

CHAPTER 10

The Lao People's Democratic Republic Country Report

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1. Background

1.1. Socioeconomic Situation

The Lao People's Democratic Republic (Lao PDR) is the only landlocked country in the Association of Southeast Asian Nations (ASEAN). Located in the centre of the Indochina Peninsula, it borders five countries: China in the north, Viet Nam in the east, Cambodia in the south, and Thailand and Myanmar in the west. Lao PDR has a total area of 236,800 square kilometres (km²), about 70% of which is covered by mountains, and a population of 7.1 million as of 2019. The average population density is 30 persons per km². Lao PDR comprises 18 provinces, with Vientiane as the capital.

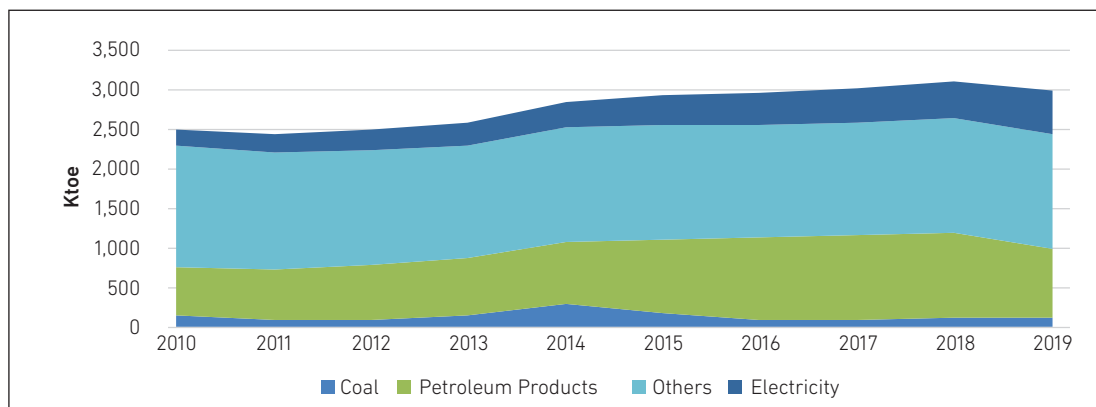
Since 1986, when Lao PDR changed its economic policy to an open-door policy, the economy has progressed and expanded rapidly. The gross domestic product (GDP) in 2019 increased by 5.2% from the previous year, to \$18,492 million in 2015 constant prices, bringing per capita income to \$2,579 (World Development Indicators, 2022). The economy has been changing gradually from agriculture-oriented activities to a wider range of activities, such as services and industry. For example, in 2019, services accounted for 42.3% of GDP, while agriculture only accounted for 15.2%. Industry accounted for 31.4%, and its share is expected to expand in the coming years due to large investments in the mineral and hydropower sectors.

1.2. Energy Supply-Demand Situation

Lao PDR is relatively well-endowed with renewable energy resources, especially hydropower and biomass. Recently, hydropower resources have been developed intensively to meet the electricity requirements of the country, as well as that of neighbouring countries. Every year, Lao PDR receives a significant number of hard currencies from those power exports. This is widely considered to be one of the driving forces that boosts socioeconomic development and energy security in the country.

Lao PDR's total final energy consumption (TFEC) grew by 2.1% from 2010 to 2019 (Figure 10.1). Electricity grew the fastest at 11.7% per year, followed by petroleum products at 3.8%. Biomass consumption, which has the highest share of the TFEC, decreased at an average rate of 0.7% per year. A small amount of coal consumption was noted in the industry sector.

Figure 10.1 Total Final Energy Consumption by Fuel Type
(Ktoe)



Ktoe = kilotonne of oil equivalent.

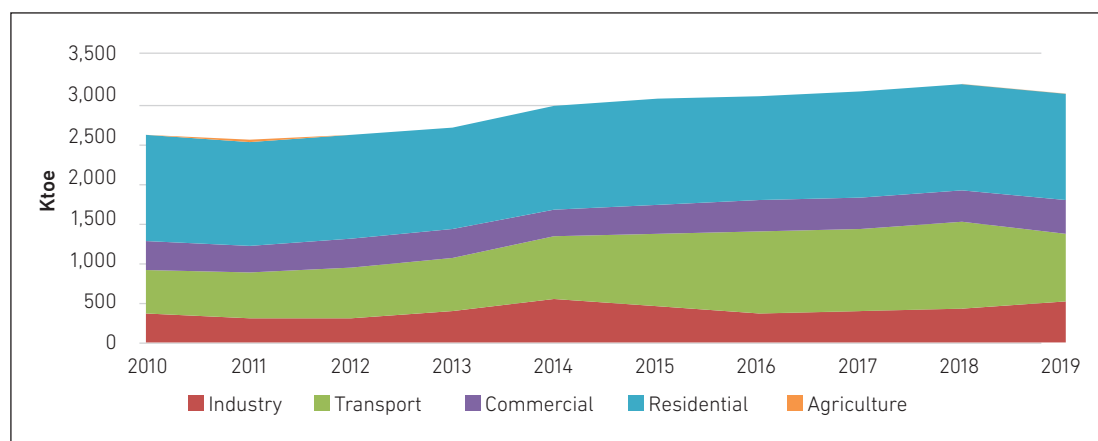
Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao Energy Balance Table Collection Historical. 14 December.

The industry and commercial sectors consume biomass, but at a lower rate than the residential sector, which dominates the country's consumption. Although the residential sector is the biggest user of biomass, its share declined from 51% in 2010 to 41% in 2019. This shift is due to the adoption of liquefied petroleum gas (LPG), the use of efficient biomass stoves in rural areas, and the increased use of electricity equipment in urban areas.

The transport energy consumption had the second largest share (27%) in the TFEC, it decreased from 43% in 2018 to 27% in 2019. However, from 2019 onward, the energy consumption in transport sector started to increase slowly due to the completion and operation of the high-speed rail Lao–China. Further, the increase in road sector energy consumption was mainly driven by the rapid growth in the number of motor vehicles.

Industry accounted for around 17% of the TFEC with an average annual growth rate of 3.6% from 2010–2019, while the commercial sector accounted for around 13% of TFEC with an average annual growth rate of 2% (Figure 10.2).

Figure 10.2 Total Final Energy Consumption by Sector



Ktoe = kilotonne of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019). Lao Energy Balance Table Collection Historical. 14 December.

In 2019, Lao PDR's total primary energy supply (TPES) was 5.9 million tonnes of oil equivalent (Mtoe), and the energy mix consisted of hydropower, oil, coal, solar and biomass. As there were many power plants in Lao PDR generating electricity for export in 2019, the export figure reached 25,048 gigawatt-hours (GWh) or equivalent to 2.15 Mtoe. This amounted to more than half of all electricity consumed in the country and 77% of total hydropower generation.

Biomass was the most consumed energy type in the country but has decreased annually. People who lack access to modern energy use biomass as a main source for cooking, heating, and many other activities because it is abundant and free of charge. In 2019, 1.62 Mtoe of biomass was used, representing 18.4% of the TPES. Consumption of oil products ranked second highest after biomass, and the majority of the country's oil product demands are met through imports from Thailand and Viet Nam. In 2019, Lao PDR's share of oil consumption was 29%. The country imported 0.92 Mtoe of oil products to supply the demand for the transport sector and others. In the same year, Lao PDR consumed 4.5 Mtoe of coal, mainly in thermal power plants such as the Hongsa Thermal Power Plant, the country's first and largest coal power plant, which began operating in 2015. Thus, coal demand increased sharply from 2015 onwards.

Due to its geographic advantages, including its many rivers, Lao PDR is rich in hydropower resources. According to the Mekong River Commission Study in 1995, Lao PDR's potential hydropower resources total 26,000 megawatts (MW). However, as of 2020, only 9,985.9 MW or 38.4% of its total potential had been realised. In 2020, Lao PDR produced around 52,217.8 GWh of electricity, of which 72% (equivalent to 37,596.8 GWh) was exported to Thailand, Viet Nam, and Cambodia; the rest was consumed domestically (Department of Energy Policy and Planning, 2020). Power exports are projected to increase sharply because the Government of Lao PDR has committed, through a revised memorandum of understanding, to export 10,500 MW to Thailand and 5,000 MW to Viet Nam. There are also plans to export 6000 MW to Cambodia; 600 MW to Myanmar; 300 MW to Malaysia; and 100 MW to Singapore. Exported power is mainly generated from hydropower. However, the

Hongsa plant has 1,878 MW of installed capacity to generate electricity for export and has exported 95% of its generated electricity since 2015.

The power sector plays a major role in the energy sector as well as in the country's economy as it generates a significant amount of national revenue. Although this revenue is insignificant in the short to medium term, it will increase in the long term because the government plans to assume ownership of private power plants. The electrification rate in Lao PDR was 94.3% in 2020 (Electric De Laos, 2020), and the government is striving to raise this to 98% by 2025. This plan is part of the government's strategy to eradicate poverty in the country. Considering the increasing demand for electricity in Lao PDR and power generation for export, balancing domestic supply with exports is an issue that must be addressed to ensure the electricity supply in the future.

1.3. Energy Policies

Since the Ministry of Energy and Mines was established in 2006, energy infrastructure and legislation has been newly developed and expanded. Energy policy has gained much public attention and support. It has gradually evolved from power sector policy to broader energy policies supporting the development of a sustainable and environmentally friendly energy sector. Close cooperation amongst ASEAN members can be credited for this improvement.

Although Lao PDR is landlocked, it is located in the middle of the Mekong subregion and is surrounded by three large economies – China, Thailand, and Viet Nam – and two medium economies – Myanmar and Cambodia. As a result, Lao PDR can position itself as a land-linked country and leverage the advantages thereof. The energy policies exchanged on the energy cooperation platform of ASEAN+3 (China, Japan, and the Republic of Korea) indicate that the substantial energy demands of these countries can drive energy trade and facilitate power integration across the region, thereby enhancing energy security and promoting sustainable development. Building on its longstanding history of trading electricity with Thailand, Lao PDR has now expanded its policy to other neighboring countries to strengthen regional energy cooperation. Specifically, Lao PDR intends to augment power exports to the aforementioned neighboring countries mentioned above.

According to the National Power Development Strategy, 2022–2030 and the Ninth Five-Year Energy and Mines Development Plan 5, 2021–2025, the Ministry of Energy and Mines has set the following goals for the power sector:

- (i) Increase power supply efficiency by 75 % for hydropower, 14 % for thermal power plants, and 11 % for renewable energy; and meet the domestic demand and export target.
- (ii) Develop transmission lines for domestic power supply and for export.
- (iii) Improve distribution and services.
- (iv) Expand the electrification rate to 98 % in rural areas by 2025.
- (v) Promote green energy usage in the transport sector by increasing the number of electric vehicles to 15 % of all cars in the country by 2025.
- (vi) Promote energy savings and conservation by reducing energy consumption by 10 % by 2030.

2. Modelling Assumptions

This study aims to forecast energy supply and demand in Lao PDR from 2020 to 2050 and to determine the country's potential for energy savings and carbon dioxide (CO₂) emission reduction, improved energy efficiency, and feasible renewable development if Lao PDR uses or implements certain alternative policy scenarios (APSs). Therefore, this study considers five scenarios: Business as Usual (BAU), APSs (APS1, APS2, APS3, APS4¹ and APS5) described below.

- (i) BAU Scenario is calculated based on the assumed growth of GDP, population, and oil prices.
- (ii) APS1, Lao PDR will implement energy saving and conservation programmes, reducing energy consumption by 10% during the study period (2020–2030) and 10% from 2030 to 2050.
- (iii) APS2, Lao PDR will make thermal power generation more efficient, increasing thermal efficiency by 30% by 2030 and 32% by 2050.
- (iv) APS3 involves a higher contribution of renewable energy to the total supply.
- (v) APS5, combines APS1, APS2, and APS3 into a single scenario.

Table 10.1 Assumption of Annual Average Growth of Gross Domestic Product and Population

| Projection period | GDP growth | Population growth |
|-------------------|------------|-------------------|
| 2019–2020 | 0.5% | |
| 2020–2030 | 3.9% | 1.5% |
| 2030–2050 | 5.7% | |

GDP = gross domestic product.

Source: World Bank, World Development Indicators.

¹ The APS 4, which promotes nuclear power generation, is omitted because there is no nuclear power plan.

3. Outlook Results

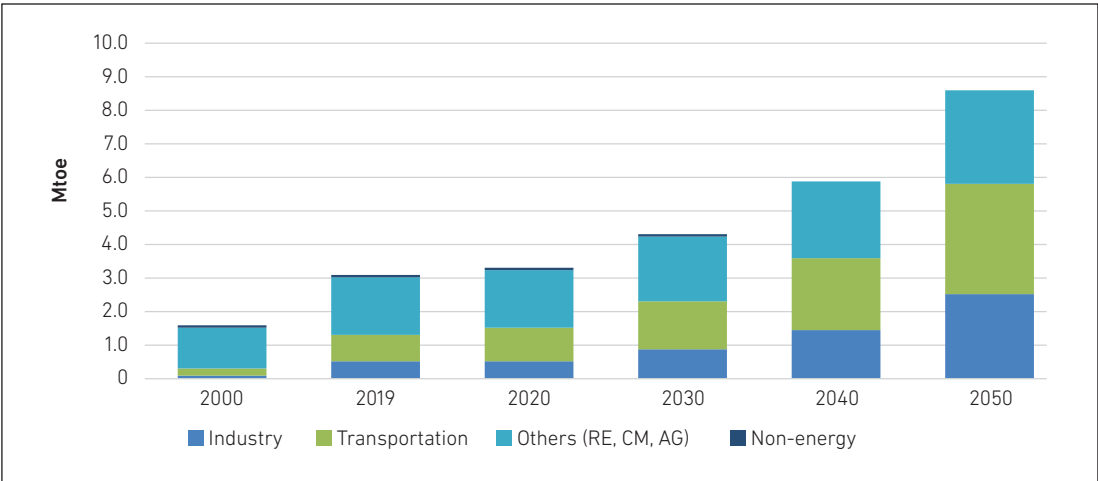
3.1. Business-As-Usual Scenario

3.1.1. Final Energy Consumption

In Lao PDR, the final energy mix comprises coal, oil, electricity, and 'others'. The country's TFEC increased from 1.51 Mtoe in 2000 to 3 Mtoe in 2019, an average annual growth rate (AAGR) of 3.7%. This growth will continue at a rate of 8.2% in 2019–2020, 2.6% in 2020–2030, 3.4% in 2030–2040, and 3.8% in 2040–2050. From 2019 to 2050, this growth will increase at a constant rate of 3.5% per year.

With respect to final energy consumption by sector, like other Southeast Asian countries, the four main sectors in Lao PDR are industry, transport, others, and non-energy. 'Others' covers subsectors such as residential, agriculture, services, and commerce. During 2000–2019, the industry sector grew the fastest, at a rate of 10% per year, followed by the transport sector at 6.2% per year, and the 'others' sector at 1.9% per year. Industry's high growth rate is expected to continue from 2019–2050 at 5.4% per year (Figure 10.3 and Figure 10.4).

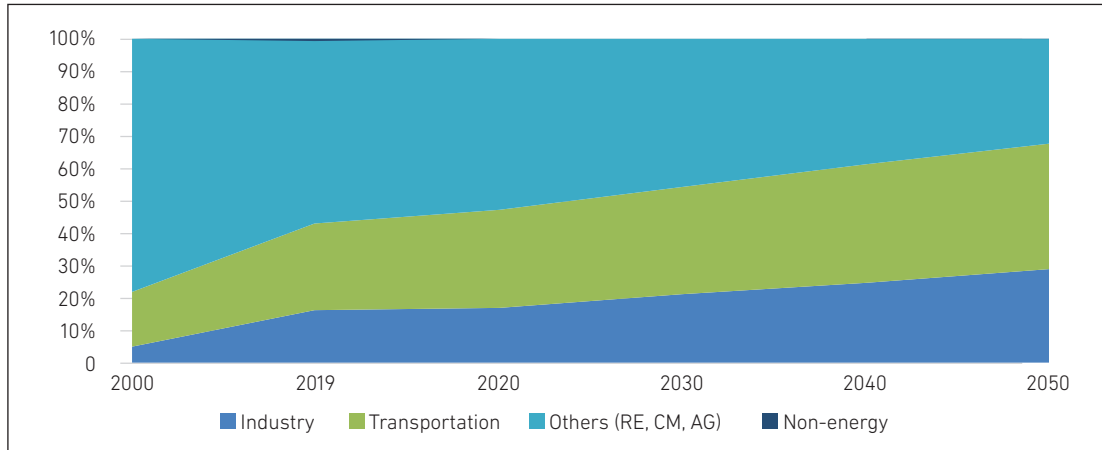
Figure 10.3 Final Energy Consumption by Sector, 2000–2050
(Mtoe)



AG = agriculture, CM = commerce, Mtoe = million tonnes of oil equivalent, RE = residential.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

Figure 10.4 Sectors' Share in Final Energy Consumption
(%)

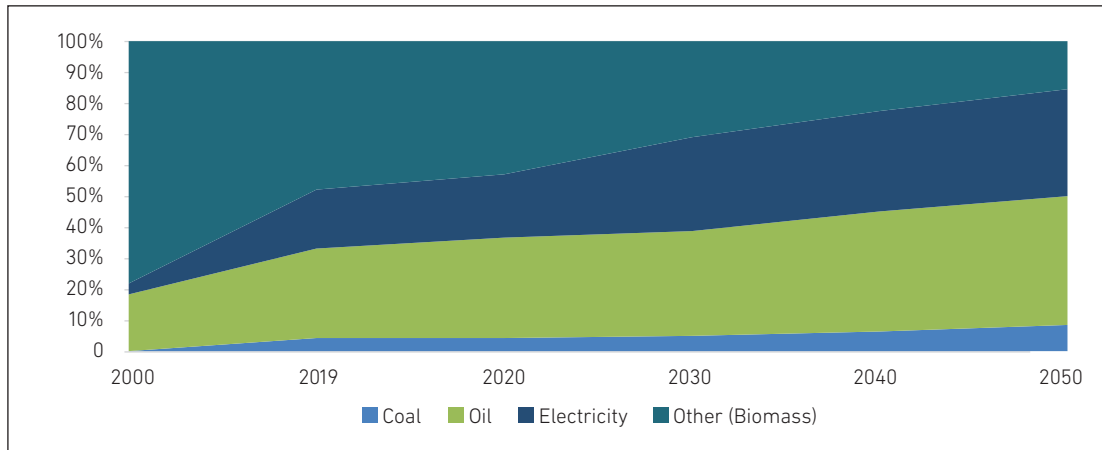


AG = agriculture, CM = commerce, RE = residential.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

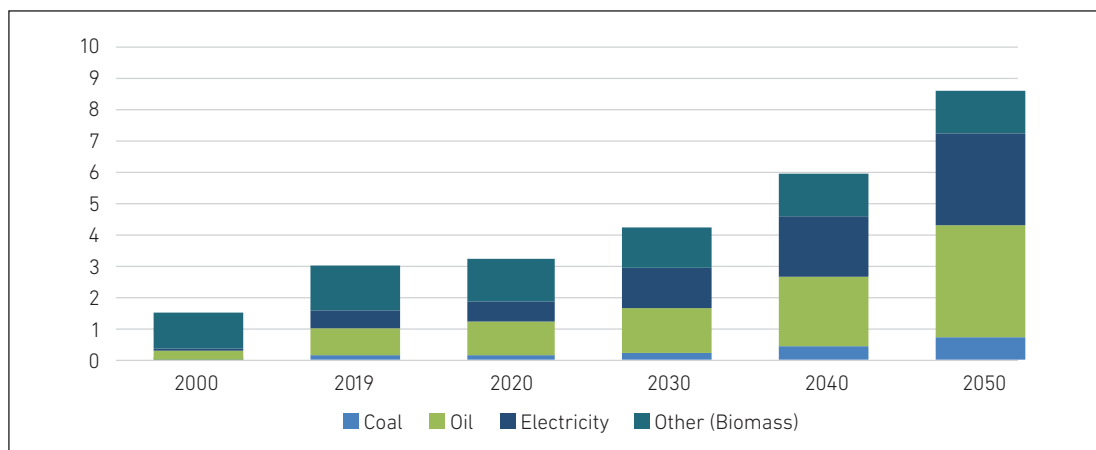
In terms of energy types, 'others' (biomass, consisting of wood and charcoal, and solar) was the most frequently used in 2019, reaching 1.43 Mtoe, representing 47.6% of the TFEC (Figure 10.6). This is expected to decrease to 15.7% by 2050. Oil will become dominant in 2030–2050 and electricity will come second during 2040–2050. 'Others' (including biomass) is expected to be dominant until 2028 due to the reliance of rural Lao people on wood for cooking (Figure 10.5). Although less convenient, wood remains cost-effective compared to other energy options. However, biomass consumption is expected to decline slightly after 2028 as LPG and electric equipment replace it.

Figure 10.5 Fuels' Share of Total Final Energy Consumption
(%)



Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

Figure 10.6 Final Energy Consumption by Fuel Type
(Mtoe)



Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result –(Lao PDR_Template_BAU_APS_LCET August 2022).

Oil is an important energy source for Lao PDR because the entire transport sector depends on it. Oil prices directly affect the country's socioeconomic development, especially the cost of living and doing business in the country. However, unlike electricity and coal, oil is not produced domestically, and Lao PDR must import it from Thailand or Viet Nam. This keeps the country dependent on its neighbours. In this regard, it is necessary to observe and monitor this trend closely. Due to their reliance on imports, Lao PDR is expected to face an oil shortage with increased prices in mid-2022 amidst the global economic situation. In 2019, the country consumed 0.863 Mtoe of oil. While this is a decrease from 2018, demand is projected to increase from 0.863 Mtoe in 2019 to 3.56 Mtoe in 2050 (an AAGR of 4.7%), making it the third highest share relative to coal, electricity, and biomass during this period.

3.1.2. Primary Energy Supply

Lao PDR's energy primarily comes from coal, oil, hydropower, and 'others' (including biomass, solar, and electricity for export). Lao PDR's total primary energy supply (TPES) increased from 1.62 Mtoe in 2000 to 6.3 Mtoe in 2019, an AAGR of 7.4%. This growth is expected to decrease steadily at a rate of 0.1% per year from 2019–2020. The TPES growth rate is projected to decrease steadily at a slower rate of 3.7% per year from 2019–2050.

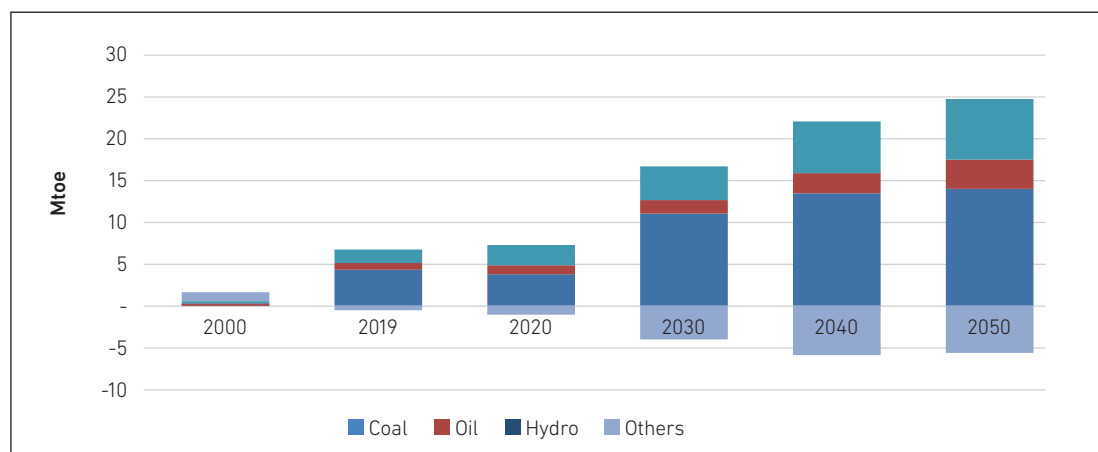
In 2019, coal was the most frequently used energy at 4.27 Mtoe, followed by hydropower at 1.73 Mtoe and biomass at 1.68 Mtoe. The Hongsa Plant is driving the high rate of coal consumption. Further, there are plans to construct coal power plants for exporting, which is expected to increase by 3.9% from 2019 to 2050. Therefore, coal's share of the TPES is projected to increase from 67.7% in 2019 to 73.3% in 2050.

Hydropower generated 1.73 Mtoe (27.5% of the TFES) in 2019 and is expected to generate 7.23 Mtoe (37.7% of the TFES) in 2050. It is forecasted to grow at an AAGR of 4.7 % from 2019 to 2050 because Lao PDR has been developing hydropower projects intensively to meet increasing domestic and export demands.

Biomass is frequently used in Lao PDR because it is a cheap fuel for cooking and is therefore the primary fuel used by rural people. The amount of biomass used has increased from 1.26 Mtoe in 2000 to 1.68 Mtoe in 2019 and is projected to increase to 1.96 Mtoe by 2050. Similar to projections regarding the share of biomass in the final energy mix, biomass as a share of primary energy is also estimated to increase by 0.5% during 2019–2050.

Oil is also experiencing high growth in Lao PDR because many people can now afford to buy private cars, significantly raising the number of vehicles. As of 2019, Lao PDR did not produce crude oil. All oil products are imported. There are 11 oil import and export companies and 12 oil distribution companies authorised within Lao PDR. In 2000, 0.27 Mtoe of oil was used, accounting for 16.8% of the TPES. This increased to 0.86 Mtoe (13.7 % of the TPES) in 2019, an AAGR of 6.3%, during 2000–2019. From 2019 to 2050, oil consumption is projected to grow at an AAGR of 4.7%, while oil will account for 18.6% of the TPES in 2050.

Figure 10.7 Primary Energy Supply
(Mtoe)



Hydro = hydropower, Mtoe = million tonnes of oil equivalent.

Source: The Lao People’s Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

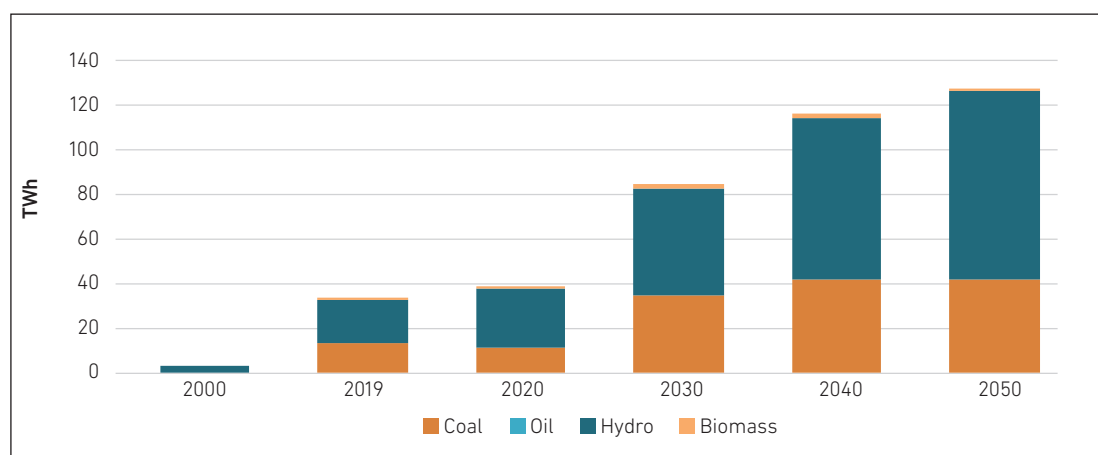
3.1.3. Power Generation

The history of power generation in Lao PDR can be divided into two periods: (i) 1970–2015, when all power was generated from hydropower sources and (ii) after 2015, when the Hongsa Coal Fired Power Plant began operating.

In 1990, Lao PDR only produced 0.82 terawatt hours (TWh) of electricity; this increased to 3.51 TWh in 2000 and 20.14 TWh in 2019. This is forecasted to increase to 84 TWh by 2050. Power generation outputs are also estimated to rise dramatically from 2019 to 2050, at an AAGR of 4.6%. The inauguration of the first thermal power plant in 2015 changed the power generation mix in Lao PDR (see Figure 10.8 for 2019 data).

In 2019, hydropower accounted for 59.7% of total generation and the Hongsa Plant accounted for 38.4%, with the remaining 0.2% coming from solar and biomass. Hydropower is forecasted to continue to dominate Lao PDR's power sector, accounting for 62.1% of total generation by 2050, while the Hongsa Plant's share is projected at 30.9%.

Figure 10.8 Electricity Generation 2050
(TWh)



Hydro = hydropower, TWh = terawatt-hour.

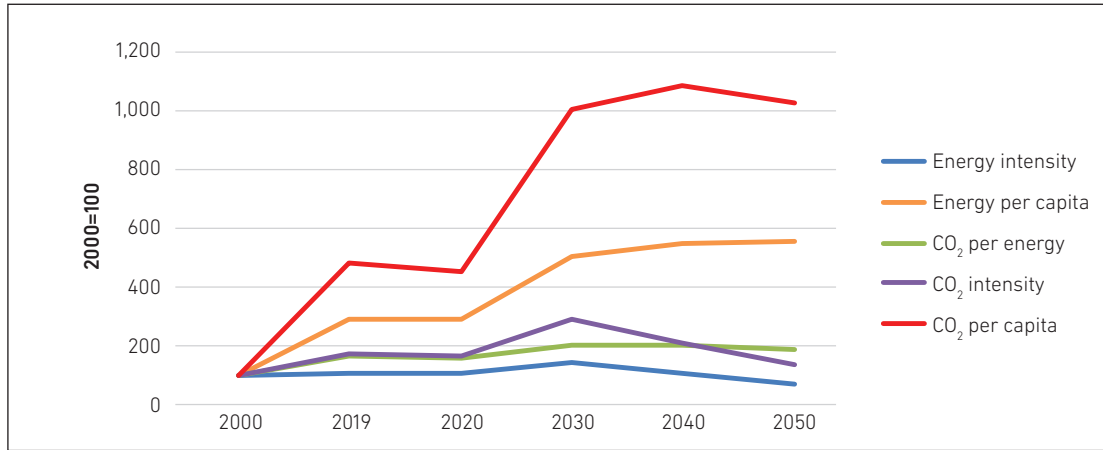
Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.1.4. Energy Indicators

Lao PDR's primary energy intensity (TPES/GDP) increased from 325 tonnes of oil equivalent per million dollars (toe/\$ million) to 341 toe/\$ million in 2019 because of steadily increasing coal consumption by the Hongsa Plant; this is expected to decline to 137 toe/\$ million by 2050.² The final energy intensity is projected to decline further to 85 toe/\$ million by 2050. This indicates that energy consumers are implementing energy efficiency and conservation programmes.

² All United States dollars in this report are in constant 2010 values unless specified.

Figure 10.9 Energy Intensity and Other Energy Indicators (2000 = 100)



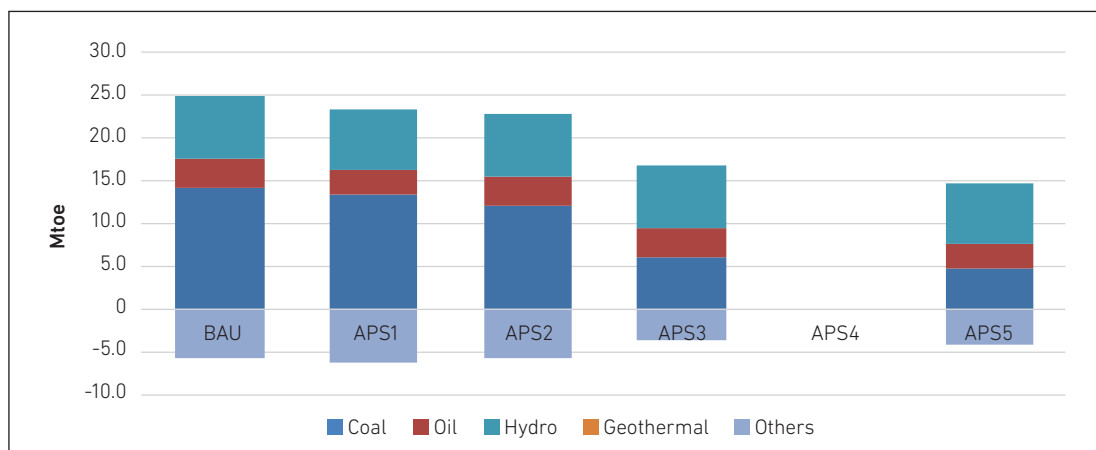
CO₂ = carbon dioxide.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.2. Energy Saving and Carbon Dioxide Reduction Potential (Alternative Policy Scenario)

As outlined above, this study considers four APSs with respect to Lao PDR's energy saving and CO₂ reduction potential: energy efficiency and conservation (APS 1), improved efficiency of the thermal power generation plant (APS 2), development of renewable energy (APS 3), and a combination of APSs 1, 2, and 3 (APS 5). Under these four APSs, various changes can be observed as shown in Figure 10.10. Under APS 1 the TPES decreases by 2.15 Mtoe (from 19.1 Mtoe to 17 Mtoe) compared with BAU. Under APS 2, more efficient thermal power generation reduces the TPES by 2 Mtoe. Under APS 3, replacing coal power generation with wind, solar will decrease the TPES from 19.1 Mtoe under BAU to 13.3 Mtoe. APS 5 combines the total reductions projected for APSs 1, 2, and 3. These reductions in the TPES mainly come from the targeted energy savings of 10%, followed by replacing coal power generation with renewable energy and improving the efficiency of thermal power generation.

Figure 10.10 Comparison of Scenarios, Total Primary Energy Supply, 2050
(Mtoe)

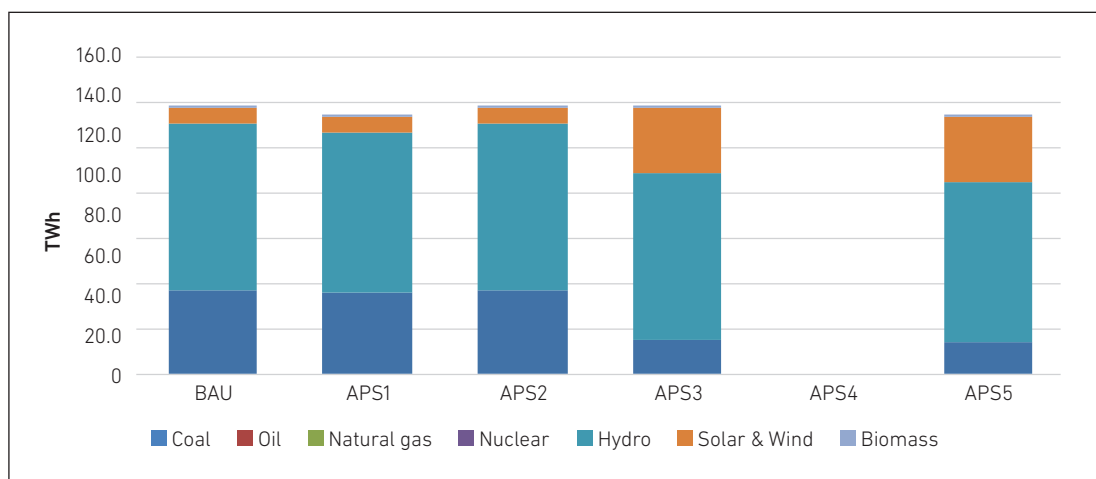


APS = alternative policy scenario, BAU = business as usual, Hydro = hydropower, Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

For electricity generation in the APS5 scenario (Figure 10.11), generation from hydropower is the largest (80.98 TWh), followed by solar and wind (32.26 TWh), coal (15.95 TWh), and biomass (1.38 TWh).

Figure 10.11 Comparison of Scenarios for Electricity Generation, 2050
(TWh)

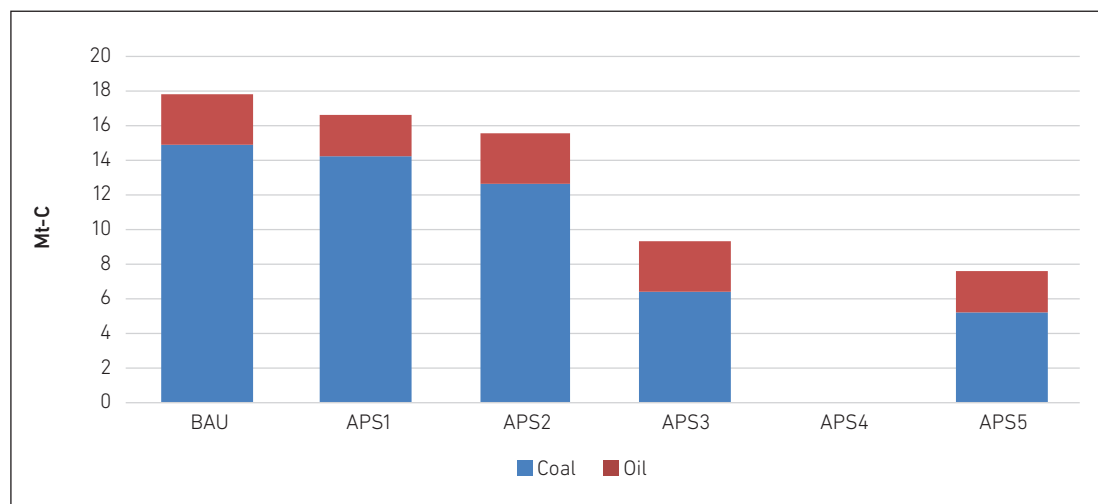


APS = alternative policy scenario, BAU = business-as-usual, Hydro = hydropower, TWh = terawatt-hour.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

Comparing projected levels of CO₂ emissions across these five scenarios reveals that APS 5 will eliminate 8.5 million tonnes of carbon (Mt-C), followed by APS 2 at 2.2 Mt-C, and APS 1 at 1.2 Mt-C. In total, this study projects that APS 5 will reduce total CO₂ emissions by 10.3 Mt-C, from 17.8 Mt-C of BAU to 7.51 Mt-C by 2050 (Figure 10.12).

Figure 10.12 Comparison of Scenarios, 2050
(Mt-C)



APS = alternative policy scenario, BAU = business as usual, Mt-C = million tonnes of carbon.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

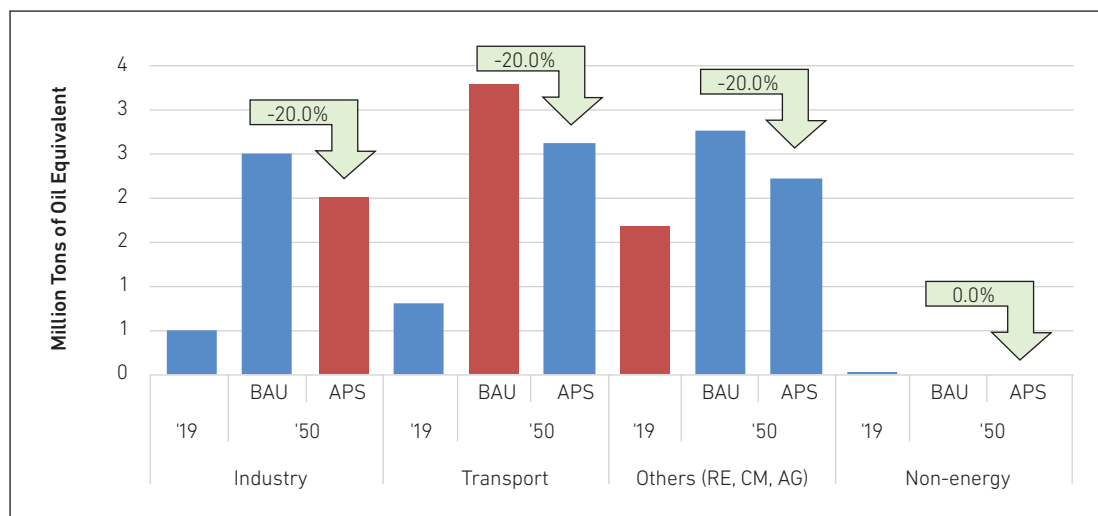
With respect to trends of final energy consumption under BAU and in the APSs in each sector, the model yields that in APS 1, final energy consumption is expected to increase from 3 Mtoe in 2019 to 6.86 Mtoe in 2050. Under BAU, from 2019 to 2030, the 'other' sector will be the largest consumer in 2030, consuming 1.93 Mtoe, or 45.8% of the TFEC energy, increasing to the second largest by 2050 with a consumption of 2.78 Mtoe (32.4%). Transport is the second largest consumer in 2030 with 1.38 Mtoe (32.8%) but is projected become the largest consumer by 2050 with 3.29 Mtoe (38.3%). The industry sector will show the highest increase in energy consumption, with a growth rate of 5.4% from 2019 to 2050, making it the third largest consumer by 2050.

The APS 1 is expected to realise energy savings of 10% of the TFEC by 2030 and another 10% by 2050, with all sector consumption decreasing by 10% compared to BAU. In APS 2, under which the efficiency of thermal power generation will improve, the results are still the same as under BAU, and final energy consumption is not affected. In APS 3, replacing coal with solar and wind will reduce primary consumption of fossil fuels and increase the use of renewable energy. Therefore, this scenario does not affect final energy consumption, which remains the same as in BAU.

Although APS 5 is a combination of APSs 1, 2, and 3, its effect is the same as that of APS 1, that is, each sector's final consumption reduced by 10 % in 2030 and expected increase of energy saving reduction of 20% in 2050.

The final energy consumption by sector (Figure 10.13) shows that a significant reduction in energy consumption of about 20% from BAU to APS is expected for industry, transport, and others.

Figure 10.13 Final Energy Consumption by Sector, Business as Usual and Alternative Policy Scenario 5 (Mtoe)



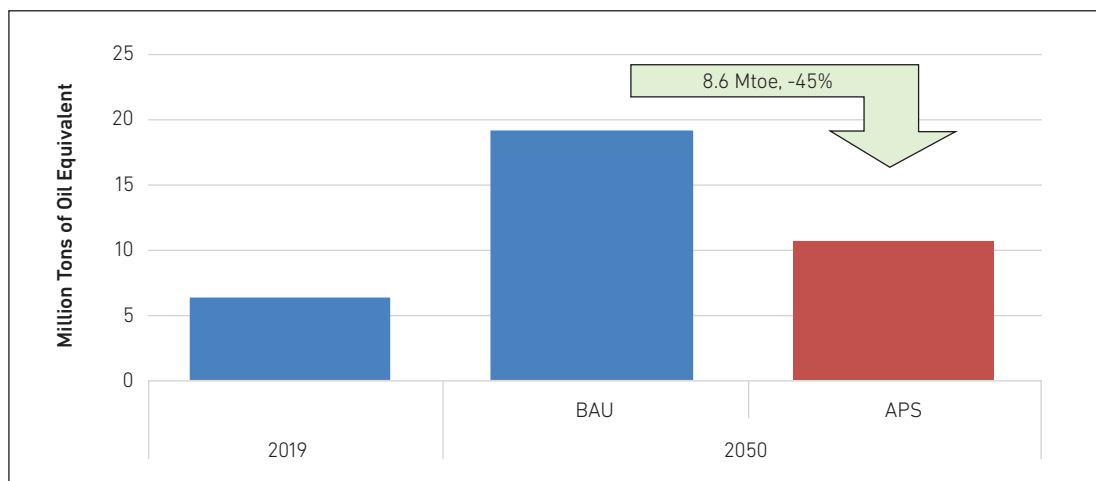
AG = agriculture; APS = alternative policy scenario; BAU = business as usual; CM = commerce; Mtoe = million tonnes of oil equivalent; RE = residential.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.2.1. Projected Energy Savings

By 2050, primary energy is expected to decrease by 8.61 Mtoe or 45% from BAU to the APS 5 level (Figure 10.14). This decrease in the TPES is due to the 20% reduction in energy consumption as well as the shift to renewable electricity such as solar photovoltaics from 2019 to 2050.

Figure 10.14 Total Primary Energy Demand, Business as Usual and Alternative Policy Scenario 5 (Mtoe)



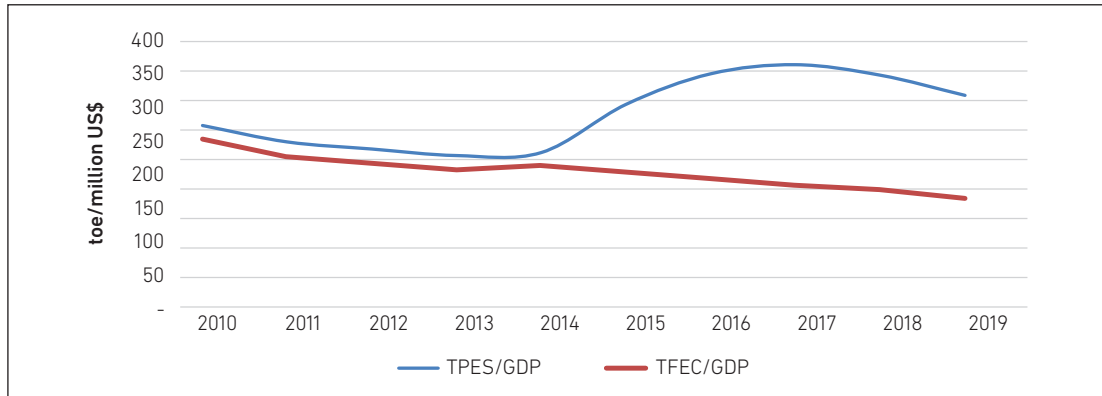
APS = alternative policy scenario, BAU = business as usual, Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.2.2. Energy Intensity

Energy intensity is defined as the TPES divided by GDP. Figure 10.15 below shows that growth decreased to 3.9% from 2010 to 2014, increased to 16.2% through 2017, and decreased again to 6.5% from 2017 to 2019. This indicates that energy intensity increased from 273 toe/\$ million in 2010 to 318 toe/\$ million in 2019 as a result of the Hongsa Power Plant beginning operations in 2015. Coal consumption also increased rapidly due to its lower thermal efficiency (less than 30%). On the other hand, the final energy consumption intensity (TFEC/GDP) showed a declining trend due to the decreased use of biomass from 251.3 toe/\$ million to 163 toe/\$ million during the same period.

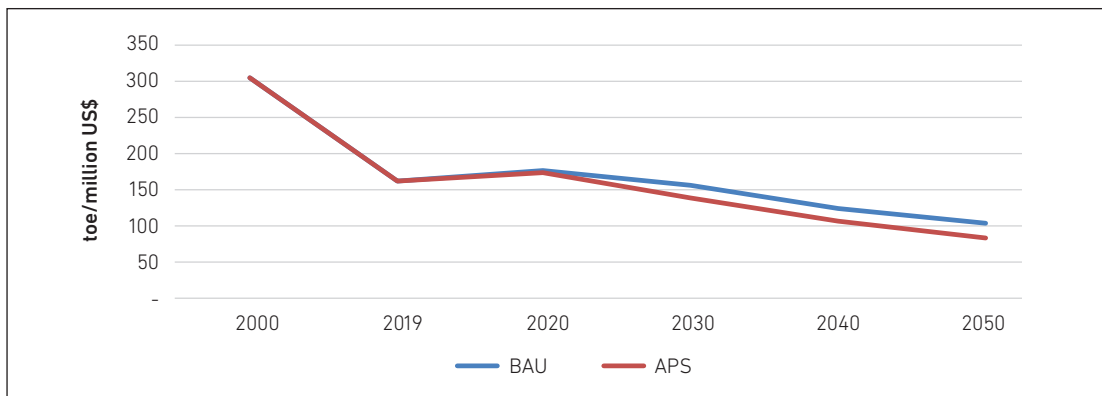
Figure 10.15 Energy Intensity, 2010–2019
(toe/million US\$)



GDP = gross domestic product, toe = tonnes of oil equivalent, TFEC = total final energy consumption, TPES = total primary energy supply.
Source: The Lao People’s Democratic Republic, Department of Energy Policy and Planning (2019), Lao Energy Balance Table Collection Historical. 14 August.

As Lao PDR endeavours to promote sustainable development and make its economy more efficient and competitive, final and primary energy intensities is significantly reduced. The final energy intensity is projected to decrease from 162 toe/million US\$ in 2019 to 104 toe/million US\$ by 2050. As Figure 10.16 shows, the final energy intensity in APS 5 is less than under BAU due to the implementation of the energy savings in APS 1.

Figure 10.16 Final Energy Intensity, Business as Usual and Alternative Policy Scenario 5
(toe/million US\$)

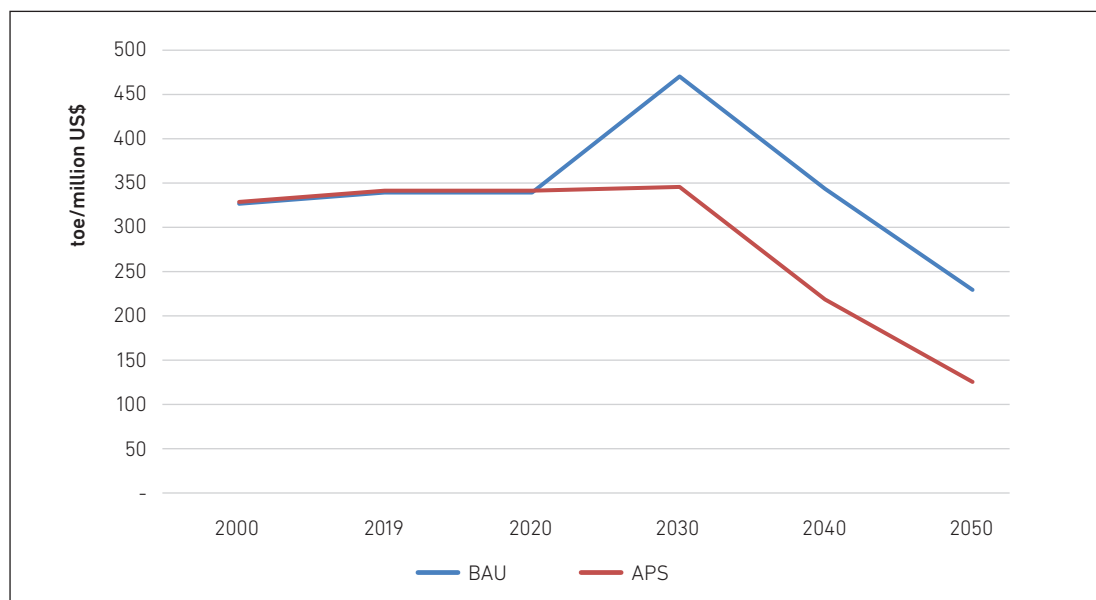


APS = alternative policy scenario, BAU = business as usual, toe = tonnes of oil equivalent.

Source: The Lao People’s Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

The primary energy intensity is also expected to decline from 341 toe/million US\$ in 2019 to 231 toe/million US\$ by 2050. As shown in Figure 10.17, in APS 5 the primary energy intensity is expected to decline more than 37 % from BAU, from 341 toe/million US\$ to 127 toe/million US\$ by 2050 due to energy savings, improved efficiency of thermal power generation, and the replacement of coal power generation with solar and wind. Therefore, the primary energy intensity will improve in the future.

Figure 10.17 Primary Energy Intensity — Business as Usual and Alternative Policy Scenario 5
(toe/million US\$)



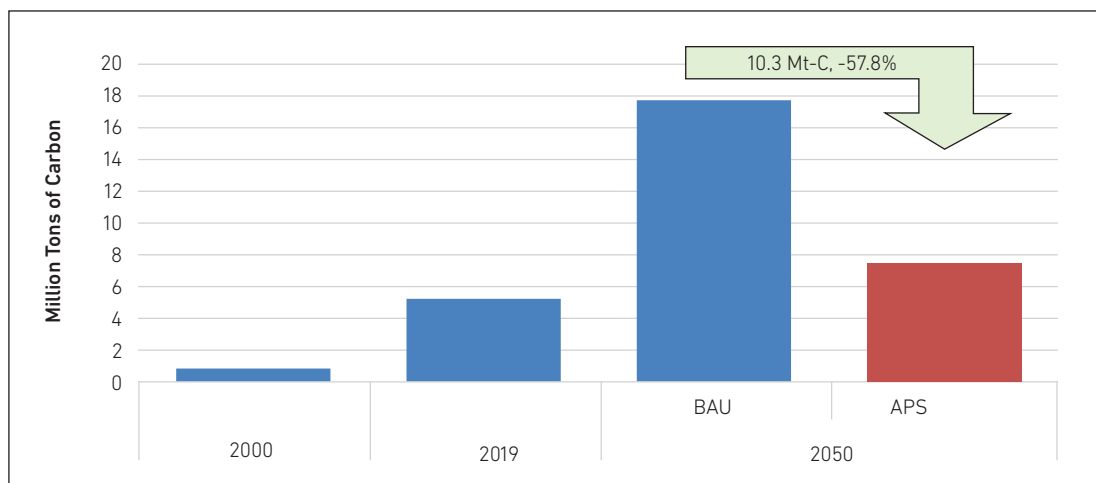
APS = alternative policy scenario, BAU = business as usual, toe = tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.2.3. Carbon Dioxide Emissions from Energy Consumption

Carbon dioxide emissions from energy consumption are projected to decrease by 57.8% from 17.8 Mt-C under BAU to 7.5 Mt-C in APS 5 due to the implementation of APSs 1, 2, and 3. By 2050, it is expected that APS 1 will reduce CO₂ emissions by around 1.2 Mt-C or 7% from BAU, APS 2 by 2.2 Mt-C or 12%, and APS 3 by 8.5 Mt-C or 48%.

Figure 10.18 Carbon Dioxide Emissions from Energy Combustion, Business as Usual vs Alternative Policy Scenario 5 (Mt-C)



APS = alternative policy scenario, BAU = business as usual, Mt-C = million tonnes of carbon.

Source: The Lao People’s Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.3. Low Carbon Energy Transition Scenario (Carbon Neutral)

Low Carbon Energy Transition (LCET) Scenario aims to see the impact of clean fuel, renewables, and new technologies to support energy transition towards carbon neutrality. A concept of carbon neutral was formalised to observe how economies can achieve environmentally sustainable development. Based on the National Determined Contribution (NDC) and Biennial Update Report (BUR) of the Department of Climate Change, Ministry of Natural Resources and Environment, the Land Use, land use Change & Forestry (LULUCF) had the capacity to remove around 13,000 kt-CO₂e (thousand tonnes of carbon dioxide equivalent) in 2014. Table 10.2 shows the potential removals of LULUCF under the LCET scenario from 2020 until 2050.

Table 10.2 Potential Removals, Land Use Change & Forestry, Low Carbon Energy Transition Scenario, 2020–2050

| Year | Removals (Mt-CO ₂ e) | Removals (Mt-CO ₂ e) |
|------|---------------------------------|---------------------------------|
| 2020 | 5.32 | 1.45 |
| 2030 | 20.80 | 5.68 |
| 2040 | 18.38 | 5.02 |
| 2050 | 7.20 | 1.97 |

Mt-CO₂e = million tonnes of carbon dioxide equivalent.

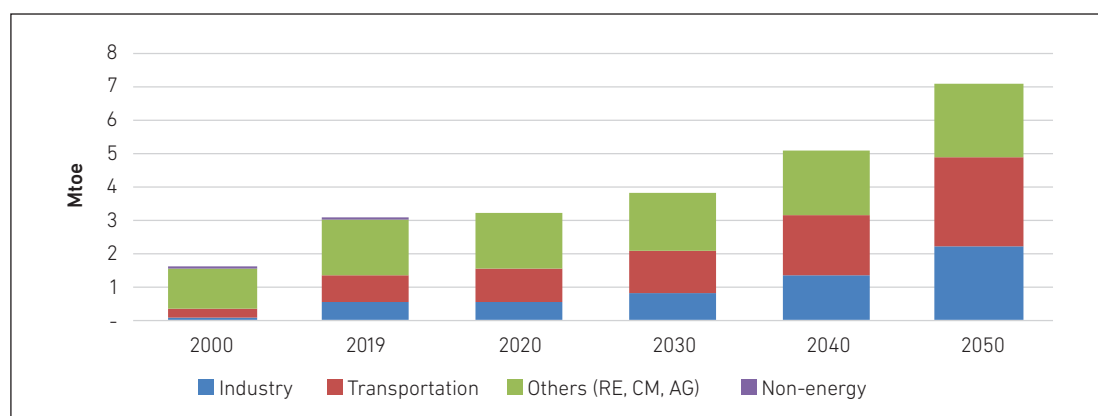
Source: The Lao People’s Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

Lao PDR aims to reduce CO₂ emissions and meet both domestic and export demands through power development. The LCET scenario considered the exiting APS scenario and add other options including the increase of hydropower development to meet full hydro's install capacity potential; the fuel switching from coal to natural gas and any substitution from fossil fuel to clean fuel and hydrogen or ammonia.

3.3.1. Final Energy Consumption by Sector

For the final energy consumption, transportation is expected to have the largest energy consumption (2.6 Mtoe), followed by industry (2.2 Mtoe), and Others (2.2 Mtoe) in 2050. (Figure 10.19).

Figure 10.19 Final Energy Consumption by Sector, Low Carbon Energy Transition Scenario, 2000–2050
(Mtoe)

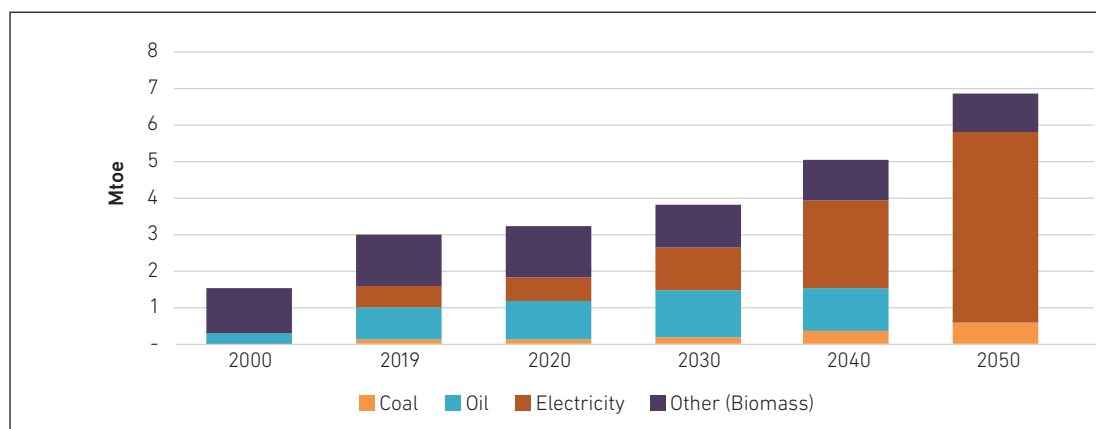


AG = agriculture; CM = commerce; LCET = low carbon energy transition scenario; Mtoe = million tonnes of oil equivalent; RE = residential.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

Electricity is predicted to be the largest energy source, contributing 5.19 Mtoe (73.6%) in the final energy consumption by 2050 (Figure 10.20). The annual growth rate of electricity during 2019–2050 is estimated to be 7.4%. In terms of energy types, 'others' (biomass, consisting of wood and charcoal), solar, and wind are included in this energy type in this scenario, consuming 1.08 Mtoe (15.3%), making it the second largest energy source by 2050. Coal will remain in the energy mix in BAU as the country has already committed to providing electricity from coal to neighbouring countries, as well as for domestic use in the dry season. Coal is predicted to contribute 0.58 Mtoe (8.3%), making it the third largest energy source by 2050. In 2030, oil consumption will be 1.30 Mtoe, making it dominant in 2030. However, it will reduce to 0.01 Mtoe (0.1%) by 2050.

Figure 10.20 Final Energy Consumption by Fuel, Low Carbon Energy Transition Scenario, 2000–2050 (Mtoe)



LCET = low carbon energy transition scenario, Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.3.2. Primary Energy Supply

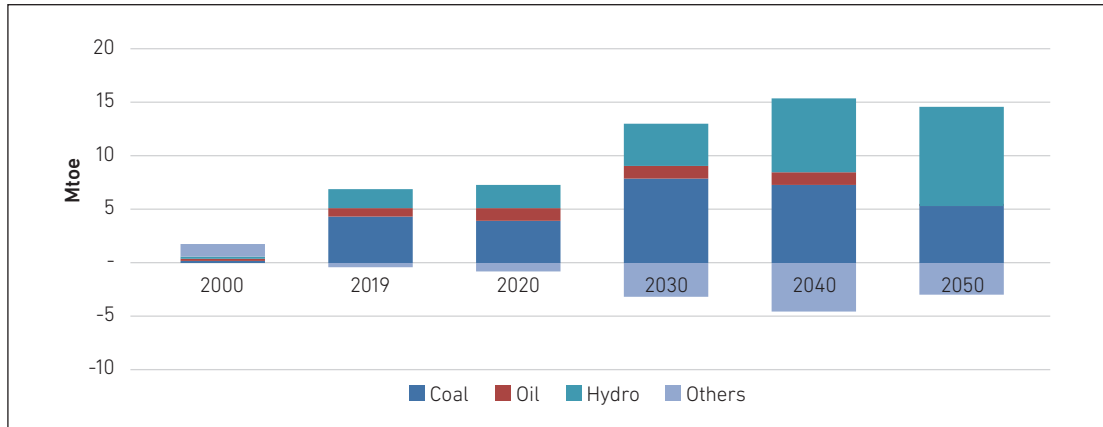
Total primary energy supply consists of coal, oil, hydropower, and 'others' (including biomass, solar, wind, and electricity for export) and will increase from 6.3 Mtoe in 2019 to 11.38 Mtoe in 2050, an AAGR of 1.9 % per year. This growth is expected to decrease at an annual rate of 0.3% from 2019 to 2020 and increase again at an annual rate of 4.4% from 2020 to 2030.

Coal was the most frequently used energy at 4.27 Mtoe (67.7%) in 2019, followed by hydropower at 1.73 Mtoe (27.5%) and others (biomass) at 1.68 Mtoe. In 2050, coal still remains dominant as it increases to 5.20 Mtoe. The share of coal will decrease from 67.7% in 2019 to 45.7% in 2050 due to the share of other sources of power production.

Hydropower is expected to generate 9.20 Mtoe (80.8% of the TFES) in 2050. It is forecasted to grow at an AAGR of 5.5% from 2019 to 2050 because Lao PDR has been developing hydropower projects intensively to meet increasing domestic demand and export more to its neighbours according to their commitment and cooperation.

In terms of 'others', biomass remains the same under BAU and LCET scenarios. It is projected to increase from 1.68 Mtoe in 2019 to 1.72 Mtoe in 2050. Similar to projections regarding the share of biomass in the final energy mix, biomass as a share of primary energy is also estimated to increase by 0.1% during 2019–2050. The share of solar in the TPES is minimal in 2018. Wind is expected to increase to 1.22 Mtoe (12.6%) in 2030 and 2.29 Mtoe (26.2%) in 2050. Wind is forecasted to grow at an AAGR of 22.4% from 2019 to 2050. Oil consumption is projected to be 0.86 Mtoe (13.7 % of the TPES) in 2019, and to 0.01 Mtoe (0.1%) in 2050, an average decrease rate of 14% during 2019–2050.

Figure 10.21 Primary Energy Supply by Fuel, Low Carbon Energy Transition Scenario, 2000–2050 (Mtoe)



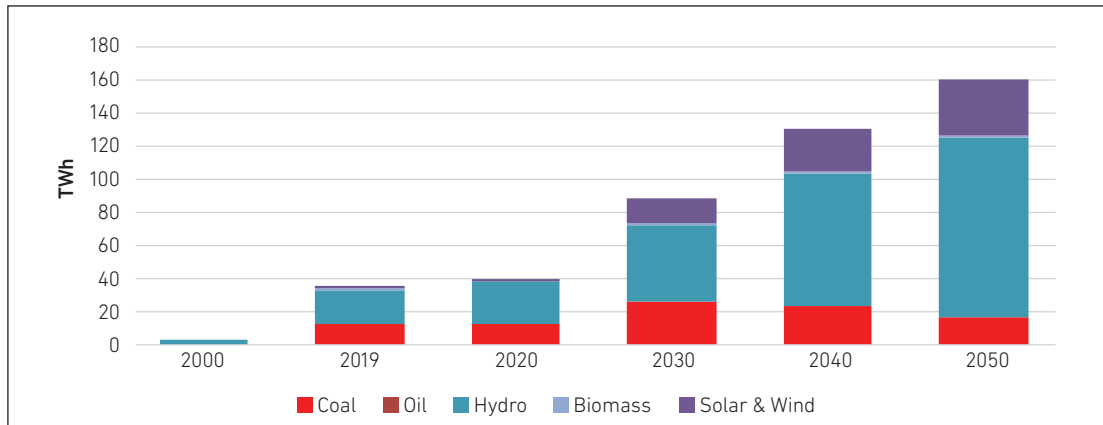
LCET = low carbon energy transition scenario, Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.3.3. Power Generation

In 2019, power generation was at 33.75 TWh. It is forecasted to increase to 160.41 TWh by 2050, at an AAGR of 5.2%. The inauguration of the first thermal power plant in 2015 changed the power generation mix in Lao PDR (see Figure 10.22 for data from 2019). In 2050, hydropower will account for 66.7% of total generation and the thermal power plant will account for 10.7%, with the remaining coming from solar (14.9%), wind (6.8%), and biomass (0.9%).

Figure 10.22 Electricity Generation by Fuel, Low Carbon Energy Transition Scenario, 2000–2050 (TWh)



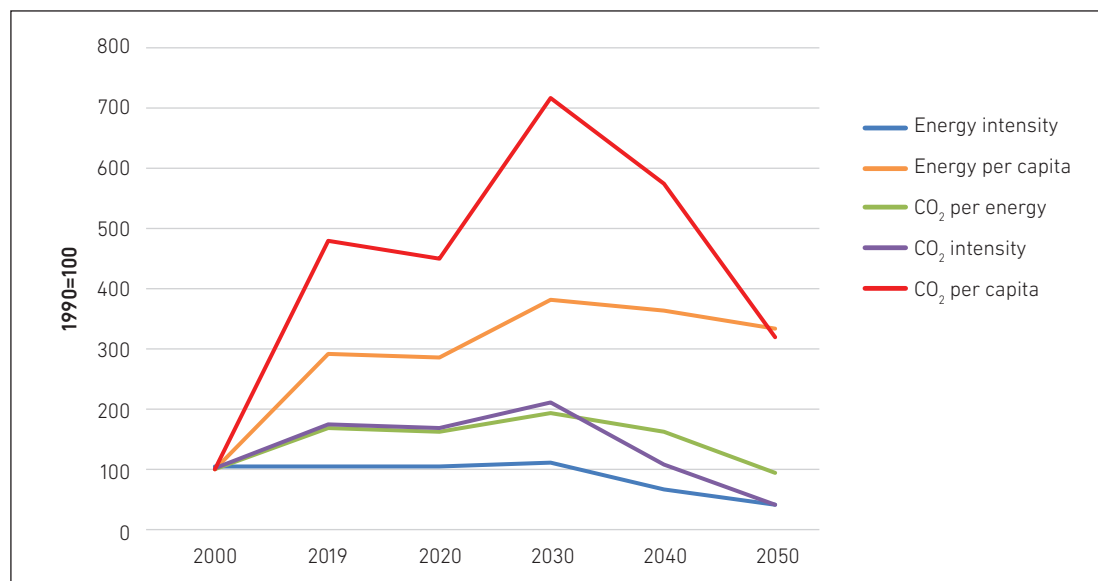
LCET = low carbon energy transition scenario, TWh = terawatt-hour.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.3.4. Energy Indicators

The primary energy intensity (TPES/GDP) is projected to decrease from 341 tonnes of oil equivalent per million dollars (toe/million US\$)³ in 2019 to 137 toe/million US\$ in 2050 because of steadily decreasing oil consumption, as well as increasing renewable energy and hydrogen. The final energy intensity is projected to decline further to 85 toe/million US\$ by 2050 (Figure 10.23).

Figure 10.23 Energy Indicators, Low Carbon Energy Transition Scenario, 2000–2050



CO₂ = carbon dioxide.

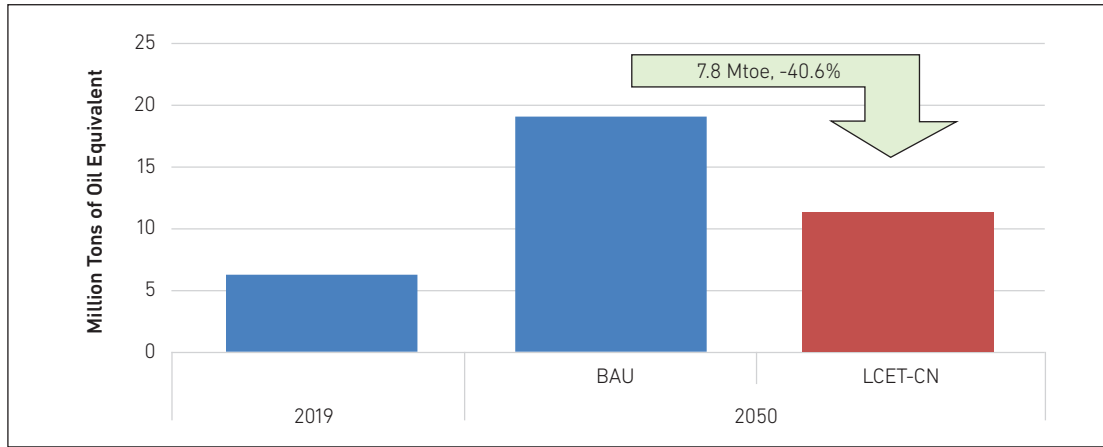
Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning (2019), Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

3.3.5. Fossil Fuel Consumption Savings and Carbon Dioxide Reduction

By 2050, primary energy is expected to decrease by 7.8 Mtoe or 40.6% from BAU to the LCET (Figure 10.24). This decrease in the TPES is due to the 10% reduction in energy consumption as well as the shift to renewable electricity such as solar photovoltaics from 2018 to 2050, wind from 2030–2050.

³ All United States dollars in this report are in constant 2010 values unless specified.

Figure 10.24 Primary Energy Supply, Business-as-Usual and Low Carbon Energy Transition Scenarios, 2019 and 2050
(Mtoe)

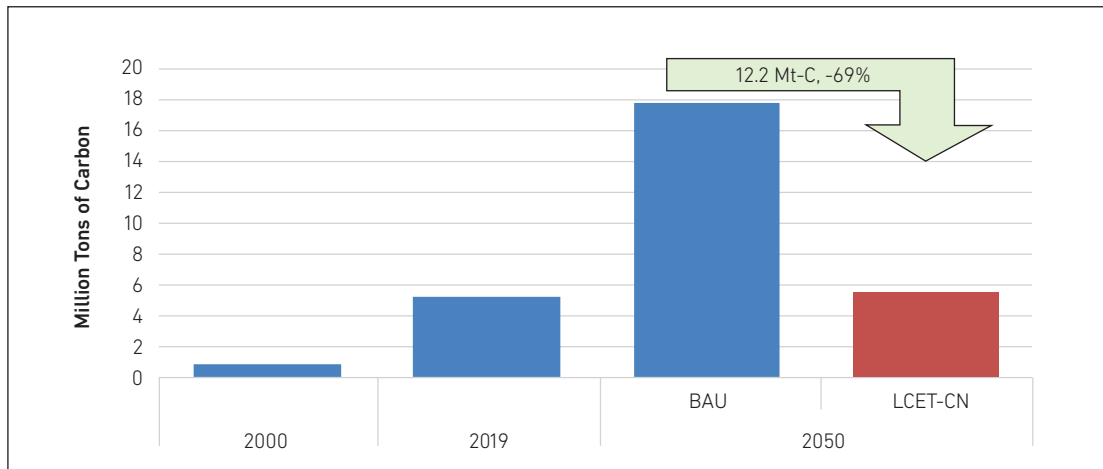


LCET = low carbon energy transition scenario, BAU = business as usual, Mtoe = million tonnes of oil equivalent.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

The CO₂ emissions from energy consumption are projected to decrease by 69% from 17.8 Mt-C under BAU to 7.5 Mt-C in LCET due to the implementation of APSs 1, 2, and 3 and fuel switching by 2050 (Figure 10.25).

Figure 10.25 Carbon Dioxide Emission Reduction, Business-as-Usual and Low Carbon Energy Transition Scenarios, 2000, 2019 and 2050
(Mt-C)



LCET = low carbon energy transition scenario, BAU = business as usual, Mt-C = million tonnes of carbon.

Source: The Lao People's Democratic Republic, Department of Energy Policy and Planning, Lao PDR Energy Outlook Result (Lao PDR_Template_BAU_APS_LCET August 2022).

4. Implications and Policy Recommendations

The purpose of LCET is to highlight energy efficiency and conservation, with a specific focus on achieving a 10% reduction in the TFEC. It seeks to explore ways to improve the efficiency of thermal power generation, promote the use of renewable energy sources, and decrease reliance on fossil fuels in the primary energy supply.

To reduce energy consumption for both TPES and TFEC and at the same time to reduce CO₂ emissions to meet NDC targets, Lao PDR will need to accelerate the share of renewable energy, especially the share of hydropower. The policy must also introduce more efficient technologies to reduce the TFEC by 20% by 2050. In order to reduce CO₂ emissions, Lao PDR may need to consider shifting from fossil fuel to electricity for all sector as much as possible. As these programmes are critical in reducing energy consumption, they should be proposed as an energy policy.

To conserve energy, the industry sector should take the lead by installing energy management systems; developing and implementing their own energy reduction plans; collaborating with the government to maintain energy security; and routinely conducting seminars on energy-efficient strategies. The transport sector should promote the use of public transportation in big cities and launch awareness campaigns about it. Other sectors should also help raise public understanding of energy conservation and follow energy management practices in building construction. In addition, more studies on how GDP rates correlate with energy consumption should be carried out, and the quality of energy statistics should be improved accordingly. Finally, the government should consider implementing the following actions:

- (i) Promote and implement energy efficiency and conservation programmes in all sectors.
- (ii) Establish a fund to support energy efficiency and conservation programmes and energy service companies.
- (iii) Promote clean coal technology to improve the efficiency of thermal power generation and reduce CO₂ emissions.
- (iv) Include the findings of this study in Lao PDR's energy policy and plan.
- (v) Promote electric vehicles, which can reduce oil imports as well as CO₂ emissions.
- (vi) Reform the electricity tariff regime to encourage more energy efficiency and conservation activities.
- (vii) Increase the share of coal thermal power generation in the power generation mix by using local coal and clean coal technology to ensure a stable supply of electricity.
- (viii) Promote a power generation mix of 67% hydropower, 11% thermal power, and 22% other sources (such as solar, wind, and biomass) from 2030 to 2050. Compared to the power generation mix of the National Power Development Strategy (NPDS). Hydropower still has the potential to be developed to meet the 75% target share. Coal is below the target at 14% of the share in the National Power Development Strategy (NPDS), but it is good for Lao PDR because it reduces CO₂ emissions. Other sources (solar, wind, and other forms of energy sources) have surpassed their target at 11% due to fuel switching. It's significant for Lao PDR to include these in the policy to be the pathway for investors to obtain financial guarantees from the bank for investment and the development of renewable energy.
- (ix) Carry out the feasibility study in detail on the integration of hydropower with renewable energy sources (solar, wind, and biomass) to understand the impact of high penetration of renewables into the power system.
- (x) Promote and expand power interconnection capacity and power trade through system-to-system transmission within ASEAN.

Reference

Department of Energy Policy and Planning (2020), *Summary of Power Generation Project of Lao PDR*.
Vientiane: Department of Energy Policy and Planning.