CHAPTER 16

# Thailand Country Report

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# 1. Background

Thailand is in the middle of the Southeast Asian mainland, with the Pacific Ocean on the southeast coast, and the Indian Ocean on the southwest coast. Its land area is approximately 513,115 square kilometres, with great plains at the centre, mountainous areas up north, and highlands in the northeast. Its gross domestic product (GDP) in 2019 was around $460.8 billion (in constant 2015 US$). In 2019, the population was 69.6 million and income per capita was around $6,620.

Thailand is an energy importer, especially crude oil, because of its very limited domestic oil resources. Thailand's indigenous energy resources include natural gas, coal (only lignite), and biomass. In 2019, proven reserves were 15.0 million cubic metres of oil and 0.14 trillion cubic metres of natural gas.

Thailand's total primary energy supply (TPES) reached 133.1 million tonnes of oil equivalent (Mtoe) in 2019. Oil accounted for the largest share at around 30.8%, followed by natural gas at 29.7%, and coal at 13.9%. 'Others', which includes the commercial and residential sectors, accounted for the remaining 25.6%. In 2019, net imports of energy accounted for 56% of the TPES. Due to very limited indigenous oil and coal resources, Thailand imported around 79% of its oil and most of its bituminous coal. Although Thailand produces large quantities of natural gas, it imported about 28% from Myanmar and other countries. Thailand uses natural gas as a major energy source for power generation. In 2019, primary natural gas supply registered at 28.6 Mtoe, around 72% of which was sourced from domestic supplies and the rest imported from neighbouring countries. Coal was mainly used for power generation, but it was also heavily used in industrial cement and paper production.

Thailand has 45.3 gigawatts (GW) of installed electricity generation capacity. In 2019, power generation was about 201.8 TWh. Most of Thailand's power came from thermal generation (coal, natural gas, and oil), which accounted for 82.8% of generation. Hydro contributed 10.1% to the generation mix, while the remaining portion was made up of geothermal, solar, small hydro, and biomass.

# 2. Modelling Assumptions

The annual GDP growth rate from 1990 to 2019 was a moderate 4.2% per year. For 2019–2050, an average GDP growth rate of 2.8% per year is assumed for Thailand. Population growth is also projected to be quite slow at around 0.5% per year between 2019 and 2050, which is comparable to average growth of about 0.5% per year between 1990 and 2019.

Efficiency programmes in all sectors are expected to help Thailand achieve its energy-saving goals. The industrial sector can improve energy efficiency through better manufacturing processes. Programmes promoting public awareness on energy efficiency and energy efficiency labelling would drive large energy savings in the residential and commercial sectors, which are included in the 'Others' category. In the transport sector, further development in the Bangkok metro area railway network would contribute to energy savings. The 30@30 programme, which aims to produce zero-emission vehicles (ZEV) comprising at least 30% total vehicle production by 2030, will encourage road-travel efficiency.

Thailand's government policies in 2022 not only continue to encourage the increased use of alternative fuels but also focus on carbon neutrality in 2050. Reductions in $CO_2$ emissions are also expected to be achieved through the increased adoption of more energy-efficient technologies. In particular, in the APS, renewable energy sources are expected to help reduce $CO_2$ emissions from electricity generation. Gasohol and biodiesel as oil alternatives are also expected to help curb $CO_2$ emissions from transportation. To achieve carbon neutrality by 2050, around 120 million tonnes of carbon dioxide (Mt-C) emissions will be able to offset the carbon sink in Thailand. This means that the energy sector is allocated a carbon emission quota of 100 Mt-C, out of the total quota.

# 3. Outlook Results

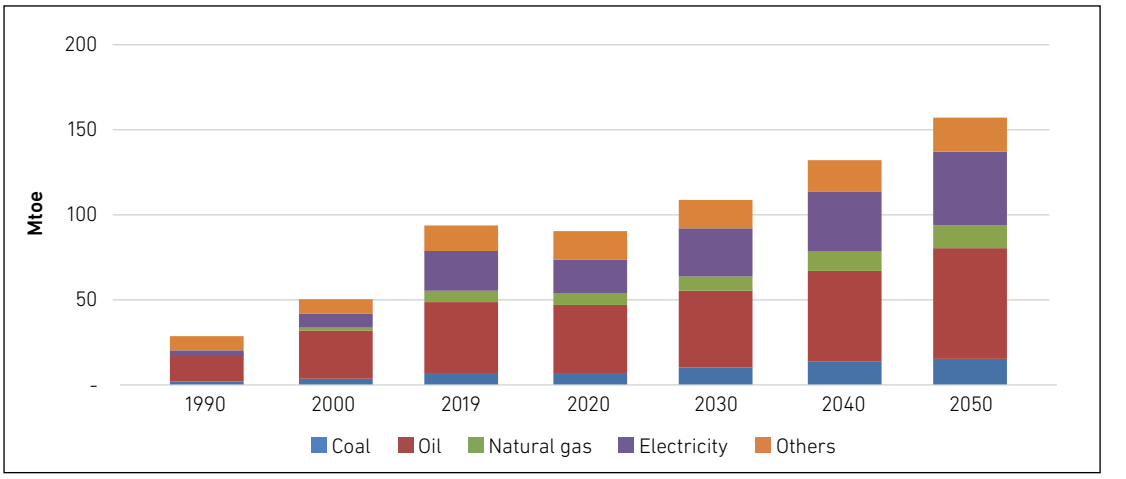
## 3.1. Business-as-Usual Scenario

### 3.1.1. Final Energy Consumption

Between 1990 and 2019, Thailand's final energy consumption grew at an average rate of 4.2% per year from 28.9 Mtoe in 1990 to 93.9 Mtoe in 2019 (Figure 16.1). Given moderate economic growth and a low population growth rate, final energy consumption is projected to grow at a slower rate of 1.7% per year between 2019 and 2050.

Oil has been the dominant fuel in Thailand's final energy consumption, accounting for 40.7 Mtoe, or a 43.4% share, in 2019. Electricity was the second-largest energy fuel, accounting for 22.7 Mtoe, or a 24.1% share, in 2019. Oil is expected to remain the largest final energy source throughout the projection period. Its share is expected to rise continuously from the 2019 to 40.9% in 2050. In 2050, the share of electricity in final energy consumption will be 27.5%, while coal will be 8.8%.

**Figure 16.1 Final Energy Consumption by Fuel, Business-as-Usual**
(Mtoe)




BAU = business-as-usual; Mtoe = million tonnes of oil equivalent.

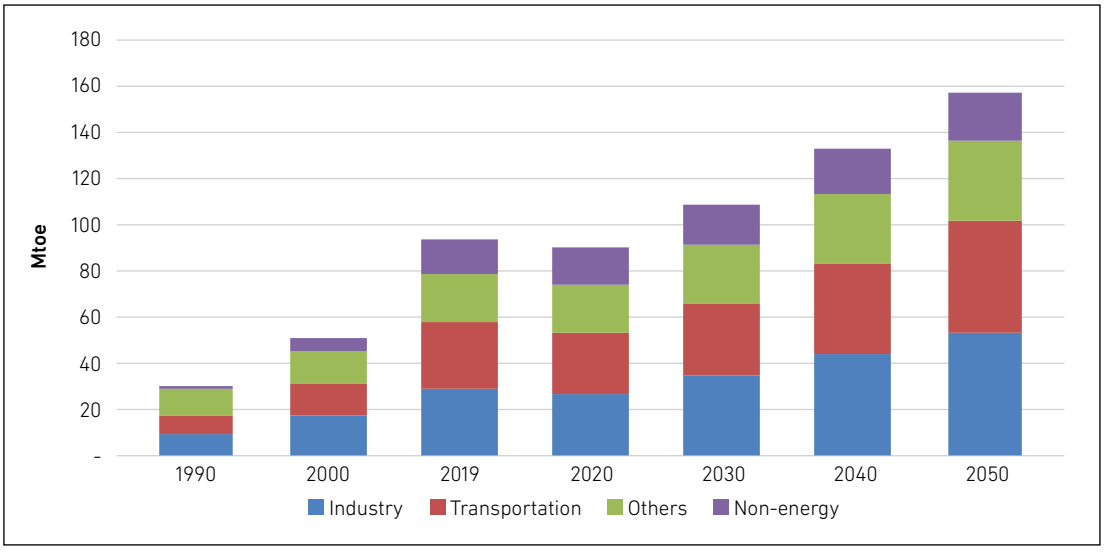
Source: Author's calculation.

In 1990, the share of industrial sector for Thailand's total final energy consumption was 30.%, equal to 8.7 Mtoe (Figure 16.2). The sector's demand grew by an average rate of 4.2% a year between 1990 and 2019, increasing its share to 30.6% (equivalent to 28.7 Mtoe) in 2019, making it the largest consuming sector. It is projected to remain the largest consumer, accounting for 33.6% (equivalent to 52.7 Mtoe) in 2050. In contrast, the 'Others' sector (mainly residential and commercial) will account for the smallest proportion of final energy consumption in 2050, at 21.8%, compared to its 37.3% share in 1990.

### 3.1.2. Primary Energy Supply

Primary energy supply grew at an average annual rate of 4.0% from 42.6 Mtoe in 1990 to 133.1 Mtoe in 2019, driven largely by fast economic development between 1990 and 1996. This growth in primary energy supply was achieved despite the severe economic crisis in 1997–1998 and the world economic crisis in 2008. In 2019, the major sources of primary energy were oil with a 30.8% (41.0 Mtoe) share; natural gas with 24.0% (39.6 Mtoe); and coal with12.3% (18.5 Mtoe).

**Figure 16.2 Final Energy Consumption by Sector, Business-as-Usual**
(Mtoe)




BAU = business-as-usual scenario; Mtoe = million tonnes of oil equivalent.

Note: 'Others' includes commercial and residential sectors.

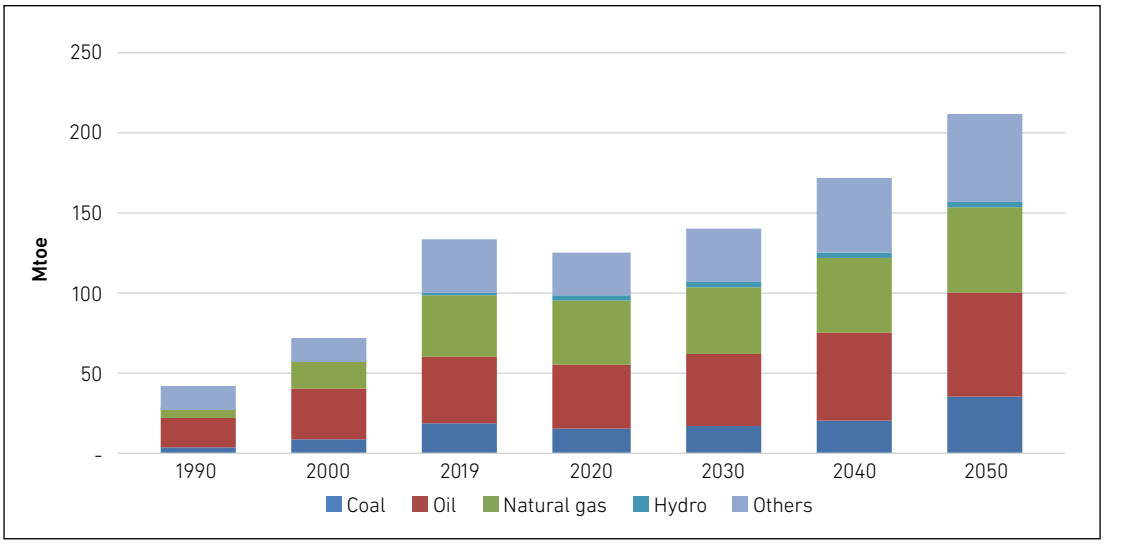
Source: Author's calculation.

Although oil remained the largest source between 1990 and 2019, its share in primary energy supply decreased from 42.8% in 1990 to 30.8% in 2019. Natural gas, which is mainly consumed in the power generation sector, became an important source of energy with its share in primary supply increasing from 11.9% in 1990 to 29.7% in 2019. The share of hydropower remained small at 1.0% in 1990 to 1.3% in 2019.

In the business-as-usual (BAU) scenario, primary energy supply is projected to grow by an average of 1.5% per year from 2019 to 2050, reaching 211.3 Mtoe in 2050 (Figure 16.3). The highest average annual growth rate is expected in coal (2.1%), with consumption projected to reach 35.2 Mtoe in 2050. Oil will follow at an annual average growth rate of 1.7%, reaching 64.4 Mtoe in 2050. Natural gas is projected to increase at an average rate of 1.0% per year. The share of oil will be almost the same around 30.5% in 2050, while the shares of coal and natural gas will be around 16.7% and 25.8%, respectively. Biomass is expected to grow at an average rate of 1.1% per year between 2019 and 2050.

The share of biomass in the total primary energy consumption will decline somewhat from 16.2% in 2019 to 14.2% in 2050.

**Figure 16.3 Primary Energy Supply by Fuel, Business-as-Usual**
(Mtoe)




BAU = Business-as-Usual; Mtoe = million tonnes of oil equivalent.

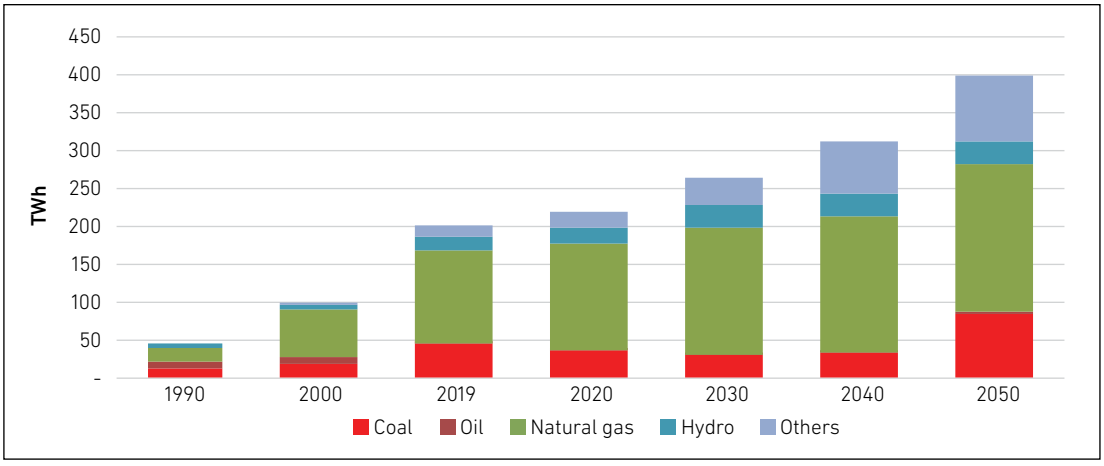
Source: Author's calculation.

### 3.1.3. Power Generation

In 1990, the total power generation was 44.2 TWh. It reached 201.8 TWh in 2019, with an average growth rate of 5.4% per year. As shown in Figure 16.4, natural gas has been a major fuel for power generation since 1990. Natural gas in power generation grew at a robust rate of 6.9% per year from 17.8 TWh (40.2% share) in 1990 to 121.4 TWh (60.2% share) in 2019. Coal had the second largest share at 25.0% in 1990 but dropped to 22.4% in 2019. Oil was the least used fuel in power generation, with only 0.4 TWh in 2019.

In the BAU scenario, power generation is expected to grow at around 2.2% per year from 2019 to 2050 and will reach 400.7 TWh in 2050. In 2050, natural gas will remain the dominant fuel used in power generation with the highest share of 49.5% or 198.2 TWh. Coal will remain the second largest source of power generation, with a share of 21.2% or a level of 85.1 TWh in 2050. Power generation from hydro will increase by 1.2% per year from 20.4 TWh in 2019 to 29.9 TWh in 2050.

**Figure 16.4 Power Generation by Fuel, Business-as-Usual**
(TWh)

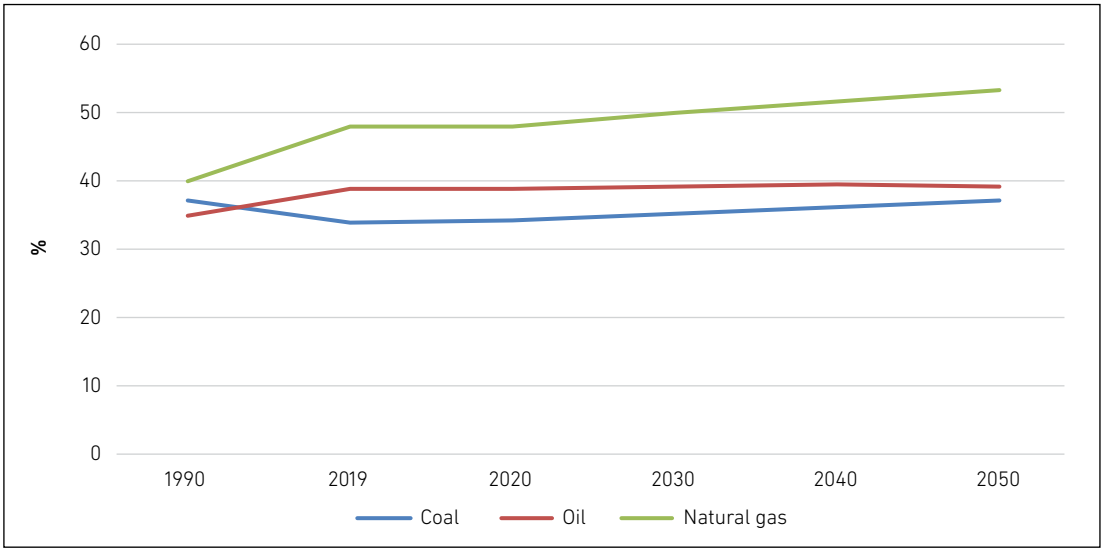



BAU = business-as-usual scenario; TWh = terawatt-hour.

Source: Author's calculation.

Out of all energy sources, natural gas has shown the greatest improvement in thermal efficiency. Its efficiency increased from 40% in 1990 to almost 48% in 2019 and is expected to reach 53.4% in 2050. In contrast, coal's thermal efficiency declined by almost 3.3% from 1990 to 2019 but is expected to improve to 37.3% over the study period (Figure 16.5).

**Figure 16.5 Thermal Efficiency by Fuel, Business-As-Usual, 1990–2050**
(%)




BAU = business-as-usual scenario.

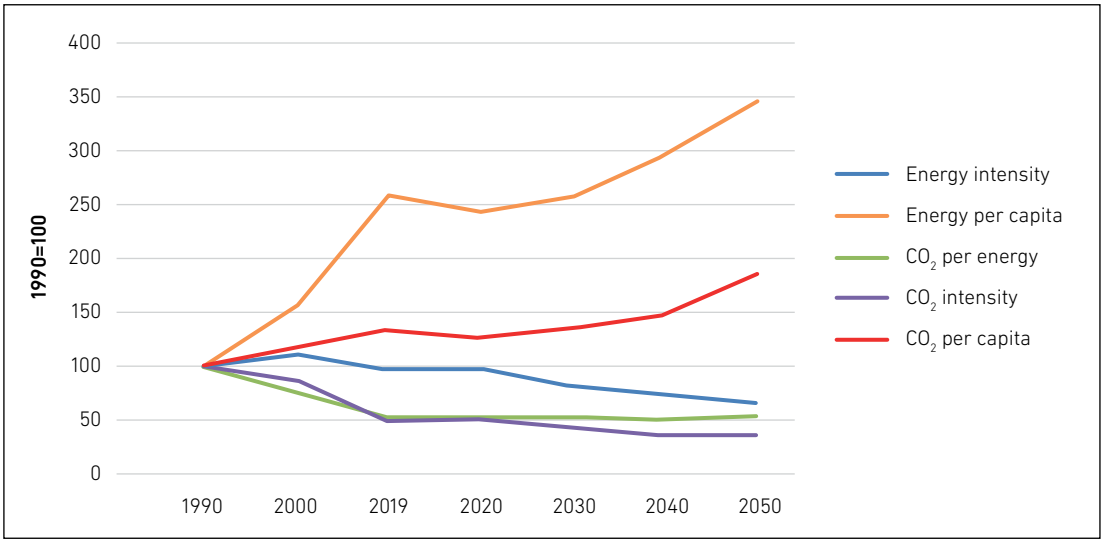
Source: Author's calculation.

### 3.1.4. Energy Indicators

Energy indicators are shown in Figure 16.6. Energy intensity in 2019 was 289 tonnes of oil equivalent per million 2015 US$ (toe/million 2015 US$). In the BAU, energy intensity is projected to decline and reach 193 toe/million in 2050, calculated in 2015 US$. Energy per capita will increase from almost 1.9 toe per person in 2019 to 2.6 toe per person in 2050.

Energy elasticity between 1990 and 2017 was 1.0, which indicates that energy demand rose at the same rate as economic output. In BAU, energy elasticity is projected at 0.61 between 2019 and 2050, which indicates that energy demand will grow at a slower rate than economic output.

**Figure 16.6 Energy Indicators, 1990–2050**




$CO_2$ = carbon dioxide.

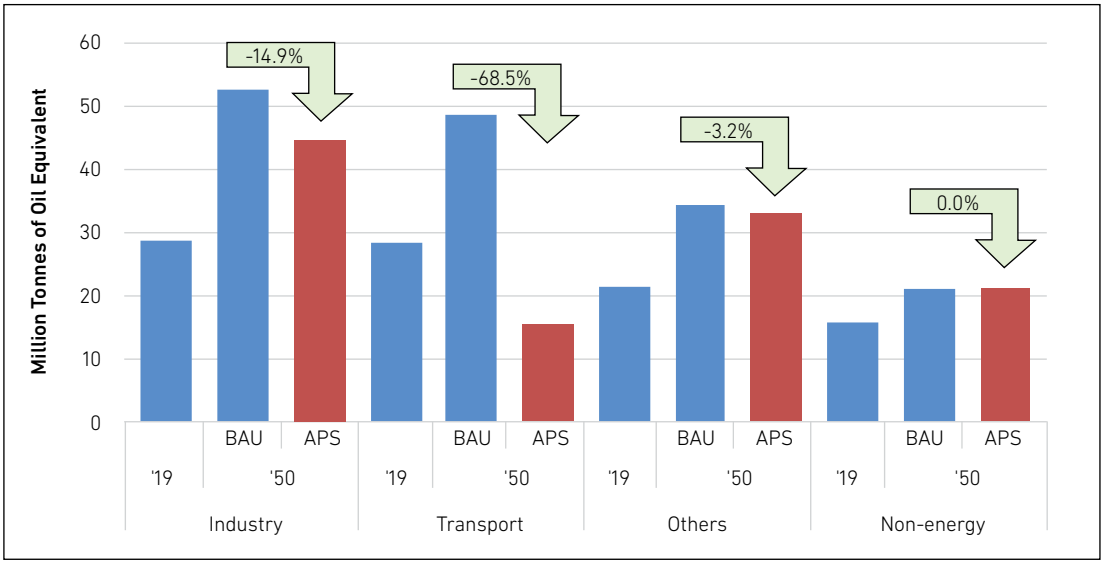
Source: Author's calculation.

## 3.2. Energy Savings and Carbon Dioxide Reduction Potential

### 3.2.1. Final Energy Consumption

In the APS, final energy consumption is projected to grow by 0.6% per year, from 93.9 Mtoe in 2019 to 114.4 Mtoe in 2050. This is 27.1% lower than in the BAU. The majority of energy savings will be achieved through energy efficiency improvement programmes implemented in industry (14.9%) and transport (68.5%). Improvements will also be achieved in 'Other' sectors (3.2%), as shown in Figure 16.7.

**Figure 16.7 Final Energy Consumption by Sector, Business-as-Usual and Alternative Policy Scenario, 2019–2050**
(Mtoe)




APS = Alternative Policy Scenario; BAU = Business-as-Usual scenario; Mtoe = million tonnes of oil equivalent.

Note: 'Others' includes commercial and resident sectors.

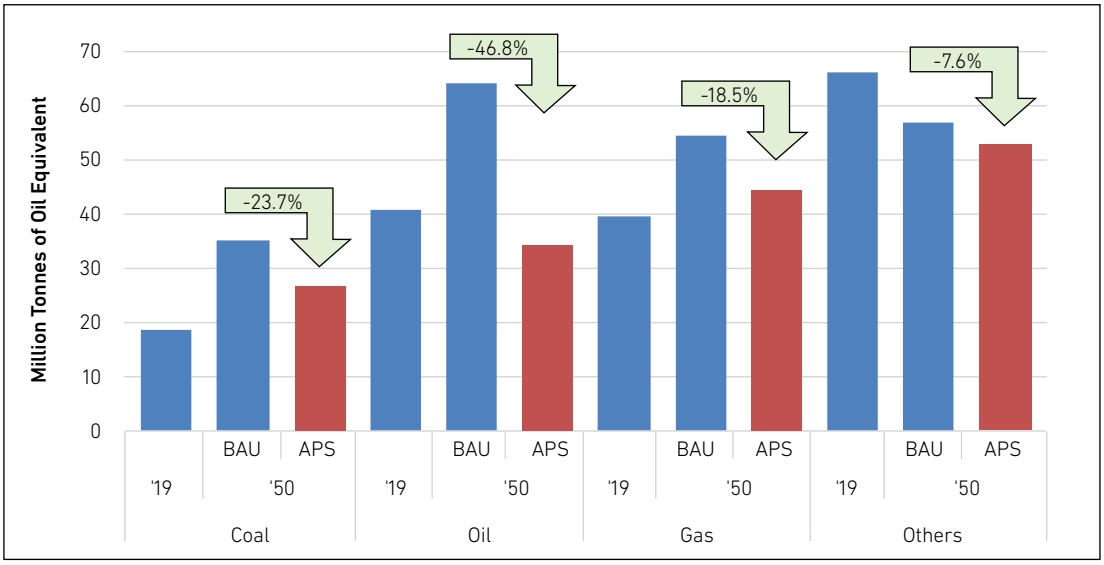
Source: Author's calculation.

### 3.2.2. Primary Energy Supply

In the APS, growth in primary energy supply is projected to be much slower than in BAU, increasing at 0.6% per year (compared with 1.5% in the BAU) to reach 158.5 Mtoe in 2050. Primary APS energy supply is expected to be about 25.0% lower than the BAU in 2050, which is an energy savings of about 52.8 Mtoe.

Coal and oil are projected to increase at slower annual average rates of 1.2% and -0.6%, respectively (compared to 2.1% and 1.5% in the BAU). Natural gas use is projected to increase at an annual average rate of 0.4% (compared to 1.0% in the BAU) from 39.6 Mtoe in 2019 to 44.4 Mtoe in 2050. The lower growth rates compared to the BAU are mainly achieved through energy efficiency and conservation measures on the demand side. The differences in the projections between the two scenarios are shown in Figure 16.8.

**Figure 16.8 Primary Energy Supply by Source, Business-as-Usual and Alternative Policy Scenario, 2019–2050**
(Mtoe)



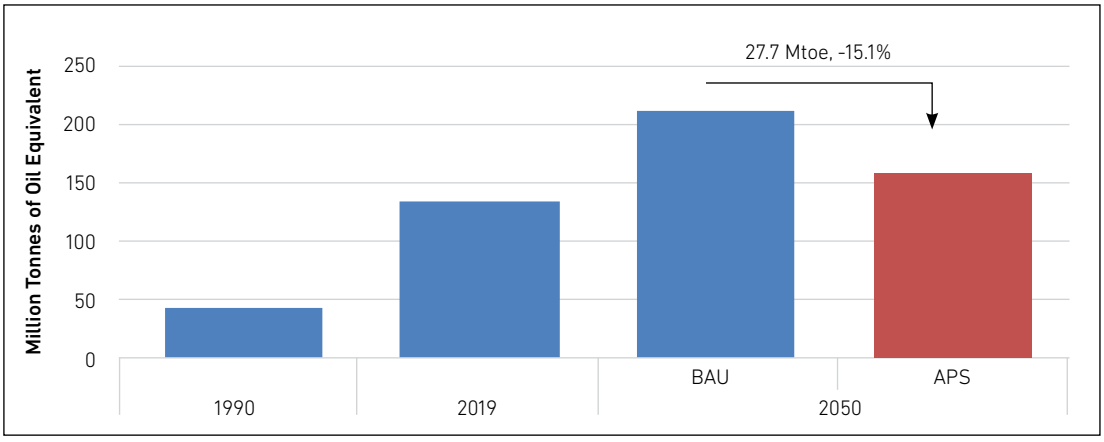

APS = Alternative Policy Scenario; BAU = Business-as-Usual scenario; Mtoe = million tonnes of oil equivalent.
Source: Author's calculation.

### 3.2.3. Projected Energy Savings

The difference between primary energy supply in BAU and the APS in 2050 is 52.8 Mtoe (Figure 16.9). This represents the energy savings that could be achieved if efficiency, conservation goals, and action plans were implemented. Oil will contribute the largest energy savings at 30.1 Mtoe, followed by natural gas at 10.1 Mtoe. Energy savings from coal will reach 8.3 Mtoe in 2050, but the contribution of non-fossil energy sources will also be 4.3 Mtoe lower than in the BAU.

In the final energy consumption, savings in the APS compared with the BAU in 2050 will reach 42.4 Mtoe. The largest savings are expected in the transport sector, at 33.5 Mtoe. The industry sector is expected to reach 7.9 Mtoe in energy savings, while sectors in the 'Other' category are expected to save a combined total of 1.1 Mtoe.

**Figure 16.9 Total Primary Energy Supply, Business-as-Usual and Alternative Policy Scenario, 1990, 2019 and 2050**
(Mtoe)

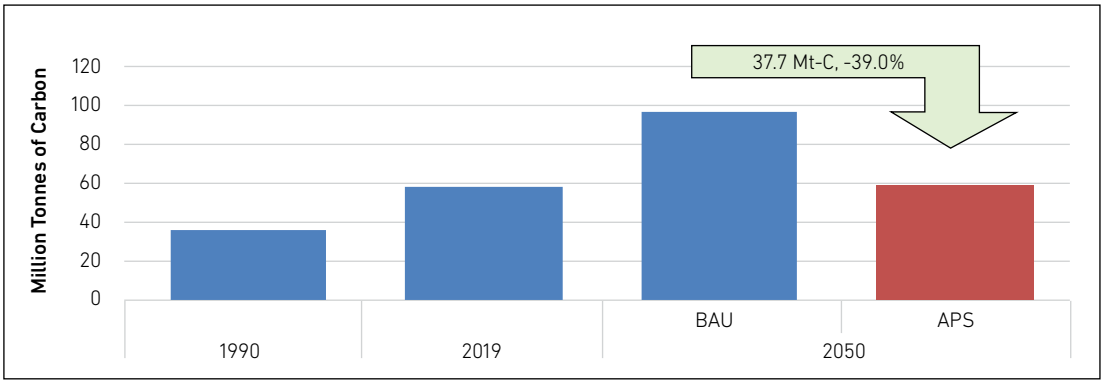



APS = Alternative Policy Scenario; BAU = Business-as-Usual; Mtoe = million tonnes of oil equivalent.
Source: Author's calculation.

### 3.2.4. Carbon Dioxide Emissions

Carbon dioxide emissions from energy consumption are projected to increase by an average of 1.6% per year, from 58.4 Mt-C in 2019 to 96.5 Mt-C in 2050 under the BAU. Under the APS, the average annual growth in $CO_2$emissions from 2019 to 2050 is projected to be only 0.02%, with an emissions level of 58.8 Mt-C in 2050. The difference in $CO_2$ emissions between BAU and the APS is 37. Mt-C, or 39.1%. This reduction in $CO_2$emissions highlights the range of benefits that can be achieved through energy efficiency improvements and savings via action plans (Figure 16.10).

**Figure 16.10 Carbon Dioxide Emissions from Energy Consumption, Business-as-Usual and Alternative Policy Scenario, 1990, 2019 and 2050**



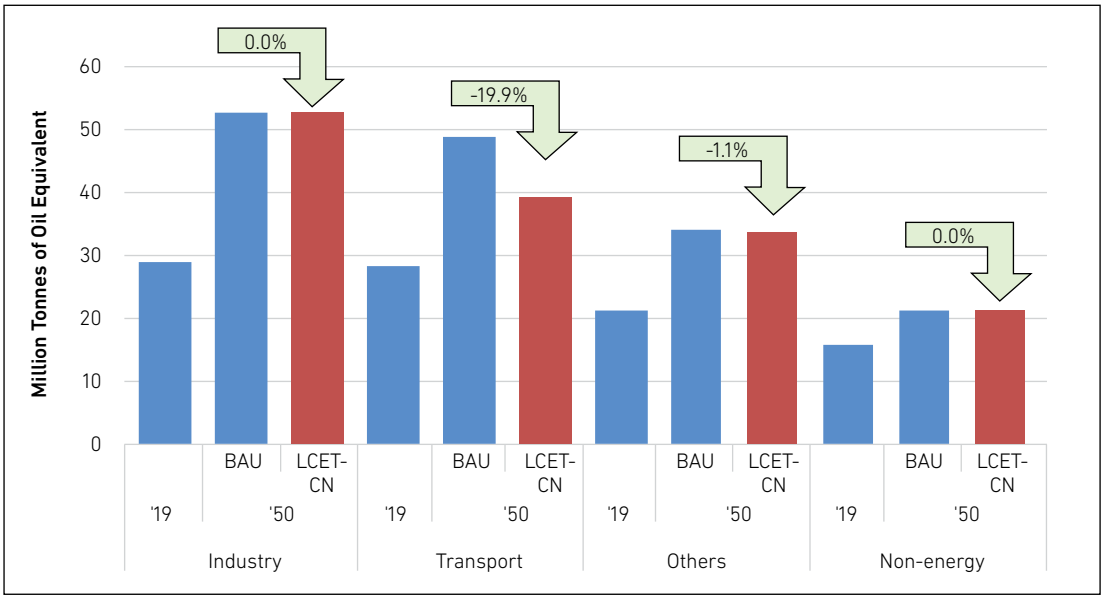

APS = Alternative Policy Scenario; BAU = Business-as-Usual scenario; $CO_2$ = carbon dioxide; Mt-C = million tonnes of carbon.
Source: Author's calculation.

## 3.3. Low Carbon Energy Transition Scenario

### 3.3.1. Final Energy Consumption Sector

In the LCET, final energy consumption is projected to grow by 1.4% per year, from 93.9 Mtoe in 2019 to 146.7 Mtoe in 2050. This is less than 1.0% lower than in the BAU. Electric vehicles, energy efficiency in road transport, and travel mode switching (behavior changes) probably drive consumption in transport down. For the BAU, the share of final energy consumption is 19.9% for transport sector and 1.1% for 'Others' sector (Figure 16.11).

**Figure 16.11 Final Energy Consumption by Sector, Business-as-Usual and Low Carbon Energy Transition Scenario**
(Mtoe)




BAU = Business-as-Usual scenario; LCET-CN = Low Carbon Energy Transition Scenario; Mtoe = million tonnes of oil equivalent.

Note: 'Others' includes commercial and residential sectors.

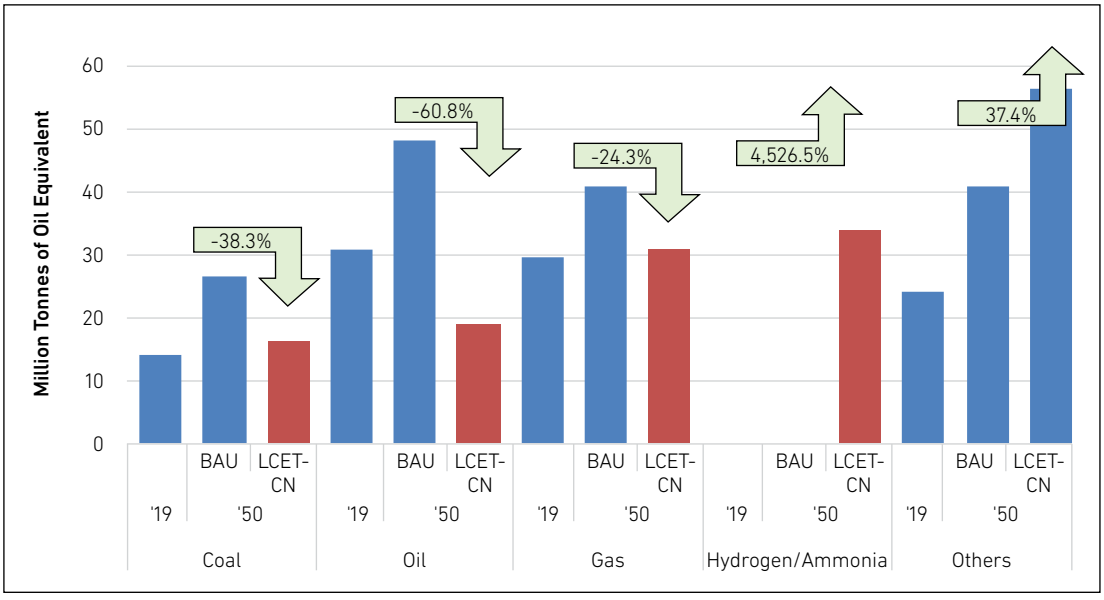
Source: Author's calculation.

### 3.3.2. Primary Energy Supply

The growth rate of primary energy supply in the LCET scenario is projected to be the same as that in the BAU, increasing at 1.5% annually and reaching 186.6 Mtoe in 2050. However, primary LCET energy supply has a different fuel mix from BAU.

To achieve carbon neutrality in 2050, fossil fuels, coal, oil, and natural gas must be replaced by alternative fuels, new energy sources such as hydrogen and ammonia, and renewable energy. In the LCET scenario, coal, oil, and natural gas are projected to be lower compared to the BAU scenario by 38.3%, 60.8%, and 24.3% respectively. However, they are expected to increase in the 'Others' category by 37.4% and hydrogen/ammonia (from 0 Mtoe in 2019 to 45.3 Mtoe). The differences in the projections between the two scenarios are shown in Figure 16.12.

**Figure 16.12 Primary Energy Supply by Source, Business-as-Usual and Low Carbon Energy Transition Scenario**
(Mtoe)



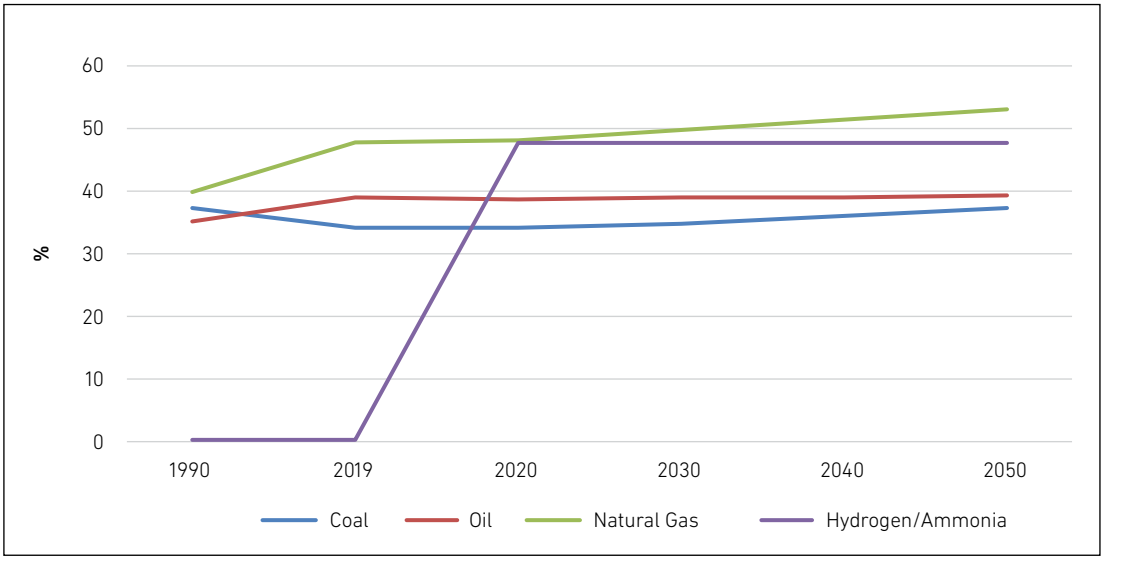

BAU = Business-as-Usual scenario; LCET = Low Carbon Energy Transition Scenario; Mtoe = million tonnes of oil equivalent.
Source: Author's calculation.

### 3.3.3. Energy Indicators

Figures 16-13 and 16-14 show the thermal efficiency and energy indicators respectively. Energy intensity reached 289 toe/million in 2019, calculated in 2015 US$. In the LCET, energy intensity is projected to decline by -1.3% per year to reach 193 toe/million in 2050, calculated in 2015 US dollars. Energy per capita will increase from almost 1.9 toe per person in 2019 to 2.6 toe per person in 2050.

In the LCET, energy elasticity is projected at 0.50 between 2019 and 2050, compared to 0.61 in BAU.

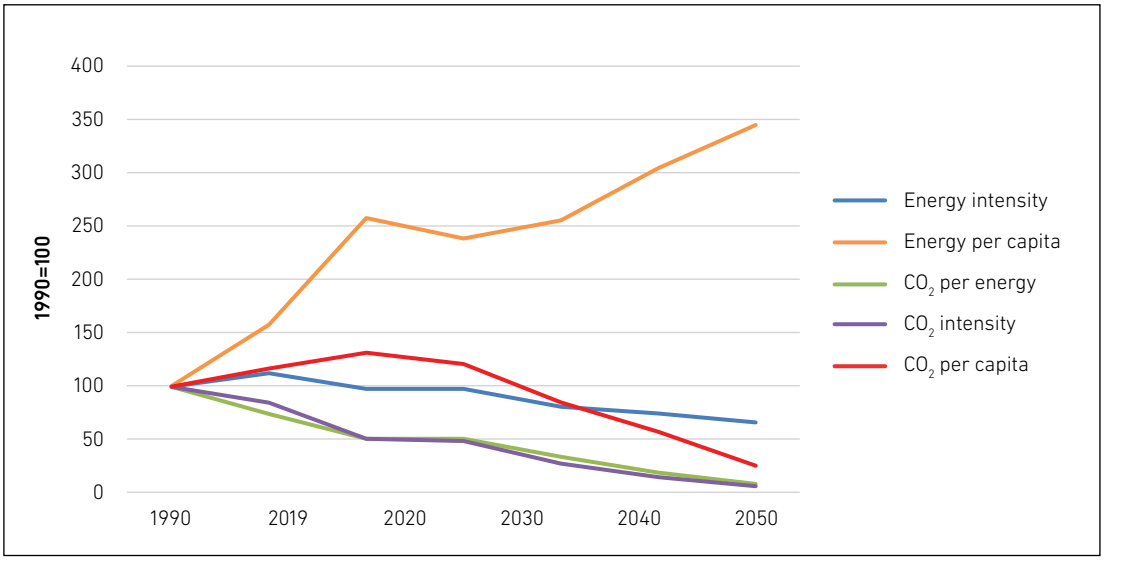
**Figure 16.13** Thermal Efficiency by Fuel, Low Carbon Energy Transition
(%)




LCET = low carbon energy transition.

Source: Author's calculation.

**Figure 16.14** Energy Indicators, Low Carbon Energy Transition



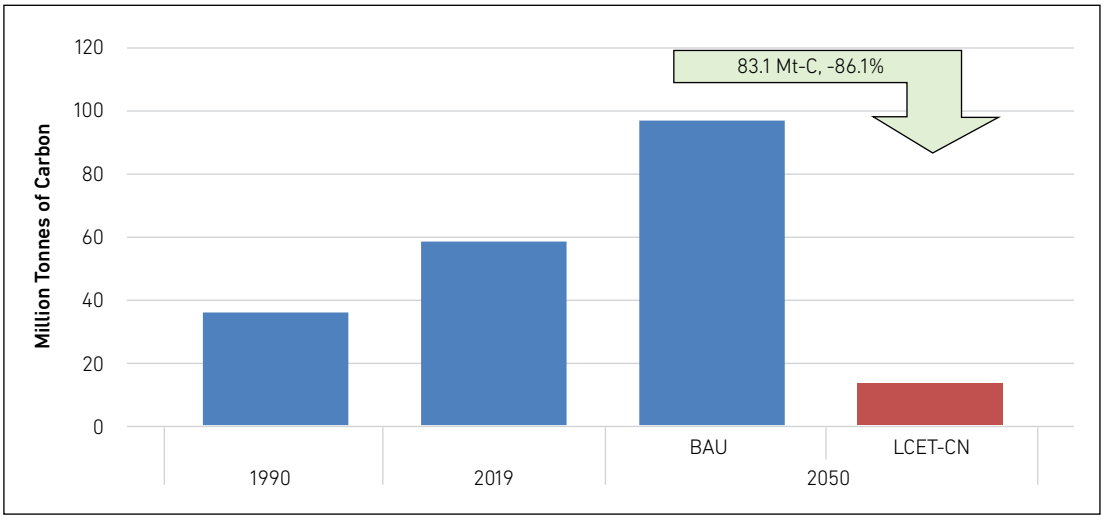

$CO_2$ = carbon dioxide.

Source: Author's calculation.

### 3.3.4. Carbon Dioxide Emission Reduction

Under the LCET, the average annual growth in $CO_2$ emissions from 2019 to 2050 is projected to be -4.6%, with an emissions level of 13.5 Mt-C in 2050. The difference in $CO_2$ emissions between the BAU and the LCET is 83.1 Mt-C, or 86.1%. This can achieve carbon neutrality, which is less than the offset capability in Thailand in 2050 of 27 Mt-C. This reduction in $CO_2$ emissions highlights the range of benefits that can be achieved through energy efficiency improvements and savings via action plans, CCS (carbon capture and storage) in industry, and in power generation for coal and natural gas (Figure 16.15).

**Figure 16.15 Carbon Dioxide Emissions from Energy Consumption, Business-as-Usual and Low Carbon Energy Transition**
(Mt-C)




BAU = business-as-usual; $CO_2$ = carbon dioxide; LCET = low carbon energy transition; Mt-C = million tonnes of carbon.
Source: Author's calculation.

# 4. Implications and Policy Recommendations

In Thailand, solely focusing emissions from energy sources would not be a sufficient to achieve the carbon neutrality target, as the BAU scenario falls significantly short of this goal. It means that there is a need to reshape the current energy consumption patterns to be more environmentally sustainable in the distant future.

APS can cut down some amount of energy consumption with energy conservation programmes and replace the high $CO_2$ emission of fossil fuels with renewable energy in government programmes. This can help ease $CO_2$ emission from energy by approximately 39% lower than in BAU. However, it is probably inadequate in terms of carbon neutral.

To set the criteria, Thailand estimates the carbon sinks in 2050 around 120 Mt-C in total, and the quota of carbon sink from the energy sector is set around 100 Mt-C. To achieve carbon neutral ($CO_2$ emission against the offset), the LCET scenario requires a greater focus on clean energy compared to current government programmes. This involves the introduction of new energy and technology, such as hydrogen/ammonia and CCS (carbon capture and storage) on fossil fuels such as coal and natural gas. However, the extensive use of hydrogen and CCS technologies may result in an estimated13.5 Mt-C, which is significantly lower than the carbon neutrality target of 27 Mt-C.

The three scenarios presented represent extremes, ranging from inaction under the BAU to high reliance on alternative fuels and energy efficiency (APS) to full adoption of pure clean energy (LCET). While policymakers may consider more moderate options, the optimal approach likely lies somewhere in between these extremes. While the LCET scenario does not address cost, it is essential to ensure that energy solutions are both affordable, environmentally friendly, and sustainable. Therefore, a balanced approach incorporating elements of both APS and LCET is necessary for optimal results.