CHAPTER 14

Philippines Country Report

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1. Background

1.1 Socio-Economic

The Republic of the Philippines (the Philippines) is an archipelagic country in Southeast Asia. It comprises 7,641 islands. It is in the western Pacific Ocean and composed of three main geographical archipelago or divisions: Luzon, Visayas, and Mindanao. The country's capital, the National Capital Region (NCR) – commonly known as Metro Manila or Manila – is in Luzon. In 2019, the country's economic output grew by 6.1%, this is 0.2% lower than the 2018 level of 6.3%. The main drivers of growth for the fourth quarter (Q4) of 2019 were trade and repair of motor vehicles, motorcycles, personal and household goods; manufacturing; and construction.[1] Services accounted for 60.4% of the total gross domestic product (GDP). The industrial sector accounted for 30.4%. Agriculture, forestry, and fishing accounted 9.2% of the total GDP. Regionally, the NCR registered the largest share in the economic output at 32.1%.

Amongst the major economic sectors, services posted the fastest growth in Q4 2019 with 7.9% while industry grew by 5.4%. Agriculture, hunting, forestry, and fishing registered a growth of 1.5%.

The country's population was projected to reach 108.7 million by the end of 2019, while the GDP growth rate was 4.8% and final consumption expenditure grew by 3.9% in 2019.

1.2. Policy

The economic growth of the country heavily relies on its energy sector, which is why the Philippine Department of Energy (DOE) places great emphasis on consumer-oriented policies, reliable energy supply, and environmental sustainability. During the Duterte Administration, the DOE set forth a set of strategic directions and energy agenda aimed to attain the development goals as envisioned in the *Ambisyon* 2040, the blueprint of a long-term, collective vision and aspirations of Filipino people. These goals are supported by national economic strategies that aim to create opportunities for inclusive growth.

The DOE has established eight "Energy Sector Strategic Directions": (1) ensure energy security; (2) expand of energy access; (3) promote of a low carbon future; (4) strengthen of partnership and collaboration between private sector and government agencies on energy-related issues; (5) implement, monitor, and integrate sector and technology 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.

[1] Gross domestic product posts 6.4% growth in the fourth quarter of 2019. Philippine Statistics Authority, https://psa.gov.ph/content/gdp. Accessed on 31 August 2022.

The Philippine Energy Plan (PEP) 2020–2040 aims to attain a clean energy future that is sustainable and energy resilient. The direction set under the recent PEP includes the aggressive Renewable Energy (RE) and Energy Efficiency and Conservation (EEC) institutionalisation programmes; the moratorium on new coal power projects; a mechanism allowing foreign ownership on large-scale geothermal projects under financial and technical assistance agreement (FTAA); the resumption of indigenous oil and gas exploration; the introduction of liquified natural gas (LNG) portfolio; establishment of strategic petroleum reserves; and exploration of hydrogen's potential. The PEP policies aim to unify the planned transition and transformation under its Clean Energy Scenario (CES). They encompass ambitious plans, strategies, and benchmarks for renewable energy, natural gas, alternative fuels, and energy-efficient technologies.

The following policies represent important achievements aligned with the strategic directives:

- In 2019, President Rodrigo R. Duterte signed Executive Order (EO) No. 30 to create an Energy Investment and Coordinating Council (EICC) with the priority task of streamlining the permitting and approval procedures for Energy Projects deemed of "National Significance". This was accomplished by harmonising rules and regulations of all government agencies involved with obtaining permits and regulatory approvals.
- Passage of RA No. 11234 – or the Energy Virtual One-Stop Shop (EVOSS) Act – signed 08 March 2019. The EVOSS is an online system that allows the coordinated submission and synchronous processing of all required data and information. It provides a single decision-making portal for actions on applications for permits and/or certification necessary for, or related to, an application of a proponent for new power generation, transmission, or distribution projects.
- The Philippine Downstream Natural Gas Regulation (PDNGR) was issued in 2019 to establish the rules and regulations that govern the downstream natural gas industry. It encompasses provisions that enable gas-fired power plants to continue operating in the absence of natural gas supply from Malampaya, the country's indigenous natural gas resource. This is in line to transform the country into a regional LNG trading transhipment hub.
- The issuance of Department Circular No. DC2018-01-0001, titled the 'Adoption of Resiliency Planning and Program in the Energy Industry to Mitigate Adverse Effects Brought About by Disasters', has facilitated the mainstreaming of the Resiliency Planning and Program. The policy paves the way for the inclusion of disaster risk and reduction programmes in energy project planning and investments, as well as the adoption of both engineering and non-engineering mechanisms on existing energy infrastructure. These measures ensure continuous delivery of energy services to consumers.
- In 2019, the Energy Efficiency and Conservation Act, or RA No. 11285, was enacted to promote the efficient use of energy in the country. The law seeks to accomplish this goal by establishing policy mechanisms and standards across various sectors.
- R.A. No. 11697, or the Electric Vehicles Industry Development Act (EVIDA), was passed to decrease the transport sector's reliance on imported fuel to safeguard the country's energy security and independence. The law provides a conducive environment for the development of electric vehicles, which includes options for micro mobility as an attractive and feasible mode of transportation, to reduce dependence on fossil fuels.

- The power sector has adopted and integrated pertinent policies, such as the Renewable Portfolio Standard (RPS) for On-Grid Areas. This standard seeks to produce a specific portion of the electricity demand from eligible renewable energy sources to develop indigenous and environment friendly energy sources. The goal is to attain the ambitious target of 35% share in the generation mix by 2030.
- In response to the country's future energy demands, Department of Energy issued Department Order No. DO2016-01-0013 entitled "Creating the Nuclear Energy Program Implementing Organization (NEPIO) in the Department of Energy". The NEPIO is responsible for proposing a national policy on nuclear energy. On July 24, 2020, President Rodrigo R. Duterte issued Executive Order (EO) 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.
- Another milestone for the energy sector is the issuance of EO No. 164, which was signed by President Rodrigo Duterte on 28 February 2022. The EO seeks to adopt a national position on energy that considers economic, political, social, and environmental issues related to nuclear power development.

The power sector implements a 25.0% reserve requirement to meet the peaking requirement of the Luzon, Visayas and Mindanao grid. In addition, efforts to develop and promote indigenous energy, such as renewable energy and hydrocarbon fuels (oil, gas, and coal), and the use of clean and smart technologies, has been on the priority list to augment the country's long-term energy needs.

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

The National Renewable Energy Program 2020–2040

The Renewable Energy Act of 2008, also known as RA No. 9513, supports the policy and programme framework to encourage the use of renewable energy resources and technologies. On 14 June 2011, the Government of the Philippines unveiled the National Renewable Energy Program (NREP), also called the "Green Energy Roadmap," as part of the DOE's Energy Reform Agenda. The NREP outlines the policy and programme framework to promote the use of renewable energy and establish a roadmap to achieve the market penetration targets of each renewable. The updated renewable energy roadmap aims to increase the installed renewable energy capacity target of 15,304 megawatt (MW) by 2030 to at least 20,000 MW by 2040. In June 2022, the 2020–2040 NREP, which was the first update of the NREP was signed. It aligned the renewable energy targets with the country's long-term vision known as the "AmBisyon Natin 2040" and reinforced the on a whole-of-nation approach to achieve the renewable energy goals and leverage its positive socio-economic benefits.

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

The aim of the Biofuels Act of 2006 is to utilise the local agricultural resources of the country as potential raw materials for biofuel production. This aims to support the country's goal of energy security while also augmenting earnings of farmers, generating employment opportunities in rural areas, and reducing greenhouse gas (GHG) emissions.

Since May 2007, a mandatory 1.0% biodiesel blend has been required in all diesel fuel sold in the country. In February 2009, the blending requirement was voluntarily increased to 2.0%. Using E10 (10%) bioethanol blend, which is supplied by most gasoline retailers, has proliferated in the country. The DOE and the National Biofuels Board (NBB) are currently revisiting and reassessing the blending requirement, considering the availability of feedstock, to ensure compliance with the Biofuels Law and facilitate the scheduled blending of biofuels.

Intensification of Electricity Access through Household Electrification

Energy access is a key to poverty alleviation. In the Philippines, providing electricity is now focused on providing electricity at the household level. Starting 2017, the total potential households being adopted for the Total Electrification Program (TEP) is 22,984,971. The data is based on the 2015 Census of Population (POPCEN2015) of the Philippine Statistical Authority (PSA).

As of 2019, household electrification level reached 92.9%, with approximately 23.2 million households having access to electricity.[2] Meanwhile, there were still around 1.6 million households that remained unserved based on data from the distribution utilities during the same year. In terms of grid-level electrification, Luzon had the highest electrification at 97.8%, followed by Visayas at 93.9%, and Mindanao at 80.0% in 2019. Further, there are various grid and off-grid programs in the Household Electrification Development Plan (HEDP) that aim to provide electricity to all targeted and identified households accessible to the grid by 2022, thus contributing to 100% electrification.

1.3. Energy Supply-Demand

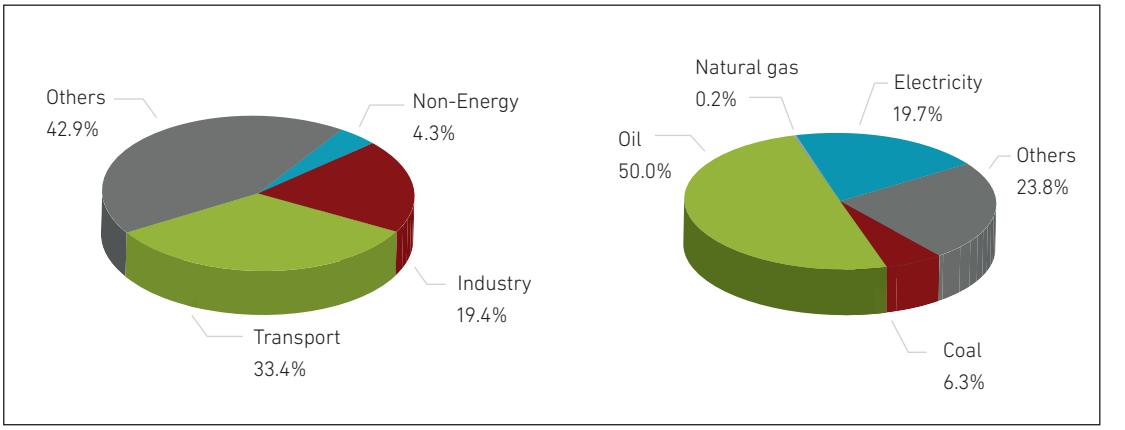
In terms of demand, the country's total final energy consumption in 2019 was recorded at 37.9 million tonnes of oil equivalent (Mtoe). Amongst the fuels, oil comprised the largest share with 50.0% (18.9 Mtoe), which can be attributed to the fuel demand by the transport sector. Electricity, which is consumed in all sectors, accounts for the second most used fuel in the country, accounting for 19.7% (7.5 Mtoe). Other fuels (biomass and biofuels) accounted for 23.8% of the total energy demand. Biomass (7.3 Mtoe), which comprised 80.0% of the other fuels and 19.7% share of the total demand, was mainly consumed in households.

According to Figure 14.1, when energy usage is analysed by sector, transport has been the largest consumer, representing 33.4% of the total demand. Industry, in contrast, accounted for approximately 19.4%. Meanwhile, the combined total of the 'Other' sector – comprised of residential, commercial and agriculture, forestry and fishery (AFF) – accounted for the 42.9% of the total energy demand.

[2] Potential households (HH) minus unserved HH divided by potential HH.

Figure 14.1 Total Final Energy Consumption, Fuel and Sector Shares, 2019

%



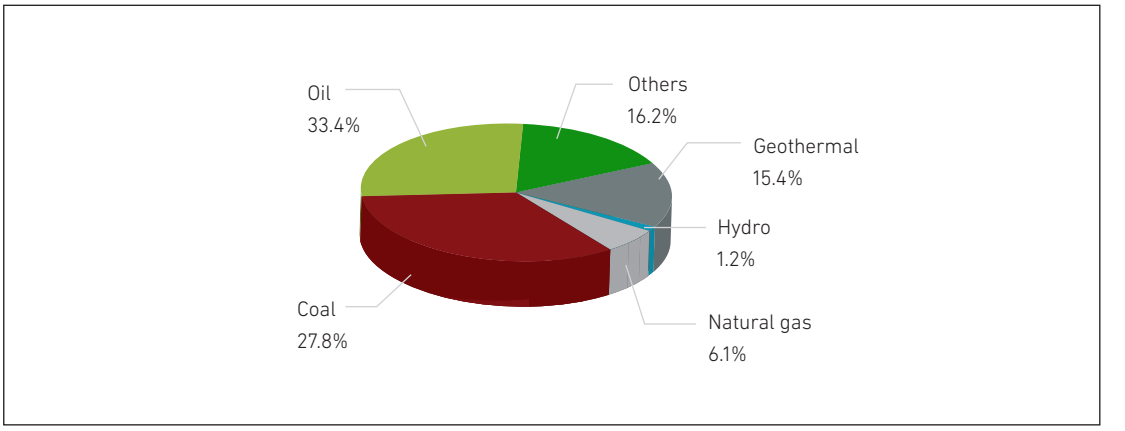
Note: 'Others' includes residential, commercial, and agriculture, forestry and fishery.

Source: Department of Energy, 2019.

The country's total primary energy supply in 2019 reached 60.0 Mtoe (Department of Energy [DOE], 2019). Oil continued to be the major source of supply, which accounted for 33.4% in the total energy supply, followed by coal at 27.8% and geothermal at 15.4%. Meanwhile, the share of indigenous production to the total supply, known as energy self-sufficiency, reached 51.6% (Figure 14.2).

Figure 14.2 Total Primary Energy Supply Mix, Fuel Shares, 2019

%



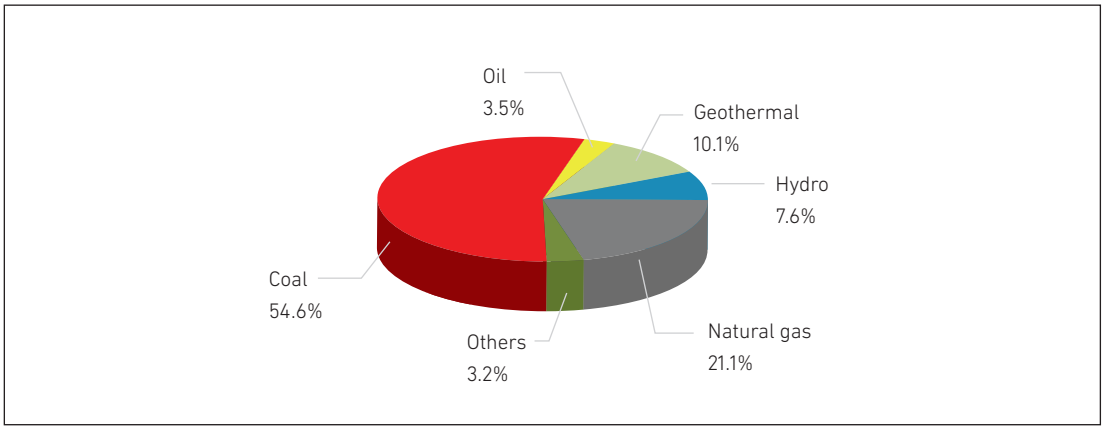
Note: 'Others' include biomass, solar, wind, bioethanol and biodiesel.

Source: Department of Energy, 2019.

Meanwhile, the country's total electricity generation in 2019 reached 106.4 terawatt-hours (TWh). Coal-fired power plants remained as the major source for power generation with total installed capacity of 10,417 MW during the period. Coal contributed 54.6% or 57.9 TWh in the total power generation mix of the country. Meanwhile, natural gas-fired power plants accounted for 21.1% or 23.4 TWh in the power mix. The country's natural gas power plants have a combined installed capacity of 3,286 MW. the combined share of renewable energy in the total power generation mix was registered at 20.8% during the period (Figure 14.3).

Figure 14.3 Total Power Generation Mix, Fuel Shares, 2019

%



Note: 'Others' include biomass, solar and wind.

Source: 2019 EBT, DOE – Philippines.

2. Modelling Assumptions

In energy modelling, gross domestic product (GDP) is the most common parameter for forecasting energy demand growth. In the model, GDP is projected to grow at an annual rate of around 5.3% for 2019–2050. Population is another crucial factor that affects energy demand, and it is expected to grow at a yearly rate of 1.5% during the same period. The population count of 109.0 million is based on the 2020 census of population and housing and was declared official by President Rodrigo Duterte through Proclamation No. 1179 dated 06 July 2021.

Due to the impact of the coronavirus disease (COVID-19) pandemic, the country's GDP experienced a negative growth of 9.5% in 2020 compared to its 2019 level. Meanwhile, an annual GDP growth rate of 6.9% is assumed for 2020–2030, incorporating the government's economic recovery programme to stimulate growth. Following a positive economic outlook, the total GDP is projected to grow at an annual rate of 5.4% for from 2030 to 2040 and 5.0% per year from 2040 to 2050. Table 14.1 provides a breakdown of the GDP growth rate assumptions.

Table 14.1 The Assumptions of GDP Annual Growth Rates, 2019–2050

Parameter	ID Name	Growth Rates (%)				
		2019–2020	2020–2030	2030–2040	2040–2050	2019–2050
GDP (constant 2010 US$)	GDP10	-9.5	6.9	5.4	5.0	5.3

GDP = gross domestic product.

Source: Authors assumption.

Population growth is a significant factor, along with GDP, for energy demand growth. Table 14.2 provides the assumed population growth.

Table 14.2 The assumptions of Population Annual Growth Rates, 2019–2020 and 2020–2050

(%)

Parameter	ID Name	Growth Rates (%)	
		2019–2020	2020–2050
Population	POP	1.4	1.5

Source: Based on author's calculation.

3. Outlook Results

3.1. Business-as-Usual Scenario

The BAU scenario serves as the baseline case for forecasting the energy demand and carbon dioxide (CO_2) emission of the energy sector. It incorporates the energy sector's existing energy policies, plans, and programmes, which are being implemented and will be pursued within the forecast period.

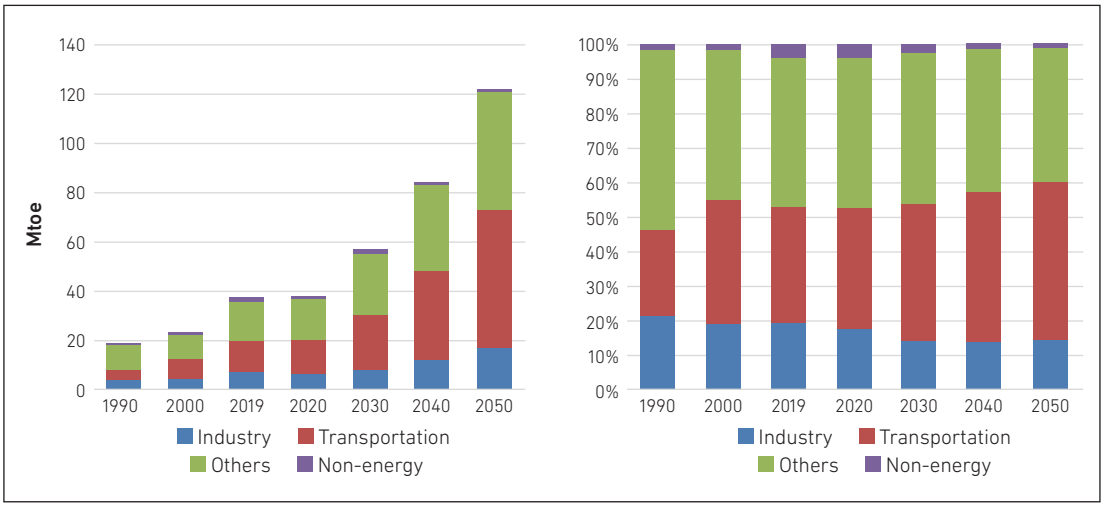
3.1.1. Total Final Energy Demand

a. Total Final Energy Demand by Sector

From 1990 to 2019, the Philippine witnessed a growth in final energy demand from 19.0 Mtoe in 1990 to 37.9 Mtoe, with an average annual growth rate of about 2.4%. During this period, energy demand in the transport sector grew the fastest at an average annual rate of 3.5%, followed by the industry sector at 2.0%. Other sectors – consisting of residential; commercial; and agriculture, forestry and fishery (AFF) – which had the largest share of 51.6% in 1990, saw a decline in their contribution to the total final energy demand mix, dropping to 42.9% due to its slow annual growth rate at an average of 1.8% during 1990–2019.

Over the planning period from 2019 to 2050, the business-as-usual scenario projects an annual average growth rate of 3.8% in final energy demand. By the end of 2050, the transport sector is expected to become the most energy-intensive, increasing its share from 24.6% in 2019 to 45.5%. It is expected to grow at an average rate of 4.9% per year. Industry will grow at an average annual rate of 2.9%, thanks to government initiatives aimed to boost the manufacturing sector. Meanwhile, the combined demand from the other sectors will contribute a substantial share of 38.6% in the total final energy demand by 2050, with an expected average growth rate of 3.1% per year (Figure 14.4). The ongoing growth of the commercial sector, coupled with the enhancement of services and the business environment, as well as the government's modernisation programmes in the agriculture sector, are the reasons behind this trend.

Figure 14.4 Total Final Energy Consumption, Sector, Business-as-Usual, 1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent.

Note: 'Others' include commercial, residential, and agriculture, forestry and fishing.

Source: 1990-2019 data (2019 EBT. DOE – Philippines; 2020-2050 data (Author's calculation).

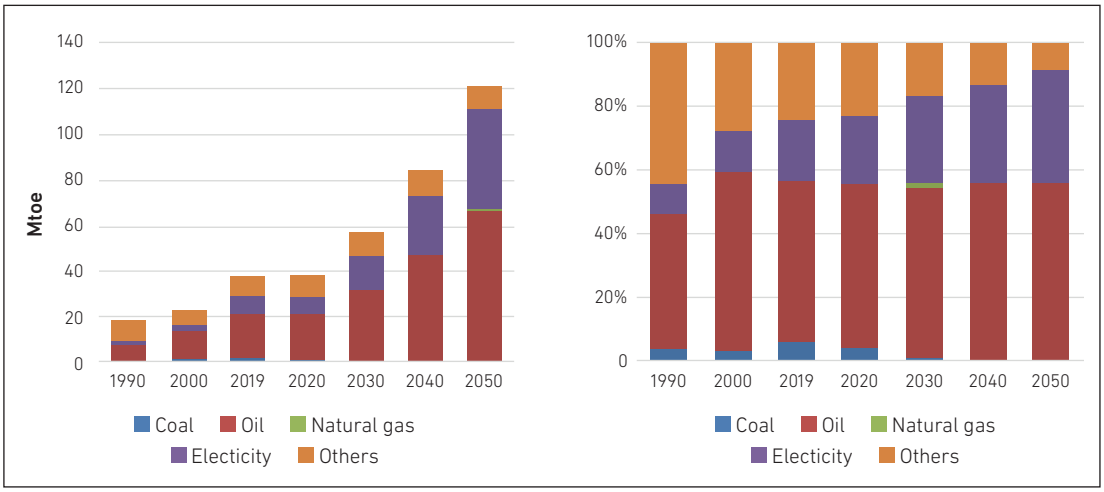
b. Total Final Energy Demand by Fuel

Throughout the planning period, petroleum products remain the most extensively consumed fuel due to their high demand in transport. In 2019, oil demand held about 50.0% of the total demand mix. Projections show a notable surge in oil demand of up to 4.7% by the end of 2030. However, this growth rate slightly decreases to 3.8% by 2050 due to the adoption of energy efficiency and conservation measures, the use of more efficient technology, and fuel switching in the end-use sector.

Electricity, which had a 19.7% share of 19.7% in the demand mix in 2019, is expected to grow at an annual rate of 5.9% and reach 35.8% in 2050. Electricity demand will expand five times from 7.5 Mtoe in 2019 to 43.7 Mtoe in 2050 due to the increased demand from all sectors such as (1) expansion of the mass and light railway systems in the transport sector; (2) households switching from liquified petroleum gas (LPG) to electricity for cooking; (3) a resurgence of the manufacturing sub-sector driving growth in industrial; and (4) increased activity in the modernisation in the agricultural sector.

According to projections, there will be a decrease in demand for coal by 0.4% and other fuels such as biomass and other renewable energy by 0.2%. This decline is due to a shift towards different sources in both the industrial sector, particularly in energy-intensive manufacturing subsectors like cement, as well as in households. Recently, biomass fuels have been increasingly used as an alternate for coal in industry, while LPG and electricity have been adopted as alternate fuels in residential settings (Figure 14.5).

Figure 14.5 Total Final Energy Demand by Fuel, Business-as-Usual, 1990–2050



Mtoe = million tonnes of oil equivalent.

Note: 'Others' include biomass, bioethanol, biodiesel.

Source: 1990-2019 data (2019 EBT, DOE – Philippines); 2020-2050 data (Author's calculation).

3.1.2. Total Primary Energy Supply by Energy

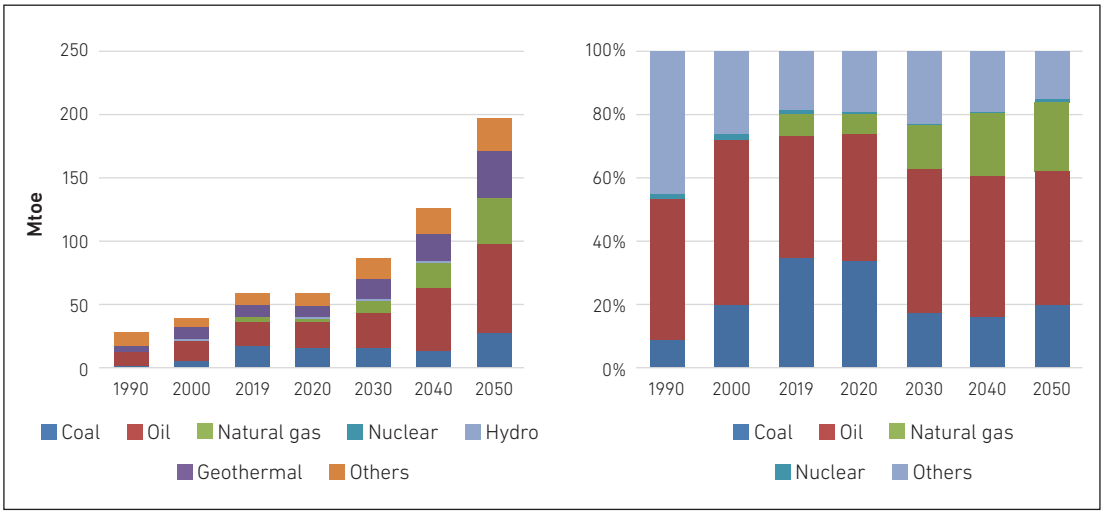
Primary energy supply in the Philippines grew from 28.7 Mtoe in 1990 to 59.7 Mtoe in 2019 at an annual average rate of 2.6%. Amongst the major energy sources, coal grew the fastest at 8.6% per year as the country embarked on an aggressive investment in baseload power plants to stabilise the country's electricity supply. Geothermal, oil, and hydro each registered average increases of 2.3%, 2.1% and 1.0%, respectively. On the other hand, primary energy supply of other fuels went down by 0.5% per year.

For 2019 to 2050, the country's primary energy supply is expected to increase threefold, from its 59.7 Mtoe in 2019 to 197.0 Mtoe in 2050, with an average growth rate of 3.9% per year. Oil will account for the largest share of the country's total energy supply, increasing from 33.4% in 2019 to 35.2% in 2050. This increase is necessary to meet the growing demands of the economic sectors, particularly transport. However, oil supply is predicted to peak in 2030 at an annual rate of 4.8% and will display a slower growth rate of 3.7% at the end of the review period. The slower growth is due to the penetration of alternative fuels, such as biofuels and electricity, and improvements in the transport sector efficiencies and mileage.

For the period 2019 up to 2050, natural gas is expected to grow at an annual average rate of 4.1%. Natural gas is mainly used for power generation. The expected growth is in line with the government programme being pushed for the development of a liquefied natural gas (LNG) Hub in the country to secure future supply of natural gas.

Major renewable energy supply from geothermal and hydro will grow at an average rate of 4.6% and 1.8%, respectively. By 2050, the combined consumption of other fuels, including biomass, solar, wind and ocean technologies, is expected to reach 12.7%, growing at an annual rate of 3.1% throughout the planning period (Figure 14.6).

Figure 14.6 Total Primary Energy Supply by Energy, Business-as-Usual, 1990–2050



Mtoe = million tonnes of oil equivalent.

Note: 'Others' include biomass, bioethanol and biodiesel.

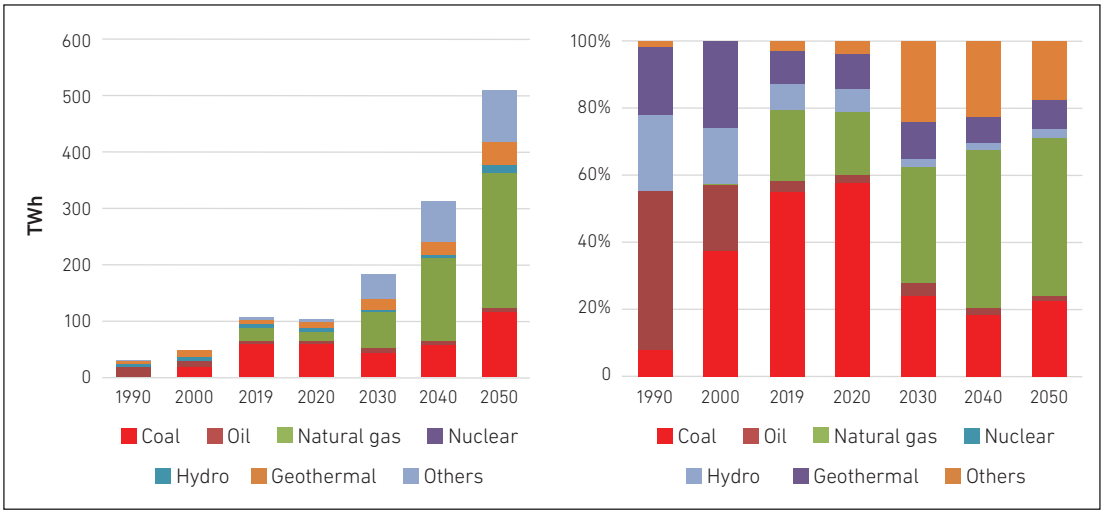
Source: 1990-2019 data (2019 EBT. DOE – Philippines; 2020-2050 data (Author's calculation).

3.1.3. Power Generation

In 2019, the total power generation reached 106.0 TWh, which was four times the country's level of 26.3 TWh in 1990. The total power generation output is projected to rise by 5.2% yearly and reach 508.9 TWh by 2050. Coal, which accounts for 54.6% of the power generation mix in 2019, would decrease its share to 22.2% in 2050 due to the coal moratorium imposed by the government in 2020. As cleaner fuel is increasingly used for power generation and coal is replaced, natural gas-fired power plants are expected to comprise 47.6% of the power generation mix.

Renewable energy sources, which include hydro, geothermal, wind, solar, and biomass are expected to contribute an aggregate share of 20.8% in 2019 up to 29.0% in 2050 (Figure 14.7).

Figure 14.7 Power Generation, Business-as-Usual, 1990–2050
(TWh)



TWh = terawatt-hour.

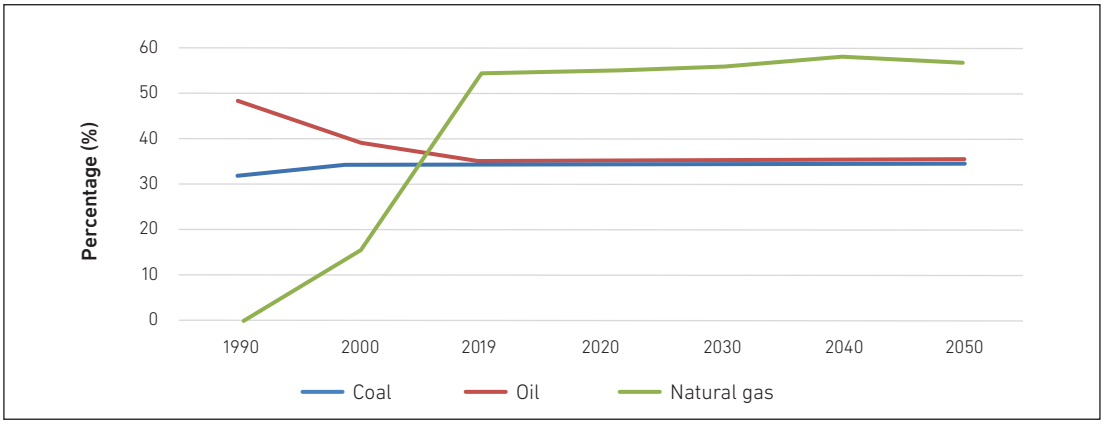
Note: 'Others' include biomass, solar and wind.

Source: 1990-2019 data (2019 EBT. DOE – Philippines; 2020-2050 data (Author's calculation).

According to projections, the thermal efficiencies of coal and oil will remain constant throughout the planning period under the BAU scenario. Coal thermal efficiency is expected to remain at 35.0%, while oil power plant efficiency is projected to remain around 36.0%. In contrast, the efficiency of natural gas power plants is expected to range from 55. 0% to 58.0% due to new capacity additions expected within the period being studied (Figure 14.8).

Figure 14.8 Thermal Efficiency, Business-as-Usual, 1990–2050

(%)

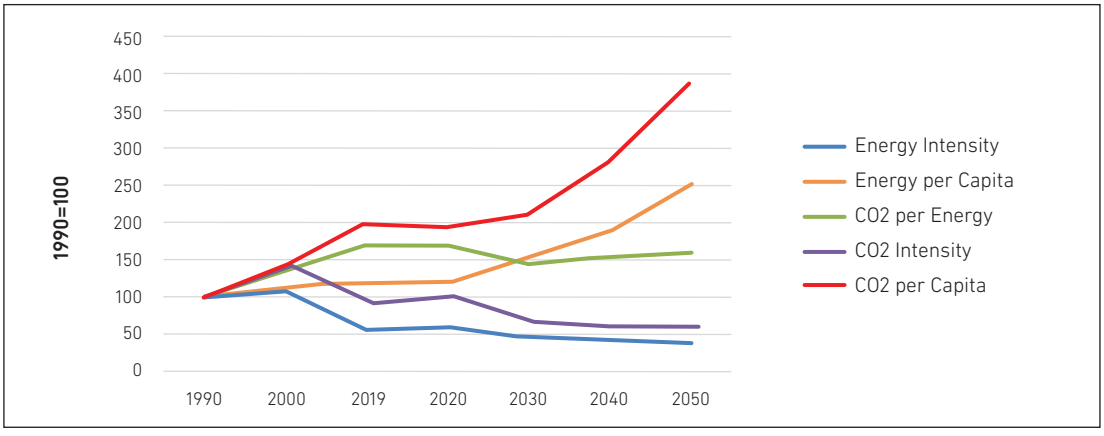


Source: 1990-2019 data (2019 EBT. DOE – Philippines; 2020-2050 data (Author's assumption).

3.1.4. Energy Indicators

Under the BAU, the energy intensity of the country is expected to decrease at a rate of 1.3% for 2019–2050. Energy intensity is defined as the ratio of total primary energy to GDP. This significant reduction in energy intensity is attributed to the government's efforts to promote energy conservation and efficiency in the various sectors of the economy. However, the energy per capita is expected to increase from 0.6 tonnes of oil per person (toe/person) in 2019 to 1.2 toe/person in 2050 due to improvements in living standards and income levels. Additionally, CO_2 per capita is expected to decrease from 0.3 tonnes of carbon per toe (t-C/toe) to 0.6 t-C/toe due to increasing demand for energy resulting from the improved standard of living (Figure 14.9).

Figure 14.9 Energy Indicators, Business-as-Usual, 1990–2050



CO_2 = carbon dioxide.

Source: Author's calculations.

Amongst the energy indicators, CO_2 energy per capita, energy per capita, and CO_2 per energy registered an increasing trend due to improvements in standard of living. Meanwhile, energy intensity and CO_2 intensity decrease over time due to the adoption of energy conservation measures, energy efficiency improvements, and a gradual shift from fossil fuels to clean energy sources, particularly renewables.

3.2. Alternative Policy Scenario

The study developed five (5) alternative policy scenarios to assess the energy savings potential of the country in addition to the business-as-usual (BAU) scenario. The assumptions in the alternative policy scenario (APS) were analysed separately to determine the individual impacts of each assumption to BAU. Table 14.3 describes the policy scenarios adopted for the study.

Table 14.3 Alternative Policy Scenarios

APS1	Improved Efficiency of Final Energy Demand
APS2	More Efficient Thermal Power Generation (coal, oil and natural gas)
APS3	Higher Contribution of Renewable Energy to Total Supply
APS4	Contribution of Nuclear Energy to Total Supply (not applied in the Philippines)
APS5 or APS	Combined Effects of APS1, APS2, APS3, and APS4

APS = alternative policy scenario.

Source: Author's assumptions.

The alternative policy scenario (APS) 1 assessed the potential impact of policy interventions in promoting the use of eco-friendly and efficient technologies in future energy consumption, as well as the corresponding reduction in CO_2 emissions. The scenario assumed a 5.0% energy savings in oil and electricity demand until 2050 through a range of measures, including intensified energy utilisation management programmes across all economic sectors. The adoption of more energy-efficient electrical appliances in residential and commercial sectors is also anticipated to result in savings. Energy labelling and rating for major electrical appliances will help consumers in choosing more efficient products, while the Information and Education Campaign (IEC) Program of the DOE will contribute to the country; energy-saving goals.

The APS2 assessed the effect of a more efficient thermal power generation, particularly for future coal and natural gas power plant technologies. In this scenario, higher efficiency was adopted for coal and natural gas. Under the BAU, the process efficiency of coal power plant was 35% while natural gas was 55%. Under the APS2, process efficiency of coal and natural gas was improved to 37% and 62%, respectively.

The APS3 evaluated the combined impact of renewable energy and alternative fuels on the total energy supply. The model integrated the targets outlined in the National Renewable Energy Program (NREP), which is part of the government's efforts to ensure energy security, protect the environment, and promote green technology. The NREP serves as a framework for the developing country's renewable energy resources, attracting investments in the renewable energy sector, advancing technology, and driving the adoption of renewable energy at the national and local levels. It establishes interim targets for the delivery of renewable energy within the timeframe. The scenario also incorporates the continued use of alternative fuels, such as biofuels, under the Biofuels Law of 2006.

3.2.1. Total Primary Energy Supply by Energy

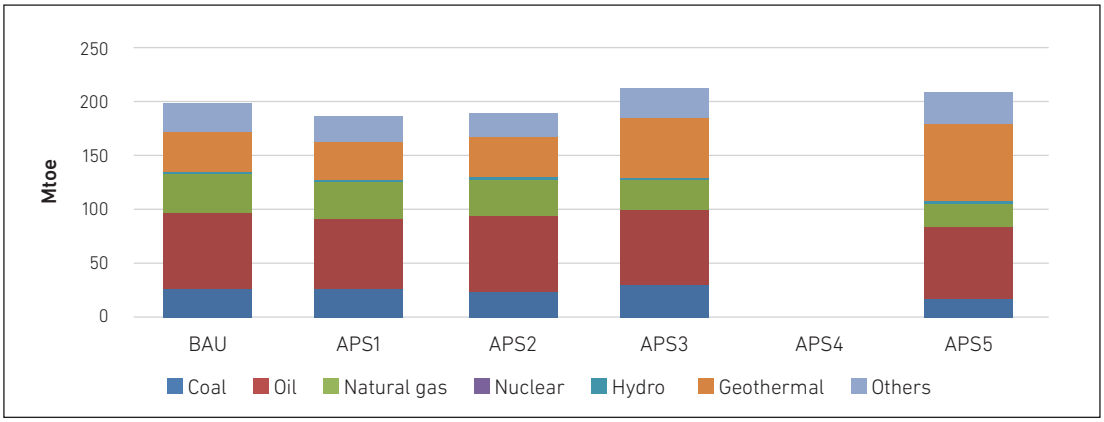
Figure 14.10 shows the changes in total primary energy supply in all the scenarios. APS1, which assumes improved efficiency of final energy demand, is projected to increase at a rate of 3.8% per year and reach 187.2 Mtoe by 2050. Compared to the BAU, APS1 shows a reduction of 5.0% or 9.8 Mtoe, which can be attributed to the projected savings from various measures to be implemented in the energy sector. These measures include intensified energy utilisation management programmes in the commercial and industrial sectors, power plants, and distribution utilities; the continued use of alternative fuels and technologies; and other measures developed with the implementation of RA No. 11285, also known as the Energy Efficiency and Conservation Act.

The total primary energy supply of APS2 is expected to reach 189.1 Mtoe by 2050, with a 4.0% or 7.9 Mtoe decrease compared to the BAU scenario. This suggests that enhancing the thermal efficiency of fossil fuel-based power plants can lead to notable energy savings.

The APS3 will result in a higher total primary energy supply of 212.1 Mtoe, which is 7.7 Mtoe more than the BAU scenario. This increase is due to the increased utilisation of geothermal, hydropower, and other renewable energy in power generation. While renewable energy sources, such as geothermal and hydropower, have lower efficiencies than fossil fuels, resulting in higher fuel input, the adoption of these cleaner sources increases total primary energy supply. During the planning period, the average annual growth rate of geothermal energy will grow at an average rate of 4.6%, resulting in an increase from 9.2 Mtoe in 2019 to 37.3 Mtoe in 2050. Additionally, the aggregate generation output from other renewable energy sources, such as solar, wind, and ocean, is expected to increase at an average rate of 2.8% per year.

When all the APS scenarios are combined (APS5), the country's total primary energy supply is projected to reach 208.0 Mtoe in 2050, with an annual average growth rate of 4.1%. The increase in supply under APS3, due to the lower efficiencies of renewables compared to fossil-based fuels, will offset the combined reduction of APS1 to APS2. This highlights the effectiveness of combining improved efficiency in energy demand and thermal power generation. Further, a higher contribution of renewable energy in the supply mix will increase TPES and decrease carbon emissions, which is beneficial to the environment (Figure 14.10).

Figure 14.10 Comparison of Total Primary Energy Supply by Energy, 2050
(Mtoe)



Mtoe = million tonnes of oil equivalent.

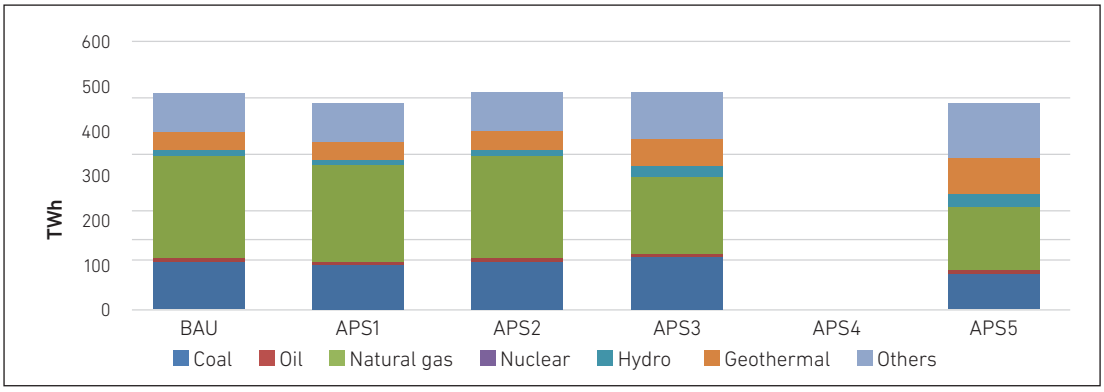
Source: Author's calculation.

3.2.2. Total Electricity Generation

Figure 14.11 shows the total electricity generation in 2050 in all scenarios. Under the APS1, total generation output is projected at 483.4 TWh. This is 5.0% lower than the BAU due to efficiency measures imposed on the different end-use sectors. As a result, all fuels registered reduced generation output compared to the BAU scenario.

The annual average growth rate in APS 1 would increase by 5.0%. Natural gas is expected to grow the fastest at 7.8% average per year, with a 4.6% reduction in output compared to BAU. The total fuel input decreased significantly by 4.7% from the BAU level of 36.1 Mtoe, largely due to reduced electricity consumption.

Figure 14.11 Scenario Comparison, Electricity Generation, 2050
(TWh)



APS = alternative policy scenario, BAU = business-as-usual, TWh = terawatt-hour.

Note: 'Others' include biomass, solar and wind.

Source: Author's calculation.

Two scenarios, APS2 and APS3, yield the same total generation output of 508.9 Mtoe. Under APS2, there is no difference in power generation output compared to the BAU. However, the higher thermal efficiencies of the fossil fuel plants lead to a reduction in fuel input by 8.5%. The combined input of fossil-based fuel (coal, oil, and natural gas) only requires 60.2 Mtoe input in APS2 compared to 65.7 Mtoe in the BAU. In the case of adding new coal capacity, the process efficiency increases from 36.0% to 43.0%.

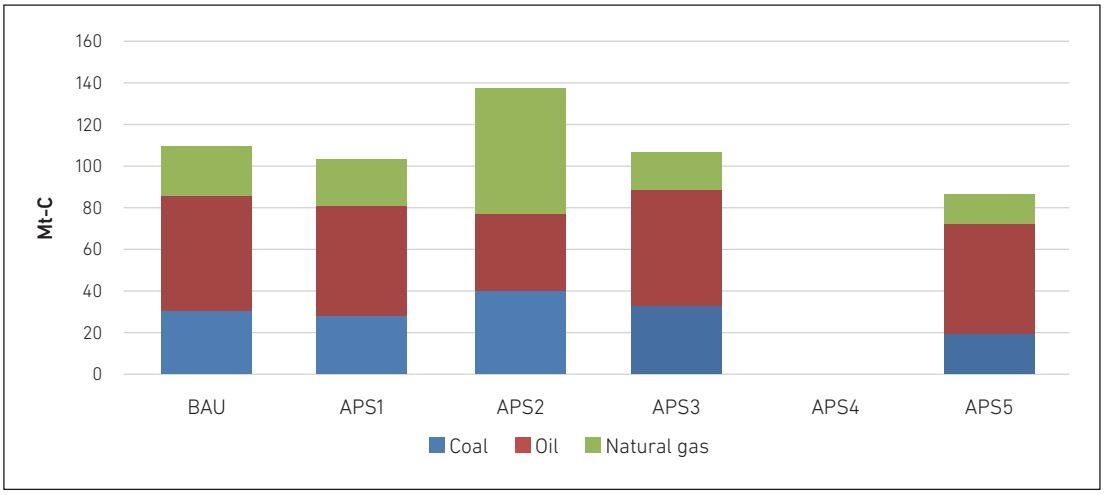
On the other hand, APS3 will have a greater share of generation from renewable energy technologies. Geothermal energy is expected to increase by 47.5% compared to the BAU, with an annual average growth rate of 5.9%. Therefore, it is recommended that the government continue to explore and utilise the country's geothermal potential.

While APS5's total generation output is equal to that of APS1 for 2050 at 483.4 TWh, the aggregate power output from coal and oil will decrease by 25.4% from the BAU from 121.1 TWh to 90.4 TWh under APS5.

3.2.3. Total Carbon Dioxide Emission, 2050

The implementation of energy efficiency measures, or APS1, will lead to a 5.4% decrease in CO_2 emissions in 2050 compared to the BAU level of 109.2 million tonnes of carbon (Mt-C). The decrease in CO_2 indicates that the energy saving goals, action plans, and policies in the promotion of energy efficiency and conservation programme will have a substantial impact in reducing CO_2 emissions (Figure 14.12).

Figure 14.12 Scenario Comparison, Carbon Dioxide
(Mt-C)



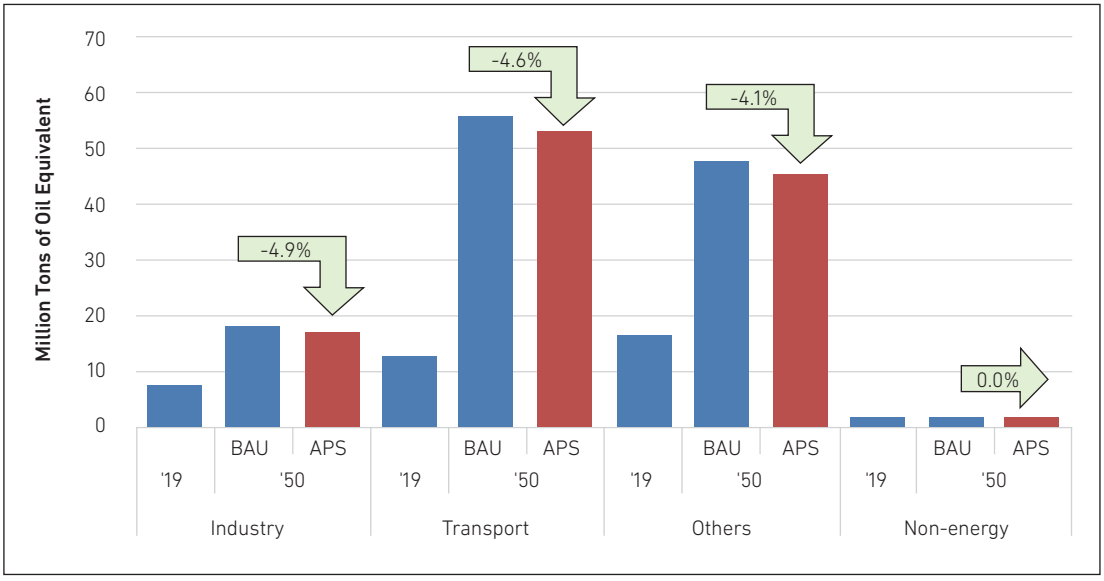
APS = alternative policy scenario, BAU = business-as-usual, Mt-C = Million Tonnes of Carbon.
Source: Author's calculation.

By improving the thermal efficiency under APS2, the total CO_2 emissions will decrease by 4.7% compared to the BAU. Similarly, increasing the share of renewable energy technology under APS3 will lead to a reduction of 2.2%. If all assumptions in APS1, APS2, and APS3 are combined, the aggregate reduction of CO2 emissions from the BAU scenario will be 20.9%.

3.2.4. Energy Saving Potential

Figure 14.13 shows the total final energy consumption by sector in 2050 under both the BAU and APS5. The implementation of energy efficiency measures in APS5 will result in a 4.4% reduction in total final energy consumption, decreasing from 122.0 Mtoe in BAU to 116.9 Mtoe in APS5. A reduction of 4.9% can be observed from industry because of technological advancements and more efficient systems and practices. Similarly, a 4.6% reduction is expected in transport, which can be attributed to the use of mass transport systems, improved transportation network and highways, increased use of electric vehicles, and higher biofuel blends. Energy demand from other sectors (residential, commercial, and AFF) will also decrease from 47.0 Mtoe in the BAU to 45.0 Mtoe in APS5, decreasing at an annual rate of 4.1%. The decrease is due to the aggressive implementation of the energy labelling programme, energy efficiency solutions for commercial infrastructures, and technology improvements.

Figure 14.13 Final Energy Consumption, Business-as-Usual vs Alternative Policy Scenario, 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

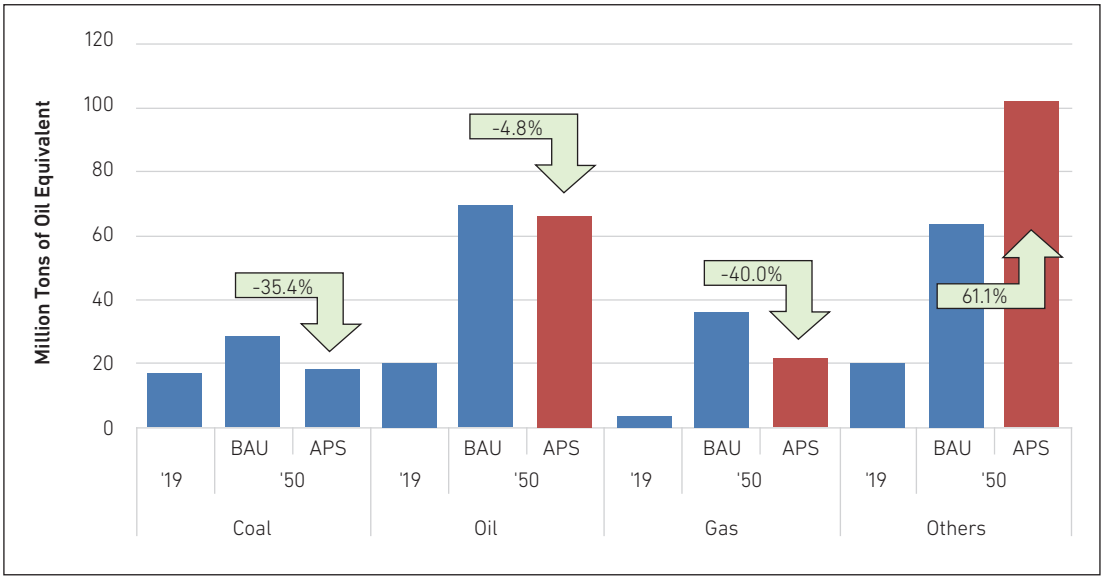
Note: 'Others' includes commercial, residential, and agriculture, forestry and fishery.

Source: Author's calculation.

Figure 14.14 illustrates a comparison of total primary energy supply by fuel between the BAU and APS in 2050. It is projected that primary energy supply will increase by 5.6% from 197.0 Mtoe to 208.0 Mtoe by end of 2050. The growth is due to the expected increase of renewables for power generation, which is included in the category of 'Others'. The efficiency of renewables, especially geothermal at 10%, is lower compared to fossil-based fuels like coal, which has an efficiency of 35.0%. The 'Others' category is expected to increase from 63.5 Mtoe to 102.2 Mtoe in 2050 due to the aggressive implementation of policy mechanisms under Renewable Energy Act of 2008. By 2050, the share of renewables under APS5 is would reach 54.3% by 2040 and 50.0% by the end of the study period. The result is consistent with the PEP 2020–2040, which targeted a 50% share for power generation by 2040. Meanwhile, coal consumption is expected to further decline from 28.0 Mtoe in the BAU to 18.1 Mtoe in the APS5, as an effect of increasing renewable energy for power generation and the use of other fuels in the end-use sector. Similarly, natural gas consumption is expected to decrease by 4.3% compared to the BAU due to the increasing share of renewable energy for power generation.

Figure 14.14 shows the comparison of total primary energy supply in 2050 between BAU and APS5. The combined effect of energy efficiency measures and higher thermal power plant efficiency was negated by the increase of renewables for power generation. This is because the efficiency of other renewable energy resources is much lower than fossil-based plants, such as natural gas and coal. As a result, the total primary energy supply is expected to rise by 5.6% in 2050 compared to the BAU level of 197.0 Mtoe.

Figure 14.14 Total Primary Energy Supply Comparison, Fuel, Business-as-Usual vs Alternative Policy Scenario, 2050
(Mtoe)



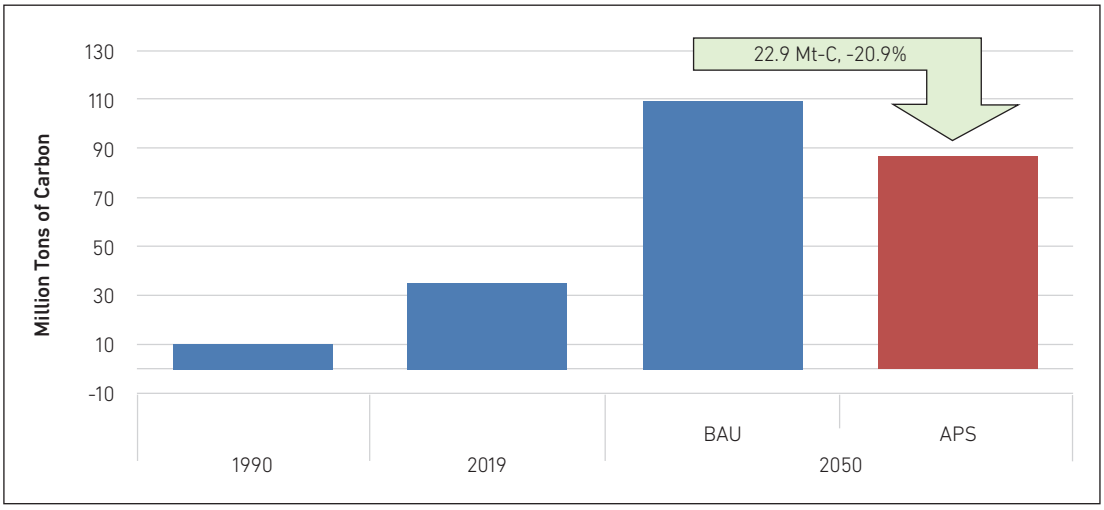
APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

Note: 'Others' include geothermal, hydro, biomass, bioethanol, and biodiesel.

Source: Author's calculation.

Figure 14.15 compares CO_2 emissions in 2050 between BAU and APS5. The implementation of energy efficiency measures, higher thermal power plant efficiency, increased use of renewable energy for power generation resulted in a significant reduction of 22.9 Mt-C or 20.9% reduction in the CO_2 emissions in APS5 compared to the BAU level. The result shows that the combined strategies under the scenarios will help the energy sector to achieve its goal of reducing emission levels in line with the Nationally Determined Contribution targets.

Figure 14.15 Carbon Dioxide Emission Comparison, Business-as-Usual vs Alternative Policy Scenario, 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.
Source: Author's calculation.

3.3. Low Carbon Energy Transition Scenario, Carbon Neutral

A new scenario called low carbon energy transition (LCET) scenario was created to assess the impact of new technologies on energy supply, consumption, and emissions reduction. A concept of achieving carbon neutrality was introduced to analyse how economies can integrate technology advancements, energy sources, activities, and behaviour to reach this goal. Currently, the Philippines has no net zero emission target unlike other ASEAN countries such as Malaysia and Indonesia. To establish a net zero target, more aggressive goals were adopted, including the use of new and emerging technology and fuels that are projected to form part of the global energy mix in the future.

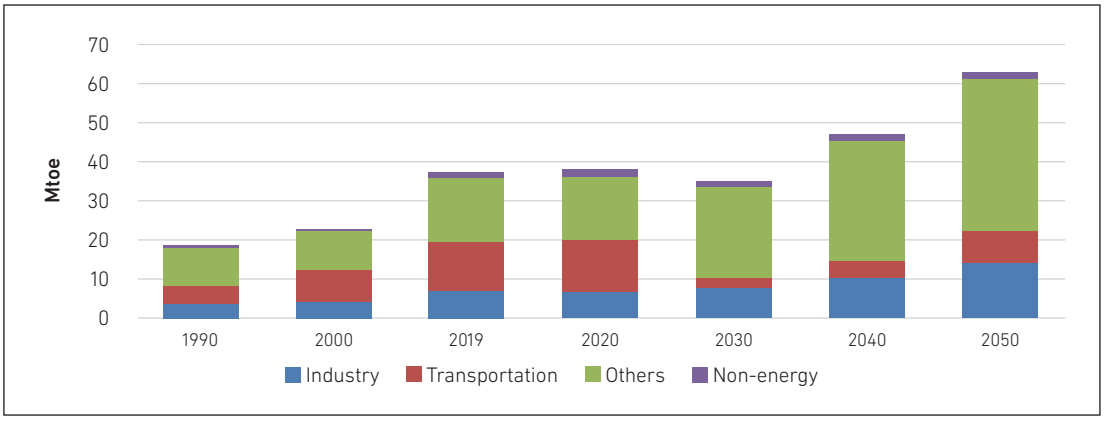
In developing the scenario, several measures were considered in the model, including the use of carbon capture utilisation and storage (CCUS) from 2040 to 2050 to reach 55.0% efficiency in natural gas plants and 45.0% efficiency in coal power plants. Additionally, hydrogen fuel will replace diesel in road transport starting in 2040, with a 5.0% share targeted in 2050. The scenario also includes a higher penetration rate of electric vehicles at 20.0% in transport by 2050. Bioethanol and biodiesel blends are projected to be at 20% by 2050. Energy savings on oil and electricity are also targeted to increase to 20% by the end of 2050. The energy savings is applied in the industrial, commercial, and residential sectors. In terms of power generation, the share of renewable energy is targeted to reach a 60% by 2050. Due to the new developments under the nuclear power programme of the government, the model also assumed a 1000 MW nuclear power plant as part of the power generation mix starting in 2035. The government sees nuclear power as a potential part of the country's energy mix in the future, as demonstrated by their initiatives under EO No. 116, which calls for a study on the adoption of a national position on nuclear energy programmes. Additionally, EO No. 164 seeks to adopt a national position that will consider economic, political, social, and environmental factors related to nuclear power development. The model also considered fuel switching in the industrial and residential sectors as follows:

- Biomass for Coal in the industrial Sector (5% by 2050)
- Electricity for LPG in the residential sector (at least 5% by 2050)

3.3.1. Final Energy Consumption Sector

Figure 14.16 illustrates the final energy consumption by sector from 1990 until 2050 under the LCET scenario. The average annual growth rate from 1990 to 2019 is 2.4%. Compared to APS5, the final energy consumption in 2050 is much lower under LCET, reaching 63.9 Mtoe. For the period 2019 to 2050, the annual average growth rate of final energy consumption is expected to slow down from 2019 to 2050, with a rate of 1.7% due to the combined assumption used in the model.

Figure 14.16 Final Energy Consumption by Sector, Low Carbon Energy Transition Scenario, 1990–2050
(Mtoe)



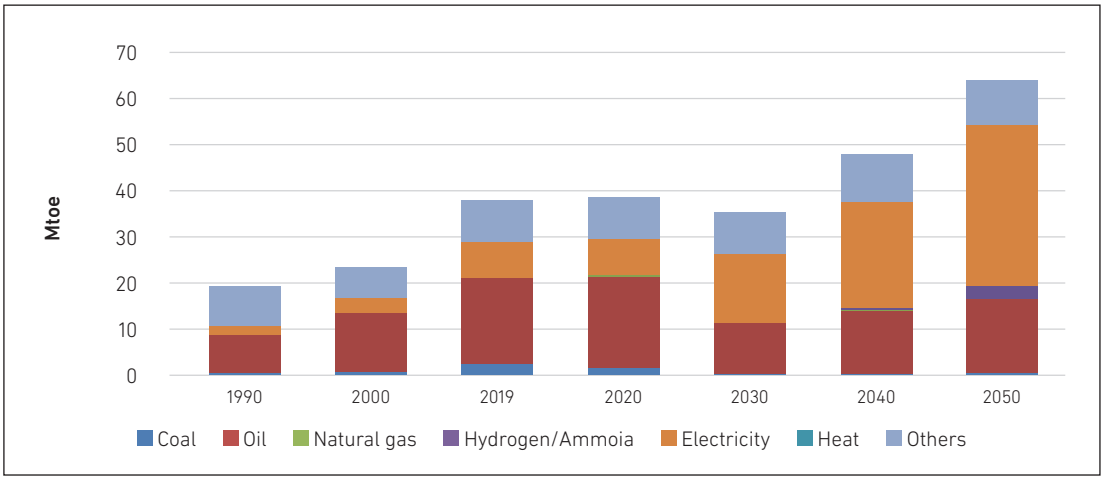
Mtoe = million tonnes of oil equivalent.

Note: 'Others' include commercial, residential, and agriculture, forestry and fishery.

Source: Author's calculations.

Introducing hydrogen fuel for transport sector from 2040 onwards would impact the consumption of diesel. In 2050, hydrogen is seen to reach 2.7 Mtoe, with an average annual growth rate of 22.8% from 2040 to 2050. Meanwhile, oil will reduce to 0.5% per year from 2019 until 2050, compared to an average annual growth rate of 4.0% under the APS5 scenario. The final energy consumption by fuel under the LCET scenario is shown in Figure 14.17.

Figure 14.17 Final Energy Consumption by Fuel, Low Carbon Energy Transition Scenario,1990–2050
(Mtoe)



Mtoe = million tonnes of oil equivalent.

Note: 'Others' include biomass, bioethanol, and biodiesel.

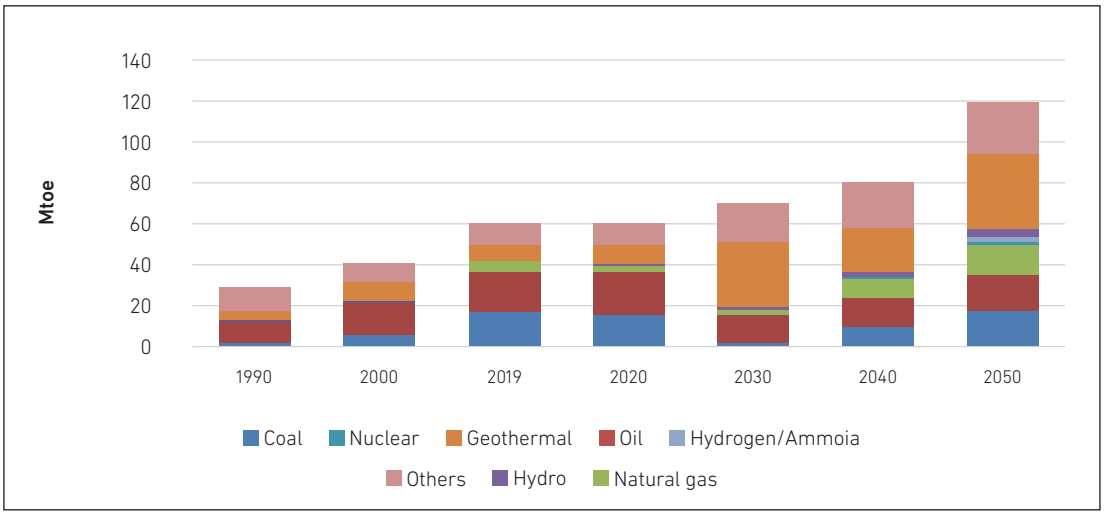
Source: Author's calculations.

3.3.2. Primary Energy Supply

The LCET scenario projects a total primary energy supply of 119.1 Mtoe in 2050 in Table 14.18, much lower than the APS5 scenario's 197.0 Mtoe. The average annual growth rate of the total primary energy supply is 3.9% from 2019 to 2050 under the BAU, higher than 2.2% under the APS5. Only oil shows a negative average annual growth with –0.4% due to the combined initiatives identified in the LCET scenario. The government's decision not to construct any new coal plants into the system results in a 0.2% annual growth rate for coal. The combined share of hydropower, geothermal, and other renewable sources (such as solar, wind, biofuels, and others) is expected to make up 55.0% of the total supply mix, as the study assumed 60.0% share of renewables for power generation.

Figure 14.18 Primary Energy Supply by Fuel, Low Carbon Energy Transition Scenario, 1990–2050

(Mtoe)



Mtoe = million tonnes of oil equivalent.

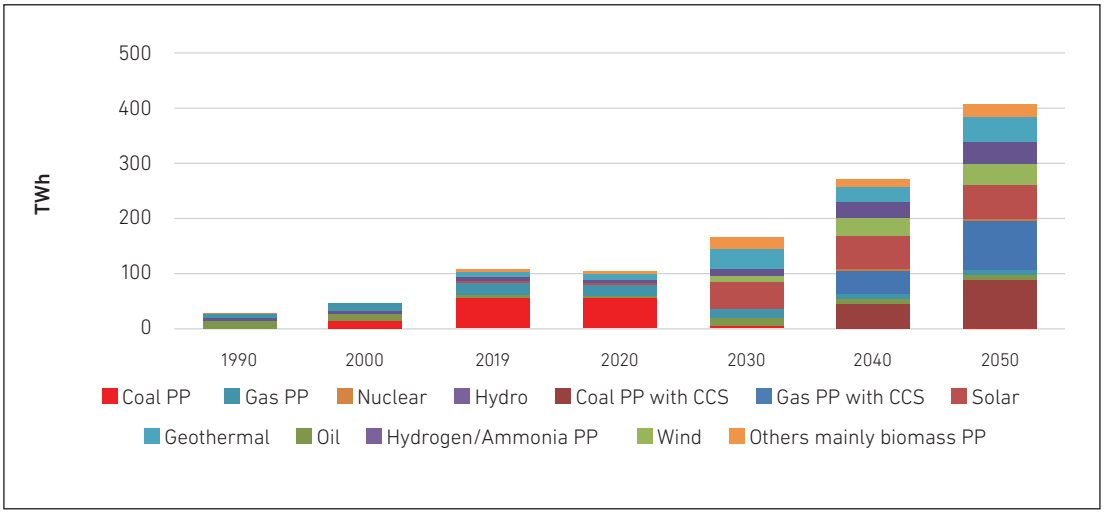
Note: 'Others' include biomass, bioethanol, and biodiesel.

Source: Author's calculations.

3.3.3. Power Generation

Figure 14.19 shows the total electricity generation in 2050 under the LCET scenario will grow to 408.0 TWh compared to 483.4 TWh under the APS5 scenario. Reduced electricity consumption due to energy efficiency initiatives leads to lower electricity generation by 2050. By the end of the study period, natural gas power plants, which include natural gas with CCUS, will constitute 23.6%; followed by coal, which includes coal with CCUS, at 22%; solar at 15.3%; geothermal at 10.5%; hydro at 10.3%; wind at 9.6%; biomass at 6.0%; and oil at 1.9%. Meanwhile, nuclear is seen to contribute a share of 0.9% in 2050.

Figure 14.19 Electricity Generation by Fuel, Low Carbon Energy Transition Scenario, 1990–2050
(TWh)



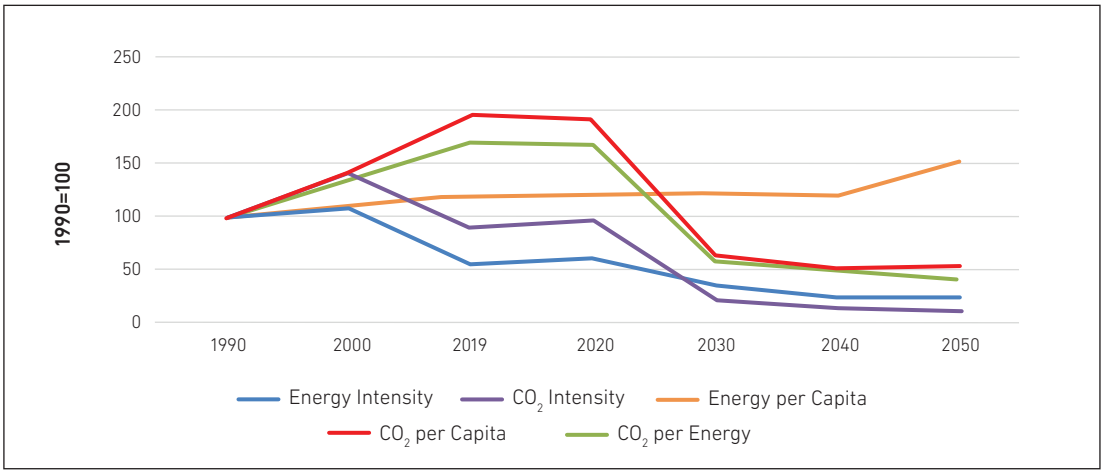
CCS = Carbon Capture Storage, PP = power plant, TWh = terawatt-hour.

Source: Author's calculations.

3.3.4. Energy Indicators

Figure 14.20 demonstrates that amongst all energy indicators, only energy per capita exhibits a positive trend. The increase is mainly driven by it the rising energy demand due to an improvement living standards. Emission per capita showed a downward trend at -4.1% per year from 2019 to 2050. Energy intensity also showed a similar trend decreasing at -3.4% per year, while CO_2 emissions intensity marked at -7.5% per year.

Figure 14.20 Energy Indicators, Low Carbon Energy Transition Scenario, 1990–2050



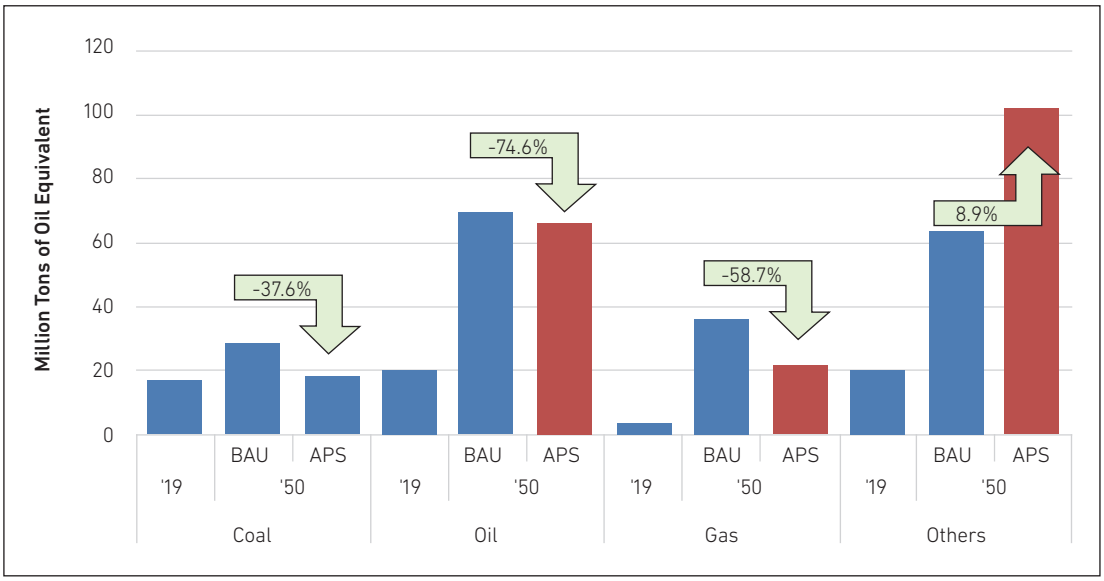
CO_2 = carbon dioxide.

Source: Author's calculations.

3.3.5. Saving of Fossil Fuel Consumption and CO_2 Reduction

Figure 14.21 shows the potential reduction in total primary energy supply under the LCET scenario, which amounts to 77.9 Mtoe, as compared to the BAU scenario. This potential savings of 39.5% could be achievable if all the initiatives under the LCET scenario are implemented.

Figure 14.21 Primary Energy Supply, Business-as-Usual and Low Carbon Energy Transition Scenarios, 1990, 2019, and 2050
(Mtoe)



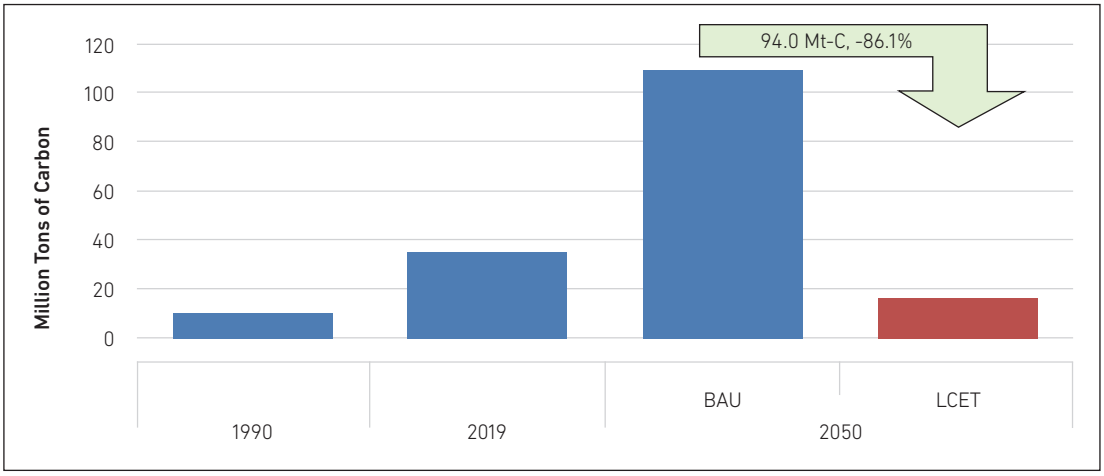
APS = alternative policy scenario, BAU = business-as-usual, Mtoe = million tonnes of oil equivalent.

Note: 'Others' include geothermal, hydro, solar, wind and biomass.

Source: Author's calculations.

Figure 14.22 shows the LCET scenario predicts a decrease in total CO_2 emissions by 2.7% to reach 15.2 Mt-C compared to 109.2 Mt-C in the BAU scenario in 2050. This reduction is about 94.0 Mt-C or 86.1% less than the BAU scenario. Based on the results of the study, the country will not achieve net carbon neutrality by 2050, given the combined assumptions used. More aggressive targets should be established to achieve a net-zero carbon future.

Figure 14.22 : Carbon Dioxide Emission Reduction, Business-as-Usual and Low Carbon Energy Transition Scenarios, 1990, 2019, and 2050
(Mtoe)



APS = alternative policy scenario, BAU = business-as-usual.

Source: Author's calculations.

4. Implications and Policy Recommendations

Based on the results of this study, the Philippines can attain its target of increasing renewable energy share, given the available resources in the country. However, achieving the 50% renewable energy share in power generation by the end of 2050 has its various issues and challenges. Significant issues and challenges were revealed in the 1,090 renewable energy service contracts (RESCs) awarded from 2009 to 2019, which had the potential to generate about 36,735 MW of installed capacity and could have exceeded the NREP, 2011–2030 target of 15,304 MW by 2030. These issues and challenges include (1) delayed implementation of renewable energy policy mechanisms; (2) complex permitting process; (3) grid interconnection issues; (4) renewable energy resource development; (5) limited access to financing; and (6) exposure to climate related risks.

This study suggests the implementation of energy efficiency and conservation (EE&C) standards and measures as one key area for achieving significant energy in the country. The government must intensify its promotion of EE&C measures with specific targets and strategies to achieve energy efficiency while still meeting the future energy demand required for economic growth. Based on the projections in the BAU, the final energy demand is expected to triple from 36.7 Mtoe in 2019 to 116.1 Mtoe by 2050. This indicates the significant energy demand of a developing nation like the Philippines, for which the present government has established an ambitious objective for the economy outlined in the Ambisyon 2040 plan. Oil will continue to have the largest share in the final energy demand on the demand side, accounting for almost half of the

demand mix by the end of the planning period. However, implementing energy efficiency and conservation programmes, as well as developing alternative fuels and technologies, can result in higher energy savings potential for oil demand. According to the model's results, the share of oil in total demand ranges between 40% to 50% indifferent scenarios. One policy recommendation is for the government to focus on the promotion of alternative fuels, such as bioethanol and biodiesel, in transport to displace the use of oil in the sector. The passing of Electric Vehicle Industry Development Act (EVIDA) will address challenges in promoting electric vehicles as an alternative fuel, and aggressive implementation of the law should be pursued. To increase the market penetration of electric vehicles, necessary infrastructure such as charging stations should be established.

As the energy requirement is expected to increase, the energy sector must develop an energy supply plan to meet the country's growing energy needs. The study suggests an optimal energy mix that can be adopted based on different APS scenarios. In the Philippines, coal, which has been a major power source in the past decades, is expected to decline further due to the increasing demand for environmentally friendly fuel sources. According to the results of APS2, improving thermal efficiency of fossil-based fuels has the potential to save energy by about 8.5% in terms of fuel input compared to the BAU scenario. This improvement led to a substantial reduction in CO2 emissions of 5.2 Mt-C or about 4.7%. Therefore, it is recommended to improve the thermal efficiencies of fossil fuel-based power plants, even though the initial investments and costs may be high. This would lead to lower production requirements and emissions in the long-term, which would benefit the energy sector. However, before implementing this policy, further investigation is necessary. Since the power sector is a deregulated industry and driven by private sector investments, the government may need to develop a policy solution to encourage investments in highly efficient technologies in the future.

The APS3 demonstrates that the government's commitment to the Renewable Energy Act of 2008, which aims to increase the use of clean and efficient alternative fuels such as geothermal, hydro, solar, wind, biomass, and other emerging renewable energy technologies, can lead to a strategy for energy security through greater reliance on indigenous resources. To ensure continued progress, policy mechanisms such as Feed-in Tariff (FIT), Renewable Portfolio Standards (RPS) for On-grid and Off-grid, Renewable Energy Market, Green Energy Option Program (GEOP), and Green Energy Auction Program (GEAP) are already in place. The government should further promote the use of renewable energy not only for power generation but also for end-use sectors. Additionally, future policy mechanisms should be established to ensure an increased share of renewable energy in the power generation mix.

The COVID-19 pandemic has prompted economies worldwide to rebuild their economic structures, taking into account energy security, affordability, and environmental sustainability. Many economies have committed to combat climate change by setting targets for carbon neutrality or net zero emissions. The emergence of new technologies, such as CCUS and alternative fuels like hydrogen, is now a global trend. Each economy should explore these new technologies and consider them as a long-term option. However, implementing new technologies requires significant investment. Long-term partnerships and secure funding are essential for successful investment. Moreover, the private sector drives the country's power sector, so policies must be

developed to encourage private sector investment in new technologies to realise the government's plans for a low carbon future or a transition to environment-friendly technologies. There are various options available to reduce energy carbon emissions both on the demand and supply side. To be able to achieve carbon neutrality, local and foreign funding support is also needed.

In the Philippines, the energy sector has developed plans for a low carbon future, as reflected in the 2020–2040 PEP. However, the country has yet to establish a net-zero scenario, unlike other ASEAN nations like Malaysia, which has a net-zero target by 2050, and Indonesia with a net-zero target by 2060 or sooner. To prepare for the future, the Philippines should start strategising, beginning with a comprehensive study of advantages and disadvantages of the potential new technologies. These strategies must align with the energy sector's objectives of providing secure, environmentally friendly, and affordable energy. Each adopted strategy should have a roadmap developed for its implementation.

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