, forestry and fishing registered 4% growth over the preceeding year, as the growth in the agriculture and forestry sector rebounded and registered a growth rate of 4%.

1.2 Policy

The Philippine Department of Energy (DOE) has set forth strategic directions and an energy agenda to assist the current administration in attaining its development goals as envisioned in the AmBisyon Natin 2040—the blue-print of a long-term, collective vision and aspiration of Filipinos, and supported by national economic strategies that will provide opportunities for inclusive growth. Within AmBisyon Natin 2040, the Philippine energy sector plays a vital role as an indispensable factor for economic growth. The DOE is primarily focused on consumer-first policies, reliability of energy supplies and affordability of tariffs.

The Philippine DOE has set eight "Energy Sector Strategic Directions" as follows: 1) ensure energy security; 2) expand energy access; 3) promote a low-carbon future; 4) strengthen the collaboration between the private sector and government agencies on energy-related issues; 5) implement, monitor and integrate sectoral and technological roadmaps and action plans; 6) advocate the passage of DOE's legislative agenda; 7) strengthen consumer welfare and protection; and 8) foster international relations and partnerships.

The following are the policies that are aligned with the strategic directions:

- In 2016, the DOE issued Department Order No. DO2016-01-0013 entitled "Creating the Nuclear Energy Program Implementing Organization (NEPIO) in the Department of Energy" to ensure continuous and adequate supply of energy via a firm national policy on nuclear energy. On 24 July 2020, President Rodrigo R. Duterte issued Executive Order No. 116 entitled "Directing a Study for the Adoption of a National Position on a Nuclear Energy Program, Constituting a Nuclear Energy Program Inter-Agency Committee, and For Other Purposes". This policy expands the involvement of other government agencies that would establish the country's policy on nuclear energy and determine its feasibility as a long-term option for power generation.

- Promoted and adopted in 2017, Executive Order (EO) No. 30, which President Rodrigo R. Duterte signed to create an Energy Investment Coordinating Council, is tasked with developing a simplified permitting and approval process to achieve a timely and expeditious implementation of energy projects tagged with "National Significance" by harmonising the regulations of all government agencies involved in obtaining permits and approvals.

- In 2017, the DOE issued Department Circular No. DC2017-11-0012, known as the Philippine Downstream Natural Gas Regulation, to establish the rules and regulations governing the downstream natural gas industry and the continued operations of gas-fired power plants upon depletion of natural gas supply from Malampaya, the country's indigenous natural gas resource. This is in line with the aspiration of transforming the country into a regional LNG trading trans-shipment hub.

- In 2018, the DOE pushed for the mainstreaming of Resiliency Planning and Program through the issuance of Department Circular No. DC2018-01-0001 entitled the "Adoption of Energy Resiliency in the Planning and Programming of the Energy Sector to Mitigate Potential Impacts of Disasters". This policy paves the way for the inclusion of disaster risk and reduction programs into the energy project planning and investments and adoption of both engineering and non-engineering mechanisms on existing energy infrastructure to ensure continuous delivery of energy services to consumers.

- After 3 decades, the Republic Act No. 11285 (The Energy Efficiency and Conservation Act) was finally passed into law and institutionalised in 2019, which aims to enhance efficient use of energy in the country through the development of policy mechanisms and standards in the different sectors.

- Pertinent policies were adopted and integrated into the power sector such as Department Circular No. DC2017-12-0015 (Promulgating the Rule and Guidelines Governing the Establishment of the Renewable Portfolio Standard for On-Grid Areas), which aims to produce a specified portion of the electricity requirements from eligible renewables resources in order to develop indigenous and environment-friendly energy sources to attain the aspirational target of 35% in the generation mix expressed in MWh by 2030.

The DOE is adopting a technology-neutral policy in coming up with an optimal energy mix, especially for the power sector. The power sector implements a 25% reserve requirement to be able to meet the peak requirement of the Luzon, Visayas and Mindanao grid. In addition, efforts to develop and promote indigenous energy such as renewables and hydrocarbon fuels (oil, gas, and coal) and to tap clean and smart technologies include the following priority infrastructure projects:

- Completing transmission projects, such as the Visayas-Mindanao Interconnection Project, by December 2020 will facilitate greater energy access through a 100% national and regional electrification;

- The Small-Island Interconnection will connect isolated island provinces in the main grid. One of the flagship programs is the Semirara-Mindoro-Panay Interconnection in support of a One-Grid Philippines goal.

- The country's Liquefied Natural Gas (LNG) capacities and capabilities will be harnessed through the PHP100 billion Batangas Integrated LNG by 2020 with an initial 5 million tonnes per annum throughput and initial reserve capacity of 200 MW.

- A Pro-Consumer Distribution Framework for energy affordability, choice and transparency through the "E-Power Mo" campaign, which was launched in 2018, will empower consumers.

Below are some of the highlights of the Philippine energy sector's plans and programmes:

Increase Renewable Energy Installed Capacity to at least 20,000 MW

The passage of Republic Act No. 9513, or the Renewable Energy Act of 2008, supported the policy and programme framework for renewables. On 14 June 2011, the government unveiled the National Renewable Energy Program (NREP) or the "Green Energy Roadmap", anchored on the DOE's Energy Reform Agenda, which aims to ensure greater energy supply security for the country. Under the updated roadmap, which guides efforts in realising the market penetration targets of each renewable energy resource in the country, the target of 15,304 megawatt (MW) installed renewables capacity by 2030 is envisioned to be increased to at least 20,000 MW by 2040. To achieve this, the NREP also provides for policy mechanisms to support the

Renewable Energy Act. These policy mechanisms include: Renewable Portfolio Standards (RPS), Feed-in Tariff (FIT), Green Energy Option Program and Net-Metering for Renewable Energy.

The RPS sets the minimum percentage of generation from eligible renewables resources, provided by the generators, distribution utilities and electric suppliers. In 2017, the on-grid target RPS was set to 35% in MWh by 2030 to 2040. At the end of 2017, renewables resources reached a total of 7,080 MW installed capacity, or about 31% of the total.

On the other hand, the FIT provides guaranteed payments on a fixed rate per kWh for renewables generation, excluding for own use. The Energy Regulatory Commission (ERC) has approved FIT rates that will apply to renewables resources, particularly run-of-river hydro, biomass, wind, and solar. Effective October 2015, the approved FIT rates for biomass, hydropower, solar and wind are PhP[4] 6.63, PhP5.90, PhP8.69, PhP7.40 per kWh, respectively. Currently, there is no FIT rate for ocean energy since the technology is still in the research and development stage. In 2019, the ERC approved a lower FIT-All rate of PhP0.0495 per kWh charged to all on-grid consumers supplied with electricity[5].

Biofuel Blending as Mandated by the "Biofuels Act of 2006"

The DOE is aggressively implementing Republic Act No. 9367 or the Biofuels Act of 2006. The law intends to tap the country's indigenous agricultural resources as potential feedstock for biofuel to contribute to energy security, as well as to augment farmers' incomes, generate rural employment, and reduce greenhouse gas (GHG) emissions.

The mandatory 1% biodiesel blend in all diesel fuel sold in the country since May 2007 was increased to 2% in February 2009 on a voluntary basis. On the other hand, the country now enjoys an accelerated use of E10 (10%) bioethanol blend, as supplied by most of the gasoline retailers. The DOE, together with the National Biofuels Board, is revisiting/re-evaluating the blending requirement, with due consideration on the availability feedstock and to facilitate the scheduled blending of biofuels in compliance with the Biofuels Law.

[4] Philippine peso

[5] ERC Approves a Lower Feed-in Tariff Allowance, Energy Regulatory Commission (https://www.erc.gov.ph/ContentPage/61912) (accessed 1 August 2020).

Intensification of Electricity Access through Household Electrification

The provision of electricity is now focused on households throughout the country. Household electrification levels reached 88.3% in 2017. There were about 20.9 million electrified households out of the 23.7 million total in 2017 based on the Distribution Development Plan 2018-2027 by the Distribution Utilities. On a grid level, in 2017, Luzon has the highest electrification at 94.8%, with Visayas at 88.2% and Mindanao at 70.8%. Aside from these, there are also various grid and off-grid programs that also aim to contribute to 100% electrification of all targeted and identified households accessible to the grid by 2022. These are embodied in the Household Electrification Development Plan.

1.3 Energy Supply-Demand Situation

In terms of demand, the country's total final energy consumption in 2017 was recorded at 36.7 million tonnes of oil equivalent (Mtoe). Amongst the fuels, oil constituted the largest share at 48.5% (17.8 Mtoe), which can be attributed to transport sector fuel demand. Others (primarily biomass, which is largely consumed in residential use), and electricity closely followed with shares of 24.5% (9.0 Mtoe) and 18.2% (6.7 Mtoe), respectively.

On a per sector basis, transport has been the largest single-sector user of energy, accounting for 32.3% of the total demand, while industry is at 21.6%. Others collectively (most prominently residential, as well as commercial, and agriculture, forestry and fishery(AFF) make up 41.7%).

The country's total primary energy supply[6] in 2017 reached 55.9 Mtoe. Oil continued to be the major source of supply which accounted for 33.5% in the total energy supply, followed by coal and geothermal, with 26.2% and 15.8%, respectively. Total indigenous energy production reached 29.5 Mtoe, bringing energy self-sufficiency to 50.9% during the period (Figure 14-2).

Meanwhile, the country's total electricity generation in 2017 reached 94.4 TWh. Coal-fired power plants remained as the major source for power generation, with total installed capacity of 8,049 MW during the period. Coal contributed 49.6%, or 46.8 TWh, to the total power generation mix of the country. Meanwhile, natural gas-fired power plants accounted for 21.8%, or 20.5 TWh in the power mix. The country has five existing natural gas power plants, with a combined installed capacity of 2,862 MW. On the other hand, the combined share of renewables in the total power generation mix was registered at 24.6% during the period.

[6] Based on the 2017 Philippine Energy Balance Table

2. Modelling Assumptions

Five scenarios were developed to assess the energy savings potential of the country aside from the Business-as-Usual (BAU) scenario. The BAU scenario serves as the reference case in the projection of the energy demand and carbon dioxide (CO2) emissions of the energy sector. The BAU incorporates the energy sector's existing policies, plans and programmes, which are being implemented and pursued within the forecast period.

The Alternative Policy Scenario (APS) 1 assessed possible policy interventions in terms of efficient and environment-friendly technologies for future energy use, together with corresponding CO2 emissions reductions. The scenario assumed that a 20% energy savings will be achieved in 2050 through a range of measures, including intensified energy utilisation management programs in the commercial and industrial sectors, power plants and distribution utilities, as well as the continuous use of alternative fuels and technologies. The Information and Education Campaign (IEC) Program of the DOE will also contribute to the energy saving goals of the country. In the residential and commercial sectors, energy labelling and ratings on major electrical appliances will help consumers to choose more efficient electrical products.

The APS2 assessed the effect of a more efficient thermal power generation, particularly for future coal and natural gas power plant technologies.

The APS3 measured the result of the combined contribution of renewables and alternative fuels to the total energy supply. As part of the government's initiatives to ensure security of energy supply and, at the same time, to protect the environment and promote green technology, the targets set under the NREP were incorporated in the model to test its impact in the total primary energy supply. The NREP lays down the foundation for developing the country's RE resources, stimulating investments, developing technologies and providing the impetus for national and local renewable utilisation. It sets out indicative interim targets for the delivery of renewables within the timeframe. In this scenario, the aggregated 20 gigawatt (GW) renewables capacity is assumed in 2050.

Under APS4, or the Nuclear Scenario, a 1,200 MW capacity was considered to determine the impact of possible long-term nuclear option in the country. The scenario is considered as a diversification measure that will aid energy security. Although the country has no firm policy direction on nuclear energy, the President of the Philippines has issued Executive Order (EO) No. 116, which directs the conduct of study for the adoption of national position on Nuclear

Energy Program in the Philippines. Lastly, the APS5 will focus on the combined effects of APS1, APS2, APS3 and APS4.

In the model, the gross domestic product (GDP) is projected to grow at an annual rate of around 4.9% for the period 2017 to 2050. The population of the country is expected to grow at the rate of 1.4% yearly for the same period. Population growth is based on the adjusted 2000 Census-based medium population projections using the results of the 2010 census of population.

3. Outlook Results

3.1. Business as Usual Scenario

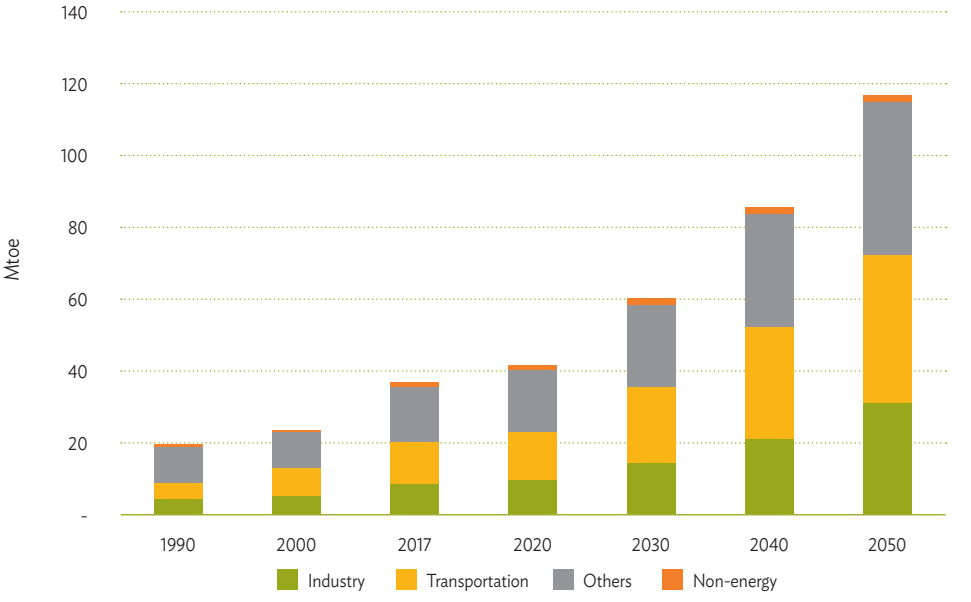
3.1.1 Total final energy consumption

3.1.1.1 Total final energy consumption by sector

The Philippines' final energy consumption grew from 19.0 Mtoe in 1990 to 36.7 Mtoe in 2017 at an average annual growth rate of about 2.5%. During this period, energy demand in the transport sector grew at an average annual rate of 3.5%, while the industry sector grew at 2.4%. Residential, commercial and AFF (others) initially had the biggest share at 51.6% in 1990 and declined to 41.7% share in the total final energy consumption mix due to its sluggish growth of 1.7% average per year from 1990-2017.

Meanwhile, final energy consumption is expected to grow at an annual average rate of 3.6% in the BAU scenario over the planning period 2017 to 2050. By the end of 2050, the combined demand of the other sectors will contribute a substantial share of 36.6% in the total final energy consumption, albeit with a slightly slower growth rate of 3.1% average per year. This can be attributed to the continuous expansion of the commercial sector as services and the business environment improves, and to the government's modernisation programs in the agriculture sector. However, as a single sector, transport will remain the most energy-intensive, taking up a 32.3% share in 2017 and growing at an average rate of 3.9% per year. Industry will grow vigorously at an average annual growth rate of 4.1% as the country's economy boosts government programs in the manufacturing sector. (Figures 14-1 and 14-2).

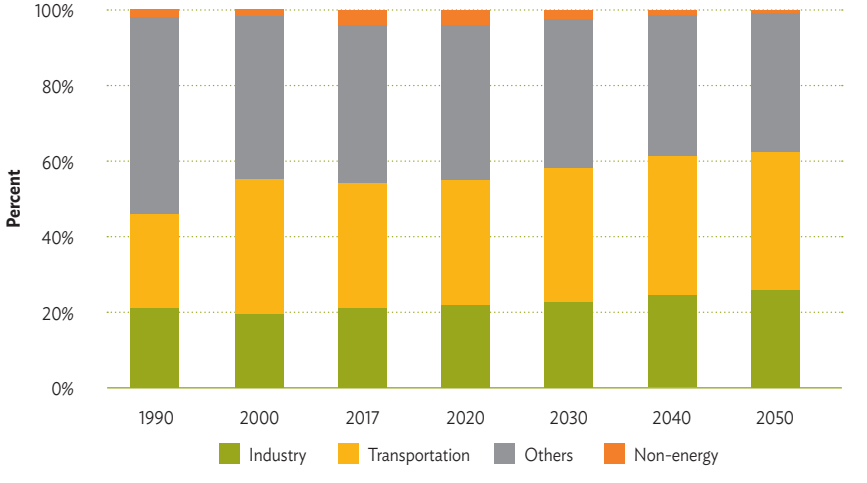
Figure 14.1. Total Final Energy Consumption by Sector, BAU



BAU = business as usual.

Source: Author's calculation.

Figure 14.2. Share of Total Final Energy Consumption, BAU



BAU = business as usual.

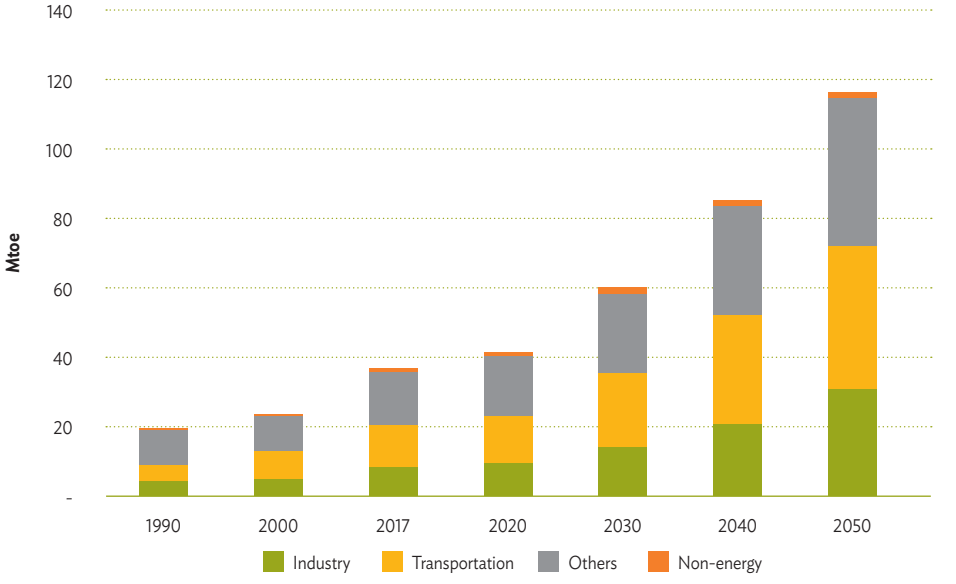
Source: Author's calculation.

3.1.1.2 Total final energy consumption by fuel

Petroleum products remain the most consumed fuel throughout the planning period due to the demand in the transport sector. Oil demand share of total final energy consumption takes about 48.5% in 2017, though it slightly decreases to a 45.1% share in 2050. Electricity is the second-most consumed energy source after oil and initially started with a share of 18.2% in 2017 in the demand mix and will grow to 33.2% in 2050. Electricity demand will quintuple from 6.7 Mtoe in 2017 to 38.6 Mtoe in 2050 due to the increased demand from all sectors, including: 1) expansion of the mass and light railway systems in the transport sector; 2) increase in household consumption due to fuel switching between electricity and LPG for cooking; 3) upsurge of the processes in the industry sector due to the resurgence of the manufacturing sub-sector; and 4) boost in activity in the modernisation of the agricultural sector.

Coal, which is largely used in the industry sector, is seen as having an upward trend, with demand quadrupling from 3.2 Mtoe in 2017 to 14.5 Mtoe in 2050 as industry requirements in cement and other energy-intensive manufacturing subsectors increase. On the other hand, the demand for other fuels such as biomass and other renewables is projected to have a minimal growth of 0.5% per year (Figures 14-3 and 4-4).

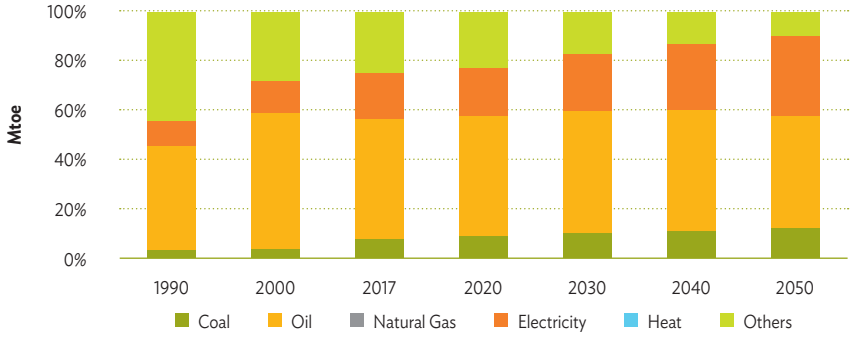
Figure 14.3. Total Final Energy Consumption by Fuel, BAU



BAU = business as usual.

Source: Author's calculation.

Figure 14.4. Share of Total Final Energy Consumption, BAU



BAU = business as usual.

Source: Author's calculation.

3.1.2 Total primary energy supply by fuel

Primary energy supply in the Philippines grew from 28.7 Mtoe in 1990 to 55.9 Mtoe in 2017 at an annual average rate of 2.5%. Amongst the major energy sources, coal grew the fastest, at 8.7% per year, as the country embarked on an aggressive investment in baseload power plants to stabilise the country's electricity supply. Geothermal, oil and hydro each registered average increments of 2.4%, 2% and 1.7%, respectively. On the other hand, primary energy supply of other fuels went down by 0.5% per year.

For the planning period 2017 to 2050, the country's primary energy supply is expected to expand three folds from its 2017 level of 55.9 Mtoe to 176.6 Mtoe in 2050 at an average growth rate of 3.5% per year. Consumption for all major energy sources are projected to rise with coal growing at 4.7% per year. Coal will account for the largest share in the total energy supply of the country from 26.2% in 2017 to 38.4% in 2050. This is to provide for the growing demand of the economic sectors particularly in the industry sub-sectors.

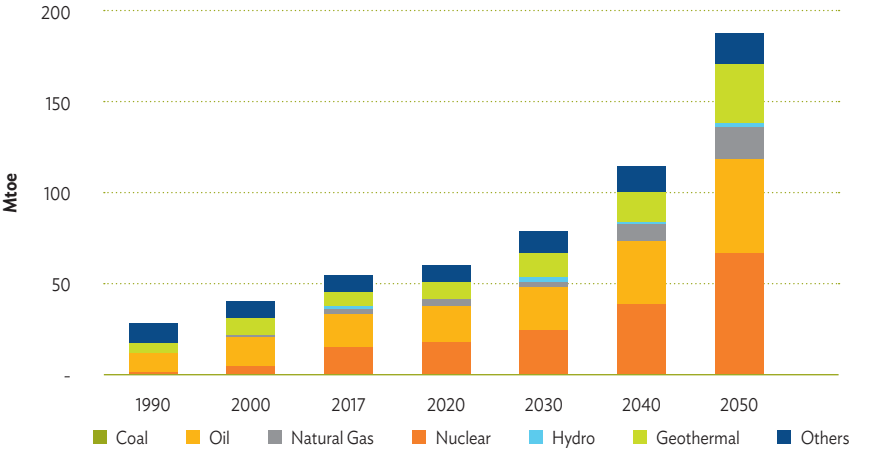
Oil will remain as one of the country's major energy requirements. However, it will display a downward trend in its overall average annual growth rate during the planning period, averaging only 3.3% growth for the period in review. The share of oil in the energy supply will decrease from 33.5% in 2017 to 30.6% in 2050 due to the penetration of alternative fuels such as biofuels and electricity and improvement in efficiencies and mileage in the transport sector.

Natural gas will expand at an annual average growth rate of 5.7% and consumption will reach 20.5 Mtoe, which will be mainly used for power generation. This is in line with the

ambitious government programme being pushed for the development of an LNG hub in the country to secure future supplies of natural gas.

On the other hand, major renewables supplies from geothermal and hydro will grow at a slower pace at an average rate of 1.9% and 2.5%, respectively, for the planning period. Other fuels' (such as biomass, solar, wind and ocean technologies) aggregated consumption will be at 9% of total consumption in 2050 and its average annual growth rate proceeds at a snail's pace of 1.5% across the planning period (Figures 14-5 and 14-6).

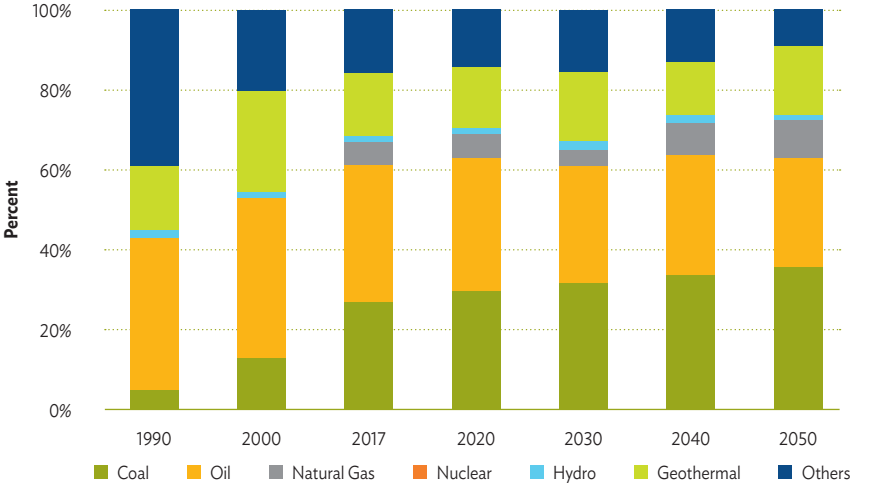
Figure 14.5. Total Primary Energy Supply by Energy, BAU



BAU = business as usual.

Source: Author's calculation.

Figure 14.6. Share of Total Primary Energy Supply by Energy, BAU



BAU = business as usual.

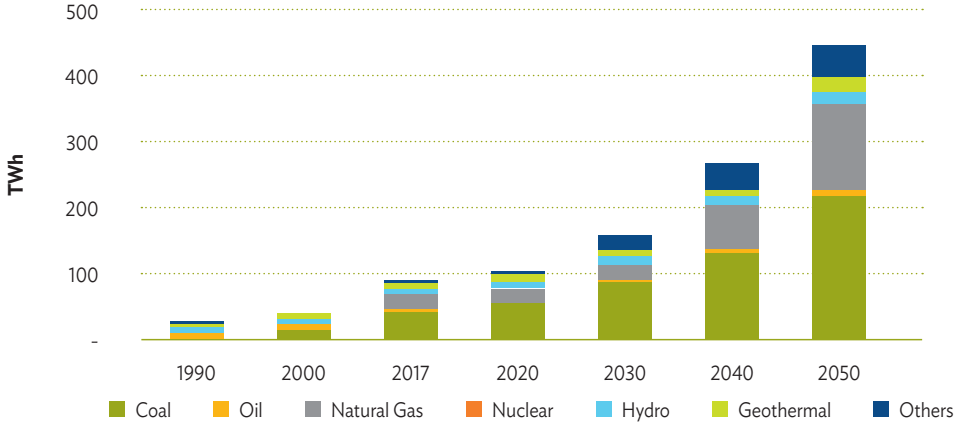
Source: Author's calculation.

3.1.3 Power generation

Total power generation in 2017 reached 94.4 TWh, more than 3.5 times the country's level of 26.3 TWh in 1990. With the committed and indicative capacities based on the Power Development Plan, the total power generation output is projected to rise by 4.8% yearly and reach 448.9 TWh by 2050. Coal will be country's major source of power, accounting for about 49.6% in 2017, peaking at 55.6% share in 2030, and declining to 49.2% in 2050. Power generation from coal will grow 4.7 times its 2017 level of 46.8 TWh and reach 221 TWh at the end of the planning period. Natural gas-fired power plants are also expected to follow an upward trend like coal, but will grow faster at 5.8% average per year, with generation levels rising more than six times its 2017 level of 20.5 TWh to 130.6 TWh in 2050.

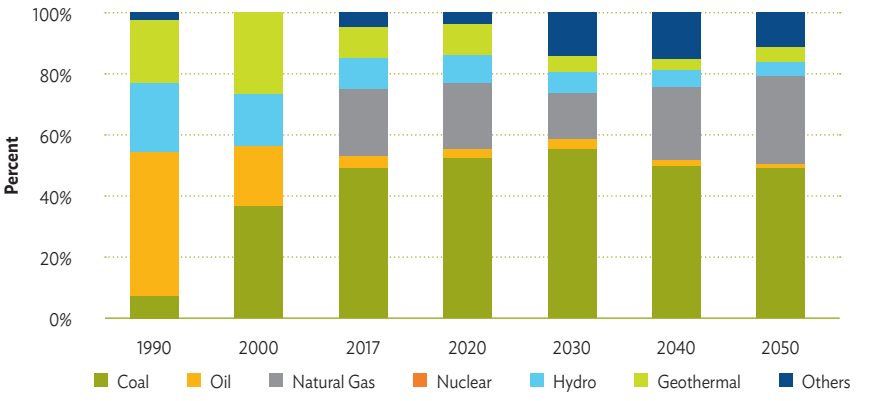
Major renewables sources, such as hydro and geothermal, are expected to contribute an aggregate share of 9.1% (4.3% share for geothermal and 4.8% share for hydro) to the country's generation mix in 2050, as output will grow at an average annual rate of 1.9 and 2.5%, respectively. Generation from other fuels (solar, wind and biomass) is expected to increase at an average annual rate of 8.5%. Meanwhile, oil has an average annual growth of 1.9% during the planning period and by 2050 is anticipated to only account for 1.6% of total power generation. (Figures 14-7 and 14-8).

Figure 14.7. Power Generation by Fuels, BAU



BAU = business as usual.
Source: Author's calculation.

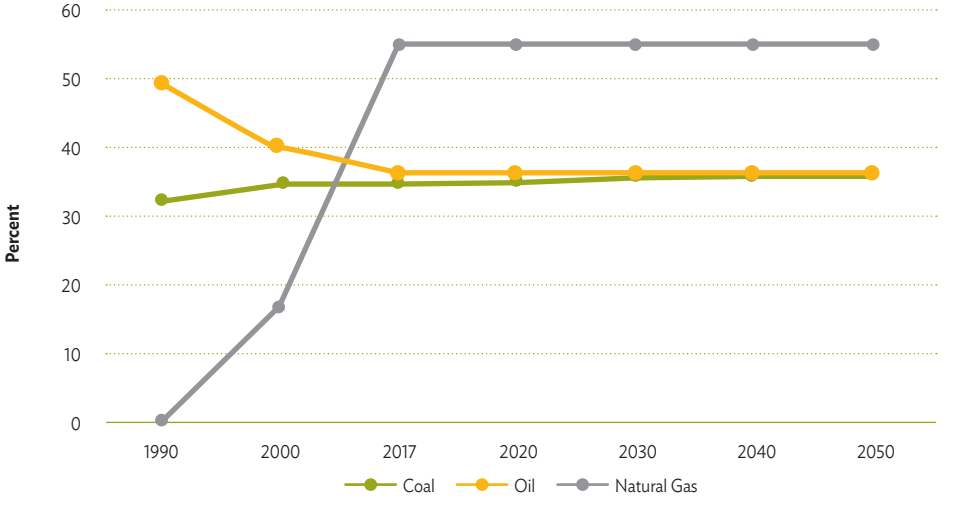
Figure 14.8. Share of Power Generation by Fuels, BAU



BAU = business as usual.

Source: Author's calculation.

Figure 14.9. Thermal Efficiency, BAU



Source: Author's calculation.

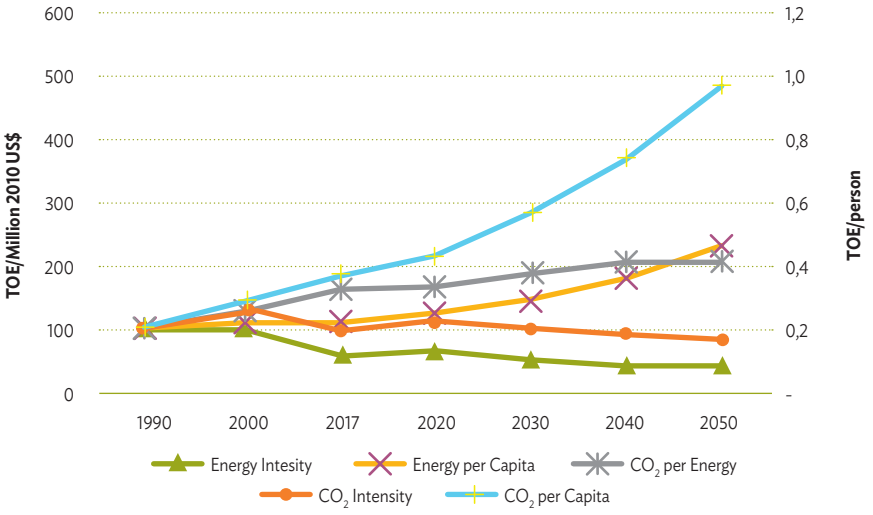
The thermal efficiencies of coal, oil, and natural gas under the BAU are projected to be fairly constant for the whole planning period. Coal thermal efficiency fluctuates between 35% and 35.9%, while oil and natural gas efficiencies are set at around 36% and 55%, respectively, for the entire planning period (Figure 14-9).

3.1.4 Energy indicators

Under the BAU, the country's average annual energy intensity decreases at 1.3% for the period 2017 to 2050. Energy intensity is the ratio of total primary energy over GDP. The significant

reduction of energy intensity is attributable to the government's efforts in promoting energy conservation and efficiency in the different sectors of the economy. Meanwhile, energy per capita has an increasing trend from 0.5 tonnes of oil equivalent (toe)/person in 2017 to 1.1 toe/person in 2050. The increasing trend is due to the improvement on the standard of living and income of the people (Figure 14-10).

Figure 14.10. Energy Intensity, Energy Per Capita and Energy Elasticity



Source: Author's calculation.

3.2. Alternative Policy Scenarios

As mentioned above, the assumptions in the APSs were analysed separately to determine the individual impacts of each assumption in APS1 (energy efficiency), APS2 (thermal efficiency), APS3 (higher renewables), APS4 (contribution of nuclear energy) and APS5 (the combination of all these assumptions).

3.2.1 Total primary energy supply by fuel

Figure 14-11 shows the changes in total primary energy supply in all the scenarios. APS1, which assumes improved efficiency of final energy consumption, is projected to increase at a rate of 3.3% per year as levels reach 163.7 Mtoe by 2050. Compared to the BAU scenario, APS1 has the second-largest energy saving potential next to APS5, compared to other scenarios registering a 7.3% reduction, or 12.9 Mtoe lower. This is attributable to the projected savings from the range of measures that will be implemented in the energy sector, such as intensified energy utilisation management programs in the commercial and industrial

sectors, power plants and distribution utilities, the continuous use of alternative fuels and technologies and other measures that will be developed with the implementation of RA No. 11285, or the Energy Efficiency and Conservation Act.

APS2's total primary energy supply will be lower by 5.1% or 9 Mtoe as compared to the BAU scenario and will reach 167.6 Mtoe in 2050, indicating that improving thermal efficiency alone in fossil fuel-based power plants can lead to notable energy savings.

Under APS3, the total primary energy supply will be at 182.3 Mtoe, which is higher by 5.7 Mtoe as compared to BAU. This is mainly due to the ramp up in utilisation of geothermal, hydropower and other renewables in power generation. Efficiencies of renewables are lower as compared to fossil fuels, resulting to higher fuel input, thus increasing total primary energy supply. During the planning period, geothermal energy will grow at an average rate of 4% per year and will grow from 8.8 Mtoe in 2017 to 31.8 Mtoe in 2050. The aggregate generation output from solar, wind and ocean is expected to increase at an average rate of 10% per year.

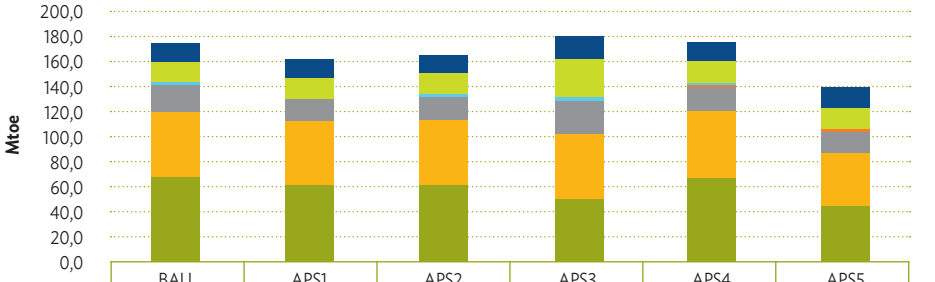
Under APS4, where nuclear energy is assumed to be part of the energy mix, total primary energy supply is expected to be higher by 0.2 Mtoe compared to BAU. This is due to the assumption that nuclear power plants' thermal efficiency is at 33%, lower than the efficiencies of the natural gas and coal power plants at 35%–35.9% and 55%, respectively.

Combining all scenarios, the country's total primary energy supply under the APS5 will grow at an annual average rate of 2.8% and reach 139.8 Mtoe in 2050. The combined effect of APS1 and APS4 is expected to yield the largest reduction at 36.7 Mtoe, which is 20.8% lower than the supply level under the BAU. This indicates the effectiveness of combining various energy assumptions (improved efficiency in the energy demand and thermal power generation, higher contribution of renewables and entry of nuclear in the supply mix) to achieve the feasible level of total primary energy supply by 2050 (Figure 14-11).

3.2.2 Total electricity generation

Figure 14-12 shows the total electricity generation in 2050 in all scenarios. Due to the efficiency measures resulting to lower electricity demand, APS1's total generation output is projected at 359.3 TWh. All fuels registered reduced generation output vis-à-vis the BAU scenario (save for nuclear, which is set at zero in both scenarios). APS1's annual average growth rate will increase by 4.1%. Natural gas is seen to grow the fastest at an average of

Figure 14.11. Total Primary Energy Supply by Energy, BAU and APS, by 2050



	BAU	APS1	APS2	APS3	APS4	APS5
Others	15,9	15,2	15,5	18,3	15,9	15,7
Geothermal	16,5	16,5	16,5	31,8	16,2	16,7
Hydro	1,9	1,6	1,9	2,5	1,8	1,8
Nuclear	-	-	-	-	1,6	1,6
Natural Gas	20,5	15,5	18,8	26,3	19,9	16,1
Oil	54,0	54,0	54,0	54,0	54,0	43,8
Coal	67,8	60,9	60,9	49,5	67,3	44,2

APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

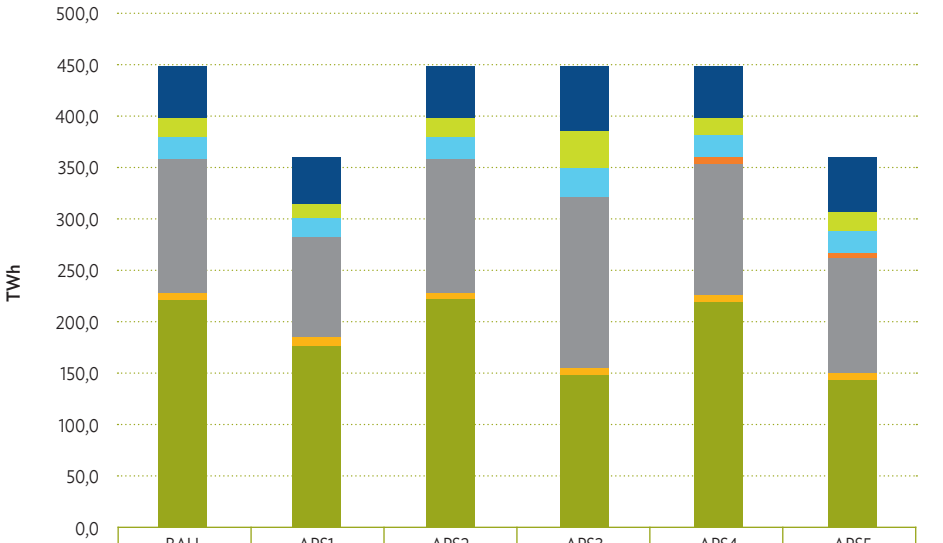
4.9% per year and output reduction at 24.3% as compared to BAU. Due to reduced consumption of electricity, the total fuel input reduced significantly by 21.1% from the BAU level of 75.4 Mtoe.

APS2, APS3 and APS4 yield the same total generation output of 448.9 Mtoe. Under APS2, there is no difference in terms of power generation output as compared with BAU. However, the effect of higher thermal efficiencies of the fossil fuel plants reduced the fuel input by 11.4%. It will only require 46.4 Mtoe of input for coal power generation in APS2, as compared to 53.3 Mtoe in BAU, to produce the same power generation output of 221 TWh as coal capacities process efficiency increases from 35% to 41%.

APS3, on the other hand, will have higher generation share from natural gas and renewables technologies. Amongst the renewables technologies, geothermal will significantly increase by 92%, as compared to BAU, and will have an annual average growth rate of 4% as the government continues to harness the geothermal potential in the country.

While APS5's total generation output is equal to that of APS1 for 2050 at 359.3 TWh, the aggregate level of power output from coal and oil from APS1 to APS5 will decline by 18%, or from 183.5 TWh to 150.1 TWh.

Figure 14.12. Total Primary Energy Supply by Energy, BAU and APS, by 2050



	BAU	APS1	APS2	APS3	APS4	APS5
Others	49,3	45,8	49,3	62,1	49,2	51,1
Geothermal	19,2	12,7	19,2	37,0	18,9	19,4
Hydro	21,6	18,5	21,6	28,6	21,5	21,0
Nuclear	-	-	-	-	6,2	6,0
Natural Gas	130,6	98,8	130,6	167,6	127,1	111,6
Oil	7,1	6,9	7,1	7,0	7,1	6,9
Coal	221,0	176,6	221,0	146,6	219,0	143,3

Coal Oil Natural Gas Nuclear Hydro Geothermal Others

APS = Alternative Policy Scenario, BAU = business as usual.

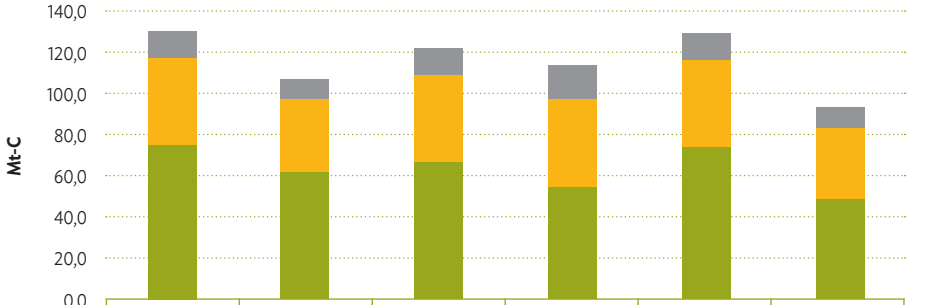
Source: Author's calculation.

3.2.3 Total CO2 emissions

APS1 (or the energy efficiency scenario) has the second-largest reduction of 23.4 million metric tonnes of carbon (Mt-C), or 17.9% lower than the BAU level of 130.5 Mt-C for 2050 and will generate 107.1 Mt-C in total. The decrease in CO2 indicates that the energy savings goals, action plans and policies in the promotion of energy efficiency and conservation programme will have a substantial impact in reducing emissions (Figure 14-13).

The improvement of thermal efficiency under APS2 will reduce the total CO2 emissions by 8.7 Mt-C or 6.7% relative to BAU. On the other hand, a boost in the share of renewables technology under APS3 will lead to a reduction of 16.2 Mt-C or 12.4%. Additional capacity of 1,200 MW from nuclear by 2035 in APS4 will slightly shed off 0.9 Mt-C or 0.7% relative to BAU. Combining all the assumptions in APS1, APS2, APS3 and APS4 will give an aggregate reduction of CO2 emissions from the BAU at 37 Mt-C or 28.4%.

Figure 14.13. CO_2 Emissions by Fuels in 2050, BAU and APS



	BAU	APS1	APS2	APS3	APS4	APS5
Natural Gas	13,1	9,9	12,0	16,8	12,8	10,3
Oil	43,0	34,6	43,0	43,0	43,0	34,6
Coal	74,4	62,5	66,7	54,5	73,8	48,5

APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

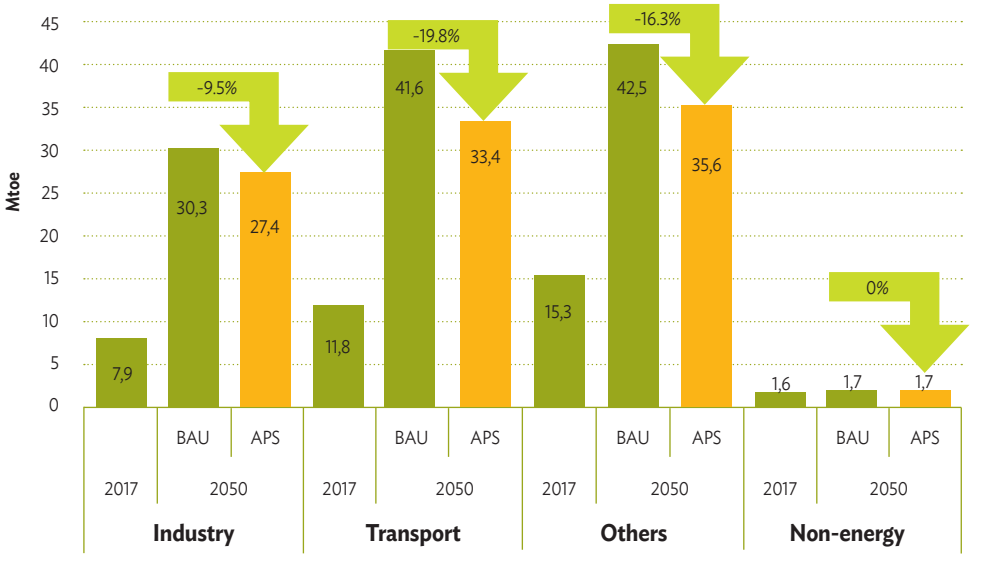
3.2.4 Energy savings potential

Figure 14-10 shows the level of total final energy consumption by sector between BAU and APS5 in 2050. Due to the improved economy-wide energy efficiency under APS5, the total final energy consumption will reduce by 15.5% or from 116.1 Mtoe in BAU to 98.1 Mtoe in APS5. A reduction of 19.8% can be observed from the transport sector, the highest reduction amongst the sectors, due to set higher efficiency standards for vehicles mandated through the passage of the 2019 Energy Efficiency and Conservation Law. It can also be attributed to use of mass transport, as well as improved networks and highways. Energy demand from residential, commercial and AFF (others) at 35.6 Mtoe in APS1 is 16.3% lower than its BAU level of 42.5 Mtoe. This can be attributed to an aggressive energy labelling programme, energy efficiency solutions for commercial purposes and infrastructures and technology improvement. Lastly, the industry sector will contribute 9.5% reduction in its utilisation from 30.3 Mtoe in BAU down to 27.4 Mtoe in APS5 due to advancement in technologies and efficient industry systems and practices.

Figure 14-15 illustrates the comparison between the BAU and APS5 total primary energy supply by fuel in 2050. The impact of improved efficiency is evident in all the fossil fuel-based sources. Coal shows a significant decline in consumption from 67.8 Mtoe in BAU to 44.2 Mtoe in APS5, the largest absolute and relative reduction of (34.8%) of any single source. This is followed by natural gas and oil, which declined substantially at 21.6% and

18.9%, respectively. This is mainly due to improved thermal efficiencies of the fossil fuel-based power plants. On the other hand, consumption of non-fossil sources increases by 4.3% compared to BAU.

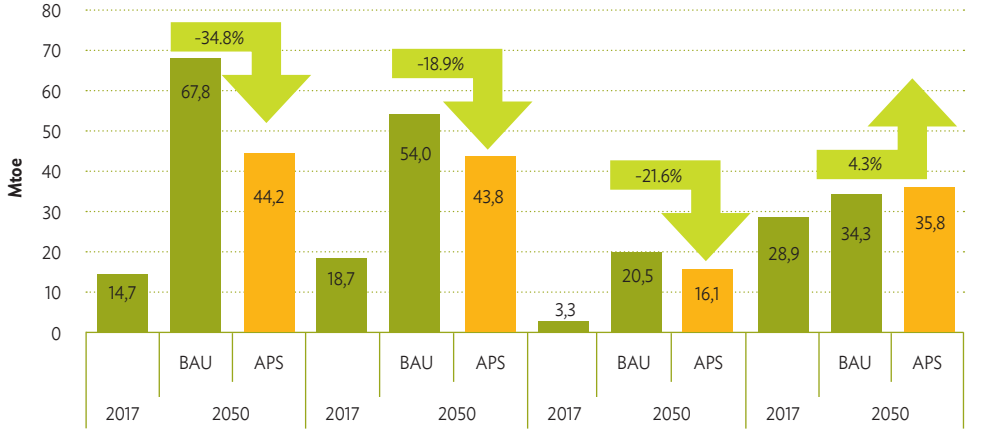
Figure 14.14. Final Energy Consumption by Sector in 2050, BAU vs APS



APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

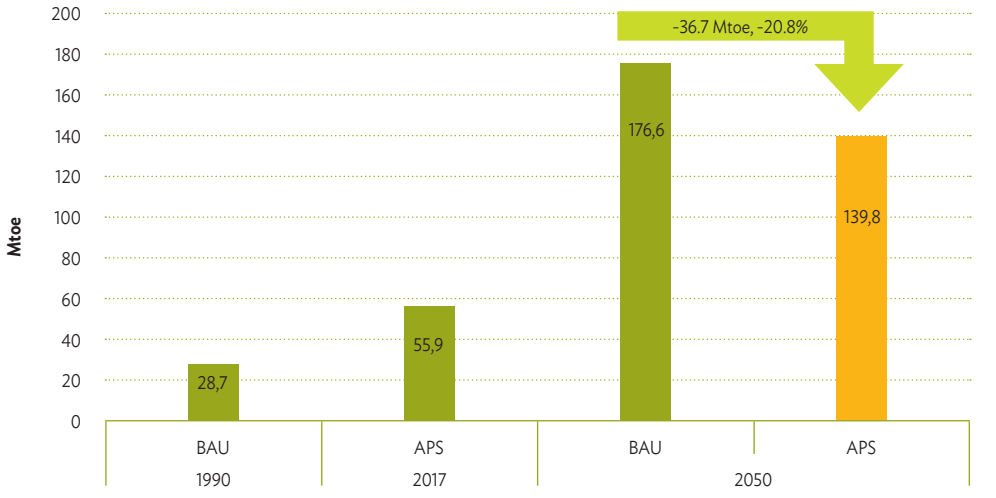
Figure 14.15. Total Primary Energy Supply by Fuel in 2050, BAU vs APS



APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

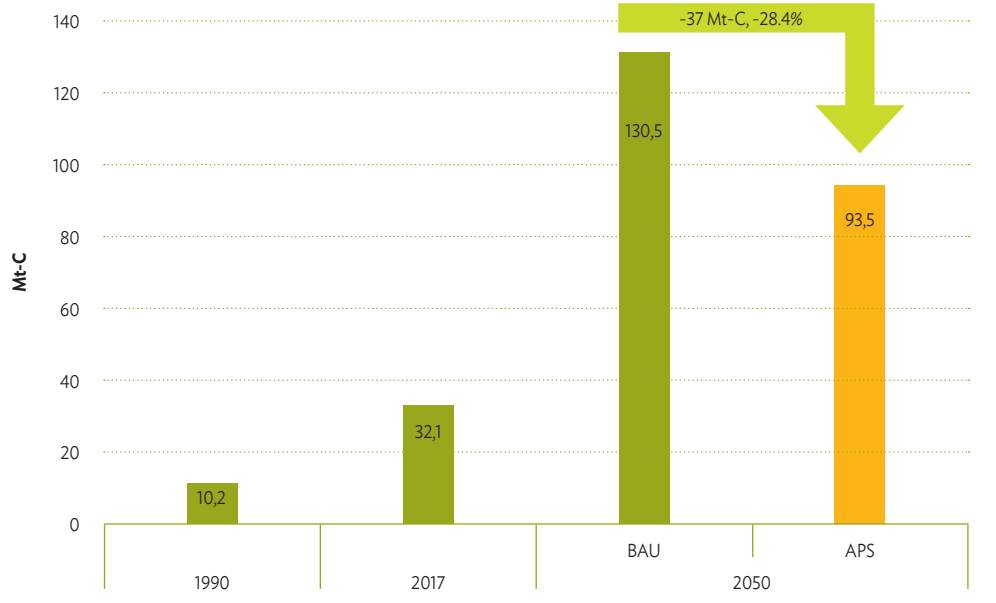
Figure 14.16. Total Primary Energy Supply in 2050, BAU vs APS



APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

Figure 14.17. CO_2 Emissions in 2050, BAU vs APS



APS = Alternative Policy Scenario, BAU = business as usual.

Source: Author's calculation.

Figure 14-16 shows the comparison between the total primary energy supply between BAU and APS5 in 2050. With the combination of energy efficiency measures, the primary energy supply in total will have a reduction of about 36.7 Mtoe or 20.8% from the BAU level of 176.6 Mtoe.

Figure 14-17 shows the comparison of CO2 emissions between BAU and APS5 in 2050. The implication of energy savings in the total primary energy supply resulted to 37 Mt-C or 28.4% reduction in the CO2 emissions in APS5 compared to BAU level. This will help the country reduce its CO2 emissions in general and achieve its Nationally Determined Contribution target.

4. Implications and Policy Recommendations

Overall, the result of this study implies the significant energy savings potential that the Philippines will achieve based on the given assumptions. Notable in the results is the energy savings potential through the implementation of energy efficiency and conservation standards and measures. Fortunately, the Philippine energy sector has realised the importance of having a policy that would drive the economic sectors toward a more prudent utilisation of energy resources and higher energy efficiency without sacrificing the economic needs reflected through the energy demand in the future. Based on the projections in BAU, the final energy consumption is expected to triple from the 2017 level of 36.7 Mtoe to 116.1 Mtoe by 2050. This shows the large energy requirement of a developing country such as the Philippines, for which the current administration has set an aspirational goal for the Philippine economy as outlined in the ***AmBisyon Natin 2040***. On the demand side, oil will remain as the biggest share in the final energy consumption, or almost half of the demand mix at the end of the planning period. Nonetheless, demand for oil will yield higher energy potential savings with the implementation of the energy efficiency and conservation programme and alternative fuel and technology development. The results of the model indicate that the share of oil in the total demand is at a range between 43% to 45.1% across different scenarios.

One policy recommendation is for the government to focus on the promotion of alternative fuels in the transport sector to substitute partly and directly for the use of oil in the sector, with the extended implementation of alternative fuels in the transport programme. However, the challenges in promoting alternative fuels must be addressed accordingly for a successful penetration in the market. While the government has passed a law on energy efficiency and conservation, the target for electric vehicle penetration should be decided and supporting policies for charging stations must be decided as well. Energy demand is also affected by consumer behaviour. **The government should intensify its promotion of energy efficiency and conservation measures with specific targets and strategy.**

With an expected growth in the energy requirement, the energy sector should lay its

energy supply plan to meet the growing energy needs of the country. The study shows the optimal energy mix that can be adopted given the different APS scenarios. For the case of the Philippines, coal will remain as a major power source due to its availability and more economical cost of production compared to other technologies. In fact, more than 70% of the committed capacities in the short term to medium term will come from coal power projects.

With this, **a recommendation is to improve the thermal efficiencies of fossil fuel-based plants, specifically for coal power plants.** The results of APS2 show that improvement of thermal efficiency of coal power plants will already give an energy savings potential of about 11.4% reduction in terms of fuel input compared to the BAU scenario. Further reduction can also be met in the improvement of thermal efficiencies of natural gas and oil power plants. Moreover, this may have substantial effect in the CO2 emissions reduction. APS2 shows a reduction of 8.7 Mt-C, or about 6.7%, just by improving the thermal efficiency of power plants. On the other hand, investments and upfront costs may be high in acquiring power plants with high thermal efficiency. However, the long-term effect on the cost of power due to lower production requirements is something to be further investigated to consider adopting such a policy. Nonetheless, the foreseeable impact can be seen in terms of energy security in general, as this will at least reduce importation requirements for coal. However, a policy challenge is that the power sector is a deregulated industry and driven by private sector investments. The government may need to think of a policy solution to drive investments in highly efficient technologies in the future.

The Philippines government has been dedicated to the implementation of the Renewable Energy Act of 2008 to further increase and enhance the utilisation of indigenous, clean and efficient alternative fuels through the development of indigenous energy such as geothermal, hydro, solar, wind, biomass, and other emerging renewables technology as a strategy for energy security through higher dependence on indigenous resources. The renewables policy mechanisms such as FIT, RPS for on-grid and off-grid, the renewables market, the Green Energy Option Program, as well as other future policy mechanisms, will ensure the share of renewables in the power generation mix.

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