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Assess EE&C Indicators and Policies to Ensure a Low Carbon Development Path

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Foreword

ASEAN countries are promoting energy efficiency policies to cope with the increase in energy consumption associated with economic development. However, over the 20-year period from 2000 to 2020, countries with large populations and economies, such as Indonesia, Malaysia, the Philippines, and Viet Nam, steadily increased their energy efficiency while their carbon intensity worsened. That is, despite progress in energy conservation, CO_2 emissions are increasing.

This report analyses the status of energy efficiency, carbon intensity, and other factors of change in the target countries, identifies the causes of the separation between improvements in energy efficiency and worsening carbon intensity, as well as issues related to energy efficiency policies, and makes policy recommendations from the perspective of low-carbon development.

The report consists of four chapters. Chapter 1 provides an analysis of ASEAN's population, economy, energy, and CO_2 emissions situation. In addition, we will discuss the issues raised by the analysis. Chapter 2 identifies the countries in ASEAN that have a significant impact with respect to energy and CO_2 emissions and selects the countries to be studied for this report. Chapter 3 analyses energy consumption, energy efficiency, CO_2 emissions, energy efficiency policies, and CO_2 emissions reduction policies in the four countries studied (Indonesia, Malaysia, the Philippines, and Viet Nam). Chapter 4 summarises and analyses trends common to the four countries surveyed based on the analysis in the previous chapter and makes sector-specific recommendations.

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List of Abbreviations/Acronyms

ADB	Asia Development Bank
ASEAN	Association of Southeast Asian Nations
AZEC	Asia Zero Emission Community
BAU	Business as Usual
CCS	Carbon Capture, and Storage
CNG	Compressed Natural Gas
COP	Conference of the Parties
DOE	Department of Energy
DSM	Demand Side Management
EE&C	Energy Efficiency and Conservation
EEDE	Energy Effciency Designated Establishments
ERIA	Economic Research Institute for ASEAN and East Asia
ESCO	Energy Service Company
ETM	Energy Transition Mechanism
G7	Group of Seven
G20	Group of Twenty
GDP	Gross Domestic Products
GEMP	Government Energy Management Program
GHG	Greenhouse Gas
IEA	International Energy Agency
IEEJ	The Institute of Energy Economics, Japan
IGCC	Integrated coal Gasification Combined Cycle
IGFC	Integrated coal Gasification Fuel cell Combined Cycle
IIP	Indices of Industrial production
JETP	Just Energy Transition Partnership
LPG	Liquified Petroleum Gas
LRT	Light Rail Transit
MoU	Memorandum of Understanding
NDC	Nationally Determined Contribution

OECD	Organisation for Economic Co-operation and Development
PPA	Power Purchase Agreement
TES	Total Energy Supply
USC	Ultra Super Critical
USD	United States Dollar
WHO	World Health Organization

Executive Summary

Association of Southeast Asian Nations (ASEAN) countries are promoting energy efficiency policies to cope with the increase in energy consumption associated with economic development. However, over the 20-year period from 2000 to 2020, countries with large populations and economies, such as Indonesia, Malaysia, the Philippines, and Viet Nam, steadily increased their energy efficiency while their carbon intensity worsened.

Four countries, i.e. Indonesia, Malaysia, the Philippines, and Viet Nam, which account for about 90% of Total Energy Supply (TES) and CO_2 emissions in ASEAN, and whose carbon intensity is worsening while energy efficiency is improving, were selected for study in this report.

The primary factor contributing to the worsening carbon intensity in these four countries is coal. Coal TES increased from 2000 to 2020, as did coal-fired power generation. On the other hand, the efficiency of coal-fired power generation is low and CO_2 emissions from the electricity and heat production sector are increasing, making coal-fired power generation with low generation efficiency a cause of worsening carbon intensity.

Next, coal consumption in the manufacturing industries, especially in the iron and steel sector, has increased, and CO_2 emissions in this sector have also increased. This is especially true in Indonesia and Viet Nam.

In the Philippines and Malaysia, energy consumption in the transport sector, especially in the road sector, is increasing, as are CO_2 emissions. The increase in the number of vehicles that use fossil fuels as their energy source along with the development of motorisation has contributed to the worsening of carbon intensity.

The four countries studied commonly decided on policies such as phasing out coal-fired power generation in the future and halting the construction of new coal-fired power plants. Measures to bridge the gap between the current situation and future targets include early shutdown of aging coal-fired power plants, conversion to high-efficiency gas-fired power plants, co-firing or single fuel combustion of ammonia and hydrogen, and introduction of carbon capture and storage (CCS) and renewable energy.

The increase in CO_2 emissions in the iron and steel sector is the result of industrial policies such as the decision to own blast furnaces. However, there is a shift from the blast furnace method to the electric furnace method or the direct reduction method as a result of climate action, and the region may consider following this trend.

The road sector should also promote the spread of zero-emissions vehicles such as electric vehicles. In doing so, it is desirable not just to introduce electric vehicles, but to combine decarbonisation and industrial development through electrification and zero-emissions in vehicle production, with the goal of becoming an electric vehicle hub in the ASEAN region, while ensuring critical mineral security.

Energy efficiency is steadily improving in the four countries studied. Energy service companies and energy audits, which are common energy efficiency policies in the four countries, can visualise various energy situations, contribute to performance improvements, achieve systematic energy management, and support energy conservation and decarbonisation activities. It is also useful to promote energy conservation outside of the studied countries.

To promote the upgrading of coal-fired power generation in ASEAN, decarbonisation of steel, production of electric vehicles and zero-emissions vehicles, and further energy conservation, it is necessary to promote energy efficiency policies from a broad perspective, including energy transition financing, technology development, industrial structure transformation, housing performance improvement, and implementation of systematic energy management such as energy service companies and energy audits.

Except for the Philippines, the three countries studied have declared a goal of being carbon-neutral by 2050 or 2060. Carbon neutrality must be maintained after it is achieved. These broad policies can help achieve long-term sustainable carbon neutrality. For ASEAN to realise a low-carbon society at an early stage, international cooperation in technology and finance will then be necessary.

Items		Unit	20 Years Transition(2000～2020)			
			Indonesia	Malaysia	Philippines	Viet Nam
Energy Consumption Index	Population	Times	1.3	1.4	1.4	1.2
	GDP	Times	2.6	2.3	2.5	3.5
	GDP per Capita	Times	2.0	1.7	1.8	2.9
	TES	Times	1.5	1.9	1.5	3.4
	of which, amount of fossil fuel	Times	1.8	1.9	1.8	6.2
	of which, fossil fuel dependency	%	11 ↑	0	11 ↑	39 ↑
	of which, coal	Times	5.7	9.4	3.6	11.6
	Electricity Output	Times	3.1	2.6	2.2	9.0
	of which, coal-fire electricity output	Times	5.3	11.2	3.5	38.0
	Final Energy Consumption	Times	1.3	2.1	1.4	2.7
	of which, final energy consumption(Industry)	Times	1.9	1.6	1.4	4.6
	of which, final energy consumption(Iron and Steel)	Times	10.0	NA	1.5	*10.0
	of which, final energy consumption(Non-metallic minerals)	Times	43.0	NA	0.0	*2.5
	of which, final energy consumption(Transport)	Times	2.3	1.9	1.2	3.5
	of which, final energy consumption(Residential)	Times	0.6	1.7	1.3	0.8
	Final energy consumption of Coal by Iron and Steel Sector	Times	489.0	NA	NA	15.8
Energy Efficiency Index	TES per GDP	Point	0.17 ↓	0.05 ↓	0.11 ↓	0.01 ↓
	CO_2 per TES	Point	0.64 ↑	0.1 ↑	0.44 ↑	1.48 ↑
	EE&C Indicator of Iron and Steel Sector	Point	0.38 ↑	NA	0.37 ↓	*0.22 ↑
	EE&C Indicator of Non-metallic minerals Sector	Point	0.04 ↓	NA	NA	*0.03 ↑
	EE&C Indicator of Road Sector	Point	0.35 ↓	0.34↓	1.00 ↓	9.08 ↓
	EE&C Indicator of Residential Sector	Point	0.03 ↑	0.15 ↑	0	0.18 ↑
	Thermal Efficiency fossil fuel-fired	Point	0.03 ↓	0	0.01 ↓	0.05 ↑
	Thermal Efficiency coal-fired	Point	0.02 ↓	0.1 ↓	0.06 ↓	0.08 ↑
CO_2 Emission Index	CO_2 Emission	Times	2.1	2.0	1.9	6.6
	of which, CO_2 emission by Electricity and Heat Production sector	Times	3.6	3.2	3.2	13.1
	CO_2 emission by Iron and steel sector	Times	10.7	NA	1.3	*14.5

EE&C = energy efficiency and conservation, TES = total energy supply, GDP = gross domestic product.
* Data duration is from 2010 to 2020.
Source: Author.

Chapter 1

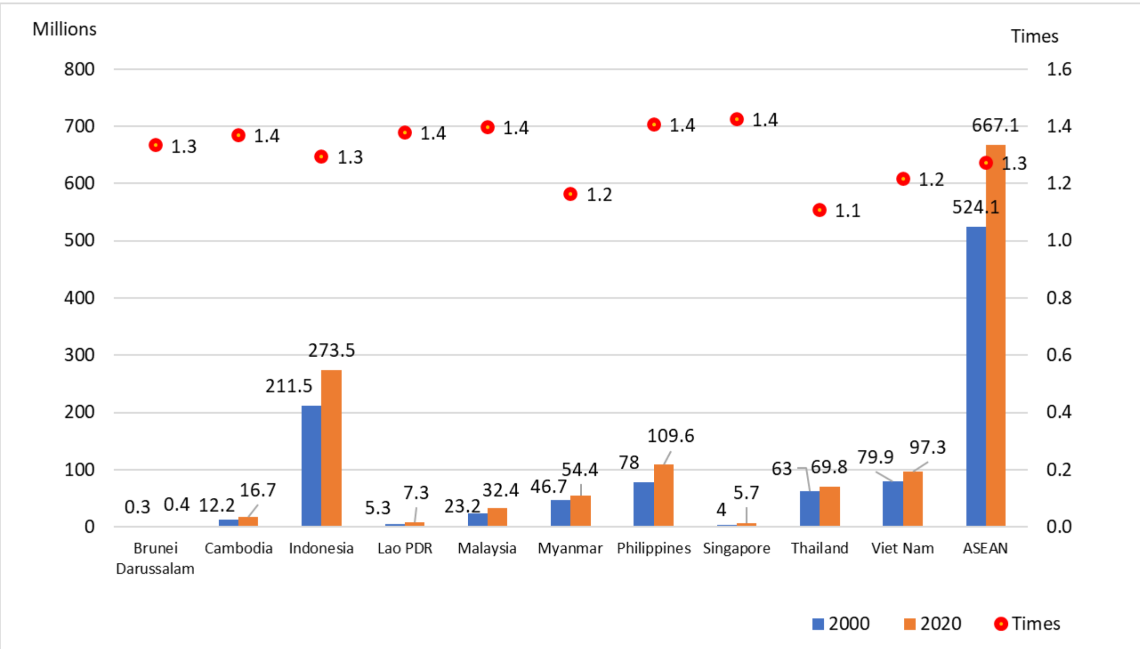
Background of the Studies

This chapter provides an analysis of the Association of Southeast Asian Nations (ASEAN's) population, economy, energy, and CO_2 emissions situation. In addition, we will discuss the issues raised by the analysis.

1. Population and Economic Situation

ASEAN's population grew 1.3 times in 20 years, from 524.1 million in 2000 to 667.1 million in 2020 (Figure 1.1).

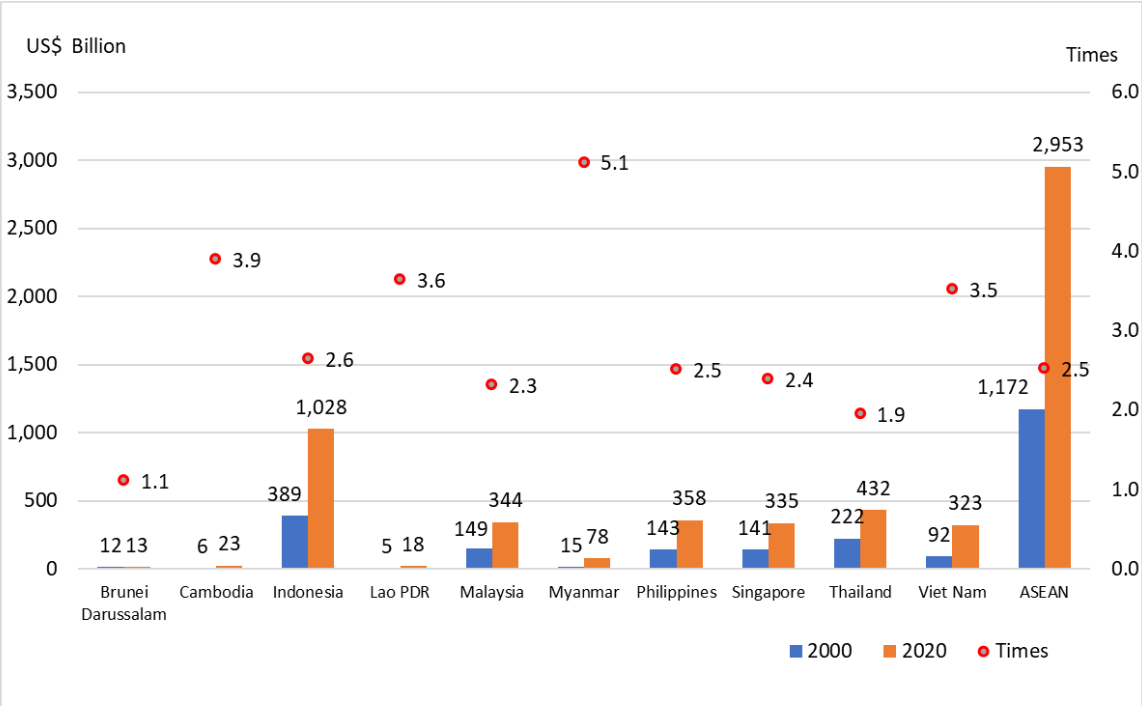
Figure 1.1. ASEAN Population (2000 vs 2020)



ASEAN = Association of Southeast Asian Nations.
Source: IEA (2022).

ASEAN's gross domestic product (GDP) has grown 2.5 times in 20 years, from $1,172 billion in 2000 to $2,953 billion in 2022 (Figure 1.2).

Figure 1.2. ASEAN GDP (2000 vs 2020) (2015 prices, exchange rate)

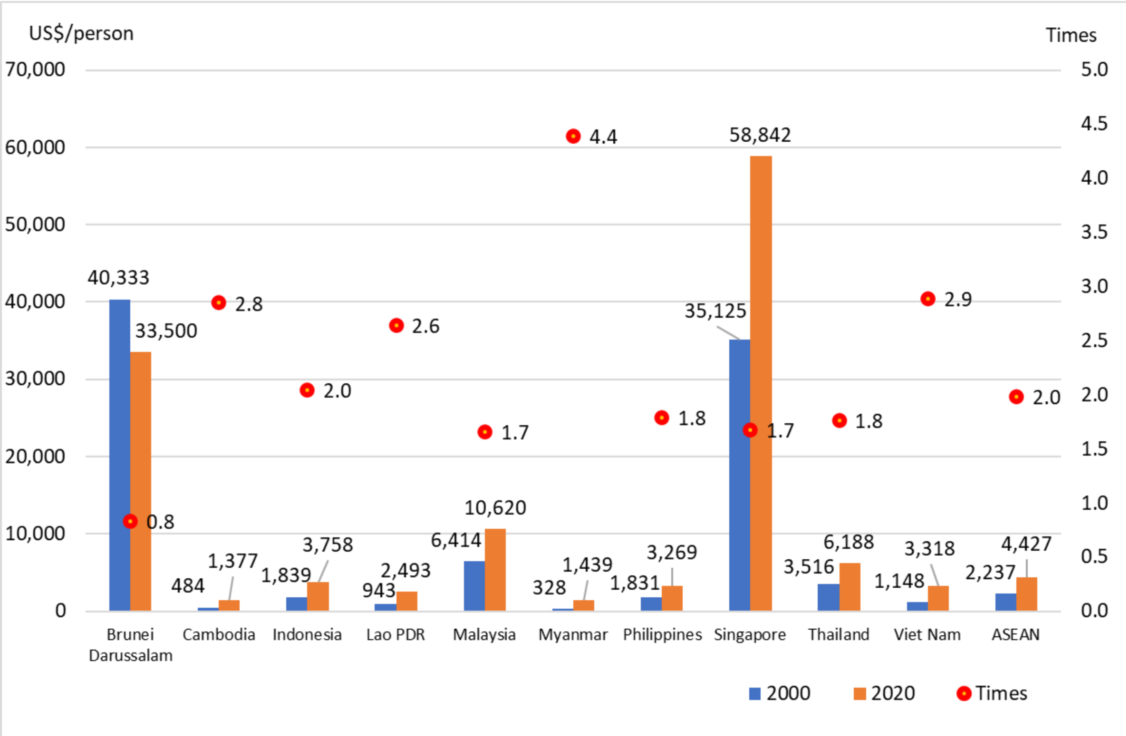


ASEAN = Association of Southeast Asian Nations.
Source: IEA (2022).

ASEAN's GDP per capita was $2,237 in 2000; in 2020, it was $4,427, doubling over 20 years (Figure 1.3).

History has proven that there is a strong correlation between economic growth and energy demand. The increase in total energy supply (TES) is also due to the improvement in the standard of living in ASEAN as a result of the growth in GDP per capita.

Figure 1.3. ASEAN GDP per Capita (2000 vs 2020)

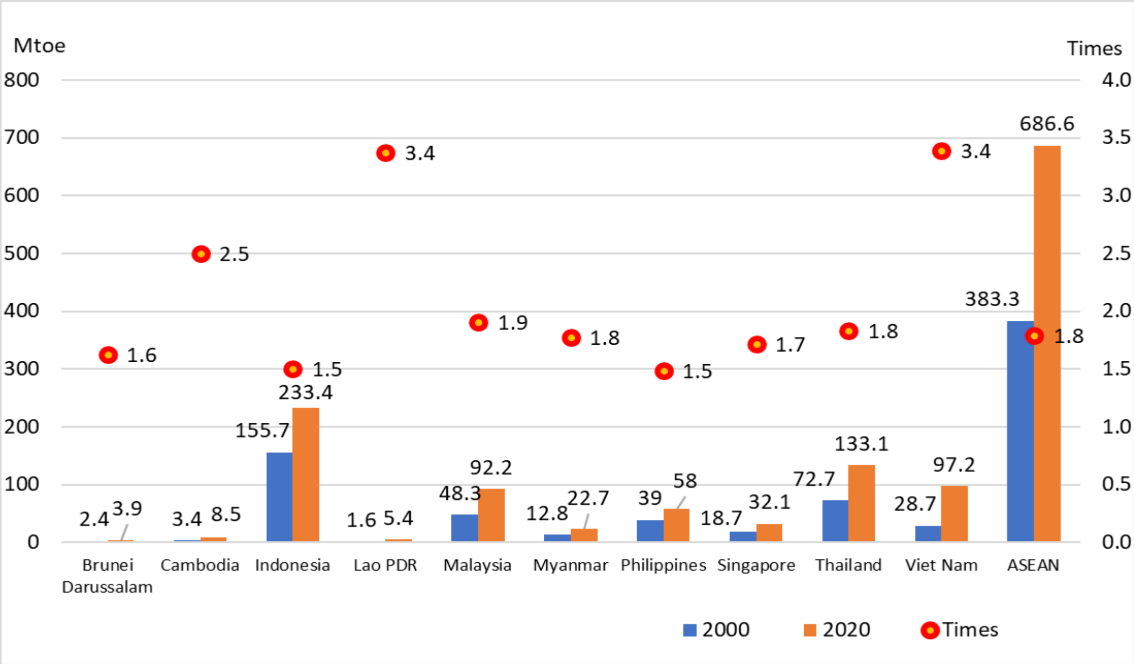


ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product.
Source: IEA (2022).

2. Energy Situation

Due to population growth, significant economic growth, and improved living standards, ASEAN's TES has grown 1.8 times in 20 years, from 383.3 million tonnes of oil equivalent (Mtoe) in 2000 to 686.6 Mtoe in 2020 (Figure 1.4).

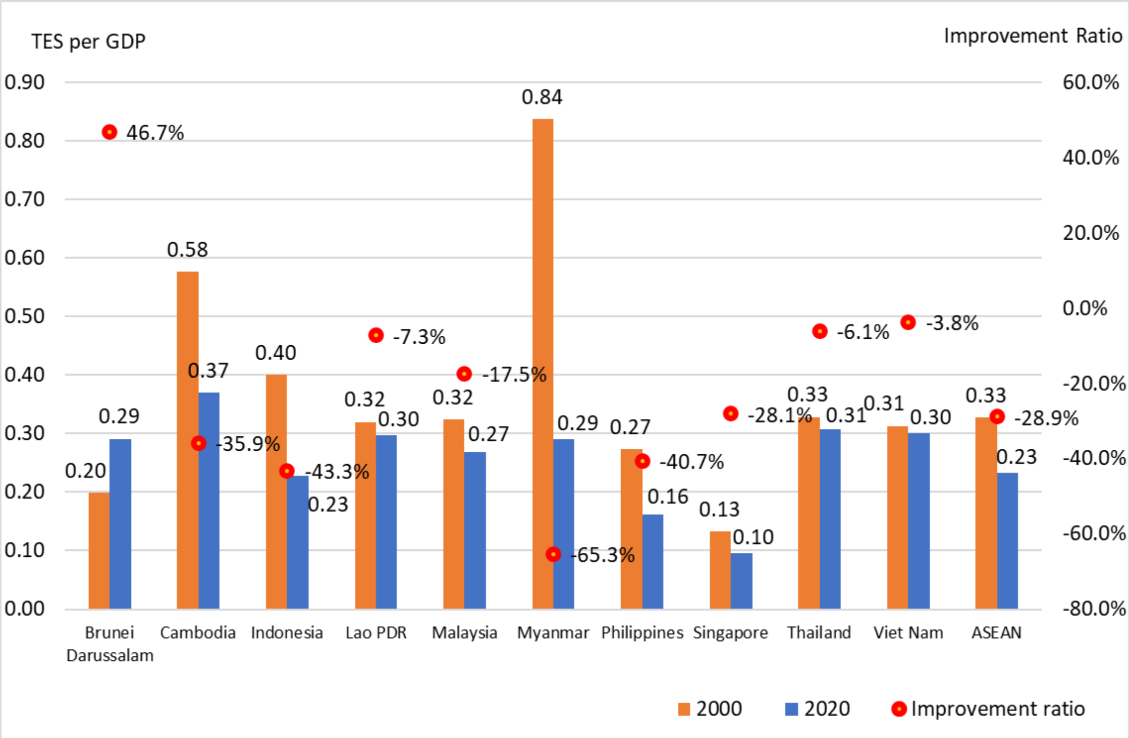
Figure 1.4. ASEAN Total Energy Supply (2000 vs 2020)



ASEAN = Association of Southeast Asian Nations.
Source: IEA (2022).

ASEAN's TES per GDP (one of the indicators of energy efficiency) improved by 28.9% from 0.33 in 2000 to 0.23 in 2020. All the ASEAN member countries, except Brunei Darussalam, made progress in energy efficiency (Figure 1.5).

Figure 1.5. ASEAN TES per GDP (2000 vs 2020)

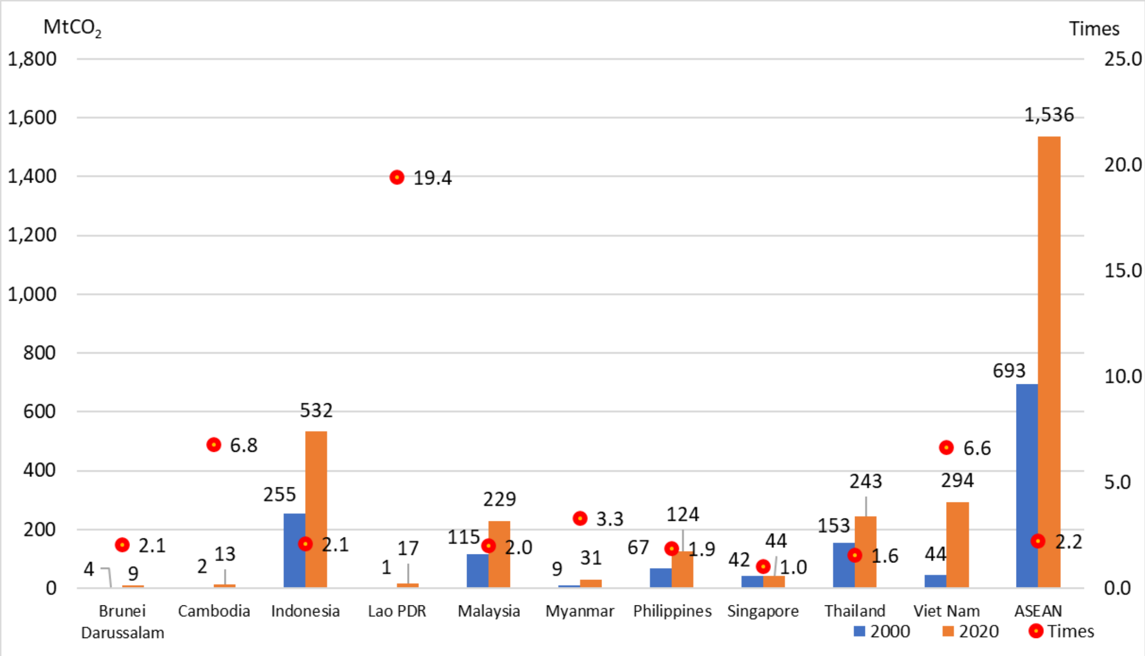


ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, TES = total energy supply.
Source: IEA (2022).

3. Status of CO_2 Emissions

With the increase in population, significant economic growth, and improved standard of living, CO_2 emissions from fuel combustion has increased, as has energy consumption. ASEAN's CO_2 emissions increased by 2.2 times from 693 metric tonnes of CO_2 ($MtCO_2$) in 2000 to 1,536 $MtCO_2$ in 2020 (Figure 1.6).

Figure 1.6. ASEAN CO_2 Emissions from Fuel Combustion (2000 vs 2020)



ASEAN = Association of Southeast Asian Nations.
Source: IEA (2022).

Here we look at the relationship between the increase in TES and the increase in CO_2 emissions. Table 1.1 summarises the growth rates of CO_2 emissions and TES for the 10 ASEAN member countries over 2000–20. Average of Organisation for Economic Co-operation and Development (OECD) and non-OECD figures are also included for comparison.

In ASEAN, TES has increased by a factor of 1.8 over the 20 years, while CO_2 emissions has increased by a factor of 2.2, exceeding the growth rate of TES. In contrast, OECD saw a decrease by a factor of 0.9 in TES over the same period, while CO_2 emissions decreased by a factor of 0.8, which is less than the rate of decrease in TES. In non-OECD, TES increased by a factor of 2.0 and CO_2 emissions increased by a factor of 2.1 over the same period.

Table 1.1. Increased Multiples of CO_2 Fuel Combustion and TES

Country	TES (a)	CO_2 Fuel Emissions (b)
Brunei Darussalam	1.6	2.1
Cambodia	2.5	6.8
Indonesia	1.5	2.1
Lao PDR	3.4	19.4
Malaysia	1.9	2.0
Myanmar	1.8	3.3
Philippines	1.5	1.9
Singapore	1.7	1.0
Thailand	1.8	1.6
Viet Nam	3.4	6.6
ASEAN	1.8	2.2
OECD	0.9	0.8
Non-OECD	2.0	2.1

ASEAN = Association of Southeast Asian Nations, OECD = Organisation for Economic Co-operation and Development.
Source: Author.

4. Energy Efficiency and Carbon Intensity

Figure 1.7 shows TES per GDP (energy efficiency) on the horizontal axis and CO_2 per TES (carbon intensity) on the vertical axis.

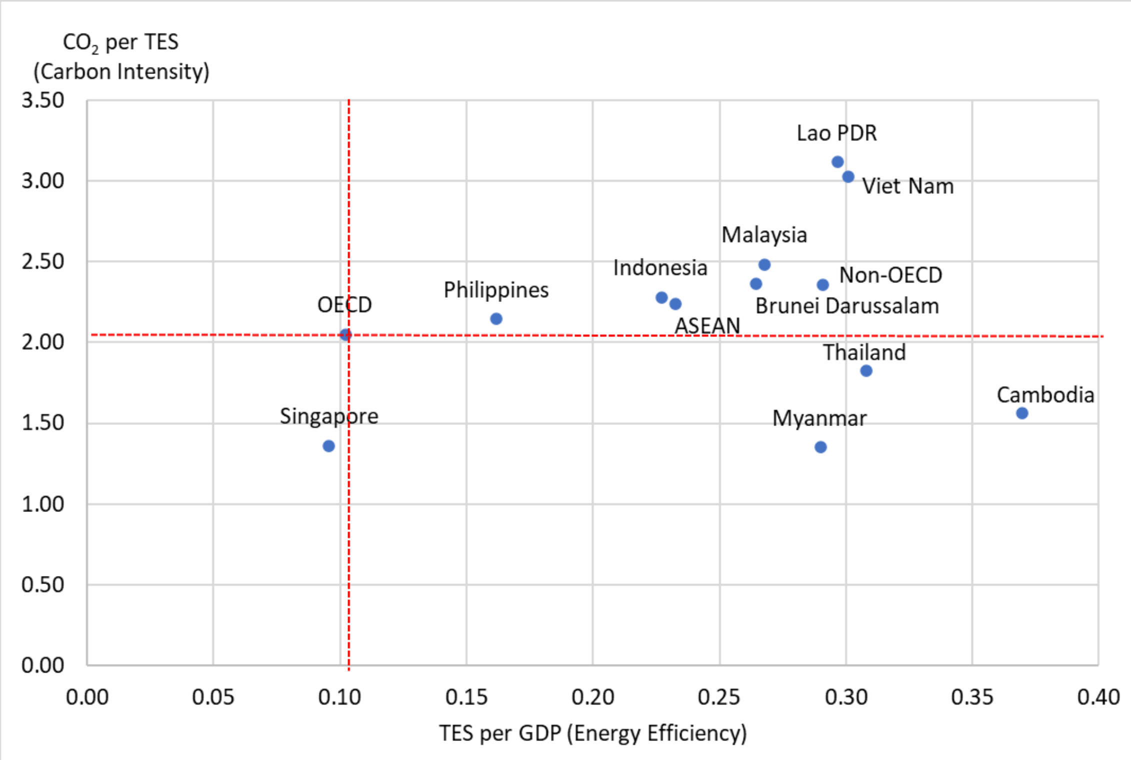
Comparing OECD average and ASEAN member countries in 2020, only Singapore is more energy-efficient and decarbonised, with both TES per GDP and CO_2 per TES being lower than those of OECD average.

On the other hand, Cambodia, Myanmar, and Thailand have lower carbon intensity than the OECD countries, but are not as energy-efficient as OECD.

Brunei Darussalam, Indonesia, Lao People's Democratic Republic, Malaysia, the Philippines, and Viet Nam are also less energy-efficient and decarbonised than OECD.

Both energy conservation and carbon intensity are often influenced by a country's industrial structure and policies. For example, countries with a large share of manufacturing have larger energy consumption and CO_2 emissions, while countries with a smaller share have smaller values for these figures. Therefore, it is necessary to analyse the industrial structure of each country and the status of energy conservation and CO_2 emissions reduction policies.

Figure 1.7. Energy Efficiency and Carbon Intensity (2020)



ASEAN = Association of Southeast Asian Nations, Lao PDR = Lao People's Democratic Republic, OECD = Organisation for Economic Co-operation and Development, TES = total energy supply.
Source: Author.

5. Elasticity

To understand the relationship between CO_2 emissions and TES, elasticity is calculated and compared.

The elasticity is the growth in CO_2 emissions over the 20-year period from 2000 to 2020 divided by the growth in TES. The formula is as follows:

$$\frac{\text{CO}_2\text{ emissions in 2020 / CO}_2\text{ emissions in 2000}}{\text{TES in 2020 / TES in 2000}} = \text{X}$$

If the growth of CO_2 emissions is greater than the growth of TES, the elasticity X will be greater than 1. If the growth of CO_2 emissions is smaller than the growth of TES, the elasticity X will be smaller than 1.

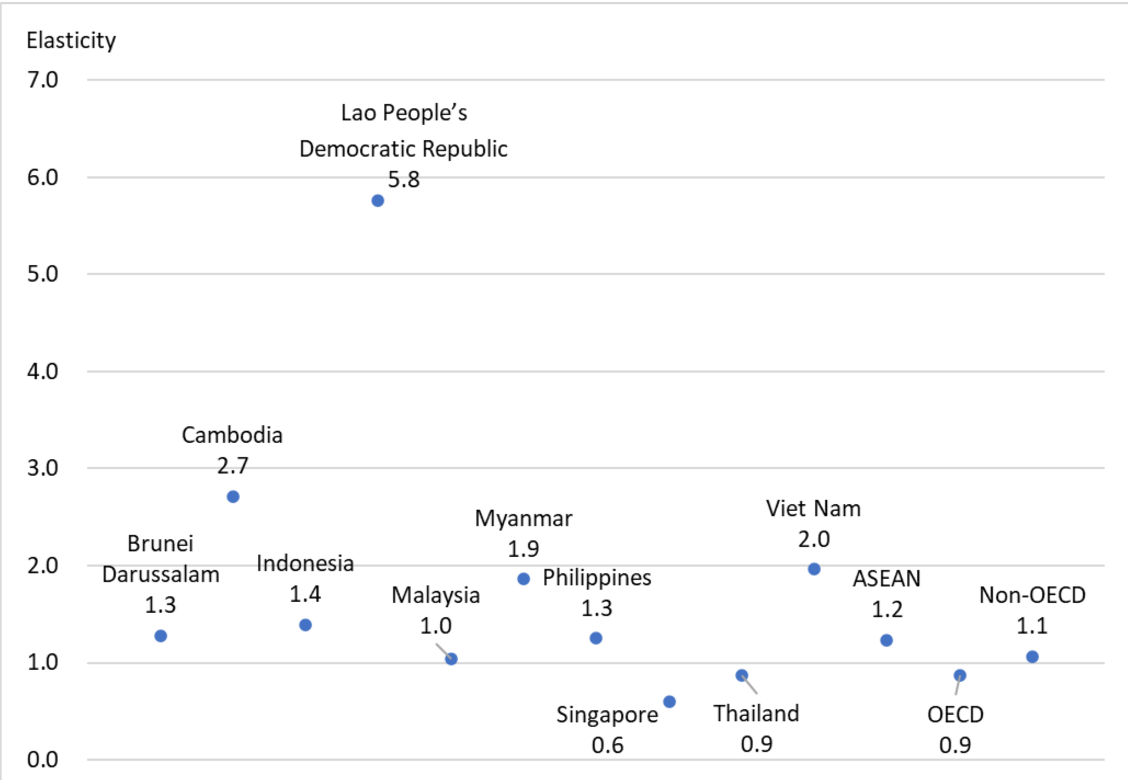
The elasticities for ASEAN, OECD, and non-OECD are calculated and plotted in Table 1.2 and Figure 1.8.

Table 1.2. Change of TES and CO_2 Emissions and Elasticity

Country	TES (a)	CO_2 Fuel Emissions (b)	Elasticity (b)÷(a)
Brunei Darussalam	1.6	2.1	1.3
Cambodia	2.5	6.8	2.7
Indonesia	1.5	2.1	1.4
Lao PDR	3.4	19.4	5.8
Malaysia	1.9	2.0	1.0
Myanmar	1.8	3.3	1.9
Philippines	1.5	1.9	1.3
Singapore	1.7	1.0	0.6
Thailand	1.8	1.6	0.9
Viet Nam	3.4	6.6	2.0
ASEAN	1.8	2.2	1.2
OECD	0.9	0.8	0.9
Non-OECD	2.0	2.1	1.1

ASEAN = Association of Southeast Asian Nations, OECD = Organisation for Economic Co-operation and Development, TES = total energy supply.
Source: Author.

Figure 1.8. Elasticity (2000 vs 2020)



ASEAN = Association of Southeast Asian Nations, OECD = Organisation for Economic Co-operation and Development.
Source: Author.

The elasticity of total ASEAN is 1.2. This means that the growth of CO_2 emissions is larger than the growth of TES.

The countries where elasticities are greater than 1, namely Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, and Viet Nam, the growth of CO_2 emissions is larger than the growth of TES. For example, the elasticity of 2.0 for Viet Nam means that the growth of CO_2 emissions is twice that of TES.

In contrast, the elasticities for Singapore and Thailand are 0.6 and 0.9, respectively. In these countries, the growth of CO_2 emissions is smaller than the growth of TES.

For comparison, the OECD and non-OECD elasticities are 0.9 for OECD and 1.1 for non-OECD. The elasticity for ASEAN is higher than that for non-OECD.

Singapore's elasticity is lower than that of OECD, while Thailand's is at the same level as that of OECD.

6. Discussions

Many ASEAN countries have elasticities greater than 1, despite progress in energy efficiency (TES per GDP). Except for Singapore and Thailand, the increase in CO_2 emissions is greater than the growth in TES in many ASEAN countries.

There are three possible reasons for this:

- Changes in the energy mix (underlying energy policy)
- Energy efficiency policy
- CO_2 emissions reduction policy

For more detailed analysis, it is necessary to examine changes in energy use, energy efficiency, CO_2 emissions status, and policies in countries with large and influential shares of TES and CO_2 emissions in the ASEAN region.

Reference

IEA (2022), *IEA World Energy Balance*. Paris: IEA.

Chapter 2

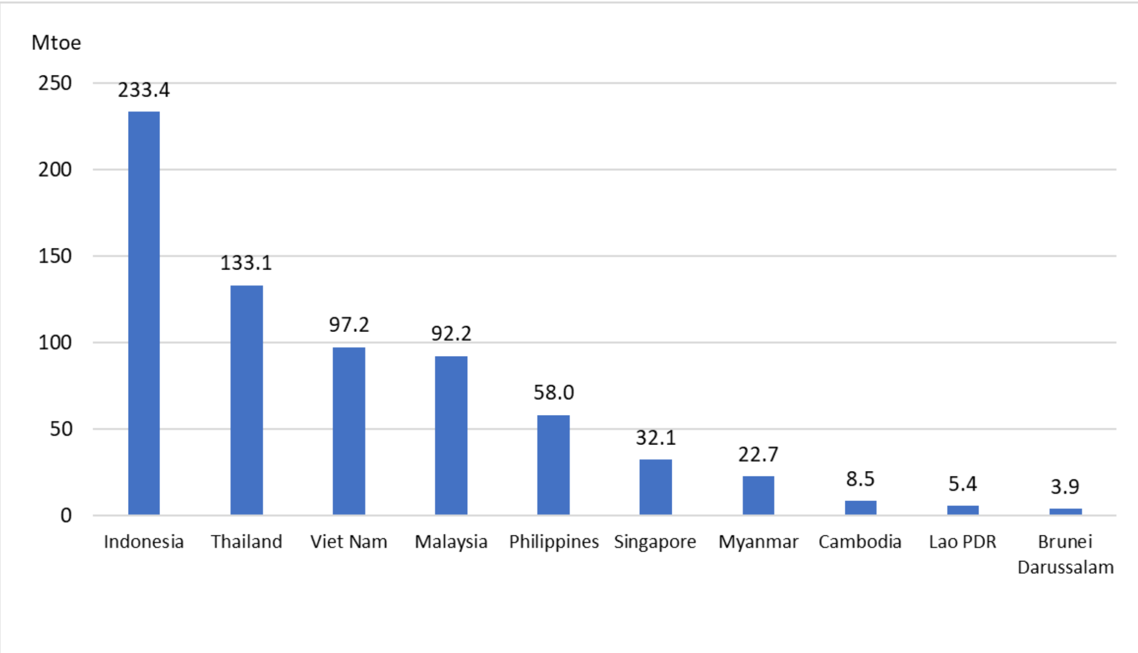
Selection of Study Target Countries

This chapter identifies the ASEAN countries that have a significant impact with respect to energy and CO_2 emissions and selects those to be studied for this report.

1. Current Status of TES

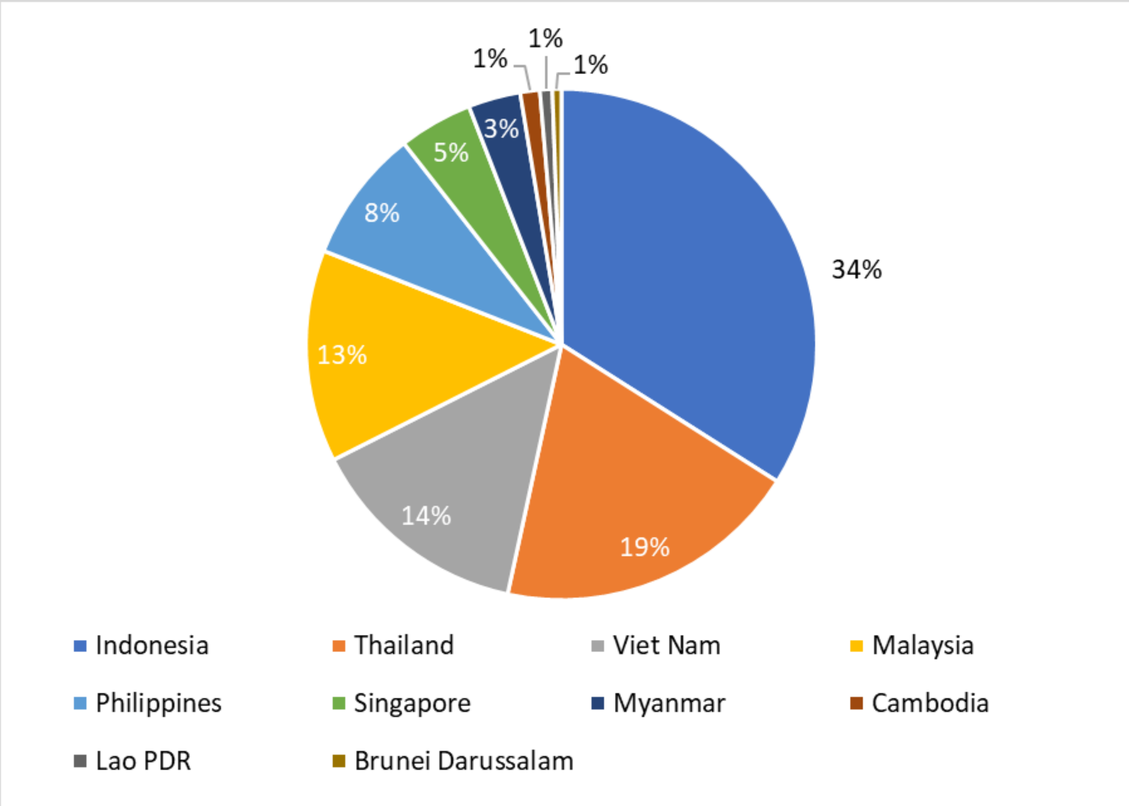
Figure 2.1 shows a graph of the countries in order of the absolute amount of TES as of 2020. The top five countries account for 89% of the absolute TES share (Figure 2.2).

Figure 2.1. ASEAN TES (2020)



ASEAN = Association of Southeast Asian Nations, TES = total energy supply.
Source: IEA (2022).

Figure 2.2. Country Share of TES (2020)

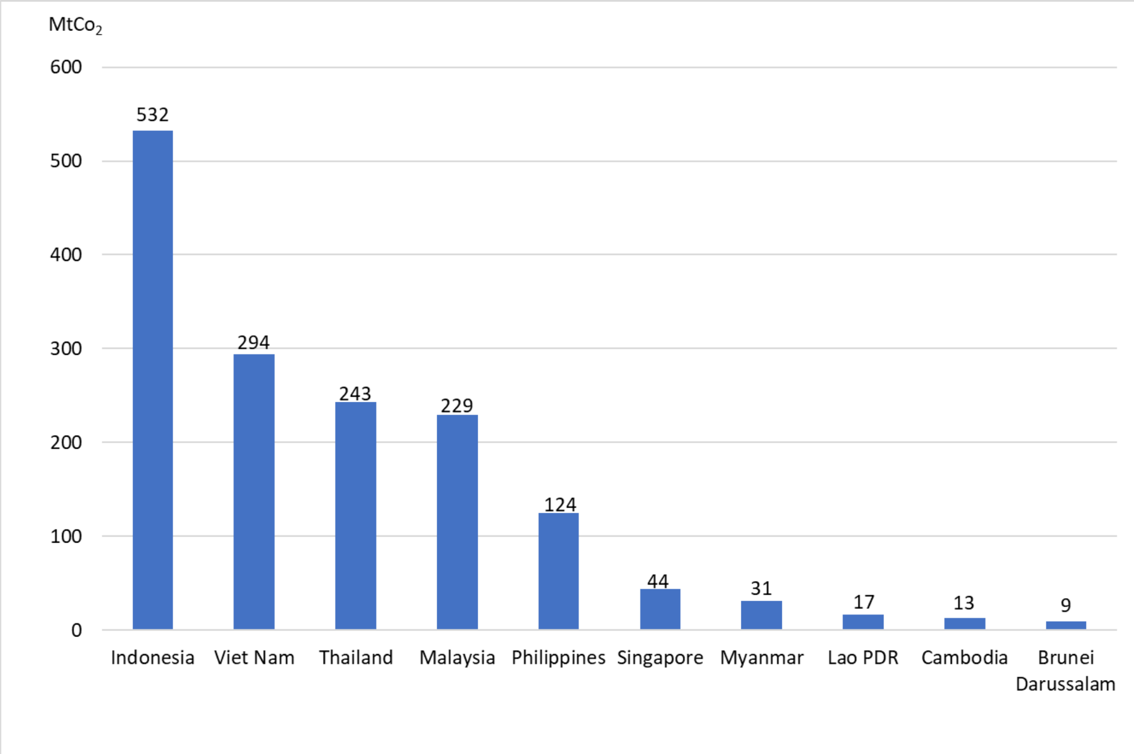


TES = total energy supply.
Source: IEA (2022).

2. Current Status of CO_2 Emissions

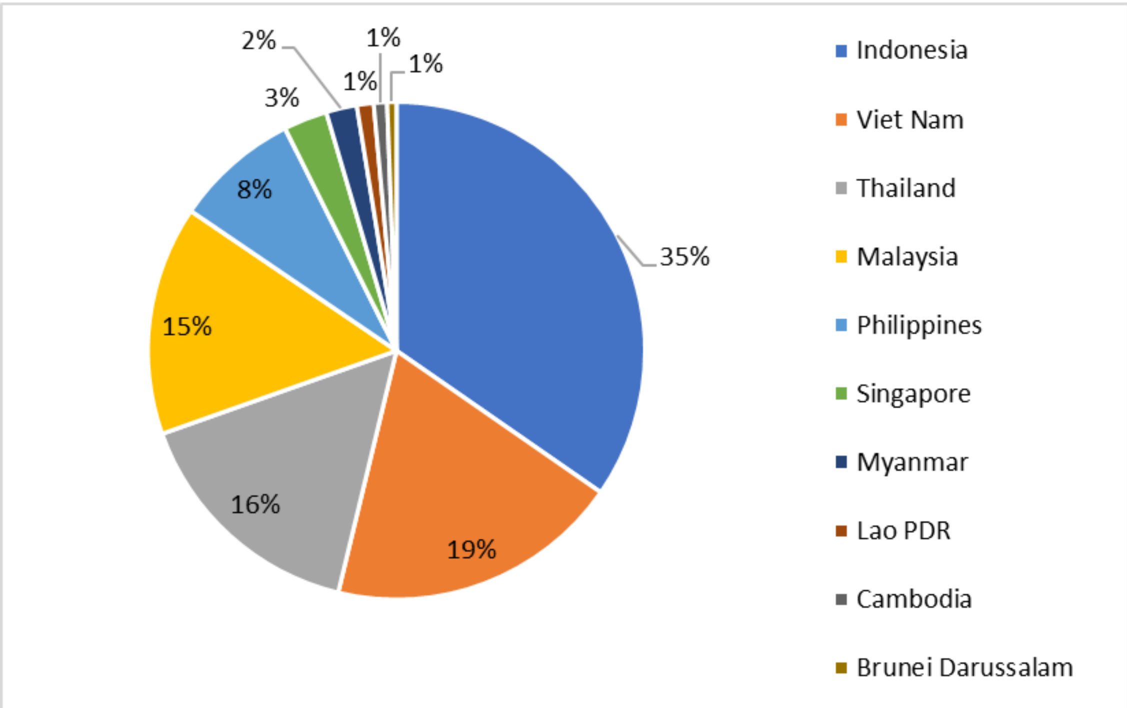
Figure 2.3 shows a graph of the countries in order of CO_2 emissions as of 2020. The total CO_2 emissions of the 10 ASEAN countries in 2020 are 1,538 $MtCO_2$. The top five countries account for 92% share of CO_2 emissions (Figure 2.4).

Figure 2.3. ASEAN CO_2 Emissions (2020)



ASEAN = Association of Southeast Asian Nations.
Source: IEA (2022).

Figure 2.4. Country Share of CO_2 Emissions (2020)



Source: IEA (2022).

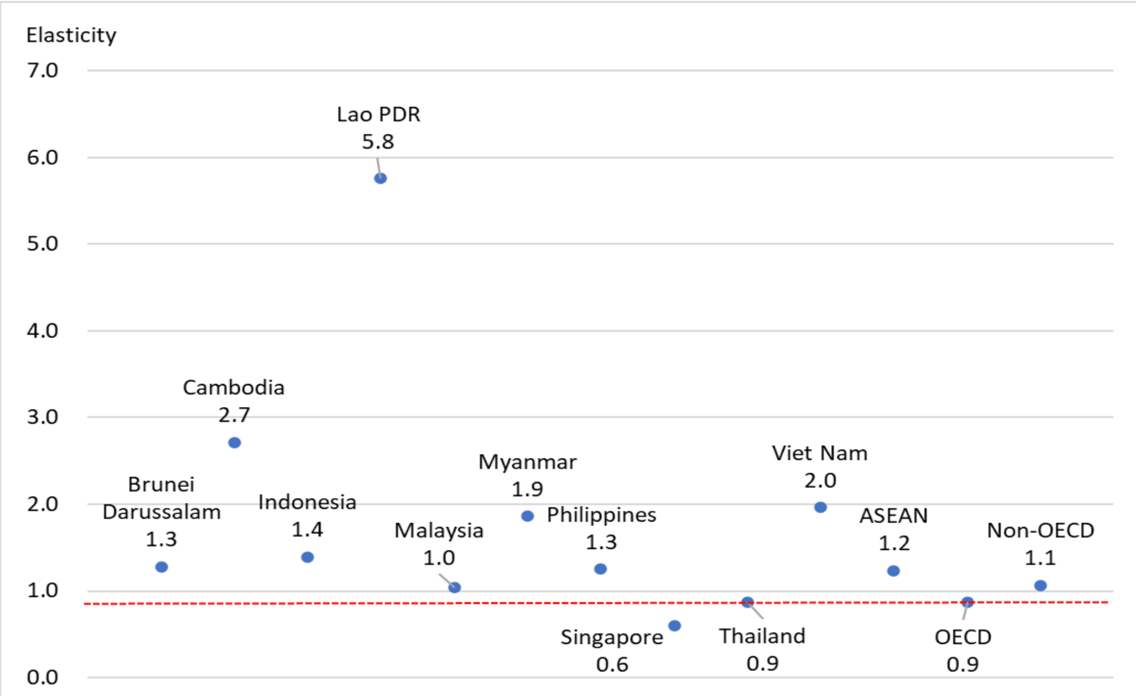
3. Selection of Survey Countries

As of 2020, the top five countries accounting for about 90% of ASEAN's TES and CO_2 emissions are Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam.

The elasticities for these five countries are 1.4 for Indonesia, 1.0 for Malaysia, 1.3 for the Philippines, 0.9 for Thailand, and 2.0 for Viet Nam.

The OECD's elasticity, on the other hand, is 0.9. Only Thailand has an elasticity comparable to that of OECD. The elasticities for the other four countries are above 1, indicating that CO_2 emissions have increased more than TES growth (Figure 2.5).

Figure 2.5. Elasticity with Border Line



ASEAN = Association of Southeast Asian Nations, OECD = Organisation for Economic Co-operation and Development.
Source: IEA (2022).

Based on the above, amongst the top five countries that account for about 90% of TES and CO_2 emissions as of 2020, four countries with elasticities of 1 or more, which is higher than the OECD's elasticity (0.9), are selected for the subject of study (Table 2.1).

Table 2.1. Selected Target Countries

Countries	CO_2 Emissions	TES	Elasticity
Indonesia	532	233.4	1.4
Malaysia	229	92.2	1.0
Philippines	124	58.0	1.3
Viet Nam	294	97.2	2.0

Source: Author.

Chapter 3
Study of Selected Countries

This chapter analyses energy consumption, energy efficiency, CO_2 emissions, energy efficiency policies, and CO_2 emissions reduction policies in the four countries studied.

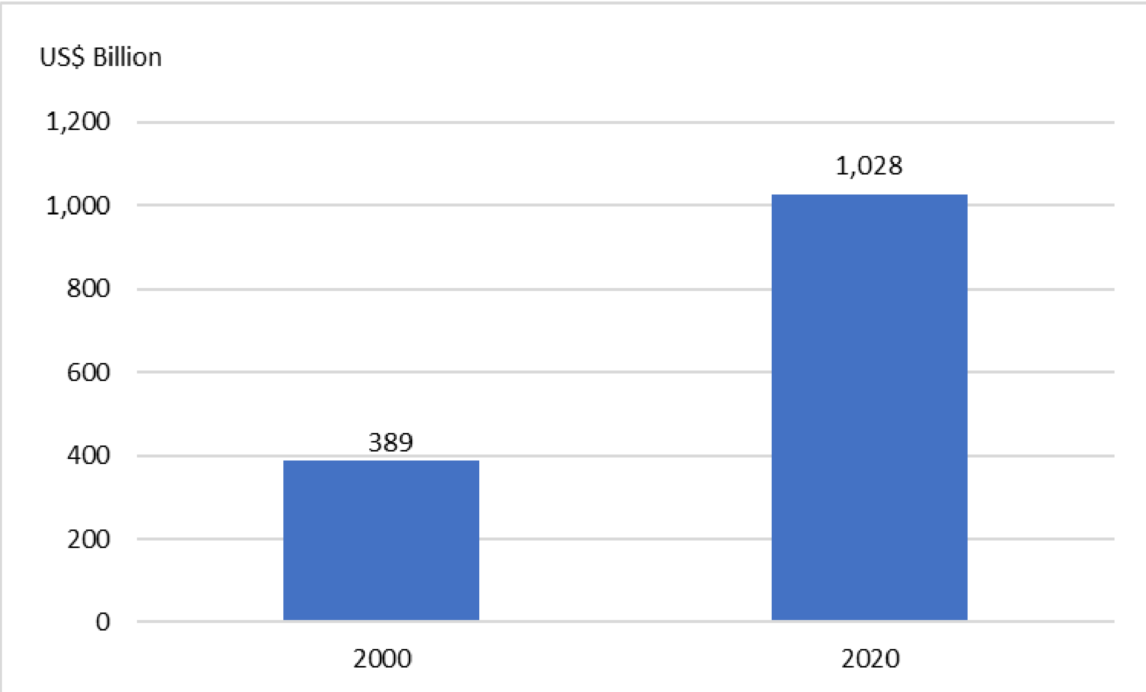
1. Indonesia

1.1. Indicators of Energy Consumption

1) Transition in GDP

Indonesia's GDP grew 2.6 times in 20 years, from $389 billion in 2000 to $1,028 billion in 2020 (Figure 3.1).

Figure 3.1. Indonesia GDP 2000 vs 2020 (2015 prices and ex rate)



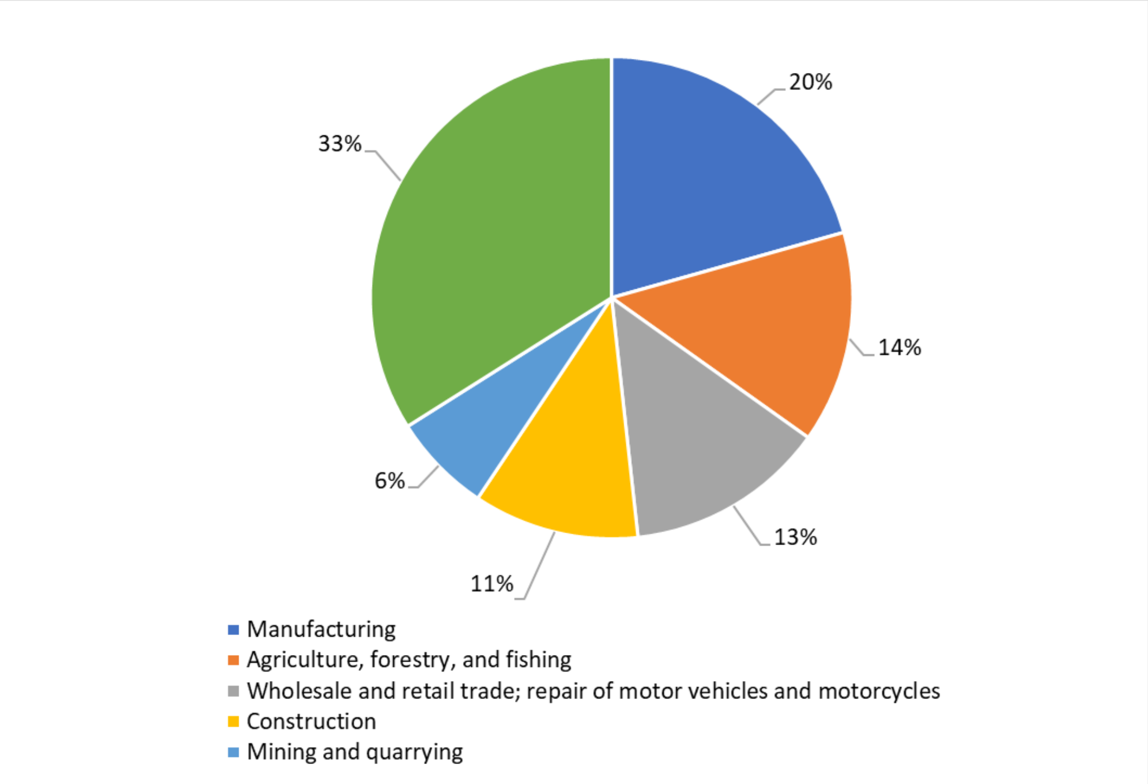
Source: IEA (2022).

2) GDP by sector and changes in industrial structure

In terms of the share of nominal GDP by sector in 2020, the manufacturing sector is in first place (20%), followed by agriculture, forestry, and fishing (14%), wholesale and retail trade (13%), construction (11%), and mining (6%) (Figure 3.2).

The Indonesian economy has shifted from its previous agricultural focus to manufacturing and services.

Figure 3.2. Indonesia GDP by Sector at Current Market Prices (2020)



GDP = gross domestic product
Source: ADB (2022).

3) Transition of TES by energy type

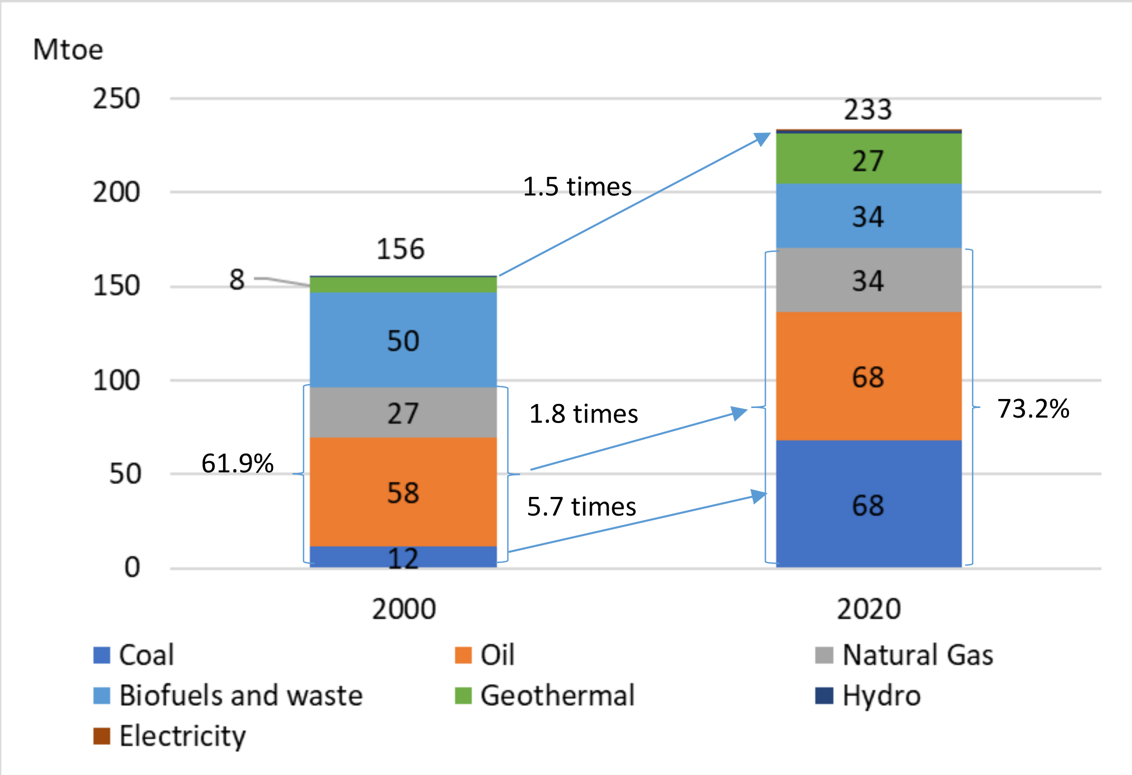
In 20 years, TES increased by 1.5 times from 156 Mtoe in 2000 to 233 Mtoe in 2020.

Of that amount, TES of fossil fuels (oil, coal, and natural gas) increased by 1.8 times from 96 Mtoe in 2000 to 171 Mtoe in 2020. If we focus on TES of fossil fuels by energy, TES of oil and natural gas increased 1.2 and 1.3 times, respectively, while TES of coal, which has a particularly high CO_2 emissions factor, increased significantly by 5.7 times, from 12 Mtoe in 2000 to 68 Mtoe in 2020.

Amongst non-fossil fuels, geothermal TES increased by a factor of 3.2 and hydro TES by a factor of 2.4. Conversely, TES of biofuels and waste decreased by a factor of 0.7.

Fossil fuel dependence (the percentage of oil, coal, and natural gas in the total) increased from 61.9% in 2000 to 73.2% in 2020 (Figure 3.3).

Figure 3.3. TES by Energy Type (Indonesia: 2000 vs 2020)

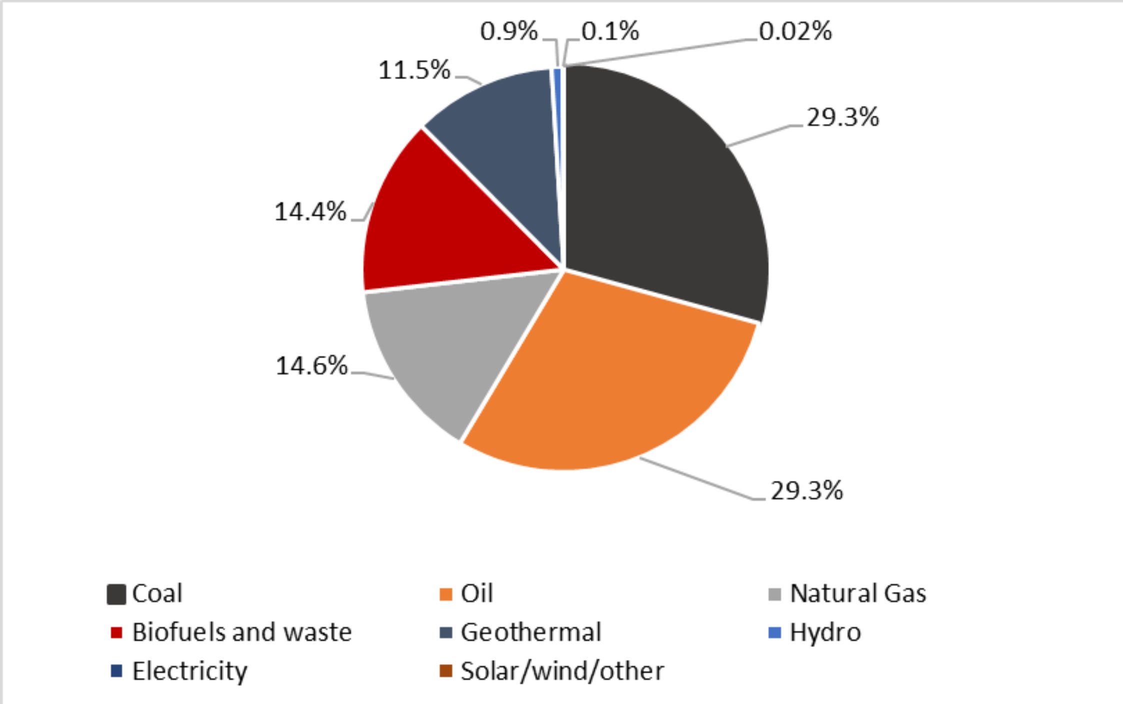


TES = total energy supply.
Source: IEA (2022).
Note: Totals may not match due to rounding.

Fossil fuels account for much of the TES, with a share of 73.2%. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 29.3% TES share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 26.8%. Amongst them, biofuels and waste, and geothermal are the main sources, while TES of solar, wind and others is very small (Figure 3.4).

Figure 3.4. TES Share by Energy (Indonesia: 2020)

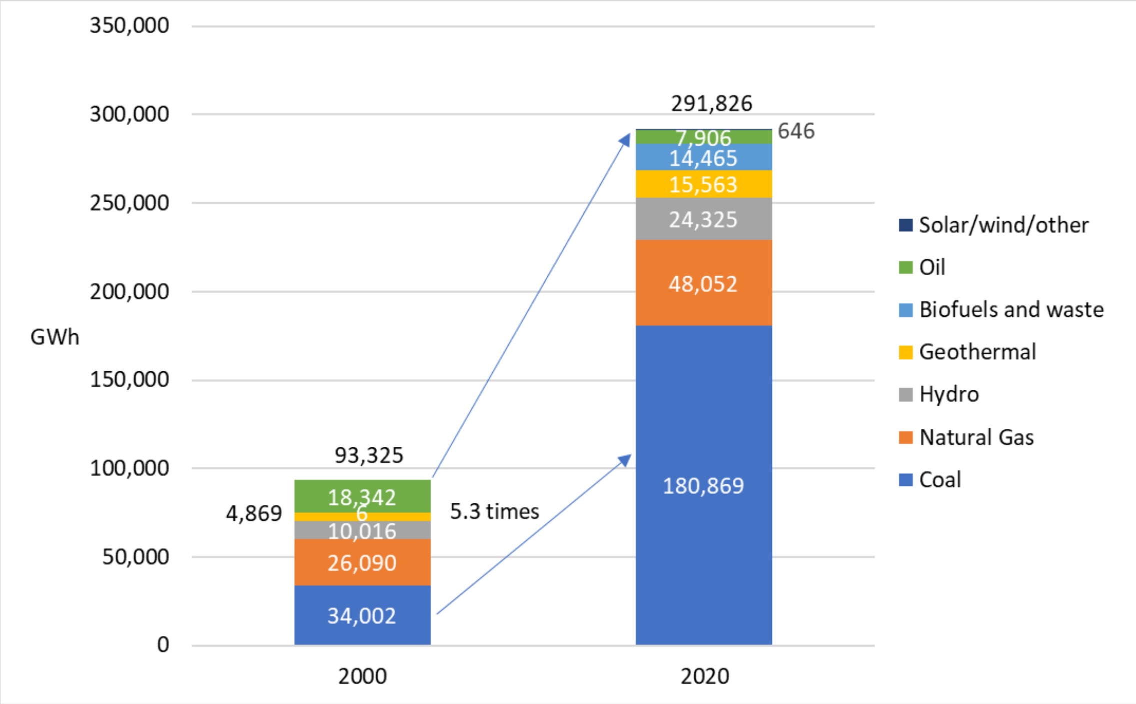


TES = total energy supply.
Source: IEA (2022).

4) Transition of power generation by fuel

Over the 20 years, power generation increased by 3.1 times from 93,325 GWh in 2000 to 291,826 GWh in 2020. In terms of power generation by fuel in 2020, coal ranks first (180,869 GWh), natural gas second (48,052 GWh), hydro third (24,325 GWh), followed by geothermal, biofuel and waste, and oil, solar power, wind power, and others. Over the 20 years, the amount of electricity generated by coal, which has the highest CO_2 emissions factor, increased markedly by 5.3 times (Figure 3.5).

Figure 3.5. Electricity Output by Fuel (Indonesia: 2000 vs 2020)



Source: IEA (2022).

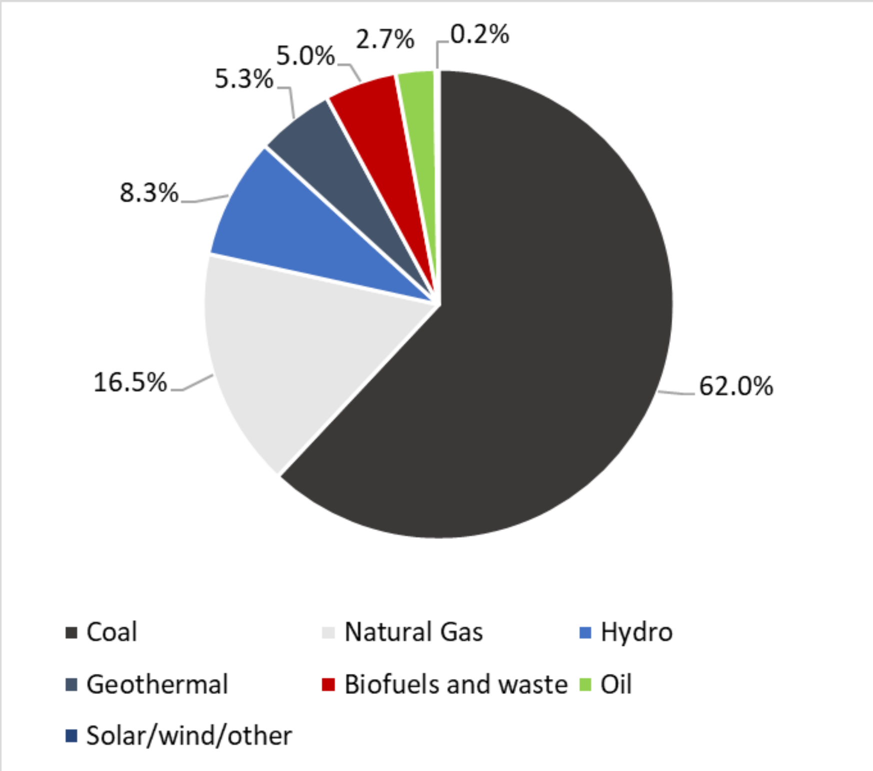
Note: Totals may not match due to rounding.

In terms of share of power generation by fuel in 2020, coal comes in first (62.0%), natural gas second (16.5%), hydro third (8.3%), followed by geothermal, biofuel and waste, and solar/wind/other.

Fossil fuels account for most of the share of power generation, at 81.2%. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 62.0% share.

On the other hand, the share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 18.8%. Amongst them, hydro (8.3%), geothermal (5.3%), and biofuels and waste (5.0%), which make use of Indonesia's nature and topography, are the main sources, while the power generation share of solar, wind, and others is very low, 0.2% (Figure 3.6).

Figure 3.6. Electricity Output Share by Fuel (Indonesia: 2020)



Source: IEA (2022).

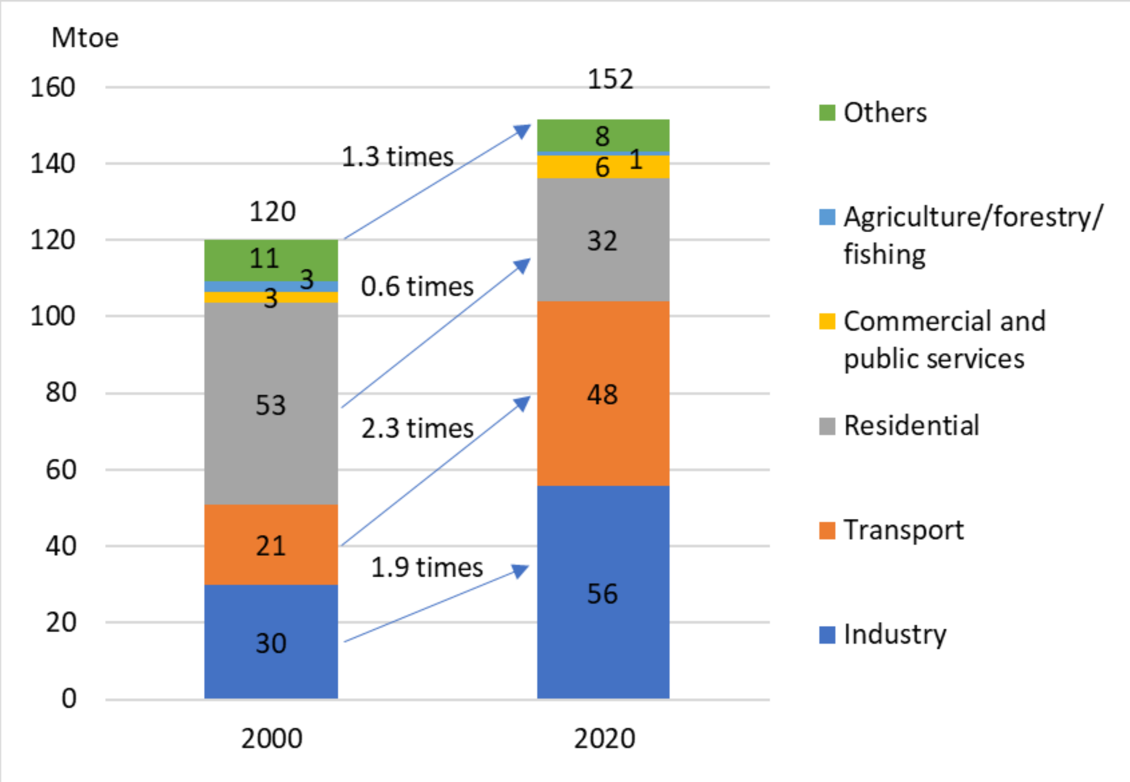
5) Transition of final energy consumption by sector

In 20 years, final energy consumption increased 1.3 times from 120 Mtoe in 2000 to 152 Mtoe in 2020. In terms of final energy consumption by sector in 2020, the manufacturing industries and construction sector (56 Mtoe) is in first place, the transport sector (48 Mtoe) is in second place, the residential sector (32 Mtoe) is in third place, followed by the commercial and public services sector (6 Mtoe), the agriculture/ forestry/fishing sector (1 Mtoe), and other sectors (8 Mtoe).

In 20 years, the final energy consumption in the industry sector increased 1.9 times from 30 Mtoe in 2000 to 56 Mtoe in 2020. In the transport sector, the final energy consumption increased 2.3 times from 21 Mtoe in 2000 to 48 Mtoe in 2020. On the other hand, the final energy consumption in the residential sector decreased by 0.6 times from 53 Mtoe in 2000 to 32 Mtoe in 2020 (Figure 3.7).

The shift in the industrial structure from being agriculture-based to being manufacturing- and services-based has led to the growth in the final energy consumption in the industry sector. The final energy consumption in the transport sector has also been growing with the development of motorisation.

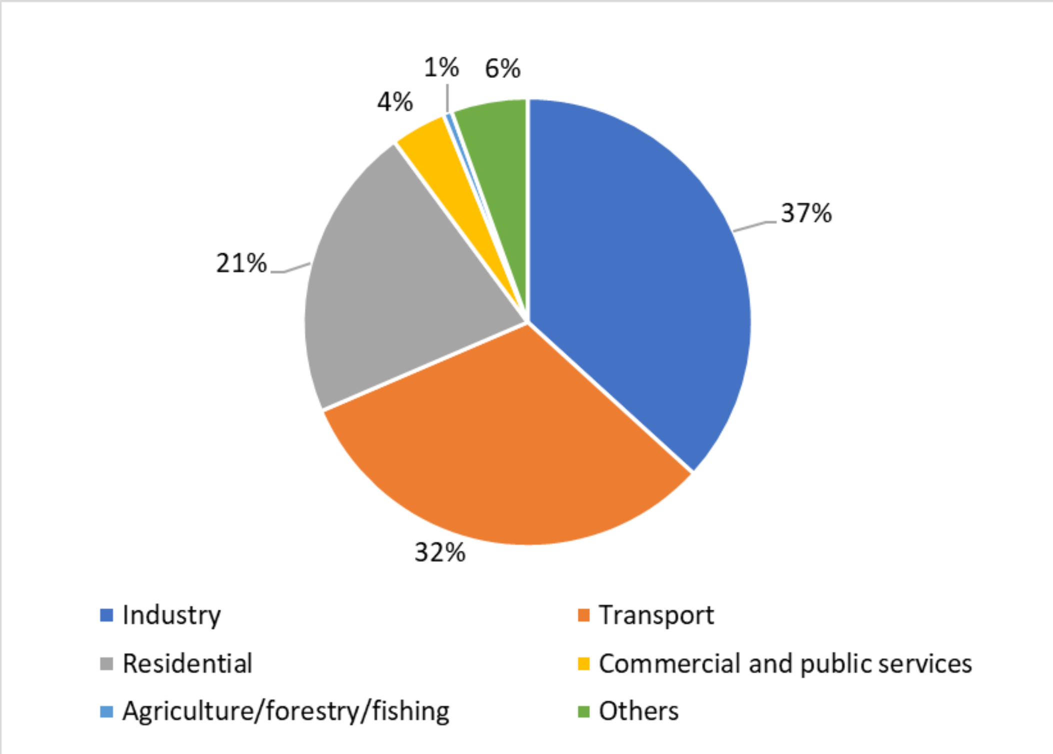
Figure 3.7. Final Energy Consumption (Indonesia: 2000 vs 2020)



Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of the share of final energy consumption by sector in 2020, the industry sector is in first place (37%), followed by the transport sector (32%), the residential sector (21%), the commercial and public services sector (4%), the agriculture/ forestry/ fishing sector (1%) and the others (6%) (Figure 3.8).

Figure 3.8. Final Energy Consumption Share by Sector (Indonesia: 2020)



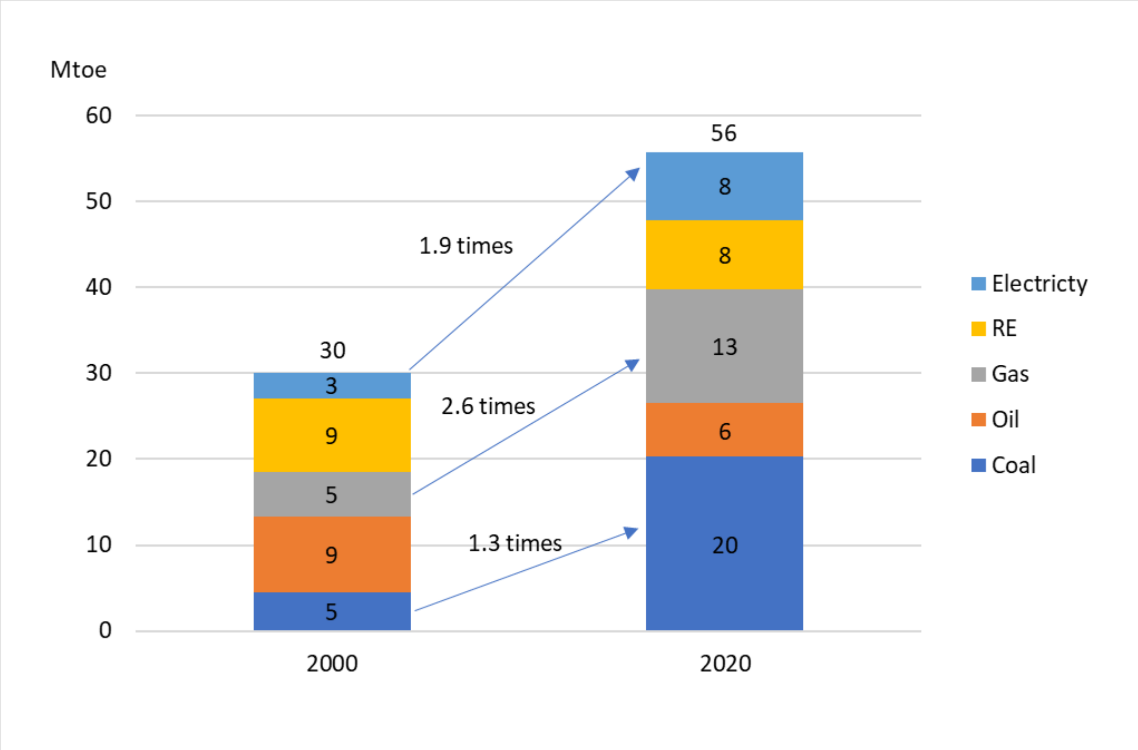
Source: IEA (2022).

6) Energy consumption and efficiency in the industry sector

The final energy consumption in the industry sector increased 1.9 times from 30 Mtoe in 2000 to 56 Mtoe in 2020.

In particular, the final energy consumption of coal increased 4.5 times from 5 Mtoe in 2000 to 20 Mtoe in 2020. The final energy consumption of natural gas also increased 2.6 times from 5 Mtoe in 2000 to 13 Mtoe in 2020 (Figure 3.9).

Figure 3.9. Final Energy Consumption Transition by Fuel (Indonesia: 2000 vs 2020)

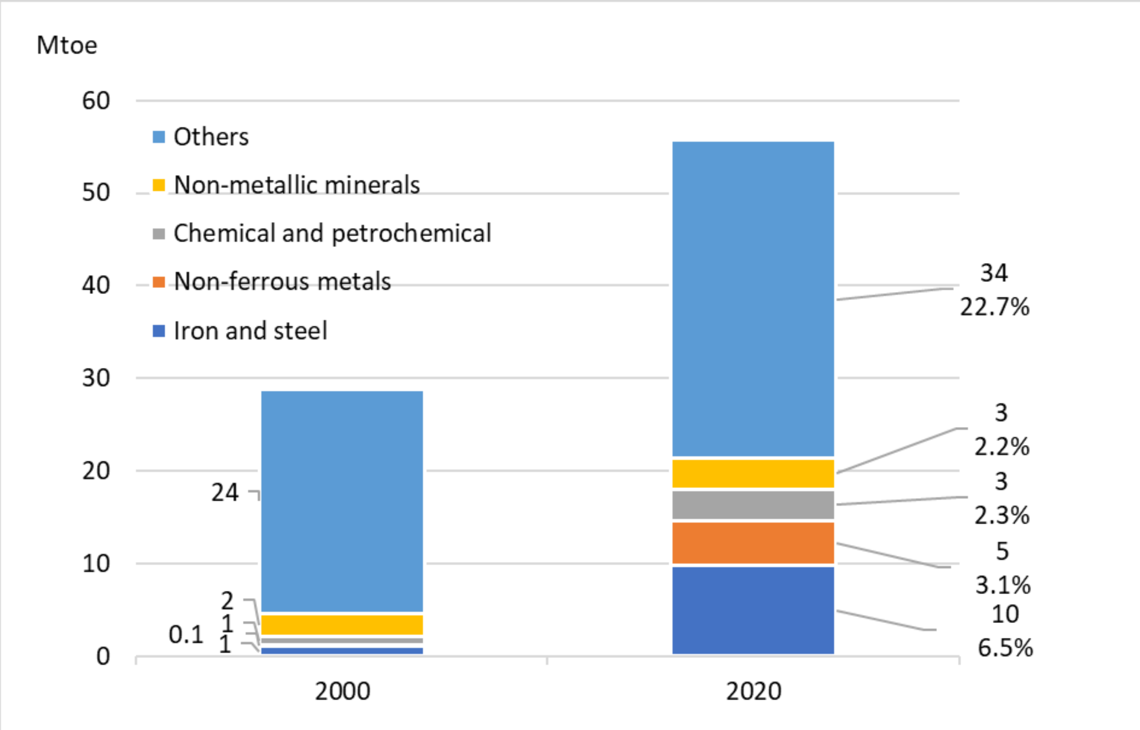


RE: renewable energy.
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of final energy consumption by industry subsector, that of the iron and steel sector increased about 10 times from 1 Mtoe in 2000 to 10 Mtoe in 2020. In addition, the final energy consumption in the non-ferrous metals sector increased about 43 times from 0.1 Mtoe in 2000 to 5 Mtoe in 2020. In addition, the final energy consumption in the chemical and petrochemical sector increased about 3.0 times from 1 Mtoe in 2000 to 3 Mtoe in 2020. It should be noted that there is no detailed breakdown of final energy consumption by industry sector in Indonesia.

In the industry sector, the share by subsector in the final energy consumption in 2020 is 6.5% for the iron and steel sector. It is 3.1% for non-ferrous metals sector. It is 2.3% for chemical and petrochemical sector (Figure 3.10).

Figure 3.10. Final Energy Consumption Transition and Share by Industry Subsector (Indonesia: 2000 vs 2020)



Source: IEA (2022).

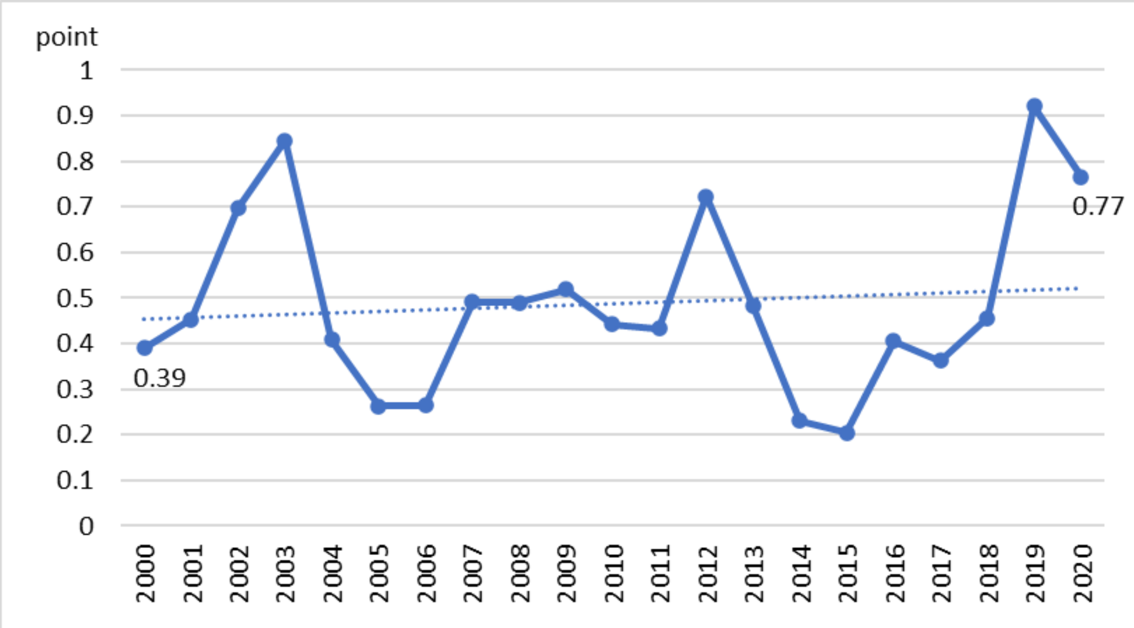
Note: Totals may not match due to rounding.

Next, we consider the iron and steel subsector and the non-metallic minerals subsector, for which statistical data are available. For the non-ferrous metals subsector, statistical data on copper and aluminum production are not available. For the chemical and petrochemical subsector, statistical data on ethylene and ammonia production are also not available.

a) Iron and Steel subsector

Figure 3.11 shows the index of final energy consumption in the iron and steel subsector divided by crude steel production. The index worsened from 0.39 in 2000 to 0.77 in 2020. The index has been deteriorating, although it fluctuates from year to year.

Figure 3.11. EE&C Indicator Transition of Iron and Steel Subsector (Indonesia)

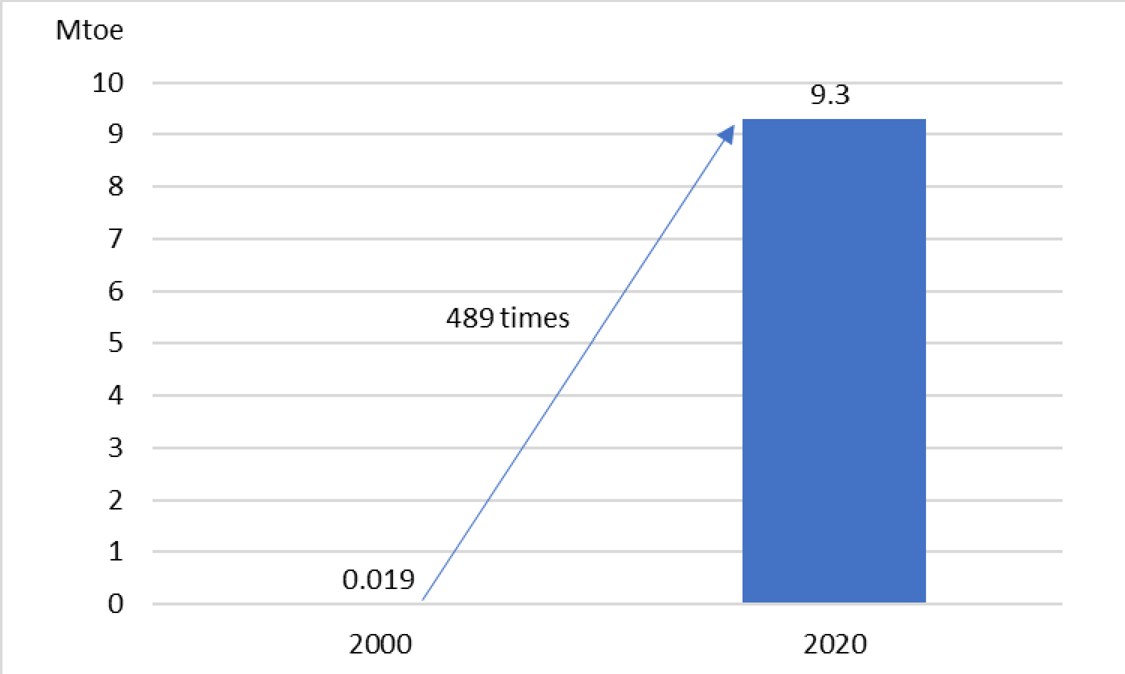


EE&C = energy efficiency and conservation.
Note: The dotted line in the graph is an approximate curve.
Source: IEA (2022) and World Steel Association.

The consumption of coal in the iron and steel subsector (6.5%), which has the largest share of energy consumption in the industry sector, increased by 489 times from 0.019 Mtoe in 2000 to 9.3 Mtoe in 2020 (Figure 3.12). This growth rate is first and prominent amongst all sectors.

One of the reasons for the sharp increase in final energy consumption in the iron and steel subsector may be related to the first blast furnace in Southeast Asia, which started operation in Java in 2013.

Figure 3.12. Final Energy Consumption Transition of Coal by Iron and Steel Subsector (Indonesia: 2000 vs 2020)

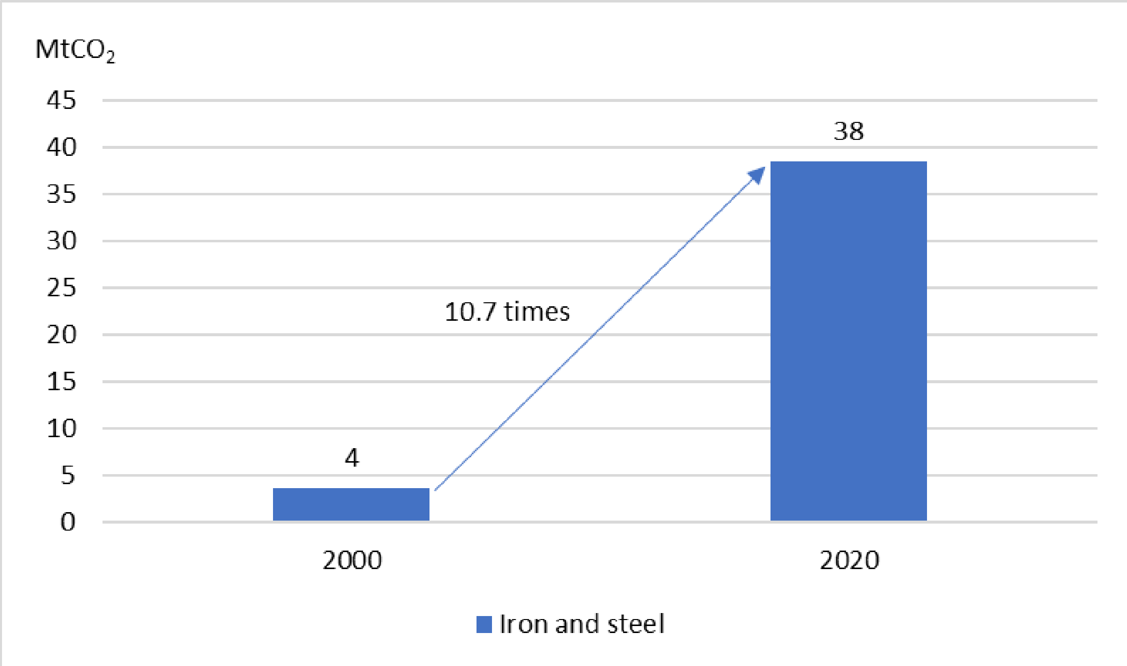


Source: IEA (2022).

In addition, the CO_2 emissions in the iron and steel subsector increased 10.7 times from 4 $MtCO_2$ in 2000 to 38 $MtCO_2$ in 2020 (Figure 3.13).

The iron and steel subsector is known for its high coal consumption. It is considered that a significant increase in the consumption of energy such as coal (by 489 times) in this subsector led to the increase of the CO_2 emissions (by 11 times).

Figure 3.13. CO_2 Emissions Transition by Iron and Steel Subsector (Indonesia: 2000 vs 2020)

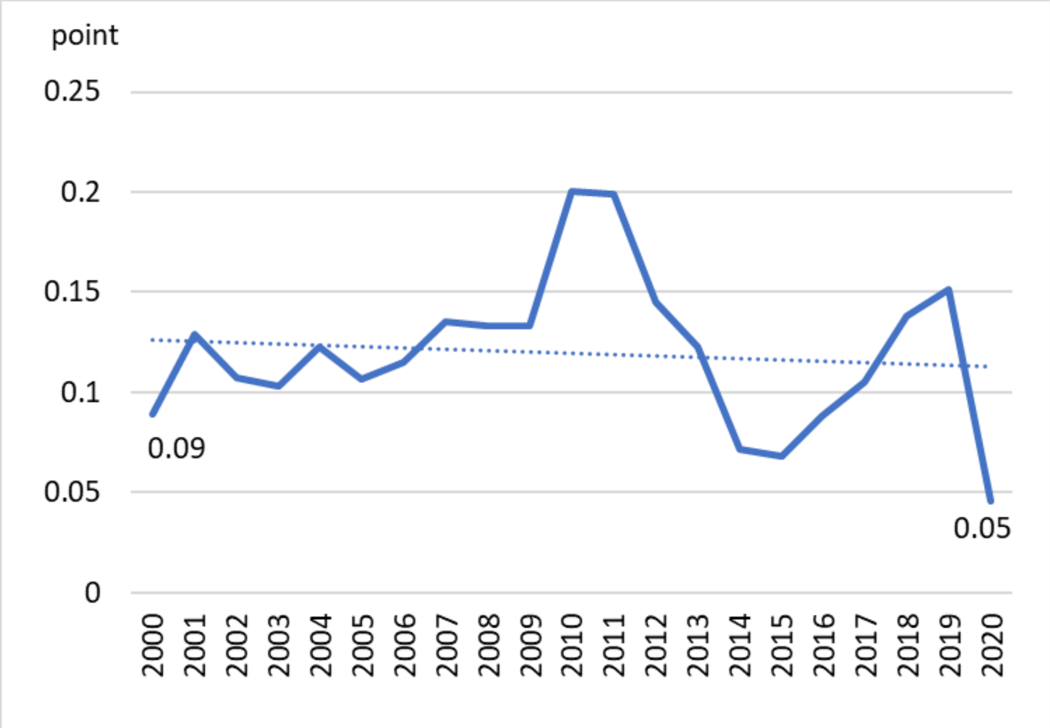


Source: IEA (2022).

b) Non-metallic minerals subsector

Figure 3.14 shows an index calculated by dividing the final energy consumption in the non-metallic minerals subsector by the cement production. The index improved from 0.09 in 2000 to 0.05 in 2020. The index has been improving, although it fluctuates from year to year.

Figure 3.14. EE&C Indicator Transition of Non-metallic Minerals Subsector (Indonesia)

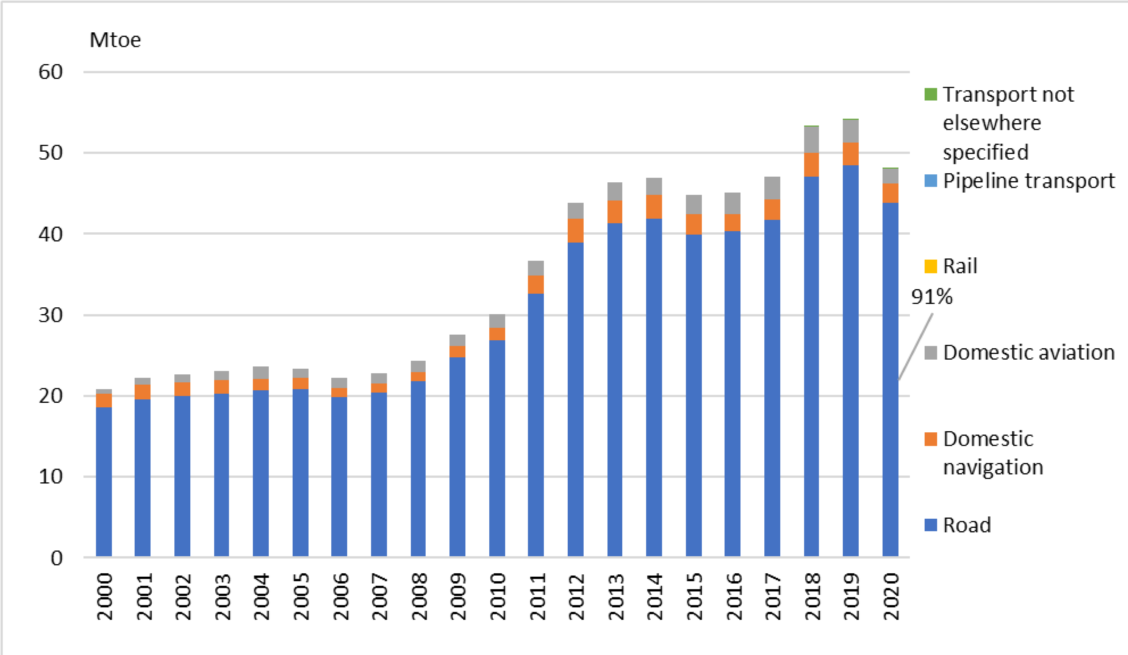


E&C = Energy efficiency and conservation.
Note: The dotted line in the graph is an approximate curve.
Source: IEA (2022) and USGS Cement Statistics and Information https://www.usgs.gov/centers/national-minerals-information-center/cement-statistics-and-information (accessed 23 May 2023).

7) Energy consumption and efficiency in the transport sector

91% of the energy consumption in the transport sector as of 2020 is represented by the road transport sector (Figure 3.15). The energy consumption in road transport rapidly increased from 2008 to 2014 and has slightly increased in recent years.

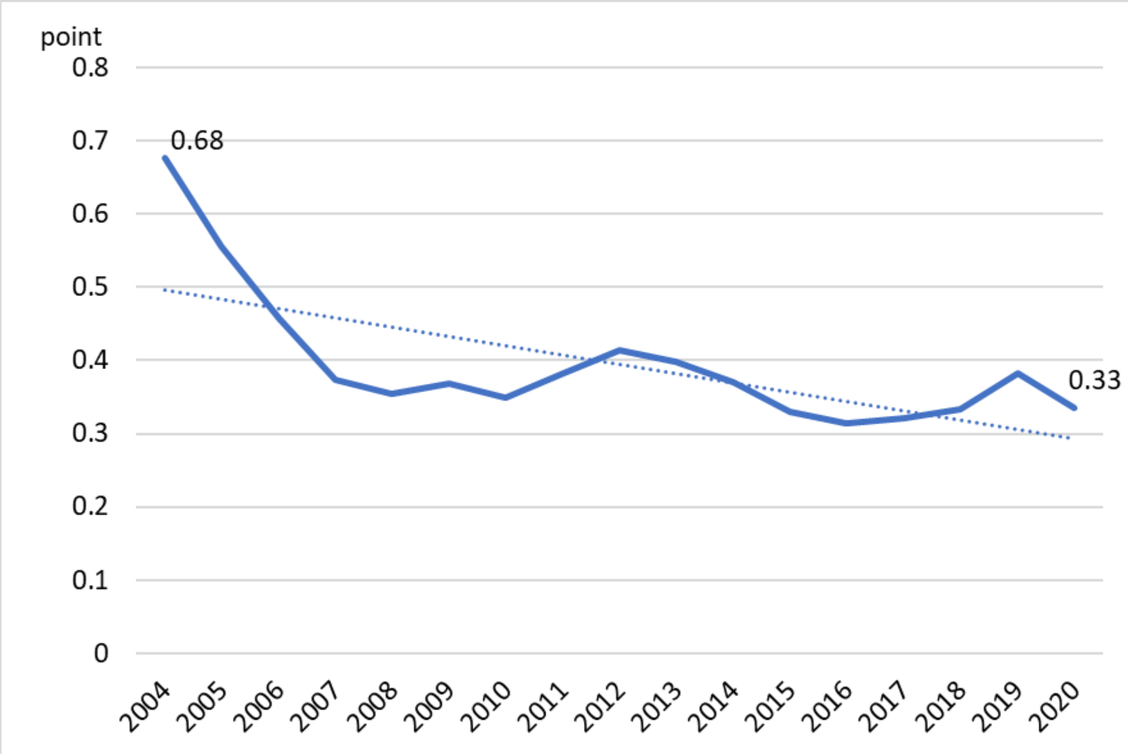
Figure 3.15. Final Energy Consumption Transition by Transport Sector (Indonesia)



Source: IEA (2022).

Next, we analyse the index obtained by dividing final energy consumption in the road transport sector by the number of registered vehicles owned. The index of 0.68 in 2000 improved to 0.33 in 2020 (Figure 3.16).

Figure 3.16. EE&C Indicator Transition of Road Sector (Indonesia)



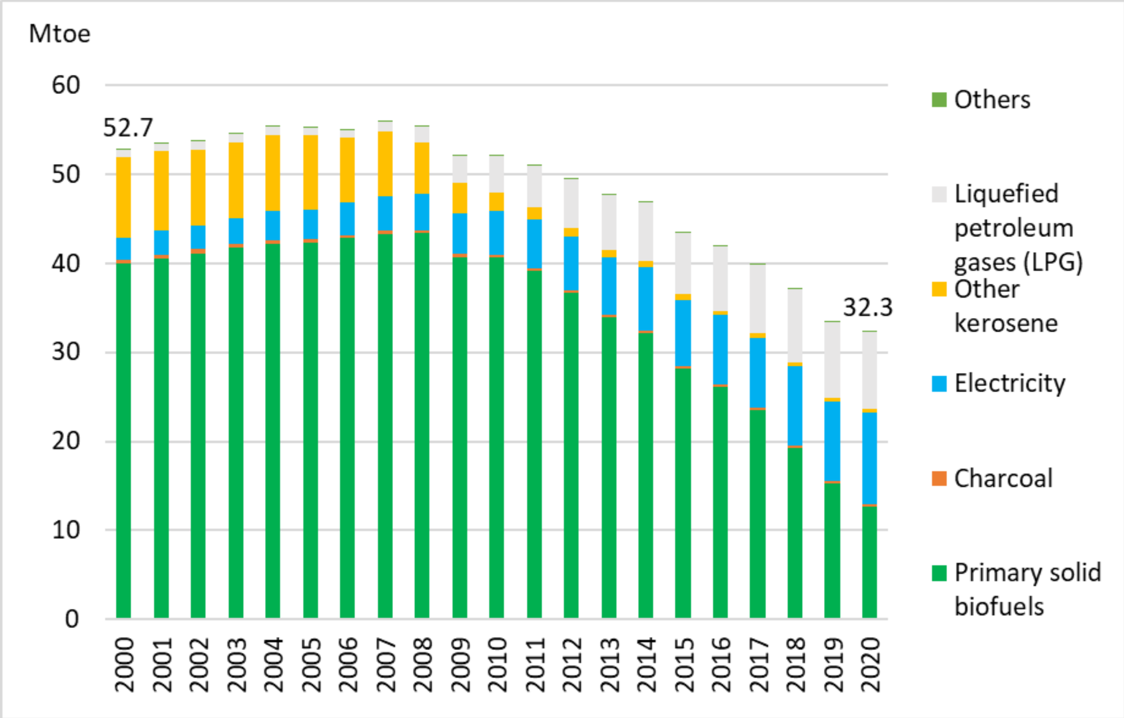
Source: IEA (2022) and ASEANStats, https://data.aseanstats.org/ (accessed 4 June 2023).

8) Energy consumption and efficiency in the residential sector

The final energy consumption in the residential sector decreased by 20.4 points from 52.7 Mtoe in 2000 to 32.3 Mtoe.

An analysis of this breakdown into traditional fuels, such as primary solid biofuels and charcoal, which are treated as carbon neutral, and modern fuels, such as liquefied petroleum gas (LPG), kerosene and electricity, shows that the traditional fuels have decreased, but the modern fuels have increased. Particularly since 2009, there has been a marked decrease in the final energy consumption of traditional fuel and a corresponding increase in that of modern fuel (Figure 3.17). It is considered that uses of electricity and LPG have increased due to improvement in living standards.

Figure 3.17. Final Energy Consumption Transition of Residential Sector (Indonesia)

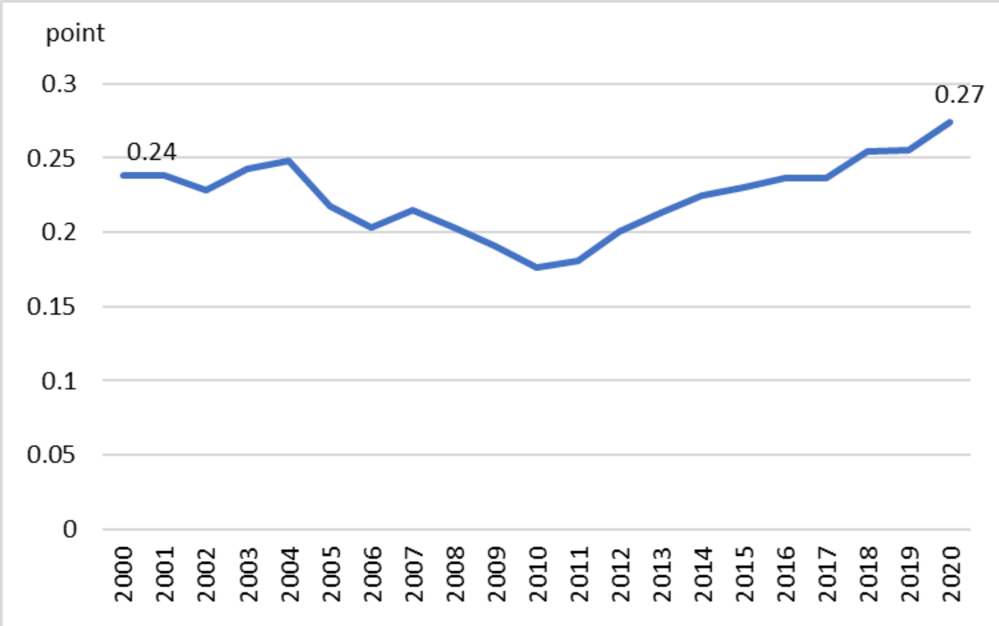


Source: IEA (2022).

Next, we analyse the index of final energy consumption of modern energy divided by the number of households. Since statistical data on the number of households in Indonesia are not confirmed, we use the deemed number of households, which is the population divided by the average number of persons per household.

Figure 3.18 shows that the indicator worsens from 0.24 in 2000 to 0.27 in 2022. The index improved from 2000 to 2010, but has deteriorated since 2011.

Figure 3.18. EE&C Indicator Transition of Residential Sector (Indonesia)



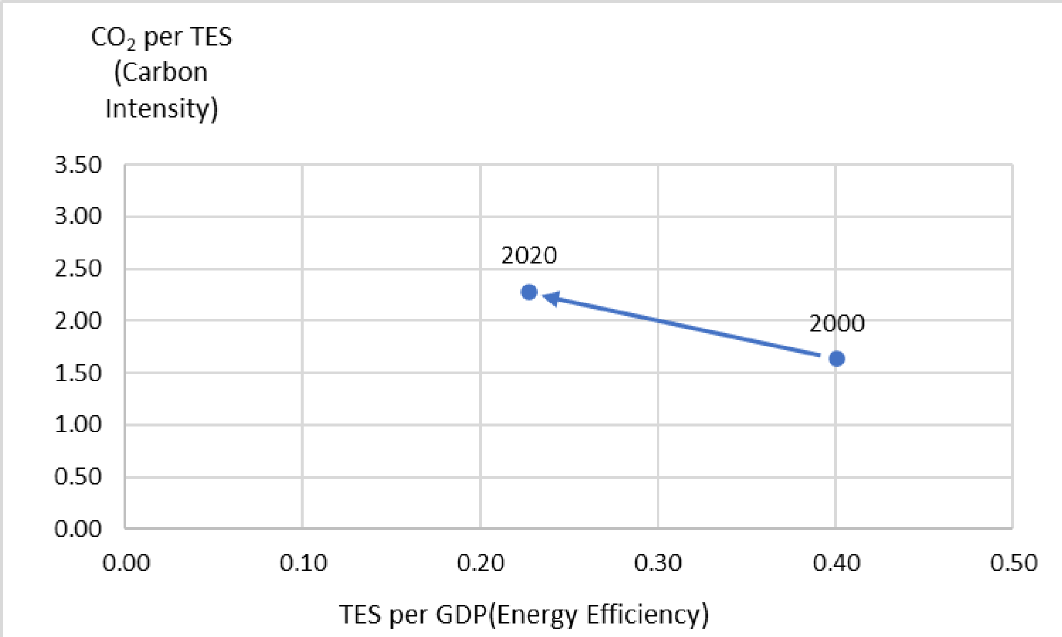
EE&C = energy efficiency and conservation.
Source: IEA (2022) and United Nations https://population.un.org/household/#/countries/ (accessed 23 May 2023).

1.2. Indicator of Energy Efficiency

1) Energy efficiency and carbon intensity

TES per GDP, a leading indicator of energy efficiency, decreased by 43% over 20 years, from 0.4 in 2000 to 0.23 in 2020. As shown in the graph below, energy conservation is making progress. On the other hand, CO_2 emissions per TES worsened from 1.64 in 2000 to 2.28 in 2020. Despite progress in energy conservation, the carbon intensity is deteriorating (Figure 3.19).

Figure 3.19. Energy Efficiency and Carbon Intensity Transition (Indonesia: 2000–20)



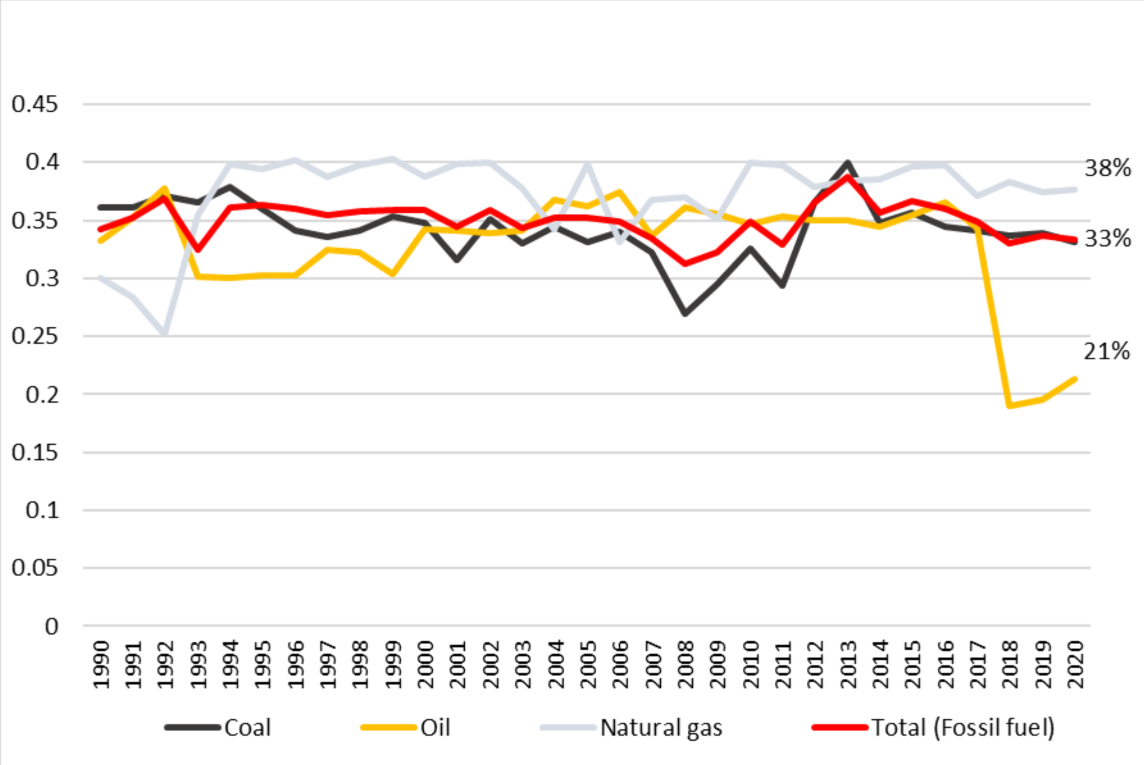
GDP = gross domestic product, TES = total energy supply.
Source: IEA (2022).

2) Power generation efficiency

Over the 20 years, the efficiency of thermal power generation (coal, oil, and natural gas) has generally remained around 35%. As of 2020, the efficiency of thermal power generation (average of coal, oil, and natural gas) is 33%.

The efficiency of coal-fired power generation over the 20-year period generally hovers around 33%, and the efficiency as of 2020 is 33% (Figure 3.20).

Figure 3.20. Thermal Efficiency Transition (Indonesia: 2000–20)



Source: IEA (2022).

1.3. Indicator of CO_2 Emissions

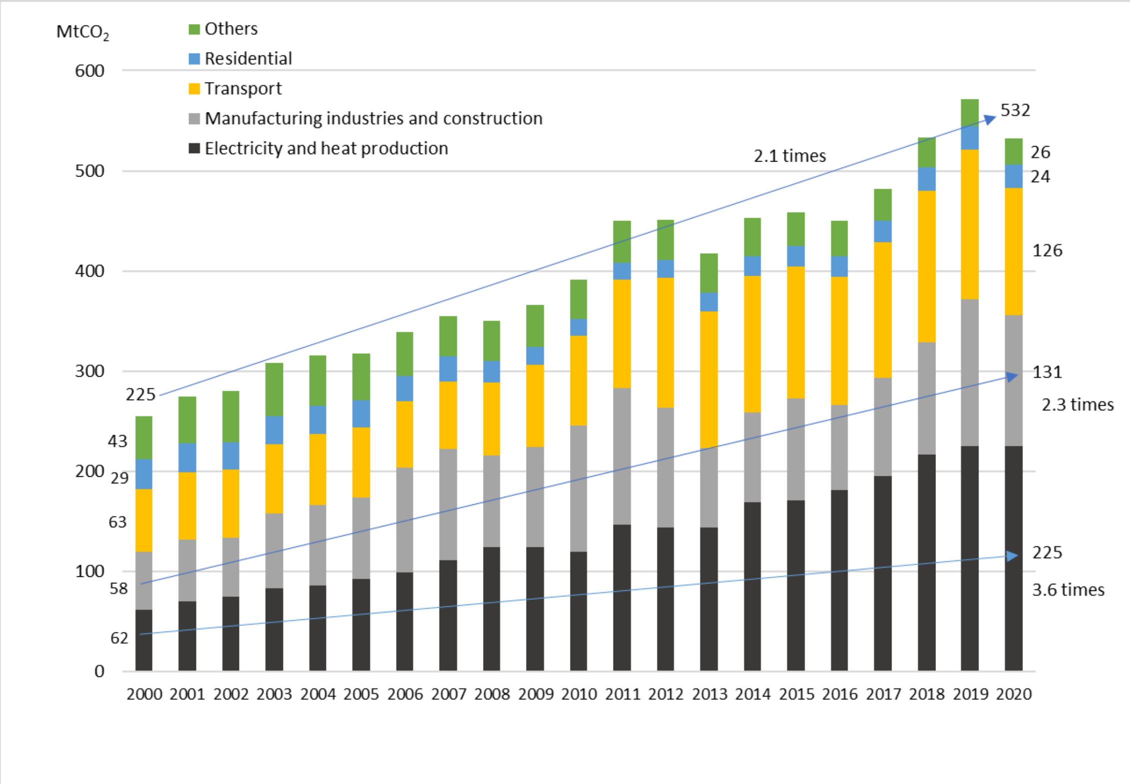
1) Transition in CO_2 emissions by sector

CO_2 emissions increased 2.1 times in 20 years, from 225 $MtCO_2$ in 2000 to 532 $MtCO_2$ in 2020.

CO_2 emissions by sector in 2020 are 225 $MtCO_2$ from the electricity and heat production sector, 131 $MtCO_2$ from the manufacturing industries and construction sector, 126 $MtCO_2$ from the transport sector, 24 $MtCO_2$ from the residential sector, and 26 $MtCO_2$ from other sectors.

Comparing CO_2 emissions over the 20-year period from 2000 to 2020, we find that the CO_2 emissions in the electricity and heat production sector increased 3.6 times from 62 $MtCO_2$ to 225 $MtCO_2$, that in the manufacturing industries and construction sector increased 2.3 times from 58 $MtCO_2$ to 131 $MtCO_2$, and that in the transport sector doubled from 63 $MtCO_2$ to 126 $MtCO_2$. The CO_2 emissions in the residential sector, on the other hand, decreased by 0.8 times, from 29 $MtCO_2$ to 24 $MtCO_2$ (Figure 3.21).

Figure 3.21. CO_2 Emissions Transition by Sector (Indonesia: 2000–20)



Source: IEA (2022).
Note: Totals may not match due to rounding.

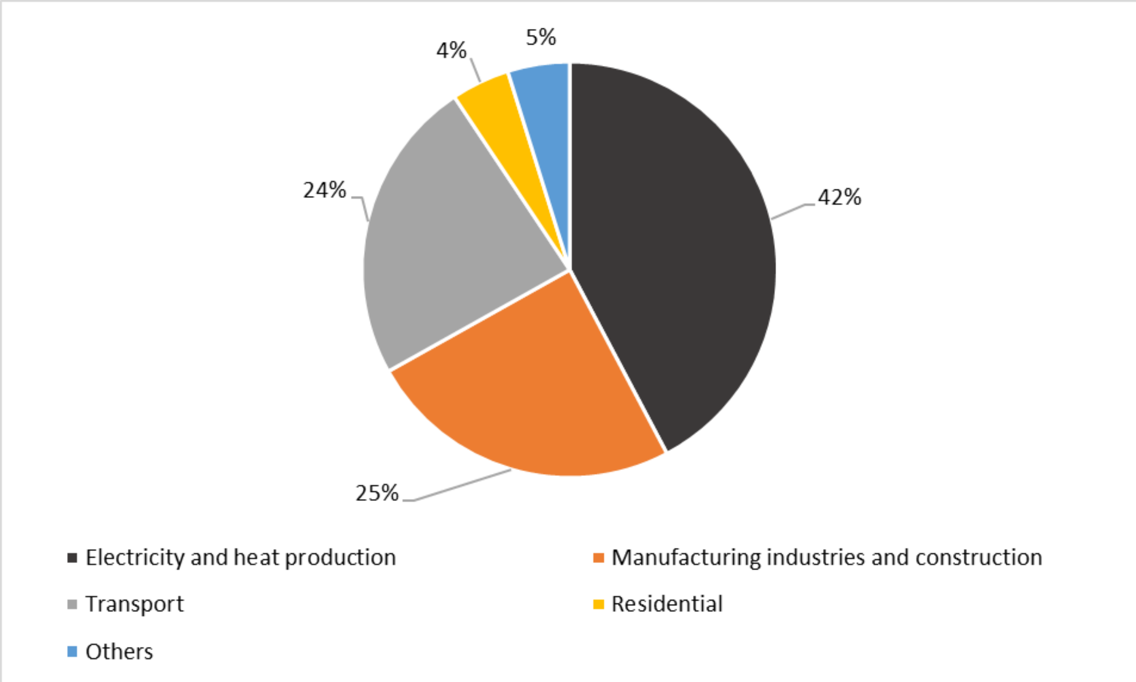
In terms of the share of CO_2 emissions by sector in 2020, the electricity and heat production sector are in first place (42%), followed by the manufacturing industries and construction sector (25%), the transport sector (24%), the residential sector (5%), and others (5%) (Figure 3.22).

In the electricity and heat production sector, the share of power generation from fossil fuels (oil, coal, and natural gas) is high, especially the share of coal-fired power generation (42%). In addition, coal-fired power generation efficiency (33%) is low compared to the OECD average (39%), suggesting that coal accounts for a large portion of CO_2 emissions from the electricity and heat production sector.

The manufacturing industries and construction sector, such as the iron and steel subsector, is energy-intensive and CO_2 emissions from coal-intensive sectors may be increasing.

In the transport sector, CO_2 emissions from automobiles are expected to increase due to the progress of motorisation.

Figure 3.22. CO_2 Emissions by Sector (Indonesia: 2020)



Source: IEA (2022).

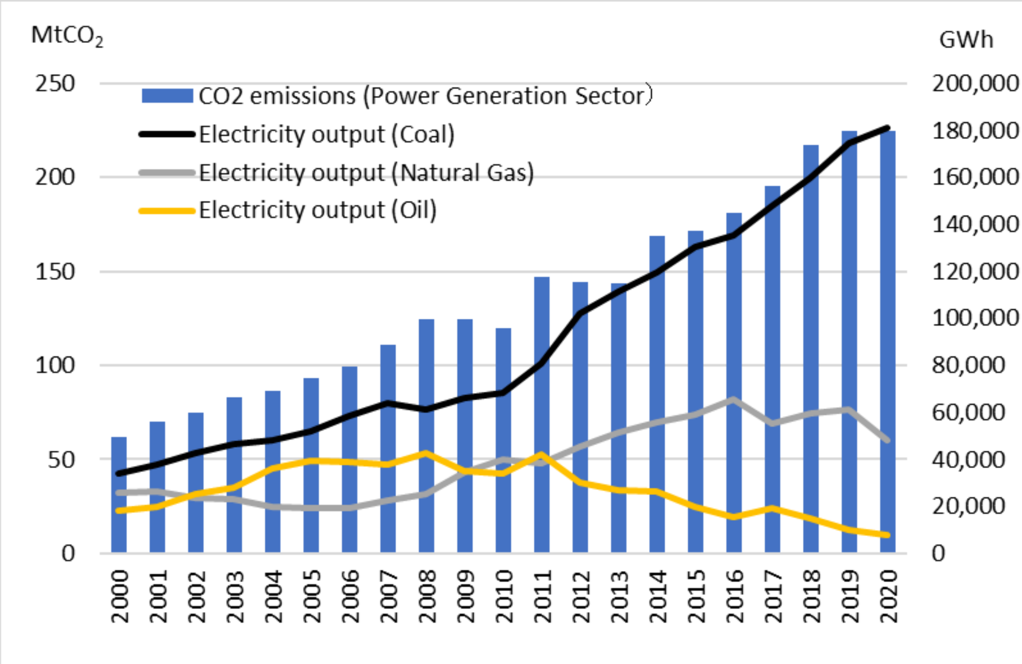
2) CO_2 emissions and coal-fired power generation

We analysed the relationship between the amount of thermal power generation of fossil fuels (oil, coal, and natural gas), which are closely related to CO_2 emissions, and CO_2 emissions from the electricity and heat production sector.

A graph of CO_2 emissions from the electricity and heat production sector versus oil-, coal-, and natural gas-fired power generation over a 20-year period is shown in Figure 3.23.

The graph indicates a strong correlation between CO_2 emissions and coal-fired power generation in the electricity and heat production sector in Indonesia.

Figure 3.23. Transition between CO_2 Emissions in Electricity Sector and Coal, Natural Gas, and Oil Electricity Output (Indonesia: 2000–20)



Source: IEA (2022).

1.4. Summary of Efficiency Indicators

Table 3.1 summarises Indonesia's energy efficiency indicator.

The major difference over the 20 years is that TES per GDP and the EE&C indicator of road transport have improved, but the EE&C indicator of the iron and steel subsector has worsened significantly.

Table 3.1. Summary of Energy Efficiency Indicator (Indonesia)

Energy Efficiency Indicator	Viet Nam		
	2000	2020	
TES per GDP	0.31	0.30	Improve
EE&C Indicator of Iron and Steel Sector	0.17	0.39	Worsen
EE&C Indicator of Non-metallic minerals Sector	0.09	0.12	Worsen
EE&C Indicator of Road Transport Sector	11.61	2.53	Improve
EE&C Indicator of Residential Sector	0.11	0.29	Worsen
Thermal Efficiency (Fossil fuel-fired)	0.29	0.34	Improve
Thermal Efficiency (Coal-fired)	0.23	0.31	Improve

EE&C = energy efficiency and conservation, GDP = gross domestic product, TES = total energy supply.
Source: Author.

1.5. Energy Efficiency Policy

Energy conservation policy in Indonesia started in 1982. Indonesia will reduce its energy elasticity below 1 by 2025 and reduce its final energy intensity by 1% annually by 2025. To achieve this goal, energy savings have been identified as follows: 15%–30% for industry, 25% for commercial buildings and 10%–30% for homes. The government will grant incentives to energy users and manufacturers of energy-saving equipment who consume more than 6,000 toe per year if they succeed in saving energy for a certain period. In addition, energy users with more than 6,000 toe per year have various obligations such as appointing an energy manager, formulating an energy conservation plan, and preparing an annual report on energy conservation.

1.6. CO_2 Emissions Reduction Policy

In its updated nationally determined contribution (NDC) and long-term strategy submitted to the United Nations Framework Convention on Climate Change in July 2021, Indonesia stated that it would reduce greenhouse gas (GHG) emissions to net zero by 2060.

The updated NDC aims to reduce GHG emissions by 29% (unconditional) and by 41% (conditional) using international assistance.

Indonesia will advance GHG reduction in the energy sector through promotion of renewable energy, energy efficiency, low-carbon emissions fuels, clean coal technology and gas-fired power generation.

Specifically, it will improve energy efficiency in the industrry, commercial, transport and residential sectors through the introduction of various devices including electric vehicles and their ecosystems, clean coal technology such as supercritical coal-fired power plants, renewable energy such as geothermal, hydro, solar, wind, biomass, and biofuels. In the transport sector, biofuels based on palm oil will be introduced.

Perusahaan Listrik Negara (PLN), Indonesia's state-owned power company, will not build any new coal-fired power plants in the future and will phase them out by 2056.

To promote the shift from coal-fired power generation to renewable and other clean energy sources, Indonesia entered into a partnership with the Asian Development Bank (ADB) in November 2021.

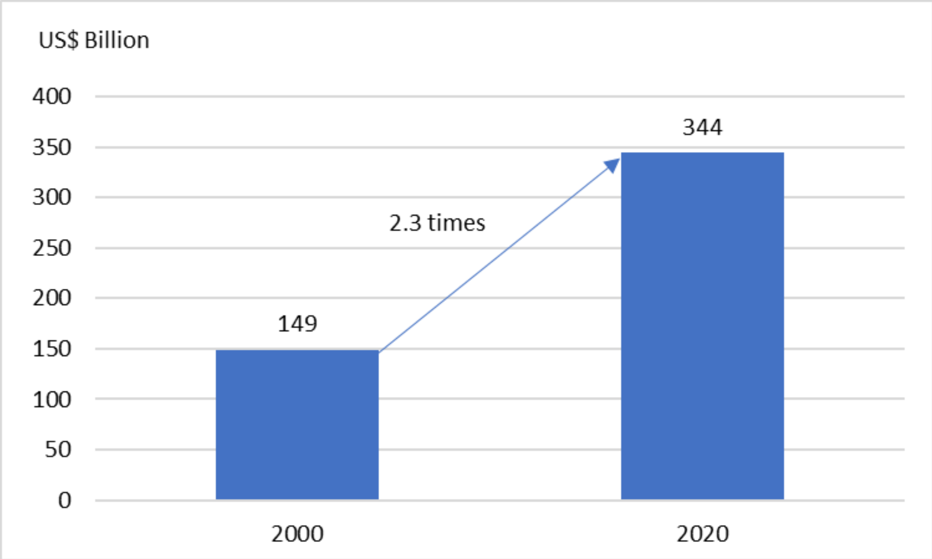
2. Malaysia

2.1. Indicators of Energy Consumption

1) Transition in GDP

Malaysia's GDP grew 2.3 times in 20 years, from $149 billion in 2000 to $344 billion in 2020 (Figure 3.24).

Figure 3.24. Malaysia GDP 2000 vs 2020 (2015 prices and ex rate)



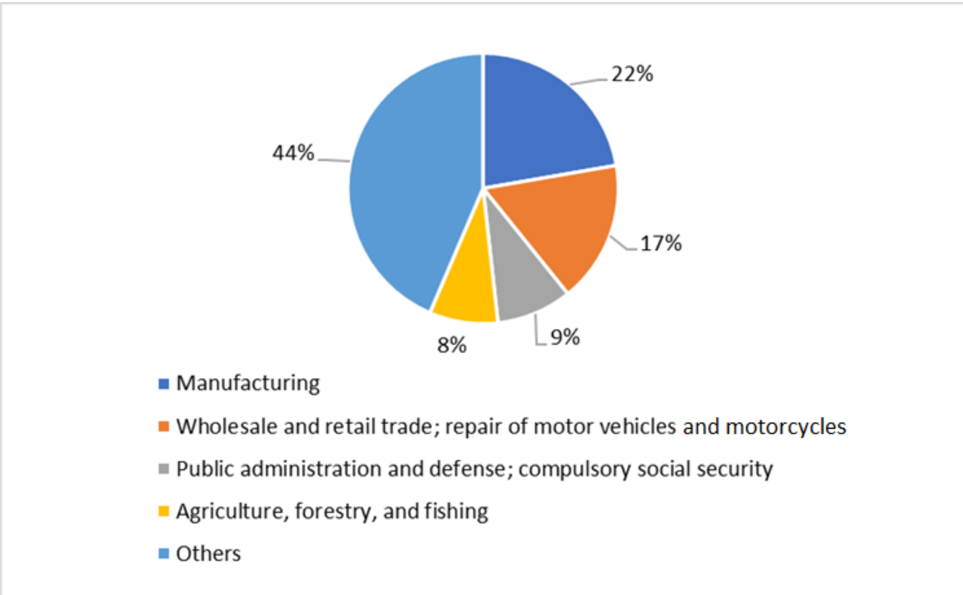
Source: IEA (2022).

2) GDP by sector and changes in industrial structure

In terms of the share of GDP by sector in 2020, the manufacturing sector is in first place (22%), followed by the wholesale and retail trade; repair of motor vehicles and motorcycles (17%), the public administration and defense; compulsory social security (9%), and agriculture, forestry, and fishing (8%) (Figure 3.25).

Malaysia's economy has shifted from its previous focus on agriculture, such as natural rubber and palm oil, to manufacturing (electrical equipment) and other high-tech industries.

Figure 3.25. Malaysia GDP by Sector at Current Market Prices (2020)



GDP = gross domestic product.
Source: ADB (2022).

3) Transition of TES by energy type

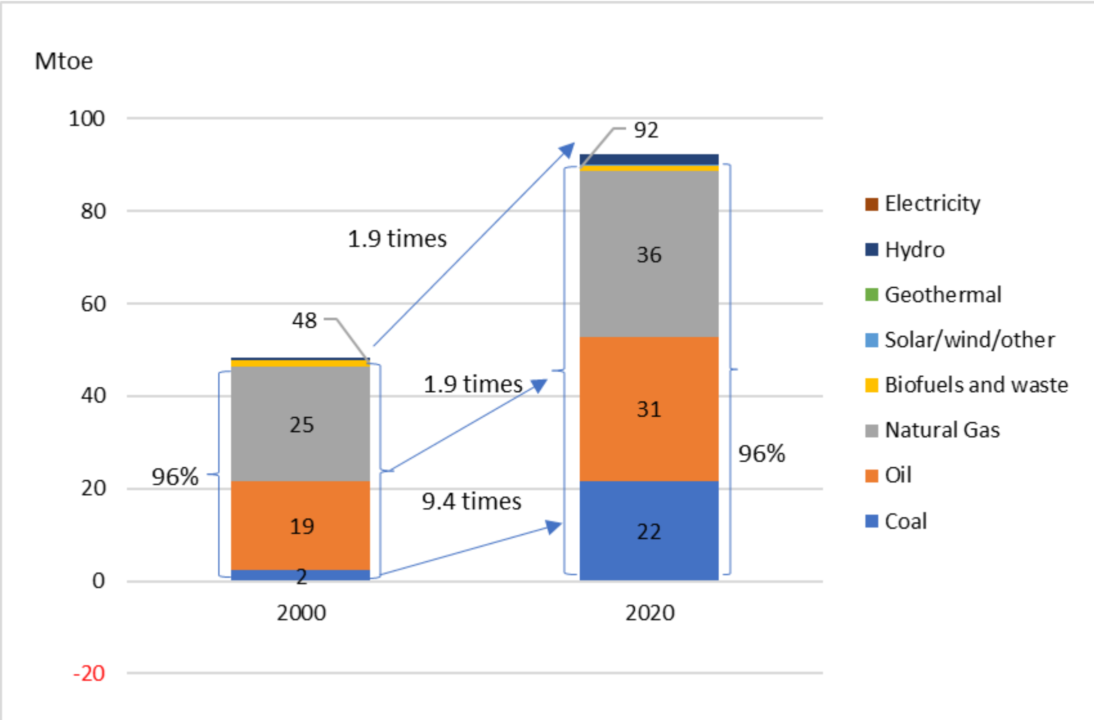
In 20 years, TES increased by 1.9 times from 48 Mtoe in 2000 to 92 Mtoe in 2020.

Of that amount, TES of fossil fuels (oil, coal, and natural gas) increased by 1.9 times from 46 Mtoe in 2000 to 89 Mtoe in 2020. Focusing on TES of fossil fuels by energy, TES of oil and natural gas increased 1.6 and 1.5 times, respectively, while TES of coal, which has a particularly high CO_2 emissions factor, increased significantly by 9.4 times, from 2 Mtoe in 2000 to 22 Mtoe in 2020.

For non-fossil fuels, hydro TES increased by 3.8 times, while biofuels and waste TES decreased by 0.9 times.

Fossil fuel dependence (the percentage of oil, coal, and natural gas in the total) remained high, remaining constant at 96% from 2000 to 2020 (Figure 3.26).

Figure 3.26. TES by Energy Type (Malaysia: 2000 vs 2020)



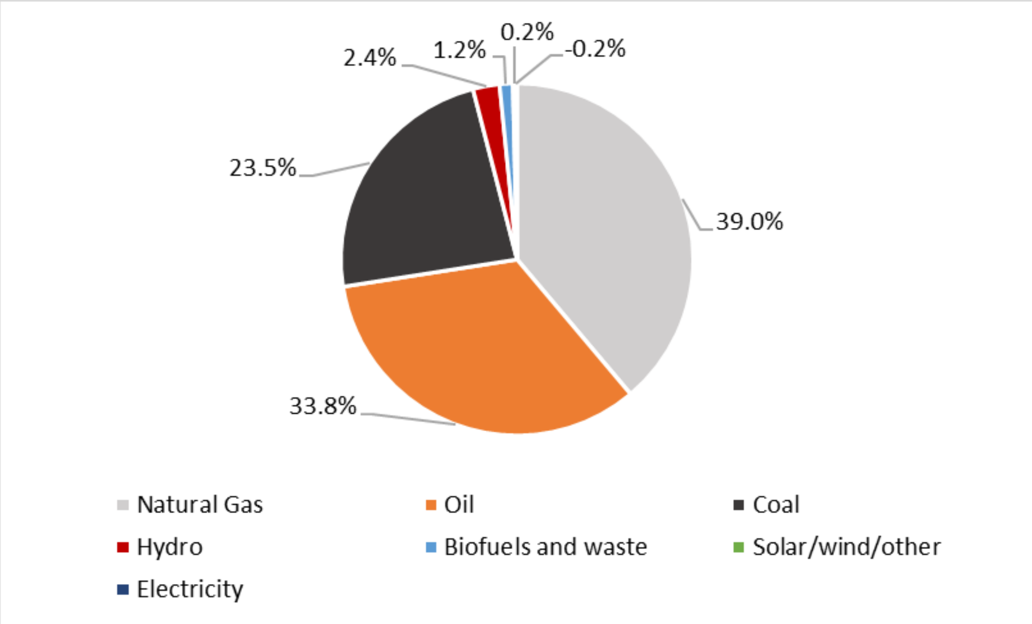
TES = total energy supply.
Note: Totals may not match due to rounding.
Source: IEA (2022).

The share of TES in 2020 by energy source is natural gas (39%) in first place, oil (33.8%) in second, coal (23.5%) in third, followed by hydropower (2.4%), biofuels and waste (1.2%), and solar, wind, and others (0.2%).

Fossil fuels, with a TES share of 96%, account for much of the TES. Natural gas has the highest share (39%), followed by oil (33.8%), and coal (29.3%), which has a high CO_2 emissions factor.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is about 4%. The share of solar, wind, and other is extremely small at 0.2% (Figure 3.27).

Figure 3.27. TES Share by Energy (Malaysia: 2020)

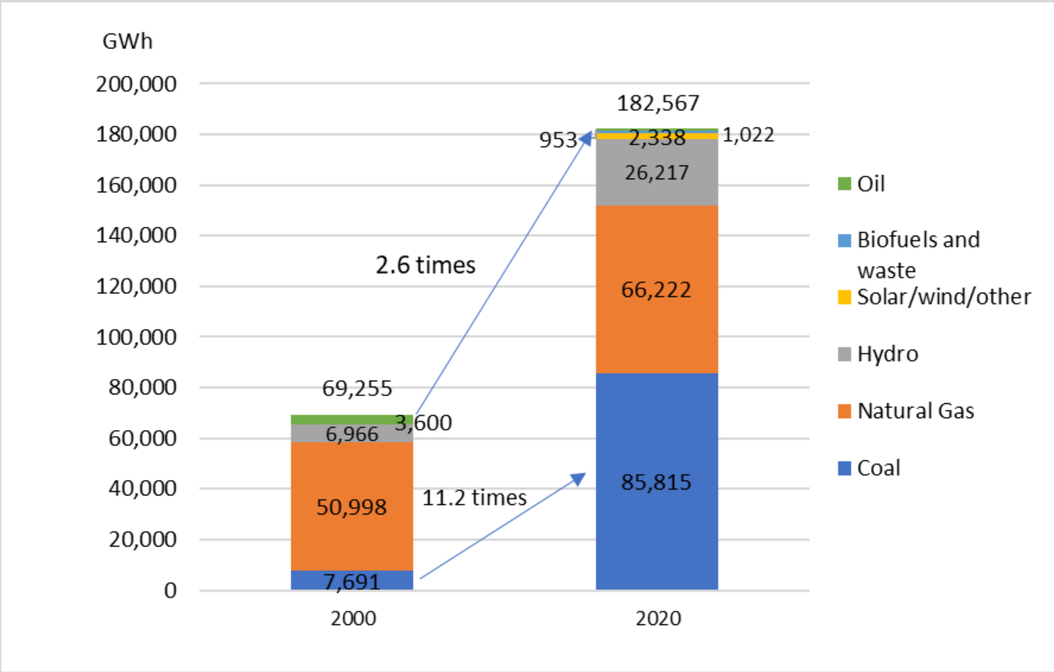


Source: IEA (2022).

4) Transition of power generation by fuel

Over a period of 20 years, power generation increased by 2.6 times from 69,255 GWh in 2000 to 182,567 GWh in 2020. In terms of power generation by fuel in 2020, coal comes in first (85,815 GWh), natural gas second (66,222 GWh), hydro third (26,217 GWh), followed by solar, wind and other (2,338 GWh), biofuels and waste (1,022 GWh) and oil (953 GWh). Power generation from coal, which has a high CO_2 emissions factor, increased 11.2 times from 7,691 GWh in 2000 to 85,815 GWh in 2020 (Figure 3.28).

Figure 3.28. Electricity Output by Fuel (Malaysia: 2000 vs 2020)



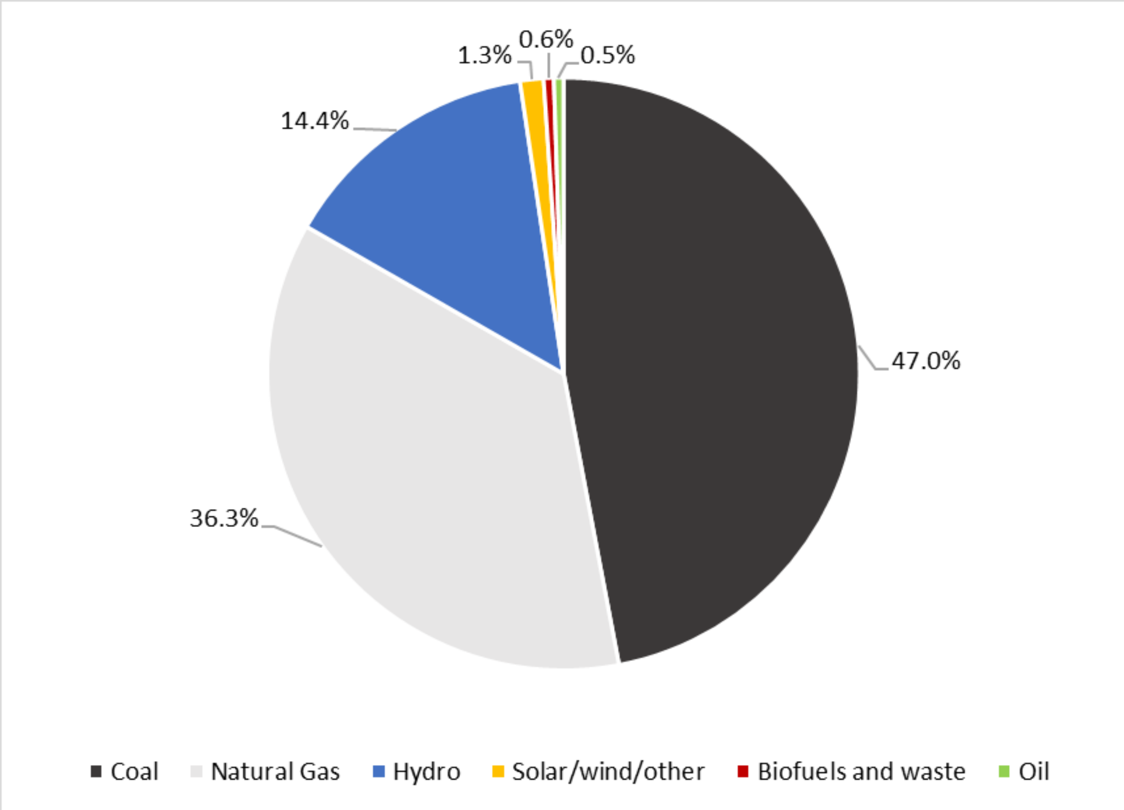
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of share of power generation by fuel in 2020, coal ranks first (47.0%), natural gas second (36.3%), hydro third (14.4%), followed by solar, wind, and other (1.3%), biofuels and waste (0.6%), and oil (0.5%).

Fossil fuels account for most of the share of power generation, at 83.8%. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 47% share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 16.2%. The breakdown is as follows: 14.4% for hydro, 1.3% for solar, wind, and other, and 0.6% for biofuels and waste (Figure 3.29).

Figure 3.29. Electricity Output Share by Fuel (Malaysia: 2020)



Source: IEA (2022).

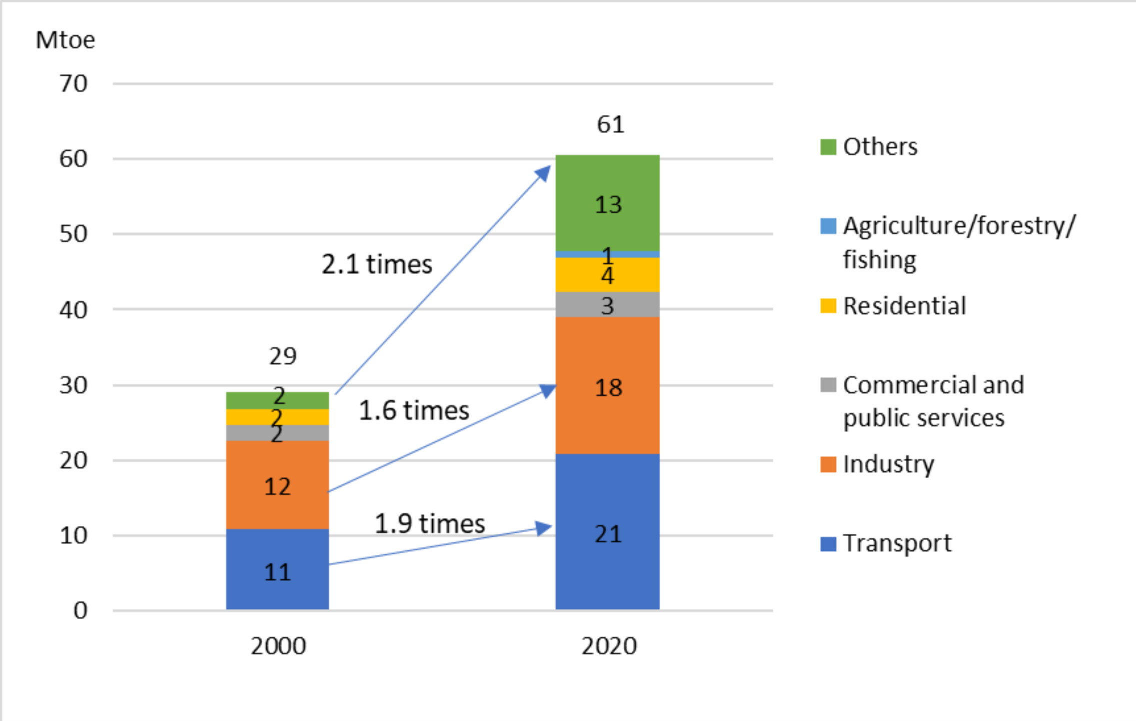
5) Transition of final energy consumption by sector

In 20 years, final energy consumption increased by 2.1 times from 29 Mtoe in 2000 to 61 Mtoe in 2020. In terms of final energy consumption by sector in 2020, the transport sector ranks first (21 Mtoe), followed by the manufacturing industries and construction sector (18 Mtoe), the residential sector (4 Mtoe), the commercial and public services sector (3 Mtoe), the agriculture, forestry, and fishing sector (1 Mtoe) and others (13 Mtoe).

The final energy consumption in the industry sector increased 1.6 times from 12 Mtoe in 2000 to 18 Mtoe in 2020. In the transport sector, the final energy consumption increased 1.9 times from 11 Mtoe in 2000 to 21 Mtoe in 2020. The final energy consumption in the residential sector increased 2.2 times from 2 Mtoe in 2000 to 4 Mtoe in 2020 (Figure 3.30).

The industry sector's final energy consumption has been growing with the progress of industrialisation. The final energy consumption in the transport sector has also been growing with the development of motorisation.

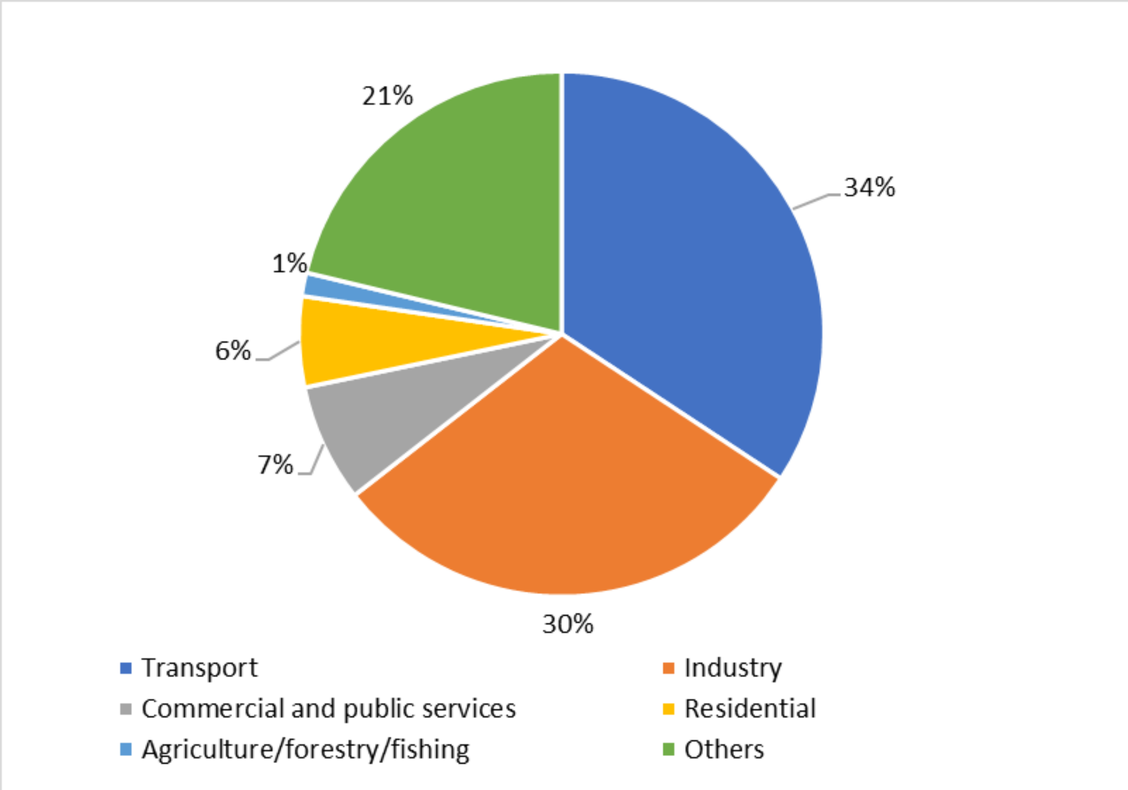
Figure 3.30. Final Energy Consumption (Malaysia: 2000 vs 2020)



Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of the share of final energy consumption by sector in 2020, the transport sector ranked first (34%), followed by the industry sector (30%), the commercial and public services sector (7%), the residential sector (6%), the agriculture, forestry, and fishing sector (1%), and others (21%) (Figure 3.31).

Figure 3.31. Final Energy Consumption Share by Sector (Malaysia: 2020)



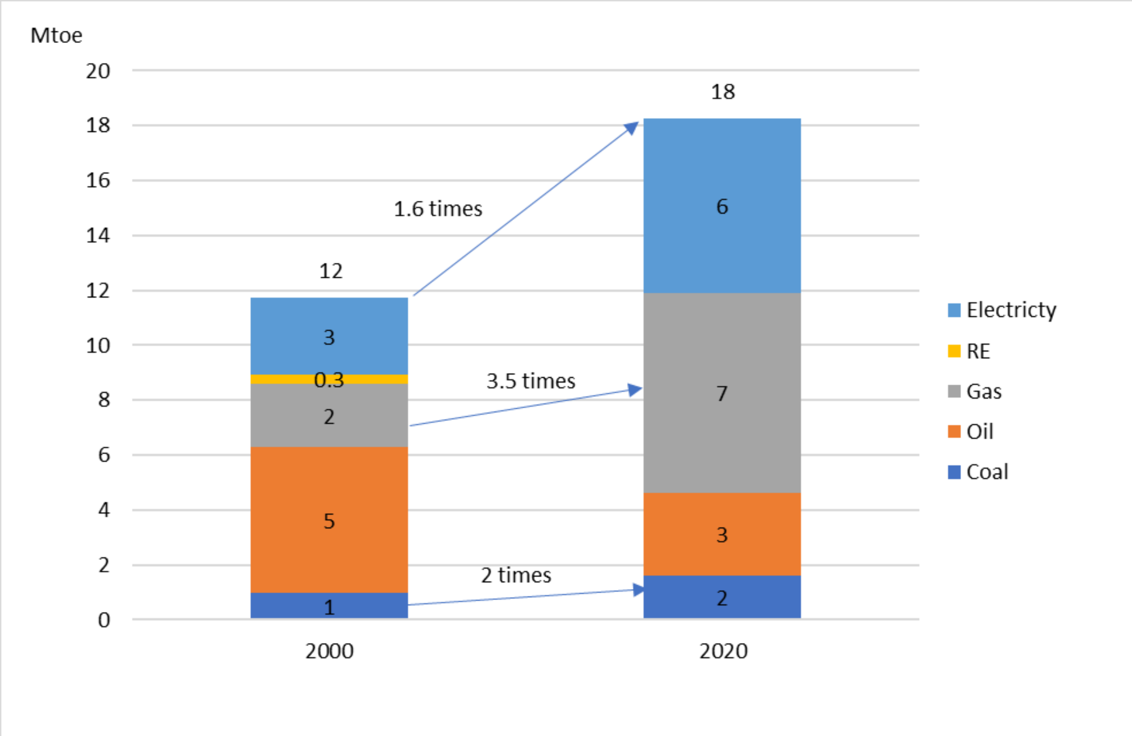
Source: IEA (2022).

6) Energy consumption and efficiency in the industry sector

The final energy consumption in the industry sector increased 1.6 times from 12 Mtoe in 2000 to 18 Mtoe in 2020.

In particular, the final energy consumption of coal doubled from 1 Mtoe in 2000 to 2 Mtoe in 2020. The final energy consumption of natural gas also increased 3.5 times from 2 Mtoe in 2000 to 7 Mtoe in 2020 (Figure 3.32).

Figure 3.32. Final Energy Consumption Transition by Energy (Malaysia: 2000 vs 2020)



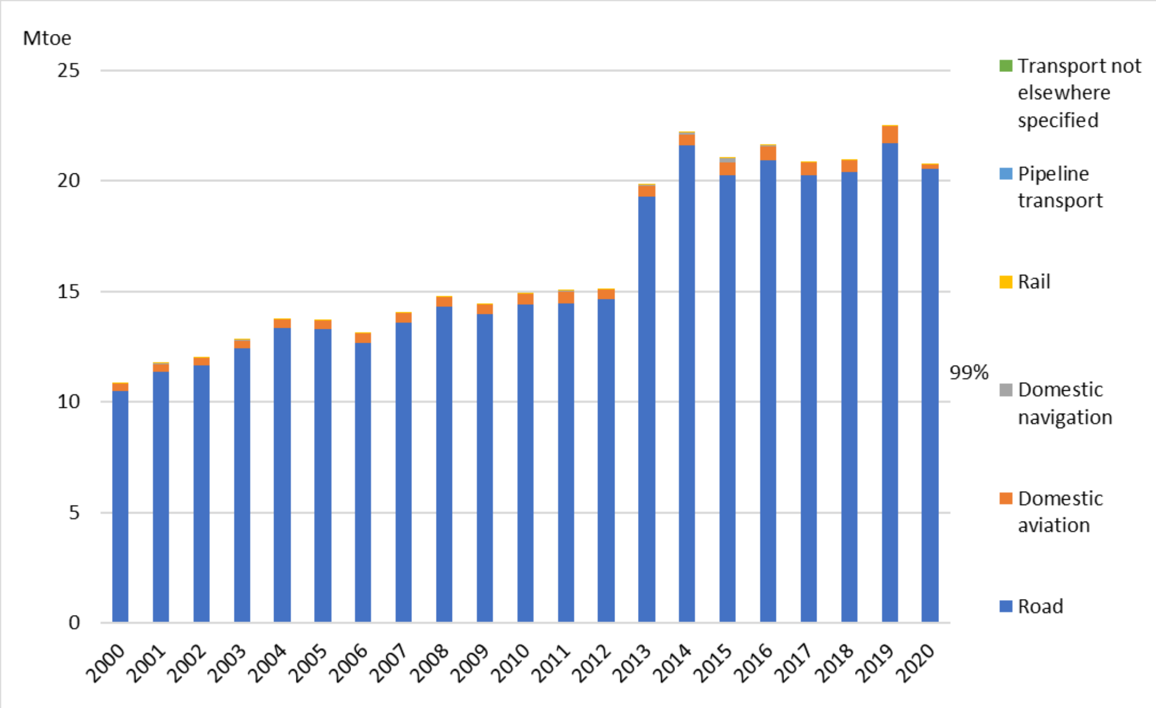
RE = renewables.
Source: IEA (2022).
Note: Totals may not match due to rounding.

In the IEA World Energy Balance 2022, subsector data of final energy consumption in the industry sector is not available for Malaysia.

7) Energy consumption and efficiency in the transport sector

99% of the energy consumption in the transport sector as of 2020 is represented by the road transport sector (Figure 3.33). The energy consumption in the road transport sector has continued to rapidly increase since 2013 and has remained almost flat in recent years.

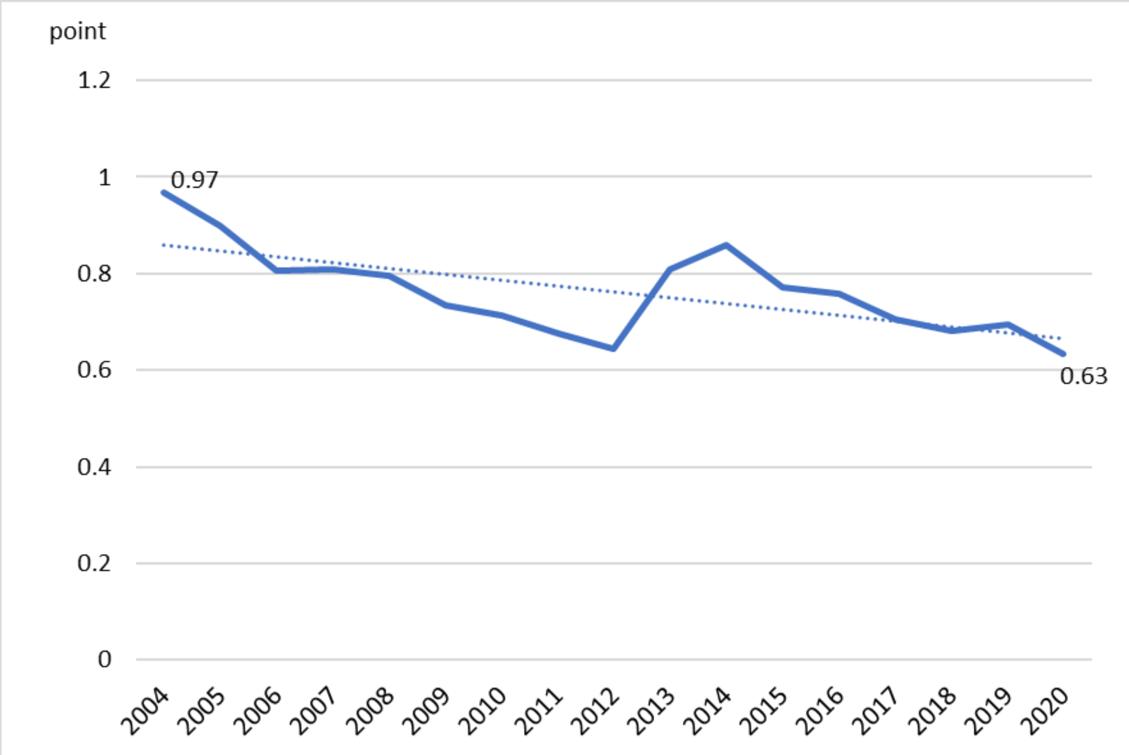
Figure 3.33. Final Energy Consumption Transition by Transport Sector (Malaysia)



Source: IEA (2022).

Next, we analyse the index obtained by dividing final energy consumption in the road transport sector by the number of registered vehicles owned. The indicator of 0.97 in 2000 improved to 0.63 in 2020 (Figure 3.34).

Figure 3.34. EE&C Indicator Transition of Road Sector (Malaysia)



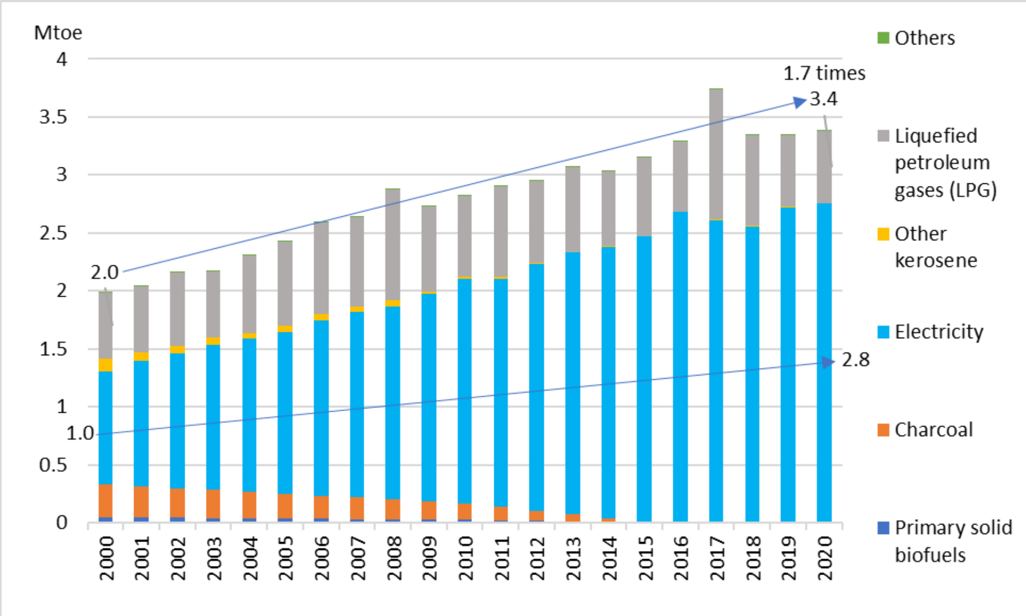
EE&C = energy efficiency and conservation.
Source: IEA (2022) and ASEANStats, https://data.aseanstats.org/ (accessed 4 June 2023).

8) Energy consumption and efficiency in the residential sector

The final energy consumption in the residential sector increased 1.7 times from 2.0 Mtoe in 2000 to 3.4 Mtoe.

The final energy consumption of traditional fuel such as charcoal has decreased and almost become zero, while that of modern fuel such as electricity and LPG has increased. In particular, the final energy consumption of electricity increased by 2.8 times in 20 years (Figure 3.35).

Figure 3.35. Final Energy Consumption Transition of Residential Sector (Malaysia)

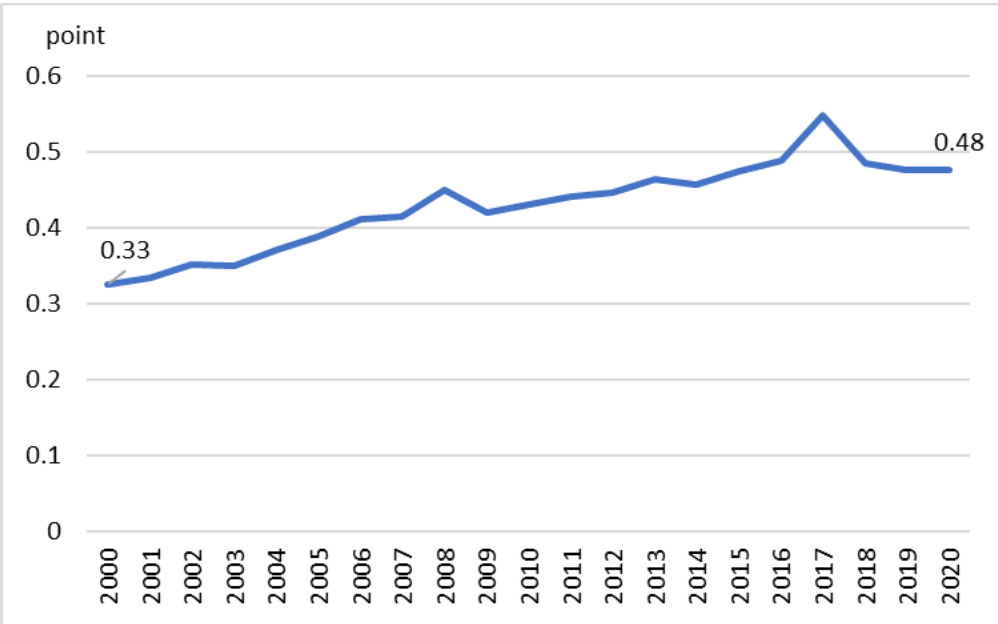


Source: IEA (2022).

Next, we analyse the indicator of final energy consumption of modern energy, such as electricity and LPG, divided by the number of households. Since statistical data on the number of households in Malaysia are not confirmed, we use the deemed number of households, which is the population divided by the average number of persons per household.

Figure 3.36 shows that the indicator worsens from 0.33 in 2000 to 0.48 in 2022.

Figure 3.36. EE&C Indicator Transition of Residential Sector (Malaysia)



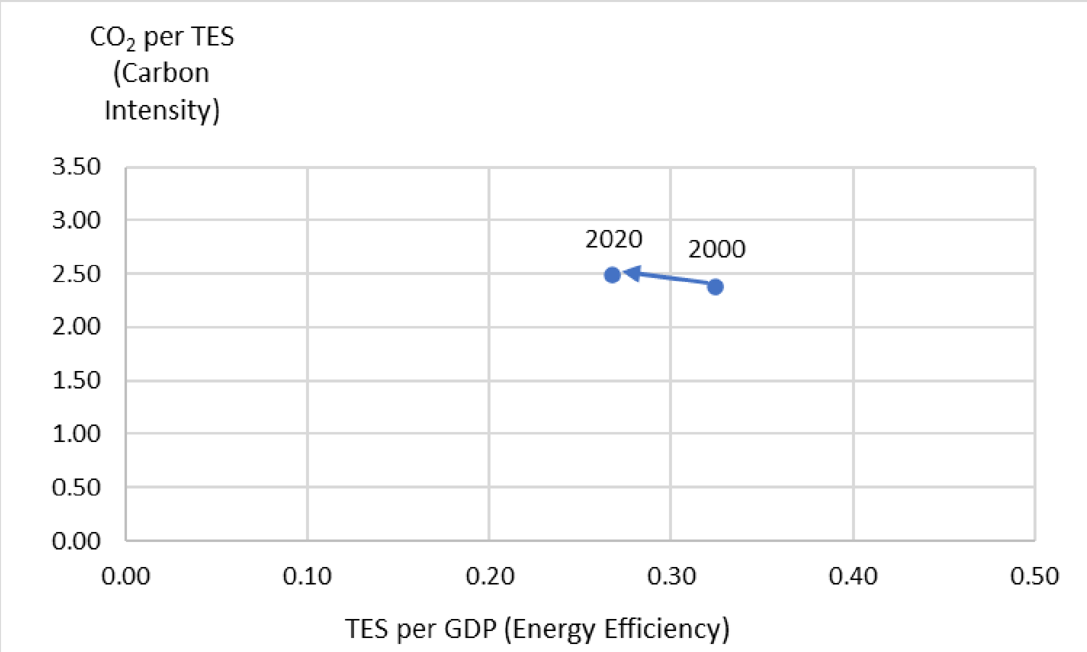
EE&C = energy efficiency and conservation.
Source: IEA (2022) and United Nations https://population.un.org/household/#/countries/ (accessed 23 May 2023).

2.2. Indicator of Energy Efficiency

1) Energy efficiency and carbon intensity

TES per GDP, a leading indicator of energy efficiency, decreased by 16% over 20 years, from 0.32 in 2000 to 0.27 in 2020. As shown in the graph below, energy conservation is making progress. On the other hand, CO_2 emissions per TES worsened from 2.38 in 2000 to 2.48 in 2020. Despite progress in energy conservation, the carbon intensity is deteriorating (Figure 3.37).

Figure 3.37. Energy Efficiency and Carbon Intensity Transition (Malaysia: 2000–20)



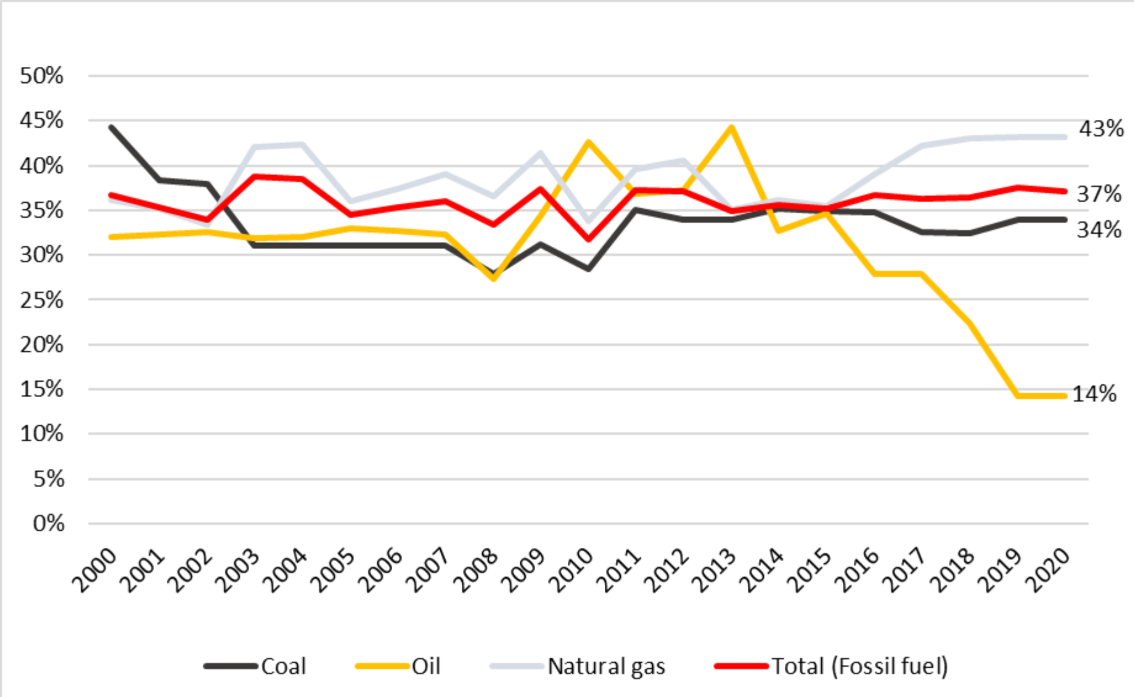
GDP = gross domestic product, TES = total energy supply.
Source: IEA (2022).

2) Power generation efficiency

Over the 20 years until 2020, the efficiency of thermal power generation (coal, oil, and natural gas) has generally remained around 36%. As of 2020, the efficiency of thermal power generation (average of coal, oil, and natural gas) is 37%.

The efficiency of coal-fired power generation over the 20-year period generally hovers around 34%, and the efficiency as of 2020 is 34% (Figure 3.38).

Figure 3.38. Thermal Efficiency Transition (Malaysia: 2000–20)



Source: IEA (2022).

2.3. Indicator of CO_2 Emissions

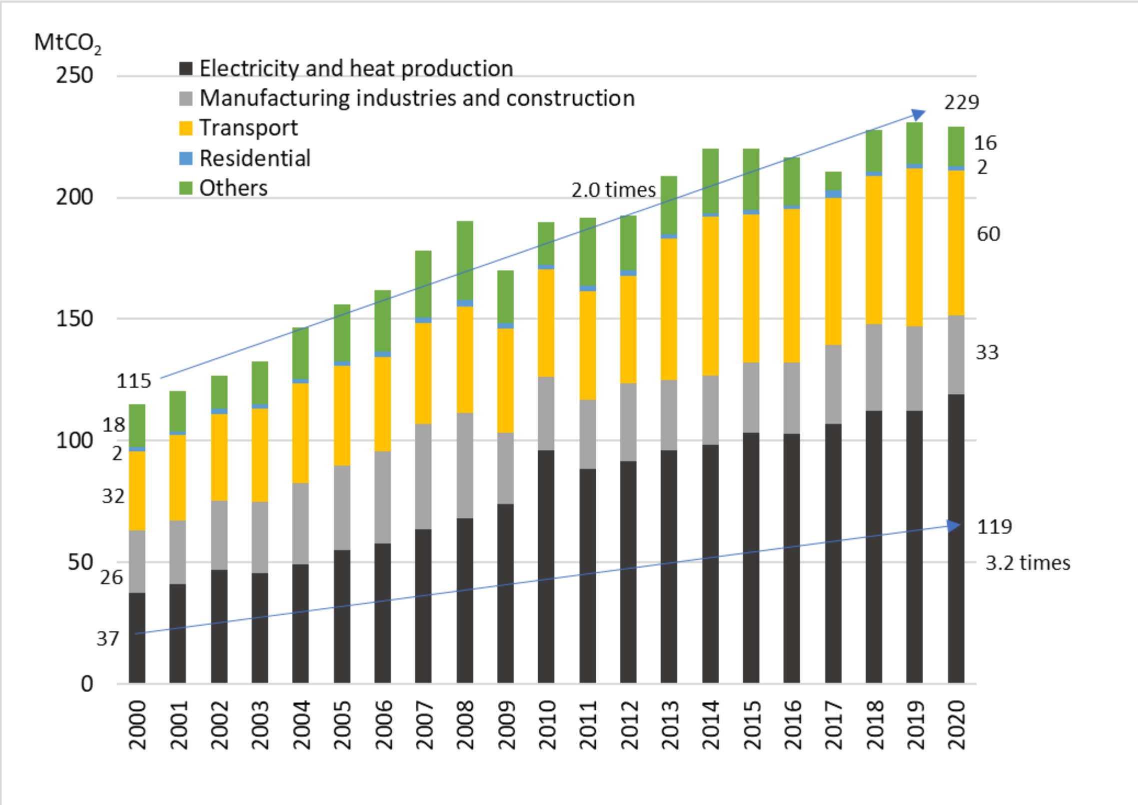
1) Transition in CO_2 emissions by sector

CO_2 emissions increased 2.0 times in 20 years, from 115 $MtCO_2$ in 2000 to 229 $MtCO_2$ in 2020.

CO_2 emissions by sector in 2020 are 119 $MtCO_2$ in the electricity and heat production sector, 60 $MtCO_2$ in the transport sector, 33 $MtCO_2$ in the manufacturing industries and construction sector, 2 $MtCO_2$ in the residential sector, and 16 $MtCO_2$ in the others.

Comparing CO_2 emissions over the 20-year period from 2000 to 2020, we find that the CO_2 emissions in the electricity and heat production sector increased 3.2 times from 37 $MtCO_2$ to 119 $MtCO_2$, that in the manufacturing industries and construction sector increased 1.3 times from 26 $MtCO_2$ to 33 $MtCO_2$, and that in the transport sector increased 1.8 times from 32 $MtCO_2$ to 60 $MtCO_2$. Meanwhile, CO_2 emissions from the residential sector decreased by 0.9 times rom 2 $MtCO_2$ in 2000 to 2 $MtCO_2$ in 2020 (Figure 3.39).

Figure 3.39. CO_2 Emissions Transition by Sector (Malaysia: 2000–20)



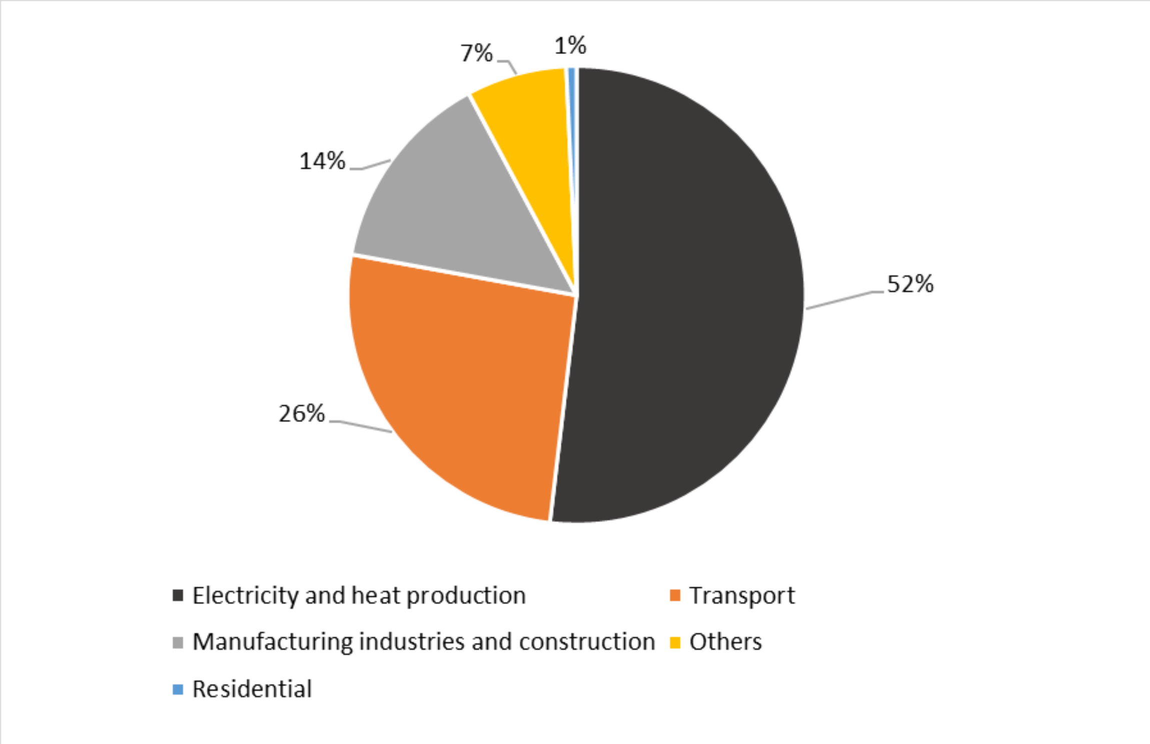
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of the share of CO_2 emissions by sector in 2020, the electricity and heat production sector is in first place (52%), followed by the transport sector (26%), the manufacturing industries and construction sector (14%), the residential sector (1%), and the others (7%) (Figure 3.40).

In the electricity and heat production sector, the share of power generation from fossil fuels (oil, coal, and natural gas) is high, especially the share of coal-fired power generation (47%). In addition, coal-fired power generation efficiency (34%) is low compared to the OECD average (39%), suggesting that coal accounts for a large portion of CO_2 emissions from the electricity and heat production sector.

In the transport sector, CO_2 emissions from automobiles are expected to increase due to the progress of motorisation.

Figure 3.40. CO_2 Emissions by Sector (Malaysia: 2020)



Source: IEA (2022).

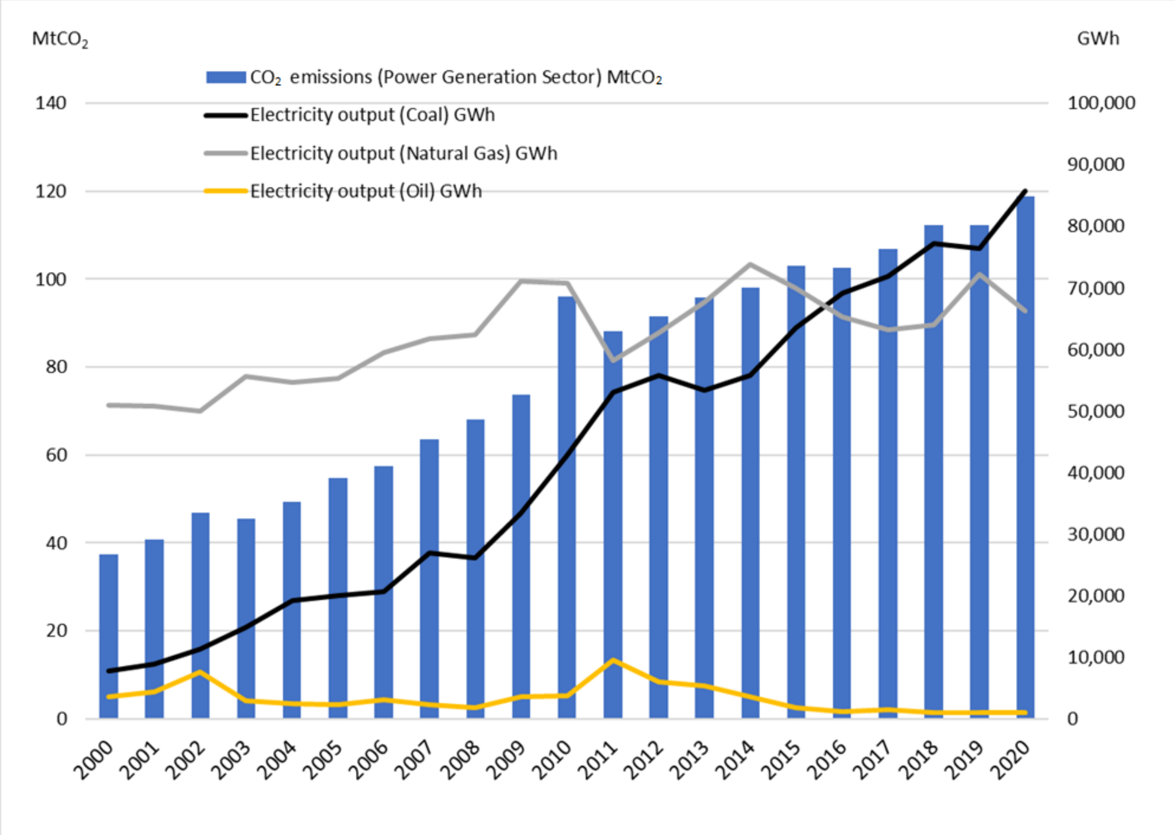
2) CO_2 emissions and coal-fired power generation

We analysed the relationship between the amount of thermal power generation of fossil fuels (oil, coal, and natural gas), which are closely related to CO_2 emissions, and CO_2 emissions from the electricity and heat production sector, in the period of 2000 through 2020.

A graph of CO_2 emissions from the electricity and heat production sector versus oil-, coal-, and natural gas-fired power generation over a 20-year period is shown in Figure 3.41.

The graph indicates a strong correlation between CO_2 emissions and coal-fired power generation in the electricity and heat production sector in Malaysia.

Figure 3.41. Transition between CO_2 Emissions in Electricity Sector and Coal, Natural Gas, and Oil Electricity Output (Malaysia: 2000–20)



Source: IEA (2022).

2.4. Summary of Efficiency Indicators

Table 3.2 summarises Malaysia's energy efficiency indicator.

The difference in 20 years is the improvement in TES per GDP and EE&C indicator of road transport and the deterioration in residential sector EE&C and thermal efficiency (coal-fired).

Table 3.2. Summary of Energy Efficiency Indicator (Malaysia)

Energy Efficiency Indicator	Malaysia		
	2000	2020	
TES per GDP	0.32	0.27	Improve
EE&C Indicator of Road Transport Sector	0.97	0.63	Improve
EE&C Indicator of Residential Sector	0.33	0.48	Worsen
Thermal Efficiency (Fossil fuel-fired)	0.37	0.37	No Change
Thermal Efficiency (Coal-fired)	0.44	0.34	Worsen

EE&C = energy efficiency and conservation, GDP = gross domestic product,
TES = total energy supply.
Source: Author.

2.5. Energy Efficiency Policy

1) History of energy efficiency policy

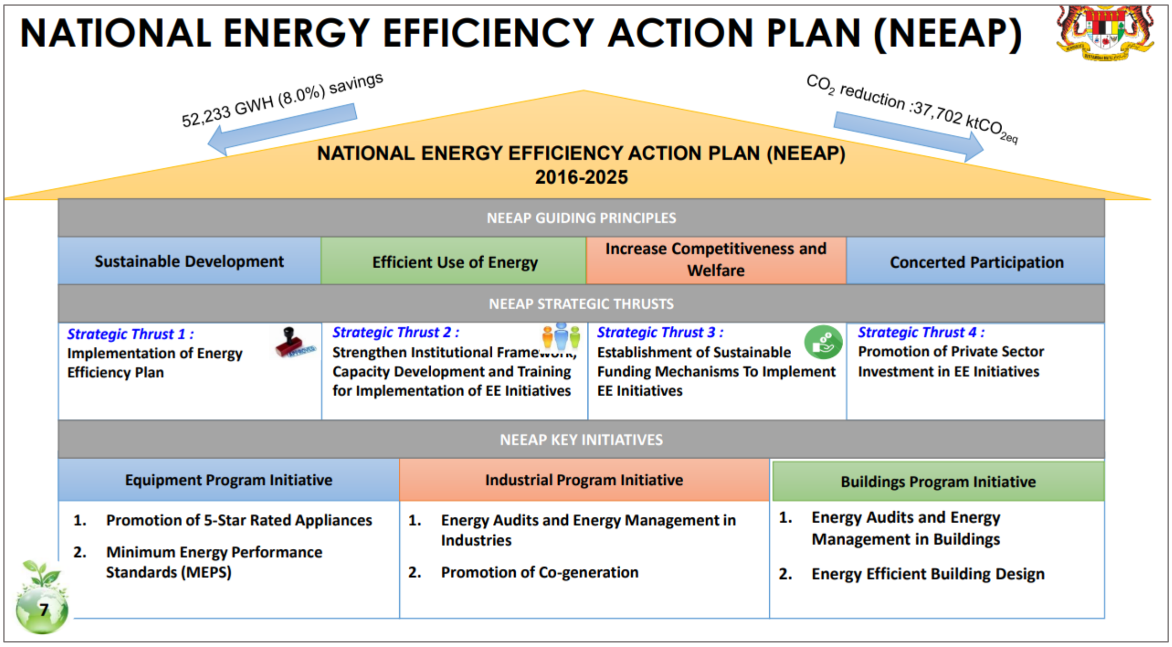
Malaysia's energy efficiency policy has been integrated with the country's energy policy from the Petroleum Development Act of 1974 to the current National Energy Policy 2022–40. Since the 2000s, energy audits and class curricula in universities on energy efficiency and renewable energy have been implemented. In 2016, the National Energy Efficiency Action Plan (NEEAP) 2016–25 was defined and the Energy Efficiency Project was implemented. The National Energy Policy 2022–40 also incorporates enhanced demand side management (DSM). Most recently, as of 2022, the Energy Efficiency and Conservation (EEC) Act has been drafted.

2) NEEAP 2016–25

NEEAP 2016–25 consists of four principles: Sustainable Development, Efficient Use of Energy, Increase Competitiveness, and Concerted Participation. Major initiatives include the Equipment Program Initiative, Industrial Program Initiative, and Building Program Initiative.

The Equipment Program Initiative has a five-star system for electrical products, Minimum Energy Performance Standards (MEPS). The Industrial Program Initiative promotes energy audit and co-generation in industry. The Building Program Initiative promotes energy audit of buildings and energy-efficient building design (Figure 3.42). NEEAP will reduce electricity demand growth by 8% from 2016 to 2025.

Figure 3.42. National Energy Efficiency Action Plan 2016–25 (Malaysia)



EE = energy efficiency.
Source: Ministry of Natural Resources, Environment and Climate Change, Malaysia.

3) Energy Service Company programme in Malaysia

The Energy Serice Company (ESCO) business in Malaysia involves the following: energy audit of government buildings, conversion to light-emitting diode lighting, highly energy-efficient buildings, zero-energy buildings, low-energy office buildings, energy committee headquarters building, elimination of incandescent lights by 2014, national energy conservation awareness campaigns, Japan-Malaysia cooperation on research for realising the green township vision in Malaysia, limiting the temperature of air conditioners in public offices to 24°C, energy-saving programmes in major public hospitals, and green procurement by the public sector.

2.6. CO_2 Emissions Reduction Policy

In September 2021, Prime Minister Ismail Sabri bin Yaakob announced the goal of achieving carbon neutrality by 2050. In line with this, the prime minister promised to halt the construction of new coal-fired power plants.

In July 2021, an updated NDC was submitted to the United Nations Framework Convention on Climate Change to reduce Greenhouse Gas emissions by 45% (Unconditional) from the 2005 baseline. Malaysia will continue its efforts to explore and optimise financing mechanisms, technology transfer, and capacity building to meet its NDCs.

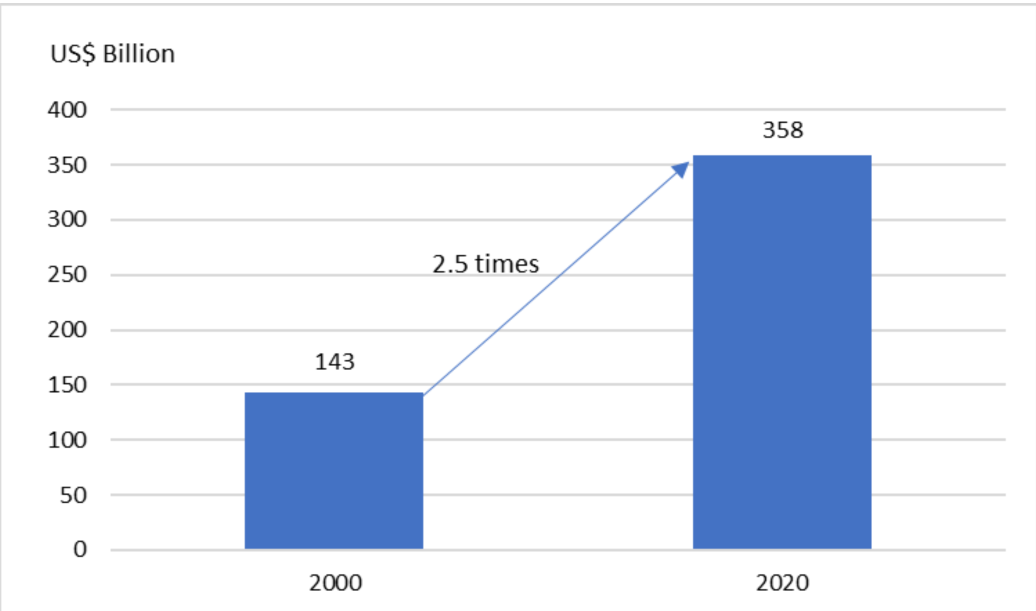
3. Philippines

3.1. Indicators of Energy Consumption

1) Transition in GDP

The Philippines' GDP grew 2.5 times in 20 years, from $143 billion in 2000 to $358 billion in 2020 (Figure 3.43).

Figure 3.43. Philippines GDP 2000 vs 2020 (2015 prices and ex rate)

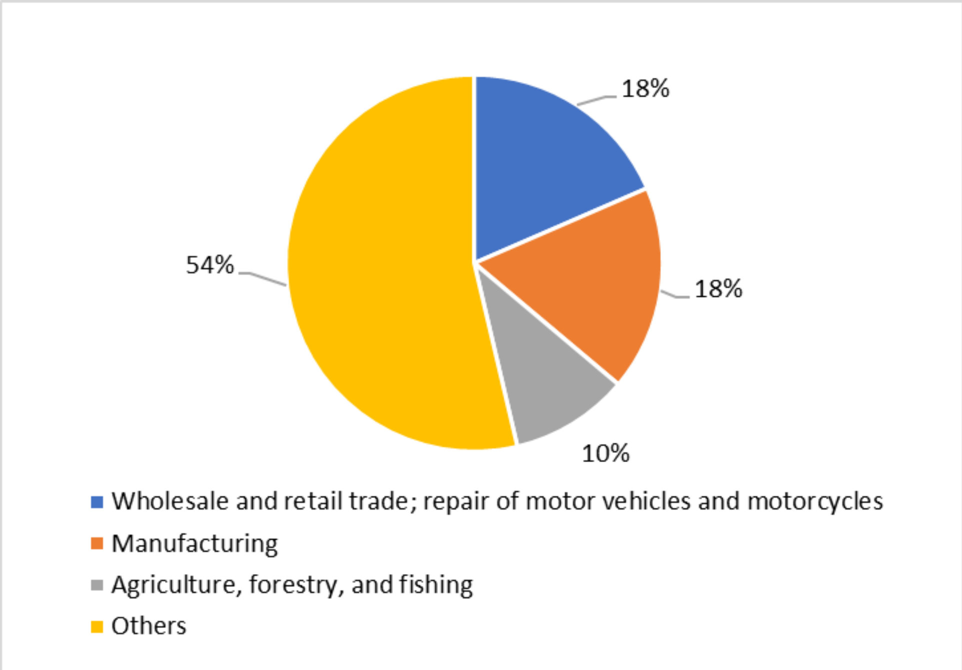


GDP = gross domestic product.
Source: IEA (2022).

2) GDP by Sector and Changes in Industrial Structure

In terms of the share of GDP by sector in 2020, the wholesale and retail trade sector is in first place (18%), followed by the manufacturing sector (18%) and agriculture, forestry and fishing sector (10%) (Figure 3.44). Wholesale and retail trade ranks first due to the country's economic pattern of importing goods and products and selling them at retail outlets. In second place, manufacturing includes automobile parts and electronic devices.

Figure 3.44. Philippines' Gross Domestic Product by Sector at Current Market Prices (2020)



Source: ADB (2022).

3) Transition of TES by energy type

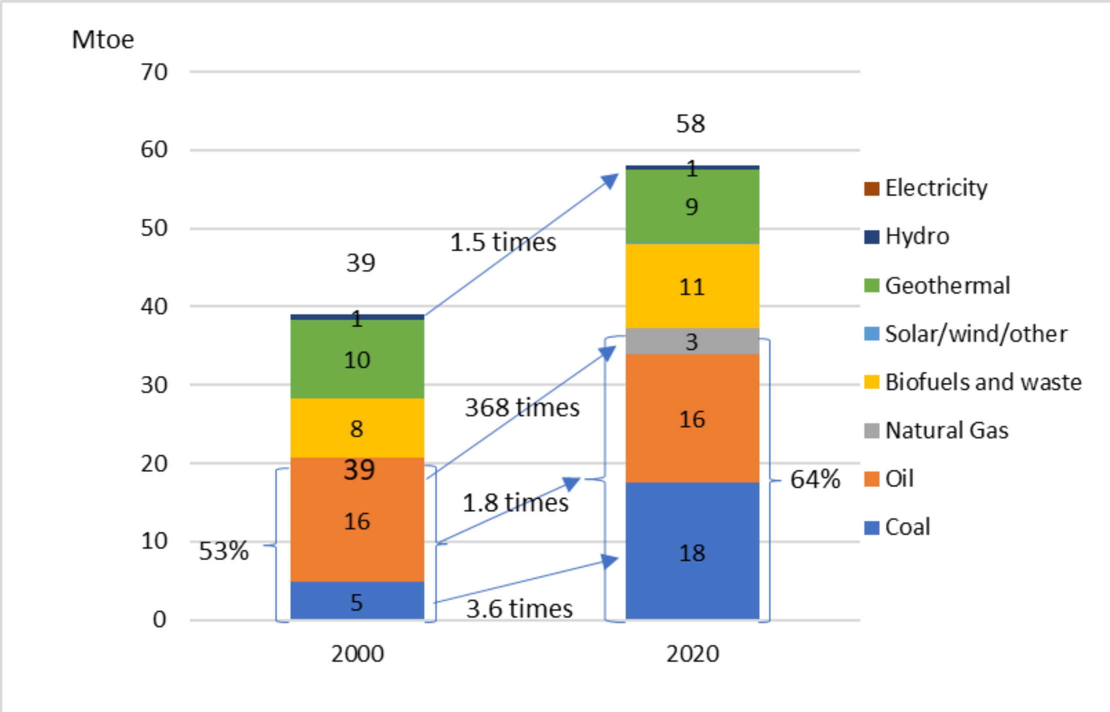
In 20 years, TES increased 1.5 times from 39 Mtoe in 2000 to 58 Mtoe in 2020.

Of that amount, TES of fossil fuels (oil, coal, and natural gas) increased by 1.8 times from 21 Mtoe in 2000 to 37 Mtoe in 2020. Focusing on TES of fossil fuels by energy, TES of oil and natural gas increased 1 and 368 times, respectively, due to development of the Malampaya gas field, while TES of coal, which has a particularly high CO_2 emissions factor, increased significantly by 3.6 times, from 5 Mtoe in 2000 to 18 Mtoe in 2020.

Amongst non-fossil fuels, geothermal TES decreased by 0.9 times and hydro TES by 0.9 times.

Fossil fuel dependence (the percentage of oil, coal, and natural gas in the total) increased from 53% in 2000 to 64% in 2020 (Figure 3.45).

Figure 3.45. Total Energy Supply by Energy Type (Philippines: 2000 vs 2020)



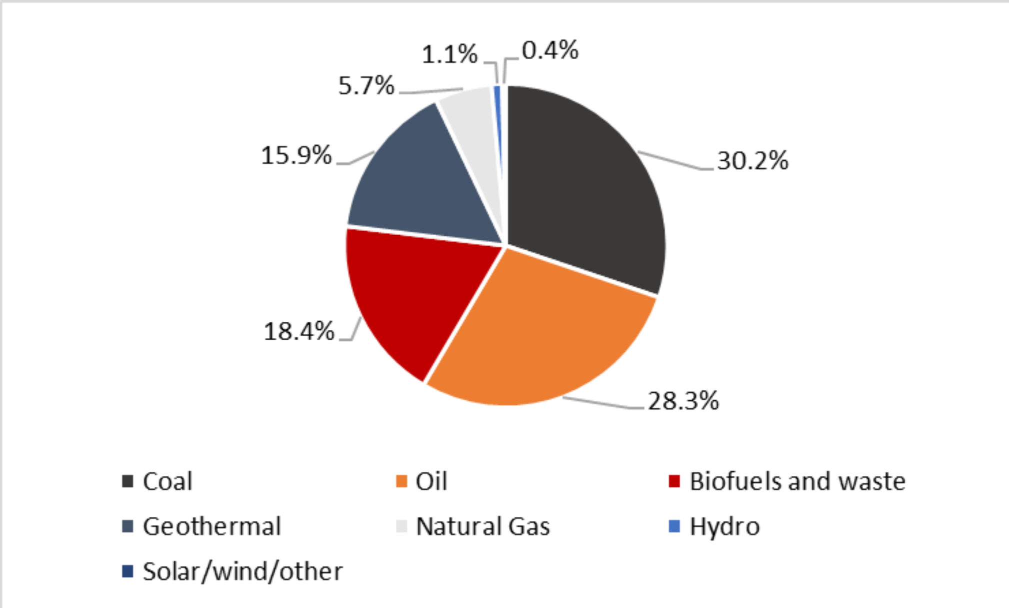
Source: IEA (2022).
Note: Totals may not match due to rounding.

The share of TES by energy source in 2020 is: coal (30.2%) in first place, oil (28.3%) in second place, biofuels and waste (18.4%) in third place, followed by geothermal (15.9%), natural gas (5.7%), hydro (1.1%), and solar, wind and other (0.4%).

Fossil fuels, with a TES share of 64.2%, account for much of TES. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 30.2% TES share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 35.8%. Amongst them, biofuels and waste (18.4%) and geothermal (15.9%) are the main sources, while TES of solar/wind/others is very small, 0.4% (Figure 3.46).

Figure 3.46. Total Energy Supply Share by Type (Philippines: 2020)

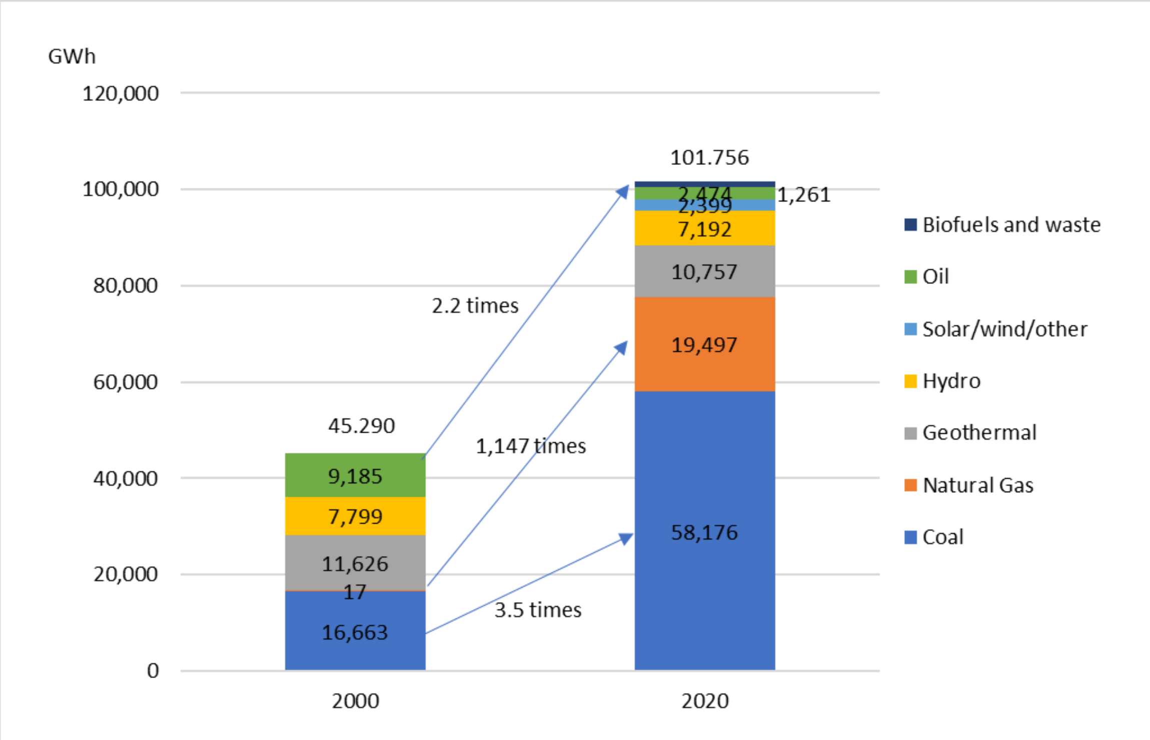


Source: IEA (2022).

4) Transition of power generation by fuel

Over the 20 years until 2020, power generation increased by 2.2 times from 45,290 GWh in 2000 to 101,756 GWh in 2020. In terms of power generation by fuel in 2020, coal comes in first (58,176 GWh), natural gas second (19,497 GWh), geothermal third (10,757 GWh), followed by hydro (7,192 GWh), solar/wind/other (2,399 GWh), oil (2,474 GWh), and biofuels and waste (1,261 GWh). The power generation from natural gas jumped 1,147 times from 17 GWh in 2000 to 19,497 GWh in 2020. Power generation from coal, which has a high CO_2 emissions factor, increased 3.5 times from 16,663 GWh in 2000 to 58,176 GWh in 2020 (Figure 3.47).

Figure 3.47. Electricity Output by Fuel (Philippines: 2000 vs 2020)



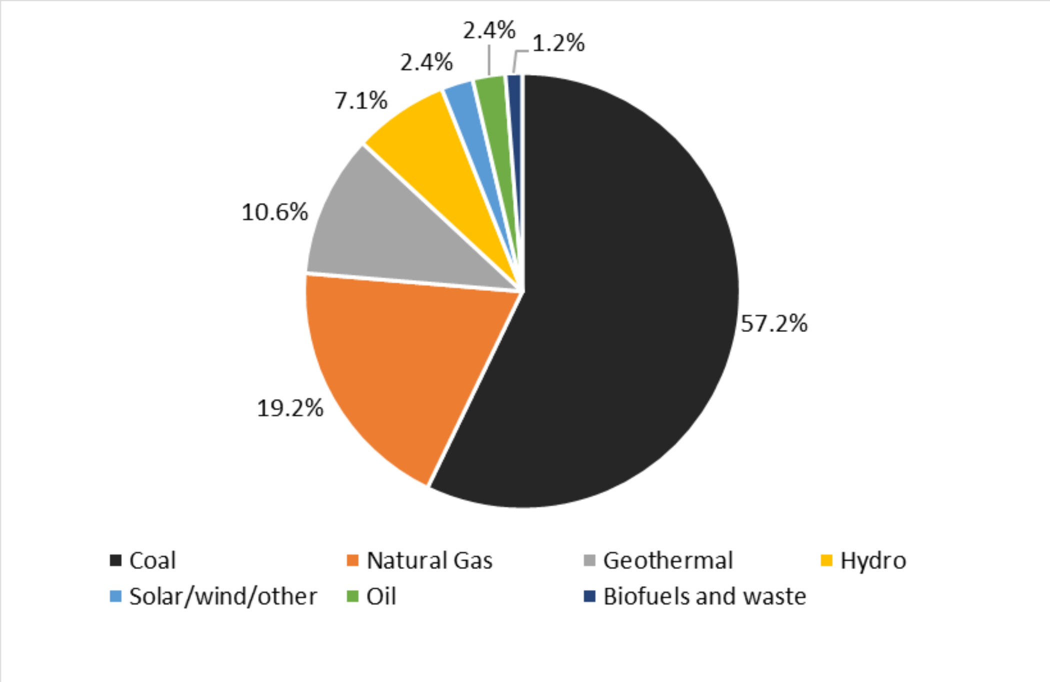
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of share of power generation by fuel in 2020, coal comes in first (57.2%), natural gas second (19.2%), geothermal third (10.6%), followed by hydro (7.1%), solar/wind/other (2.4%), oil (2.4%), and biofuels and waste (1.2%).

Fossil fuels account for most of the share of power generation, at 78.8%. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 57.2% share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 21.2%. The breakdown is as follows: geothermal (10.6%), hydropower (7.1%), solar, wind, and other (2.4%), and biofuels and waste (1.2%) (Figure 3.48).

Figure 3.48. Electricity Output Share by Fuel (Philippines: 2020)



Source: IEA (2022).

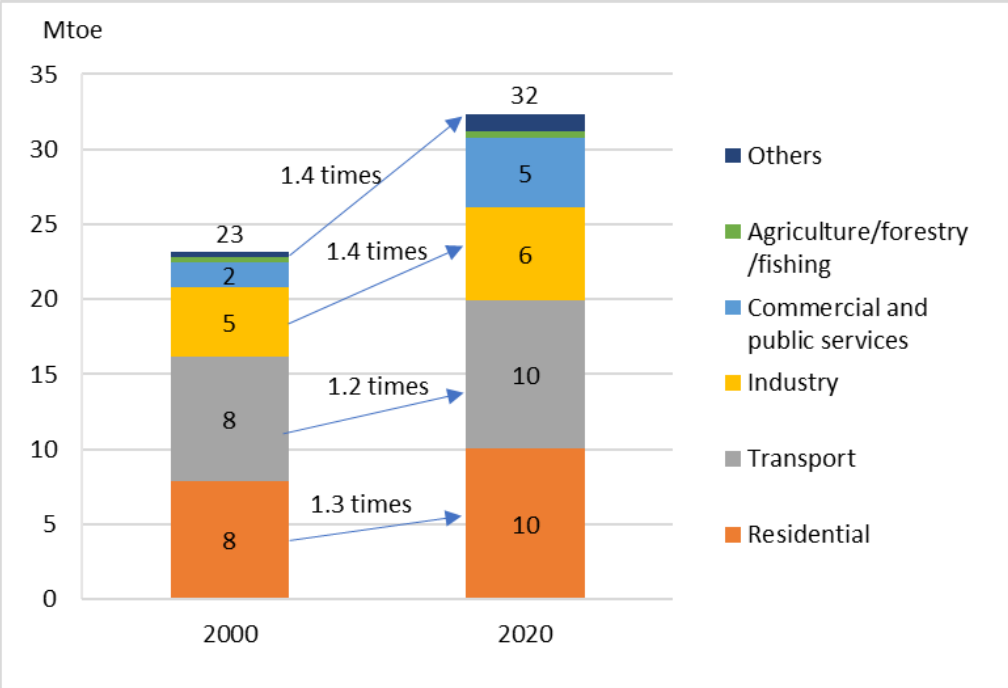
5) Transition of final energy consumption by sector

In 20 years, final energy consumption increased by 1.4 times from 23 Mtoe in 2000 to 32 Mtoe in 2020. In terms of final energy consumption by sector in 2020, the residential sector (10 Mtoe) is in first place, the transport sector (10 Mtoe) in second place, the manufacturing industries and construction sector (6 Mtoe) in third place, followed by the commercial and public services sector (5 Mtoe), the agriculture, forestry and fishing sector (0.4 Mtoe) and the others (1 Mtoe).

Comparing final energy consumption over the 20-year period from 2000 to 2020, we find that the final energy consumption in the industry sector increased 1.4 times from 5 Mtoe to 6 Mtoe, the final energy consumption in the transport sector increased 1.2 times from 8 Mtoe to 10 Mtoe, and the final energy consumption in the residential sector increased 1.3 times from 8 Mtoe to 10 Mtoe (Fig. 3.49).

The industry sector's final energy consumption has been growing with the progress of industrialisation. The final energy consumption in the transport sector has also been growing with the development of motorisation. Due to the improvement in living standards, the final energy consumption in the residential sector is also growing.

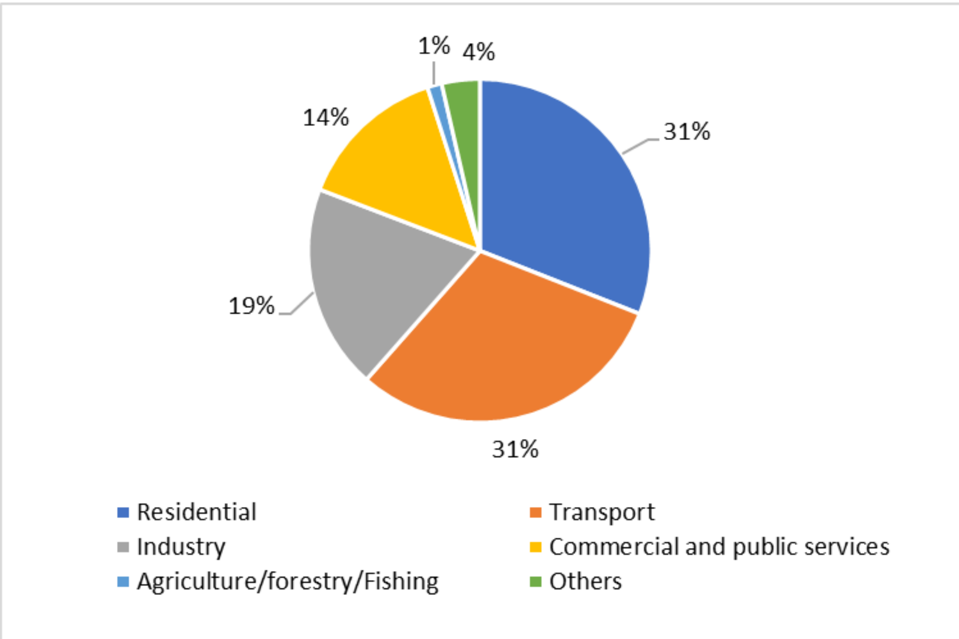
Figure 3.49. Final Energy Consumption (Philippines: 2000 vs 2020)



Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of the share of final energy consumption by sector in 2020, the residential sector (31%) and the transport sector (31%) are in first place, the industry sector (19%) in third place, followed by the commercial and public services sector (14%), the agriculture, forestry, and fishing sector (1%), and the others (4%) (Figure 3.50).

Figure 3.50. Final Energy Consumption Share by Sector (Philippines: 2020)



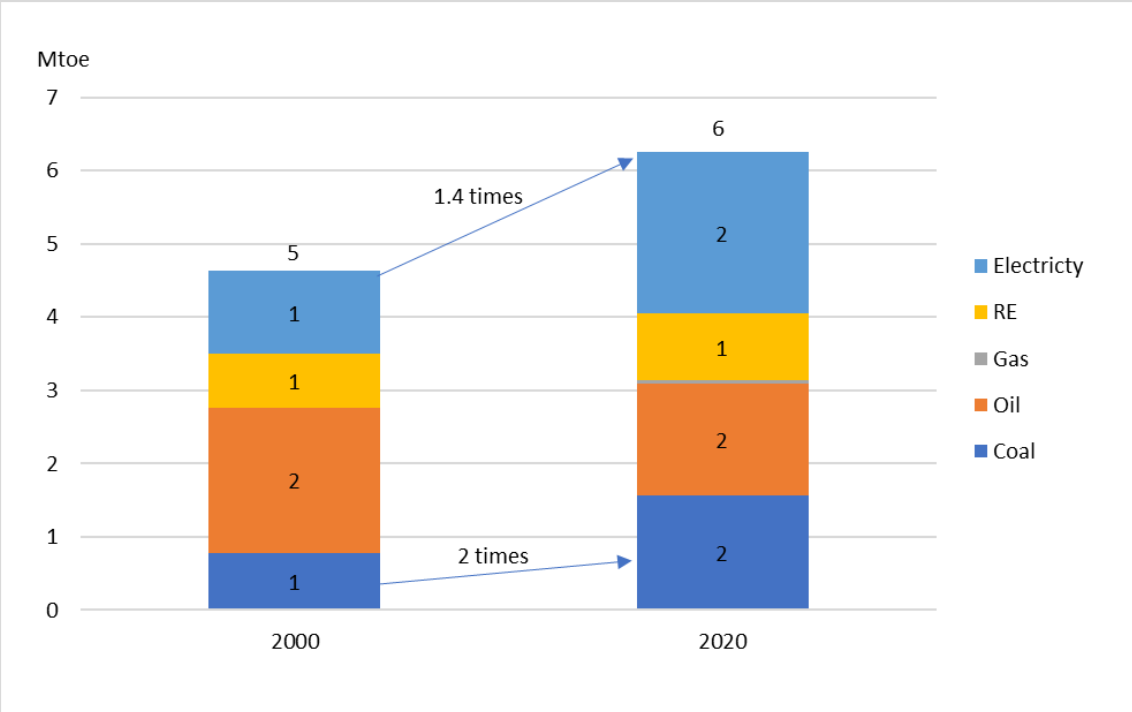
Source: IEA (2022).

6) Energy consumption and efficiency in the industry sector

The final energy consumption in the industry sector increased 1.4 times from 5 Mtoe in 2000 to 6 Mtoe in 2020.

In particular, the final energy consumption of coal doubled from 1 Mtoe in 2000 to 2 Mtoe in 2020 (Figure 3.51).

Figure 3.51. Final Energy Consumption Transition by Energy (Philippines: 2000 vs 2020)

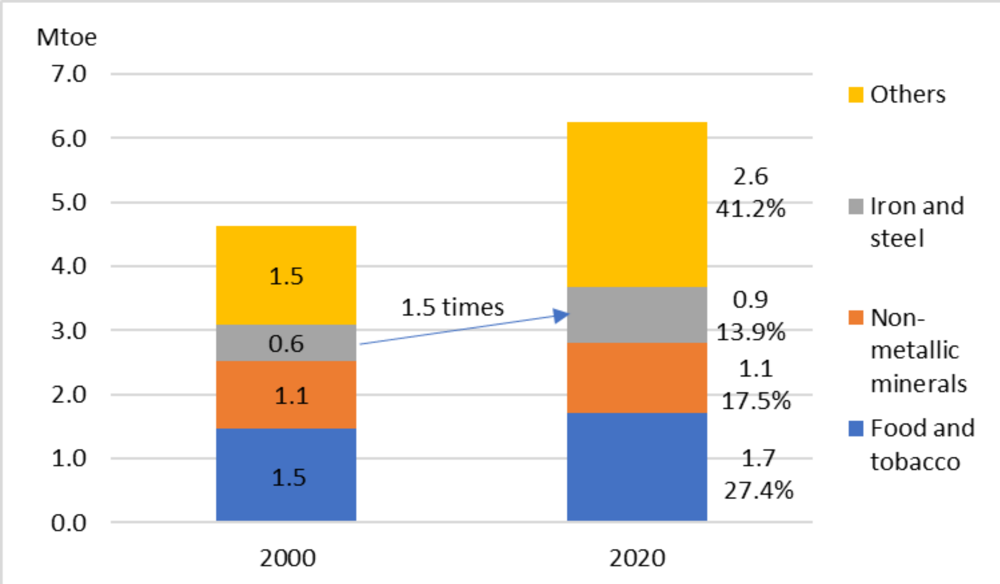


RE = renewable energy.
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of final energy consumption by industry subsector, iron and steel increased about 1.5 times from 0.6 Mtoe in 2000 to 0.9 Mtoe in 2020. In the non-metallic minerals subsector, the final energy consumption remained unchanged from 1.1 Mtoe in 2000 to 1.1 Mtoe in 2020.

In the industry sector, the share by subsector in the final energy consumption in 2020 is 27.4% for the food and tobacco subsector. The share is 17.5% for the non-metallic minerals subsector. The share is 13.9% for the iron and steel subsector (Figure 3.52).

Figure 3.52. Final Energy Consumption Transition and Share by Industry Subsector (Philippines: 2000 vs 2020)



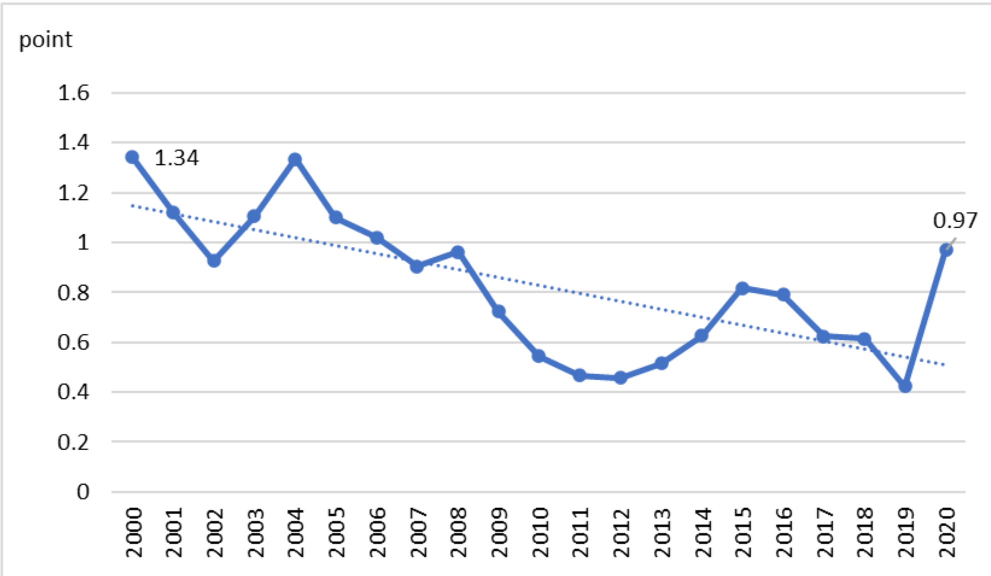
Source: IEA (2022).

Next, we consider the iron and steel subsector and the non-metallic minerals subsector, for which statistical data are available.

a) Iron and steel subsector

Figure 3.53 shows the indicator of final energy consumption in the iron and steel subsector divided by crude steel production. The indicator improved from 1.34 in 2000 to 0.97 in 2020.

Figure 3.53. EE&C Indicator Transition of the Iron and Steel Subsector (Philippines)



EE&C = energy efficiency and conversation.
Note: The dotted line in the graph is an approximate curve.
Source: IEA (2022) and World Steel Association.

b) Non-metallic minerals subsector

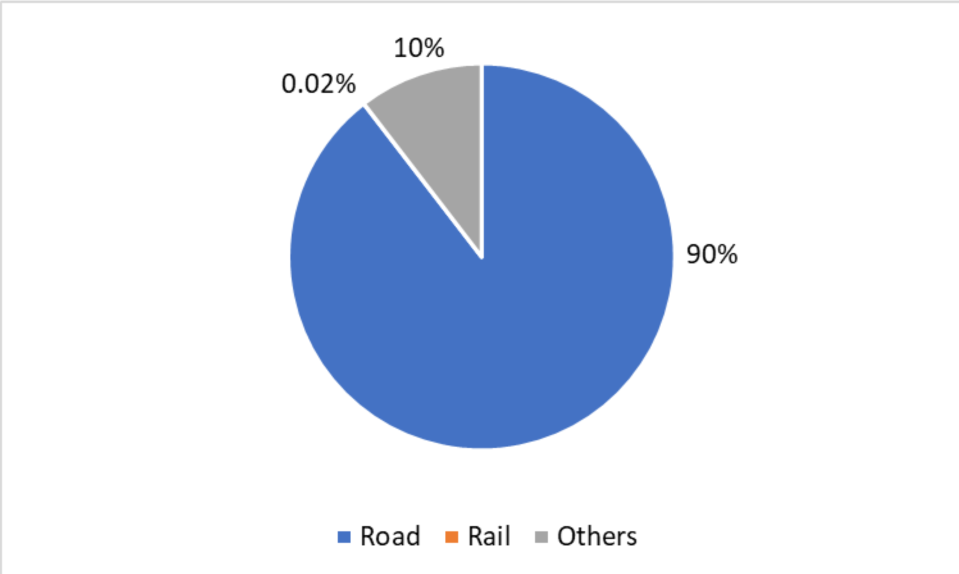
Statistical data on cement production in the Philippines are not available. Therefore, an efficiency analysis using indices such as those for the non-metallic minerals subsector could not be conducted.

7) Energy consumption and efficiency in the transport sector

In terms of the share of CO_2 emissions by sector in 2020, the transport sector (23%) has the largest CO_2 emissions share after the electricity and heat production sector (58%). Amongst the transport sectors, road transport accounts for 90% of the CO_2 emissions share (Figure 3.54).

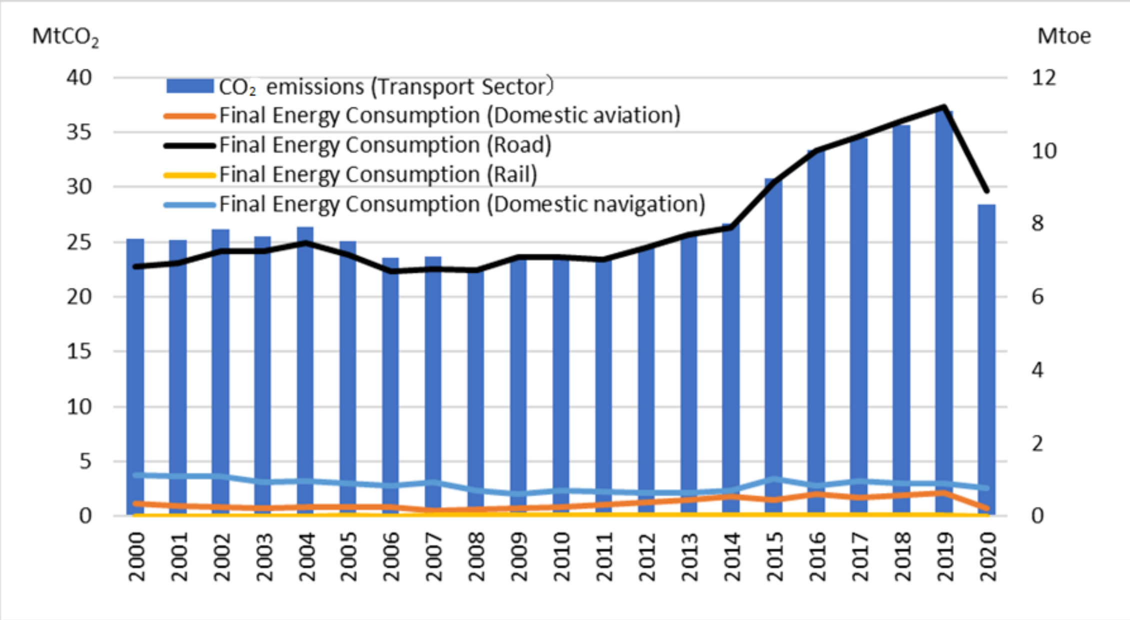
A graph of CO_2 emissions from the transport sector and final energy consumption by the road, domestic aviation, domestic navigation, and rail transport sectors over a 20-year period is shown in Figure 3.55. There is a strong relationship between CO_2 emissions in the transport sector and final energy consumption in road transport.

Figure 3.54. CO_2 Emissions Share by Transport Sector (Philippines: 2020)



Source: IEA (2022).

Figure 3.55. Transition between CO_2 Emissions in the Transport Sector and Final Energy Consumption in the Transport Sector (Philippines: 2000–20)

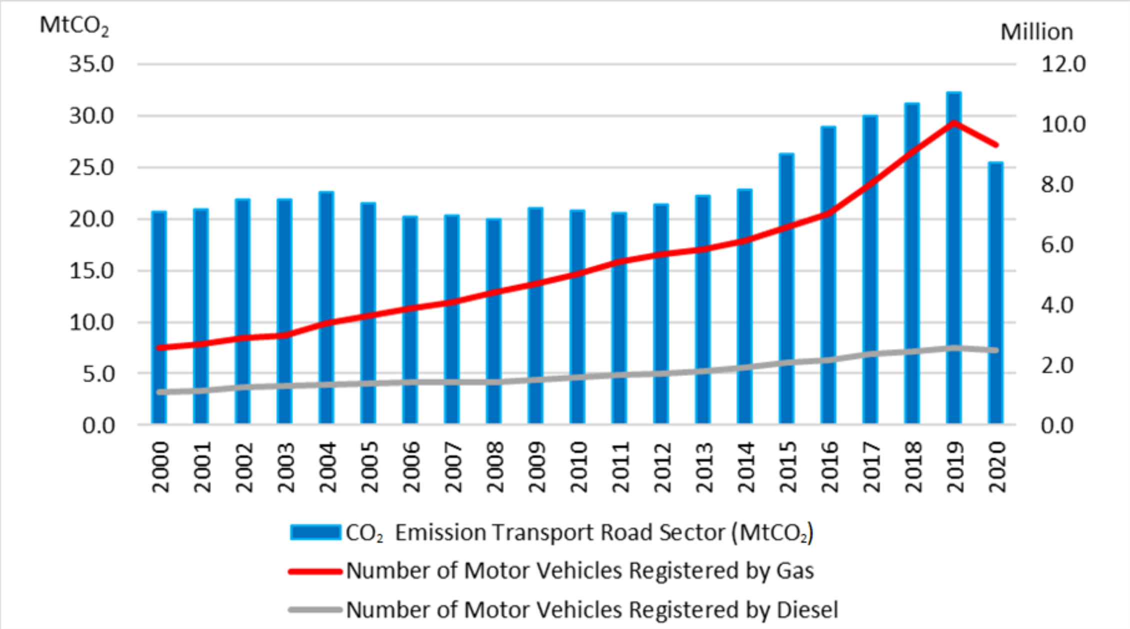


Source: IEA (2022).

A 20-year trend of the number of cars owned and CO_2 emissions from the road transport sector shows that CO_2 emissions have increased with the growth in the number of cars owned (Figure 3.56).

As of 2020, 79% of cars were gasoline-powered and 21% were diesel-powered, with fossil fuels being the energy source for nearly all vehicles. This has led to an increase in the number of vehicles using fossil fuels, which in turn has led to an increase in CO_2 emissions in road transport.

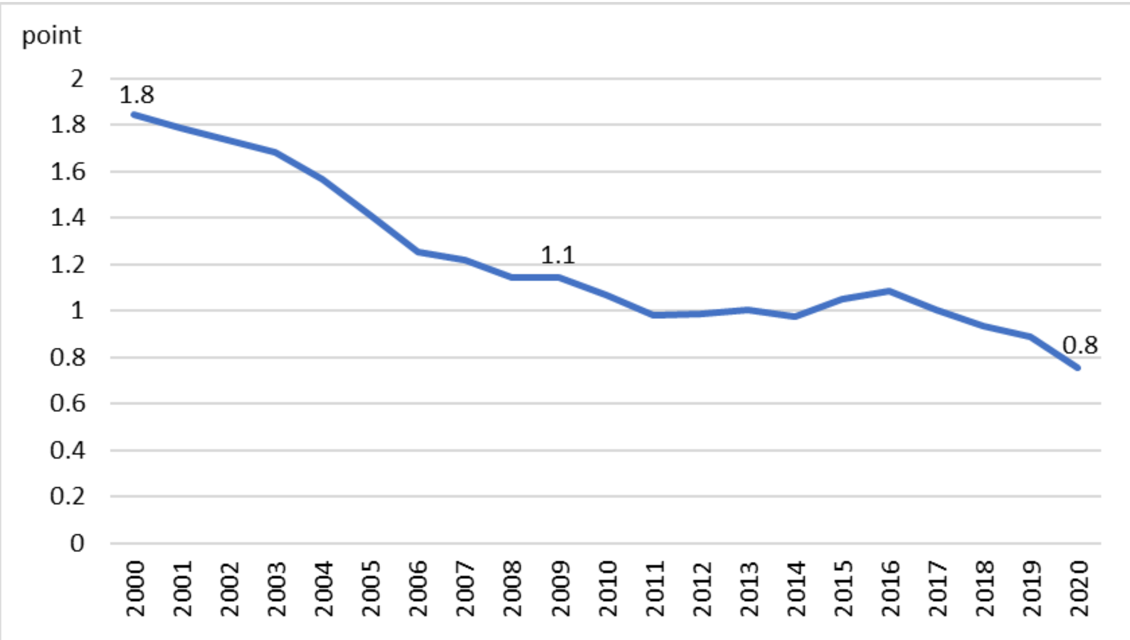
Figure 3.56. Transition between CO_2 Emissions in Road Transport and the Number of Motor Vehicles by Fuel Used (Philippines: 2000–20)



Source: IEA (2022) and Land Transportation Office.

Next, we analyse the indicator of final energy consumption in the road transport sector divided by the number of registered cars owned. The indicator of 1.8 in 2000 improved to 1.1 in 2009 and to 0.8 in 2020 (Figure 3.57).

Figure 3.57. EE&C Indicator Transition of Road Transport (Philippines)



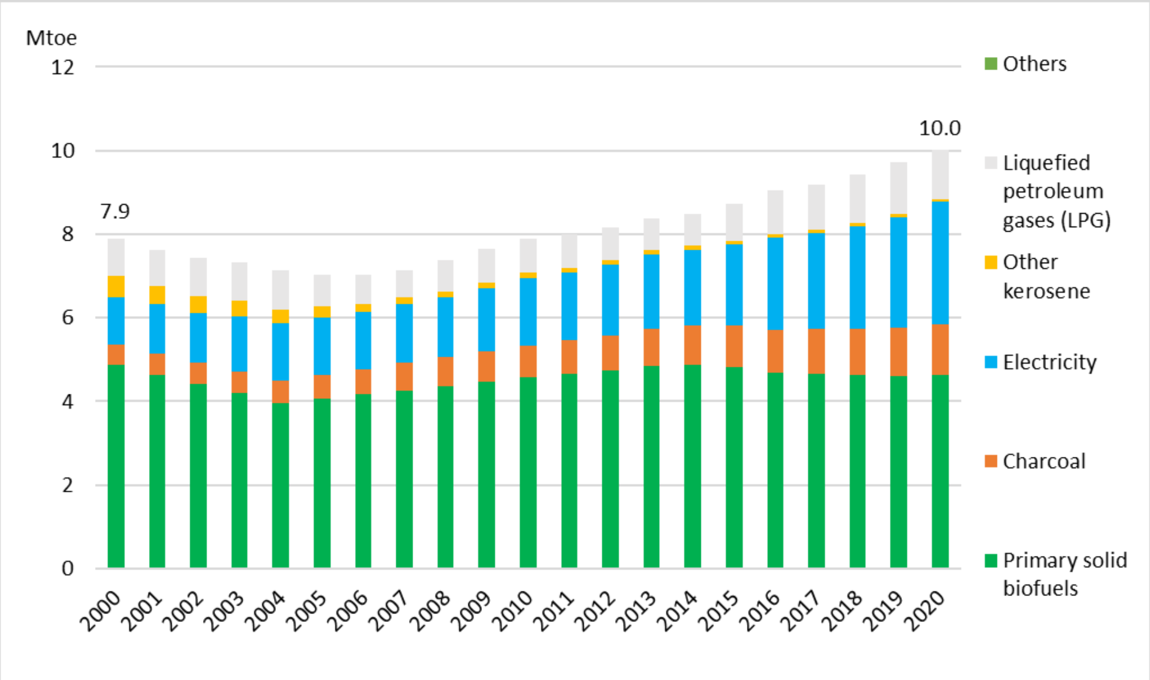
EE&C = energy efficiency and conservation.
Source: IEA (2022) and Land Transportation Office.

8) Energy consumption and efficiency in the residential sector

The final energy consumption in the residential sector increased by 27% from 7.9 Mtoe in 2000 to 10.0 Mtoe in 2020.

An analysis of this breakdown into traditional fuels, such as primary solid biofuels and charcoal, and modern fuels, such as LPG, kerosene and electricity, shows that the traditional fuels have increased, but the modern fuels have increased even more. The increase in electricity is particularly significant (Figure 3.58).

Figure 3.58. Final Energy Consumption Transition of Residential Sector (Philippines)

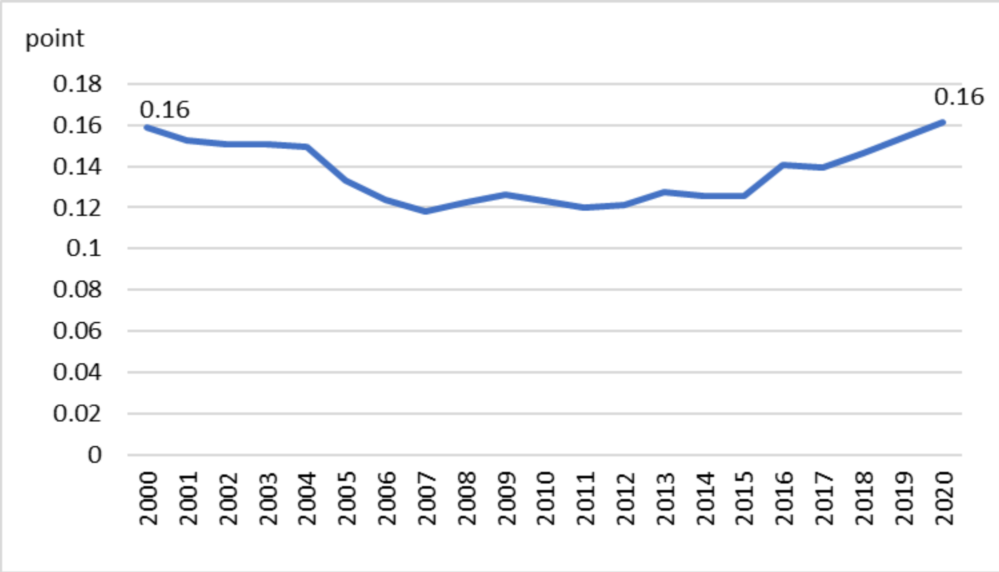


Source: IEA (2022).

Next, we analyse the indicator of final energy consumption of modern energy divided by the number of households. Since statistical data on the number of households in the Philippines are not confirmed, we use the deemed number of households, which is the population divided by the average number of persons per household.

Figure 3.59 shows that the indicator was 0.16 in 2000 and improved since then to around 2010, but has deteriorated since 2015, with the index at 0.16 in 2020.

Figure 3.59. EE&C Indicator Transition of Residential Sector (Philippines)



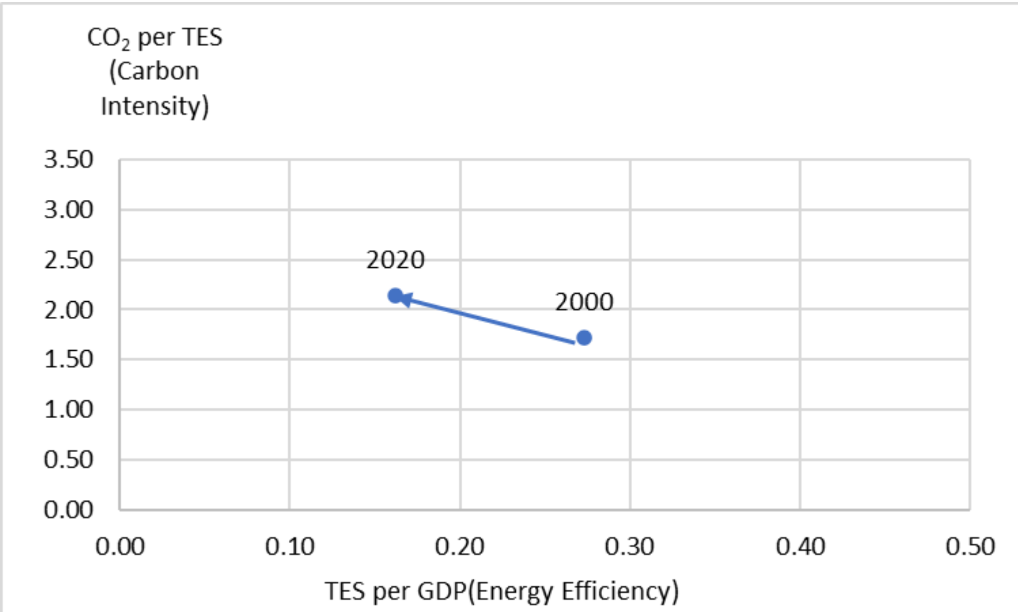
EE&C = energy efficiency and conservation.
Source: IEA (2022) and United Nations. https://population.un.org/household/#/countries/ (accessed 23 May 2023).

3.2. Indicator of Energy Efficiency

1) Energy efficiency and carbon intensity

As shown in the graph below, TES per GDP, a leading indicator of energy efficiency, has decreased by 41% over the 20 years, from 0.27 in 2000 to 0.16 in 2020, indicating progress in energy conservation. On the other hand, CO_2 emissions per TES worsened from 1.71 in 2000 to 2.15 in 2020. Despite progress in energy conservation, the carbon intensity is deteriorating (Figure 3.60).

Figure 3.60. Energy Efficiency and Carbon Intensity Transition (Philippines: 2000–20)



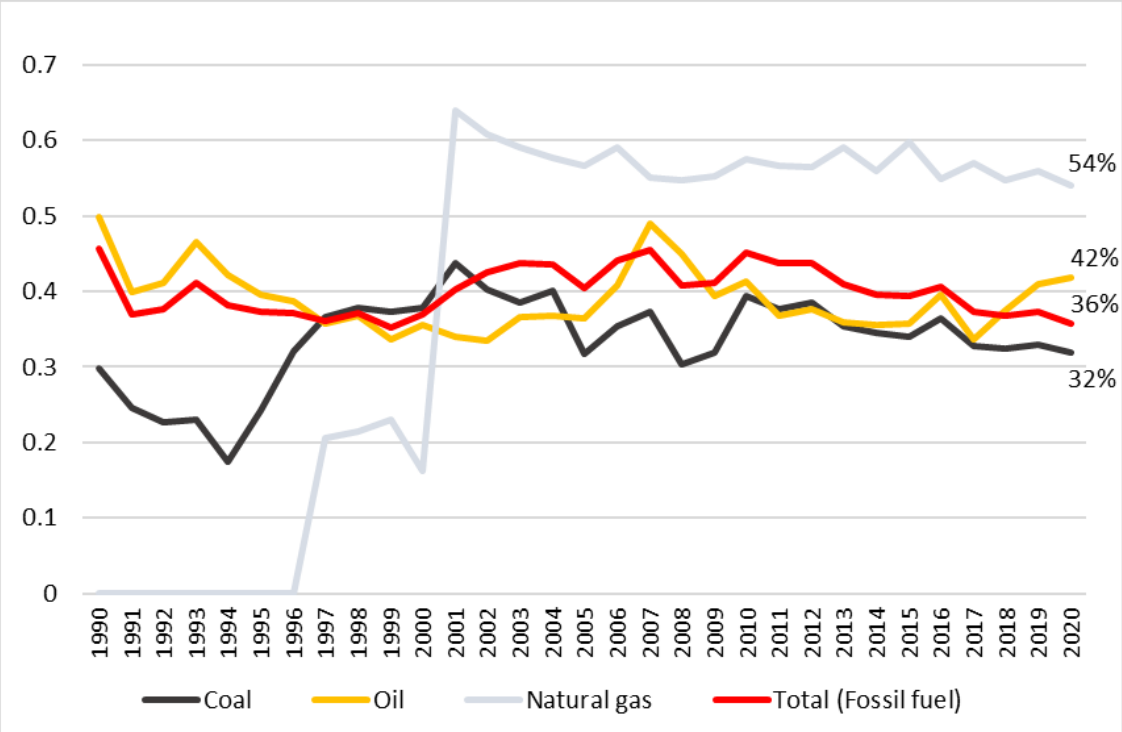
GDP = gross domestic product, TES = total energy supply.
Source: IEA (2022).

2) Power generation efficiency

Over the 20 years leading up to 2020, the efficiency of thermal power generation (coal, oil, and natural gas) has generally remained around 41%. As of 2020, the efficiency of thermal power generation (average of coal, oil, and natural gas) is 36%.

The efficiency of coal-fired power generation over the 20-year period generally hovers around 36%, and the efficiency as of 2020 is 32% (Figure 3.61).

Figure 3.61. Thermal Efficiency Transition (Philippines: 2000–20)



Source: IEA (2022).

3.3. Indicator of CO_2 emissions

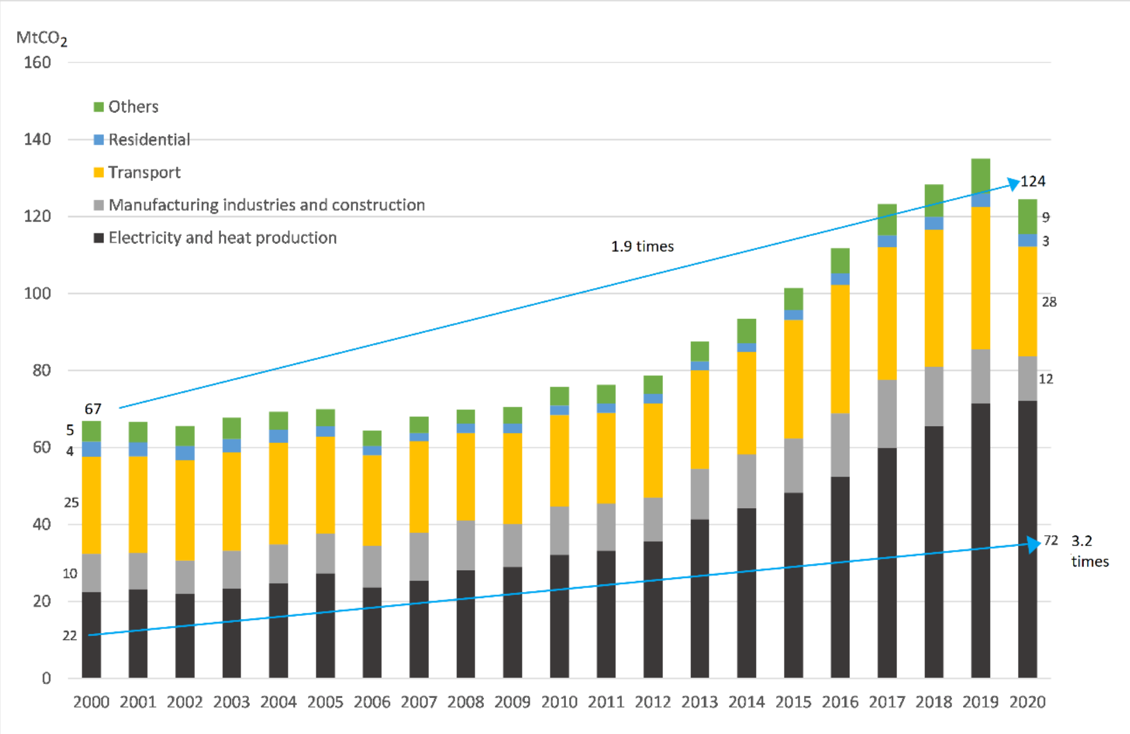
1) Transition in CO_2 emissions by sector

CO_2 emissions increased 1.9 times in 20 years, from 67 $MtCO_2$ in 2000 to 124 $MtCO_2$ in 2020.

CO_2 emissions by sector in 2020 are 72 $MtCO_2$ in the electricity and heat production sector, 28 $MtCO_2$ in the transport sector, 12 $MtCO_2$ in the manufacturing industries and construction sector, 3 $MtCO_2$ in the residential sector, and 9 $MtCO_2$ in the others.

Comparing CO_2 emissions over the 20-year period by sector from 2000 to 2020, we find that the CO_2 emissions in the electricity and heat production sector increased 3.2 times from 22 $MtCO_2$ to 72 $MtCO_2$, that in the manufacturing industries and construction sector increased 1.2 times from 10 $MtCO_2$ to 12 $MtCO_2$, and that in the transport sector increased 1.1 times from 25 $MtCO_2$ to 28 $MtCO_2$. On the other hand, CO_2 emissions from the residential sector decreased by 0.8 times from 4 $MtCO_2$ in 2000 to 3 $MtCO_2$ in 2020 (Figure 3.62).

Figure 3.62. CO_2 Emissions Transition by Sector (Philippines: 2000–20)

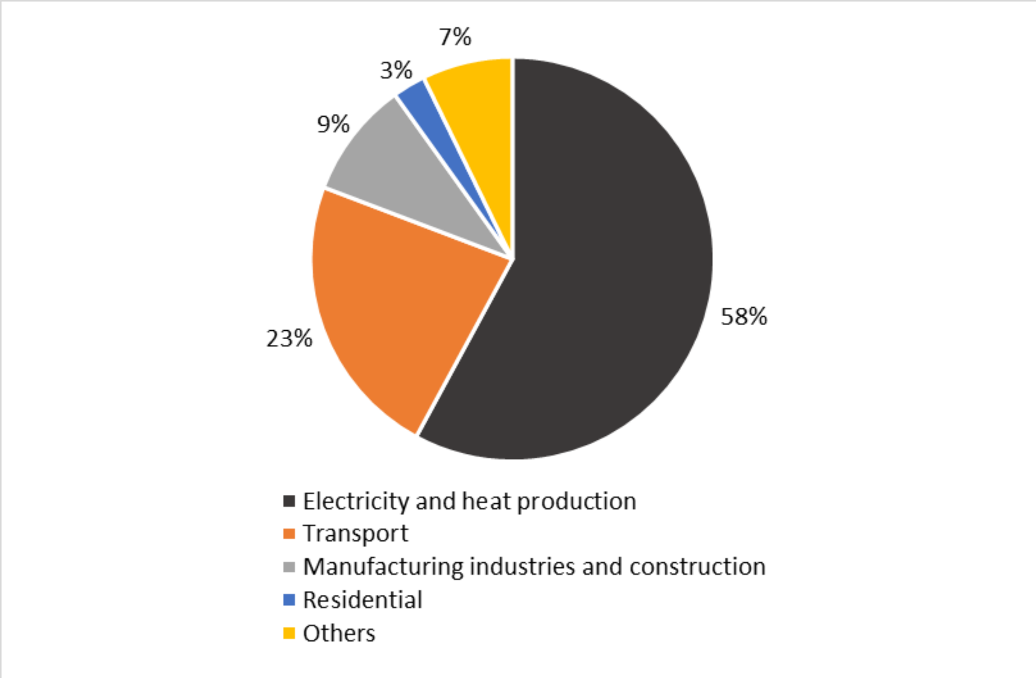


Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of the share of CO_2 emissions by sector in 2020, the electricity and heat production sector is in first place (58%), followed by the transport sector (23%), the manufacturing industries and construction sector (9%), the residential sector (3%), and the others (7%) (Figure 3.63).

In the electricity and heat production sector, the share of power generation from fossil fuels (oil, coal, and natural gas) is high, especially the share of coal-fired power generation (57.2%). In addition, coal-fired power generation efficiency (36%) is low compared to the OECD average (39%), suggesting that coal-fired power generation accounts for a large portion of CO_2 emissions from the electricity and heat production sector.

Figure 3.63. CO_2 Emissions by Sector (Philippines: 2020)



Source: IEA (2022).

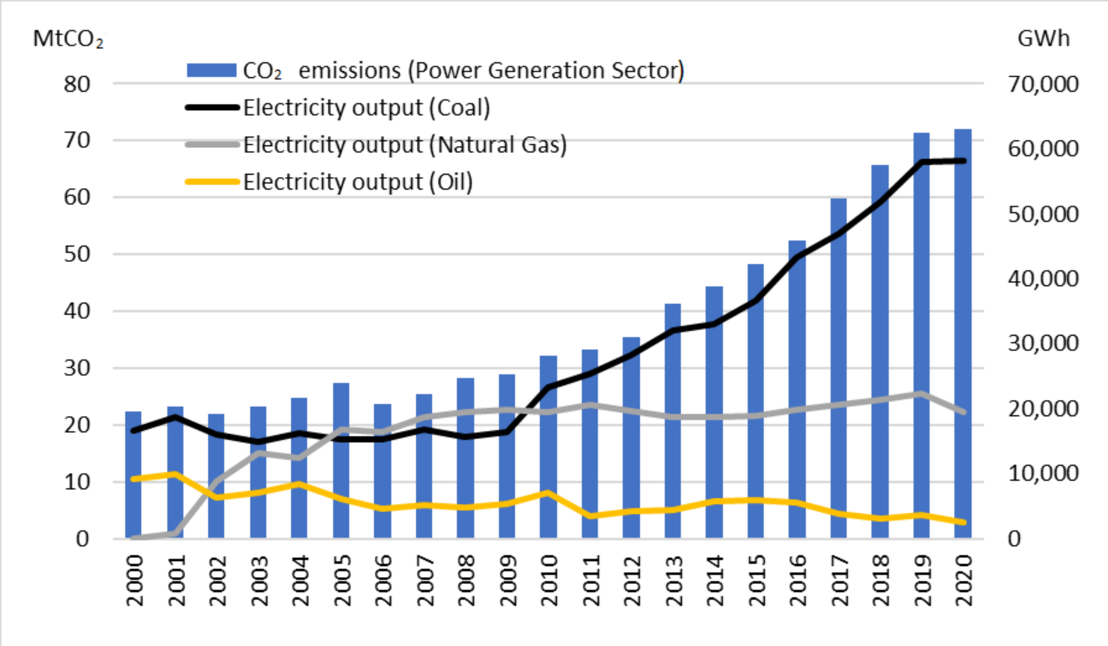
2) CO_2 emissions and coal-fired power generation

We analysed the relationship between the amount of thermal power generation of fossil fuels (oil, coal, and natural gas), which are closely related to CO_2 emissions, and CO_2 emissions from the electricity and heat production sector, in the period of 2000 through 2020.

A graph of CO_2 emissions from the electricity and heat production sector versus oil-, coal-, and natural gas-fired power generation over a 20-year period is shown in Figure 3.64.

The graph indicates a strong correlation between CO_2 emissions and coal-fired power generation in the electricity and heat production sector in the Philippines.

Figure 3.64. Transition between CO_2 Emissions in the Electricity Sector and Coal, Natural Gas, and Oil Electricity Output (Philippines: 2000–20)



Source: IEA (2022).

3.4. Summary of Efficiency Metrics

Table 3.3 summarises the Philippines' energy efficiency indicator.

The difference over 20 years is that TES per GDP and the EE&C indicator of iron and steel subsector have improved, while thermal efficiency (coal-fired plant) has deteriorated.

Table 3.3. Summary of Energy Efficiency Indicator (Philippines)

Energy Efficiency Indicator	Philippines		
	2000	2020	
TES per GDP	0.27	0.16	Improve
EE&C Indicator of Iron and Steel Sector	1.34	0.97	Improve
EE&C Indicator of Road Transport Sector	1.80	0.80	Improve
EE&C Indicator of Residential Sector	0.16	0.16	No Change
Thermal Efficiency (Fossil fuel-fired)	0.37	0.36	Worsen
Thermal Efficiency (Coal-fired)	0.38	0.32	Worsen

EE&C = energy efficiency and conservation, GDP = gross domestic product,
TES = total energy supply.
Source: Author.

3.5. Energy Efficiency Policy

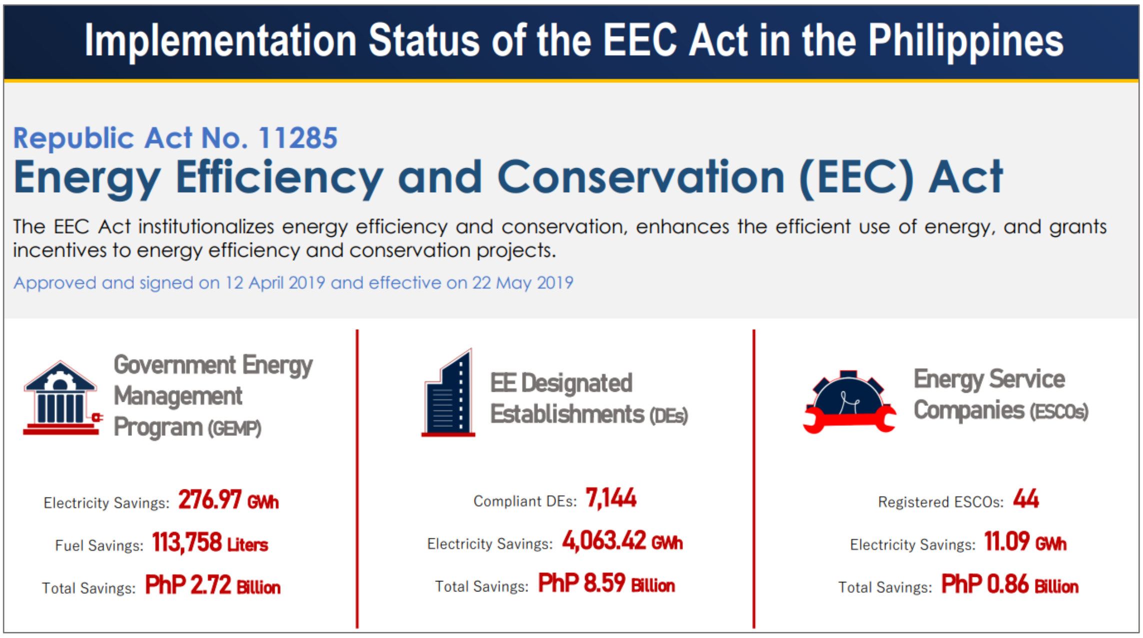
1) Energy Efficiency and Conservation Act

The Philippine EEC Act entered into force on 22 May 2019. The main pillars of this law are the Government Energy Management Program (GEMP), Energy Efficiency Designated Establishments (EEDEs), and ESCOs.

GEMP saved 276.97 GWh of electricity and EEDEs saved 4063.42 GWh of electricity. Forty-four companies registered for ESCOs, saving 11.09 GWh of electricity (Figure 3.65). The Philippines is a country with high energy prices in ASEAN, which may be a factor in the success of the ESCO project.

EEDEs were required to submit an annual energy consumption report for the duration of the project, and 23 of the 39 samples were able to submit an energy audit report during the 2022 compliance period.

Figure 3.65. Energy Efficiency and Conservation Act, Philippines



EE = energy efficiency.
Source: DOE, Philippines

2) Energy efficiency road map and Demand Side Managment programme

The Philippines has developed Energy Efficiency Roadmap 2014–2030. The target for 2030 is to reduce energy intensity by 40% compared to 2010, reduce annual energy consumption by 1.6% compared to business as usual (BAU), and reduce annual energy demand by 10,665 ktoe, which correspond to one-third of the current energy demand.

In addition, to deal with tight supply and demand, Philippines has introduced DSM to all electricity consumers (especially households, industries, and commercial organisations), excluding important facilities such as hospitals, military facilities, and airport-related facilities.

The introduction of DSM was required not only for consumers, but also for power suppliers.

In the industry sector, regulations based on the ministerial decree on the DSM programme have been in force since 2014. The industry sector voluntarily submits an energy consumption status report to the Department of Energy (DOE) based on the energy management system. These include energy audits and certification programmes in which the DOE provides advisory services to the industry and commercial sectors.

In the commercial and residential sector, there is an obligation to report energy consumption based on the energy management system. Incandescent light bulbs were phased out in 2008, and the ESCO certification system was launched.

In the transport sector, various fuel efficiency improvement programmes are being promoted.

3) ESCOs programme in Philippines

Government-affiliated and other financial institutions in the Philippines provide financial packages for renewable energy and energy efficiency projects promoted by ESCOs. Examples of ESCO initiatives include efficiency lighting systems, employing efficient heating and air conditioning solutions, and implementing centralised energy management systems, all of which are given financial incentives.

DOE has established policies and regulations such as evaluation, approval procedures, and standards for energy efficiency projects to promote ESCOs. ESCO-led project types such as Third-Party Project Developer, Project Special Purpose Vehicle, or Self-Financed will be given financial incentives and eligible facilities will be certified by an energy auditor or certified ESCO within 3 years. Energy audits are mandatory.

Registered and accredited ESCOs include private, government-owned, and managed companies that provide energy efficiency project development, design, energy savings realisation and assurance, and cost-effective services and products. As of 5 June 2023, there are 49 registered ESCOs.

3.6. CO_2 Emissions Reduction Policy

As of May 2023, the Philippines' carbon neutrality declaration cannot be confirmed.

In April 2021, the Philippines submitted a new NDC that calls for a 75% GHG reduction relative to the BAU case in 2030 (2.71% without conditions, 72.29% with conditions of international support). The Philippines aims to reduce GHGs through climate finance, enhanced access to technology, circular economy, and sustainable consumption.

In October 2020, the Philippines suspended the approval of new coal-fired power generation. In November 2021, the Philippines entered into a partnership with ADB to promote the shift from coal-fired power generation to renewable and other clean energy sources.

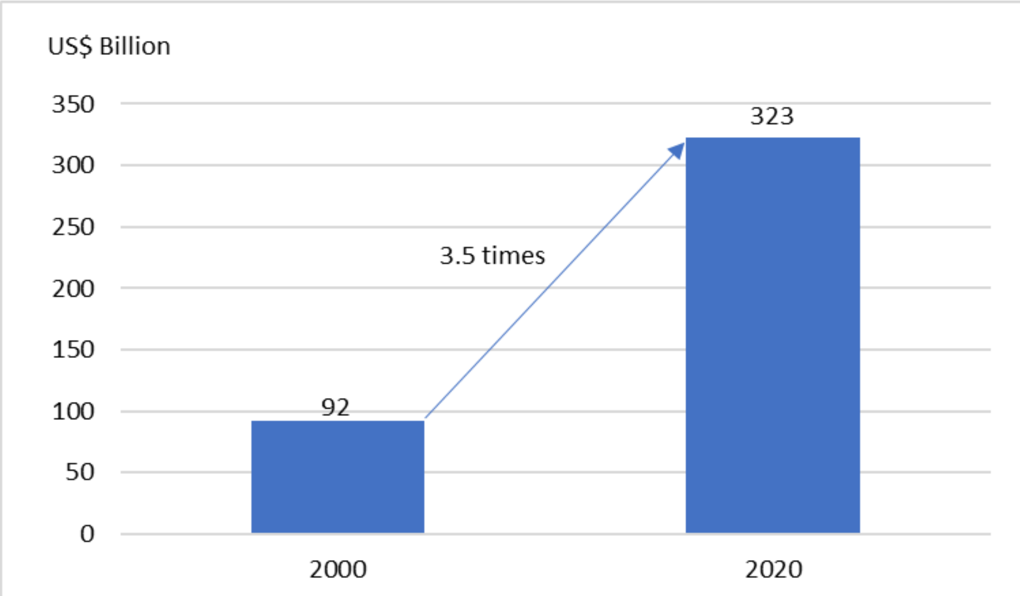
4. Viet Nam

4.1. Indicators of Energy Consumption

1) Transition in GDP

Viet Nam's GDP has grown 3.5 times in 20 years, from $92 billion in 2000 to $323 billion in 2020 (Figure 3.66).

Figure 3.66. Viet Nam Gross Domestic Product, 2000 vs 2020 (2015 prices and ex rate)

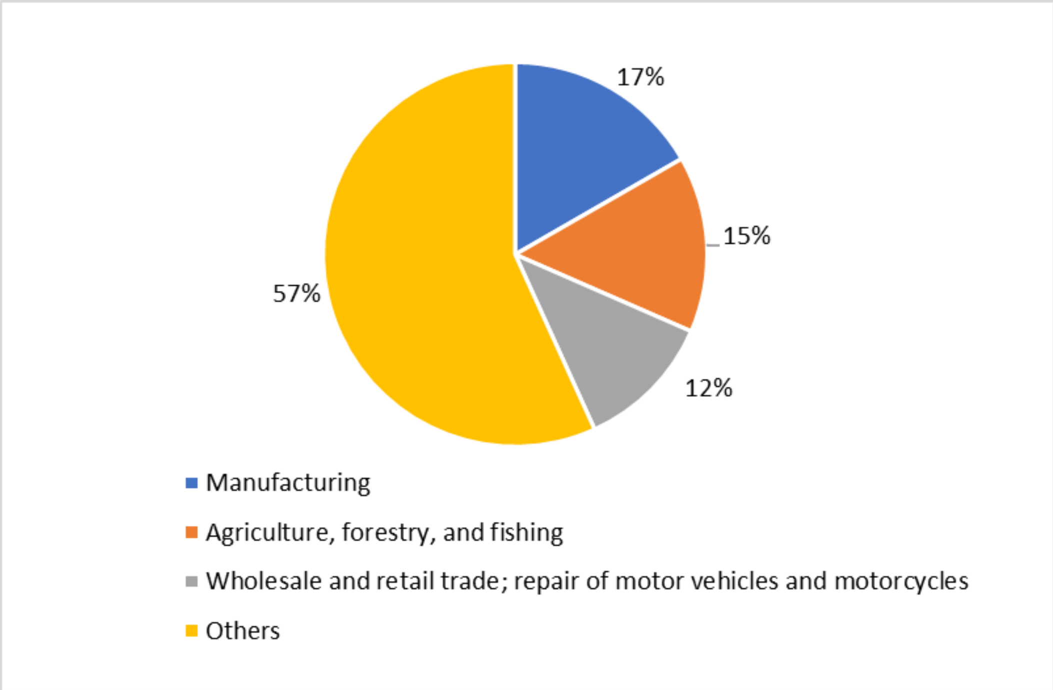


Source: IEA (2022).

2) GDP by sector and changes in industrial structure

In terms of the share of nominal GDP by sector in 2020, manufacturing is in first place (17%), followed by agriculture, forestry, and fishing (15%), and wholesale and retail trade (12%) (Figure 3.67). Viet Nam's 10-year Socio-Economic Development Strategy set the goal of 'becoming an industrialized country by 2020.' and the industrial development strategy for Viet Nam until 2025 identified three major industries, including manufacturing.

Figure 3.67. Viet Nam Gross Domestic Product by Sector at Current Market Prices (2020)



Source: ADB (2022).

3) Transition of TES by energy type

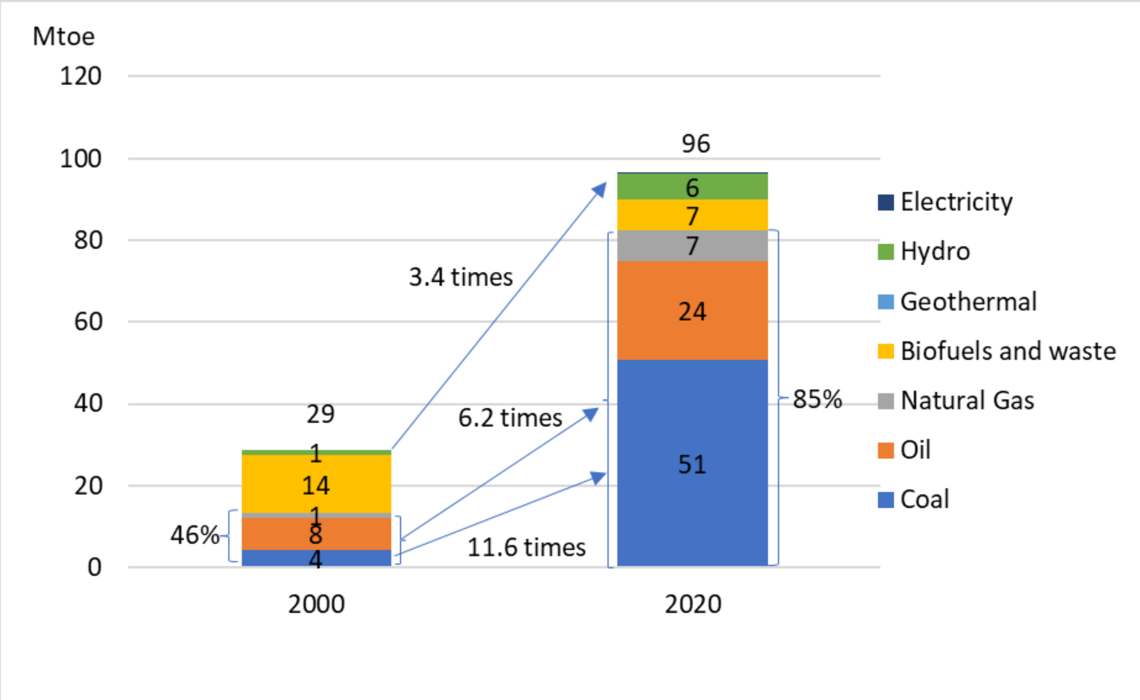
In 20 years, TES increased by 3.4 times from 29 Mtoe in 2000 to 96 Mtoe in 2020.

Of that amount, TES of fossil fuels (oil, coal, and natural gas) increased by 6.2 times from 13 Mtoe in 2000 to 82 Mtoe in 2020. Focusing on TES of fossil fuels by energy, TES of oil and natural gas increased 3.6 and 6.6 times, respectively, while TES of coal, which has a particularly high CO_2 emissions factor, increased significantly by 11.6 times, from 4 Mtoe in 2000 to 51 Mtoe in 2020.

For non-fossil fuels, hydro TES increased by 5.0 times, while biofuels and waste TES decreased by 0.5 times.

Fossil fuel dependence (the percentage of oil, coal, and natural gas in the total) increased from 46% in 2000 to 86% in 2020 (Figure 3.68).

Figure 3.68. Total Energy Supply by Energy Type (Viet Nam: 2000 vs 2020)



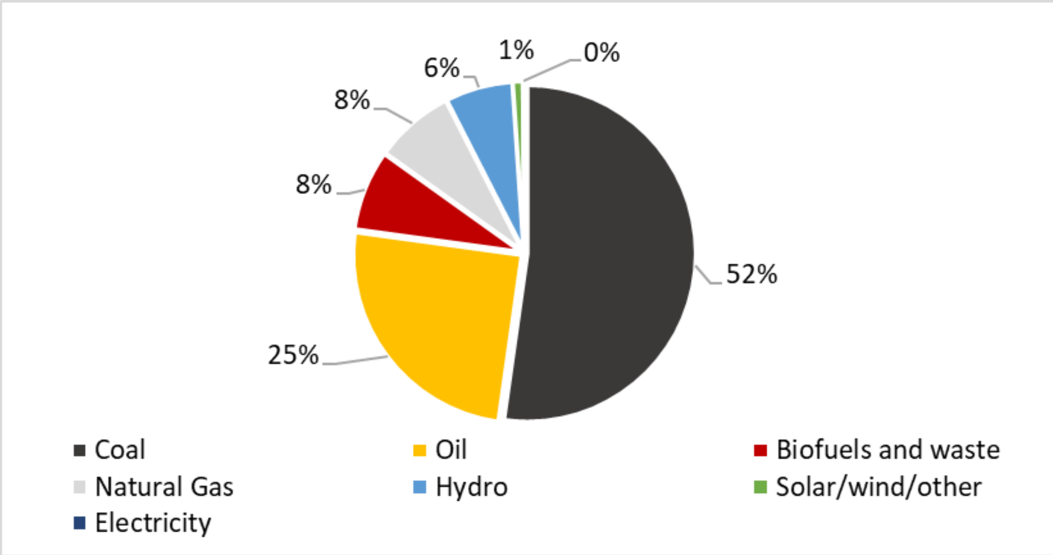
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of TES share by energy source in 2020, coal ranks first (52.2%), oil second (24.9%), biofuels and waste third (7.7%), followed by natural gas (7.6%), hydro (6.4%), and solar/wind/other (0.9%).

Fossil fuels, with a TES share of 85%, account for much of the TES. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 52% TES share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 15%. The breakdown is dominated by biofuels and waste (8%) and hydro (6%), with solar/wind/others at a very low 1% (Figure 3.69).

Figure 3.69. Total Energy Supply Share by Energy (Viet Nam: 2020)

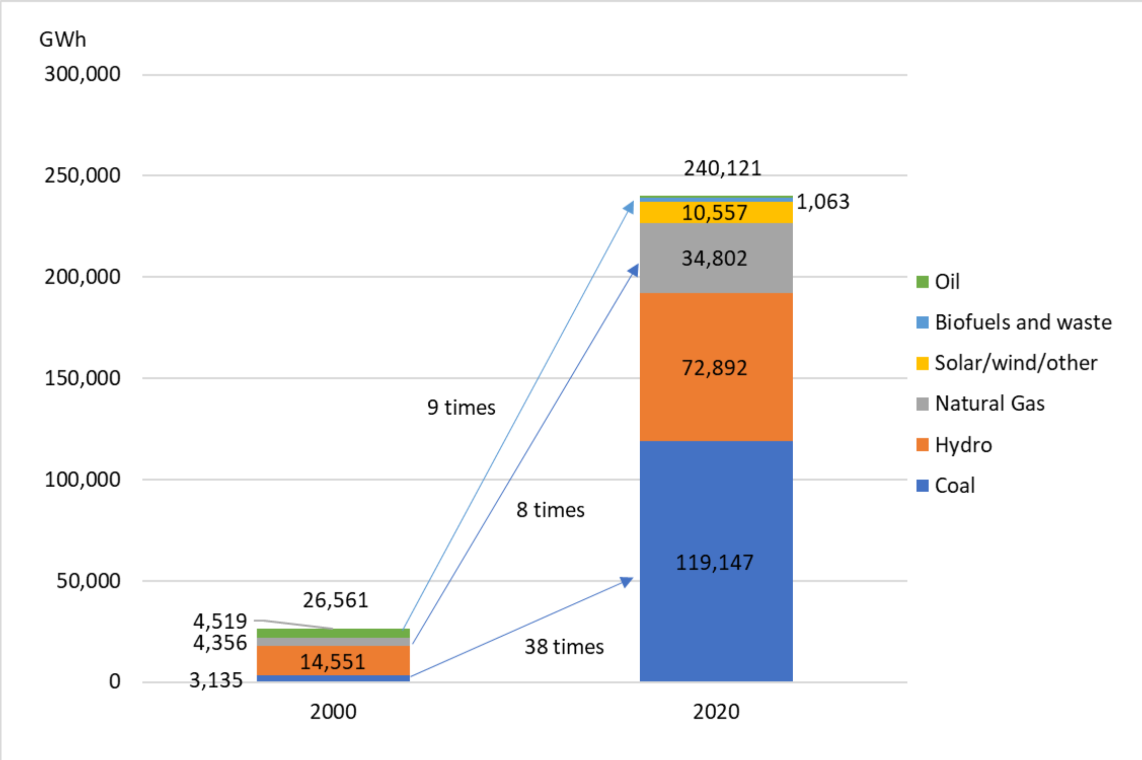


Source: IEA (2022).

4) Transition of power generation by fuel

In 20 years, power generation increased 9.0 times from 26,561 GWh in 2000 to 240,121 GWh in 2020. In terms of power generation by fuel in 2020, coal ranks first (119,147 GWh), followed by hydro (72,892 GWh), natural gas (34,802 GWh), solar/wind /other (10,557 GWh), biofuels and waste (1,660 GWh) and oil (1,063 GWh). Natural gas has increased 8.0 times from 4,356 GWh in 2000 to 34,802 GWh in 2020, mainly due to the Rang Dong oil field associated gas recovery and utilisation project. Power generation from coal, which has a high CO_2 emissions factor, jumped 38 times from 3,135 GWh in 2000 to 119,147 GWh in 2020 (Figure 3.70).

Figure 3.70. Electricity Output by Fuel (Viet Nam: 2000 vs 2020)



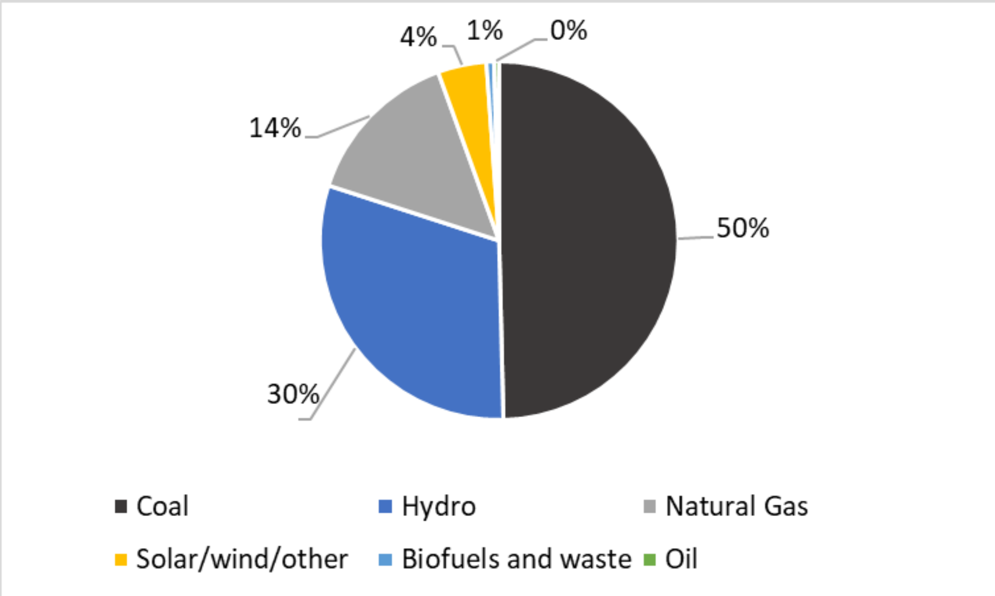
Source: IEA (2022).
Note: Totals may not match due to rounding.

In terms of share of power generation by fuel in 2020, coal ranks first (50%), hydro second (30%), natural gas third (14%), followed by solar, wind, and other (4%), and biofuels and waste (1%).

Fossil fuels account for most of the share of power generation, at 65%. Coal, which has a particularly high CO_2 emissions factor, tops the list with a 50% share.

On the other hand, the TES share of non-fossil fuels (biofuels and waste, geothermal, hydro, and solar/wind/other) is 35%. The breakdown is as follows: 30% for hydro, 4% for solar/wind/other, and 1% for biofuels and waste (Figure 3.71).

Figure 3.71. Electricity Output Share by Fuel (Viet Nam: 2020)



Source: IEA (2022).

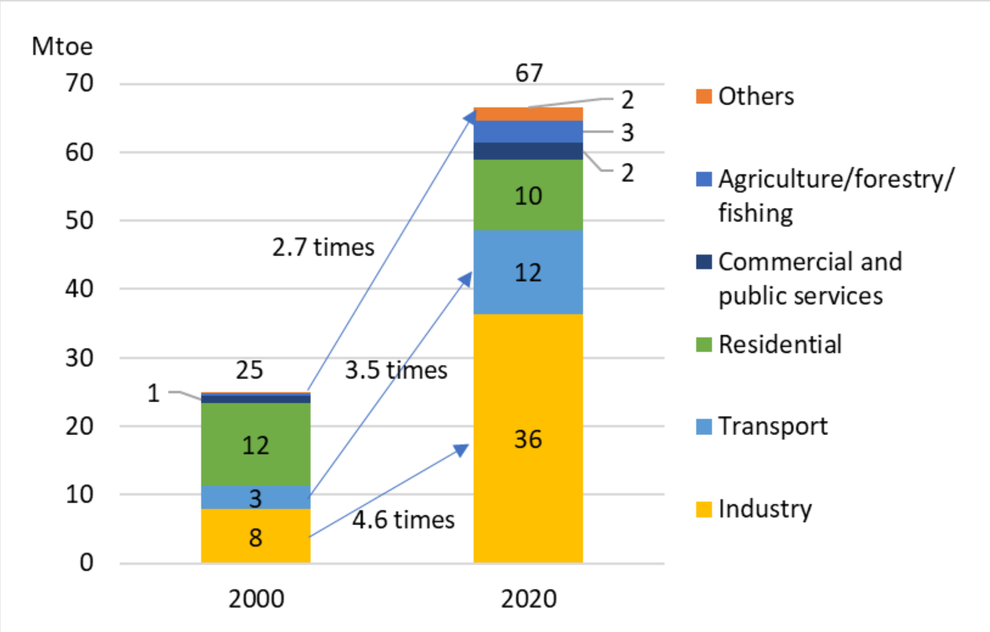
5) Transition of final energy consumption by sector

In 20 years, final energy consumption increased by 2.7 times from 25 Mtoe in 2000 to 67 Mtoe in 2020. In terms of final energy consumption by sector in 2020, the industry sector is in first place (36 Mtoe), followed by the transport sector (12 Mtoe), the residential sector (10 Mtoe), the agriculture, forestry, and fishing sector (3 Mtoe), the commercial and public service sector (2 Mtoe) and the others (2 Mtoe).

Comparing final energy consumption over the 20-year period from 2000 to 2020, we find that the final energy consumption in the industry sector increased 4.6 times from 8 Mtoe to 36 Mtoe, the transport sector increased 3.5 times from 3 Mtoe to 12 Mtoe, while the final energy consumption in the residential sector decreased 0.9 times from 12 Mtoe to 10 Mtoe (Figure 3.72).

The industry sector's final energy consumption has been growing with the progress of industrialisation. The final energy consumption in the transport sector has also been growing with the development of motorisation.

Figure 3.72. Final Energy Consumption (Viet Nam: 2000 vs 2020)

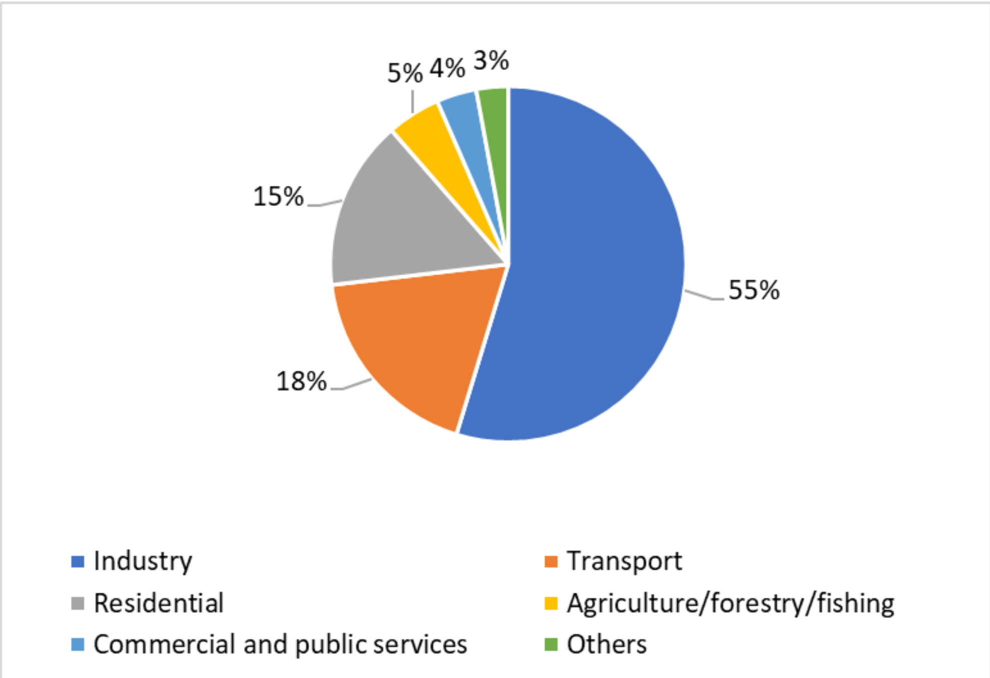


Source: IEA (2022).

Note: Totals may not match due to rounding.

In terms of the share of final energy consumption by sector in 2020, the manufacturing industries and construction sector ranked first (55%), followed by the transport sector (18%), the residential sector (15%), the agriculture, forestry and fishing sector (5%), the commercial and public services sector (4%) and others (3%) (Figure 3.73).

Figure 3.73. Final Energy Consumption Share by Sector (Viet Nam: 2020)



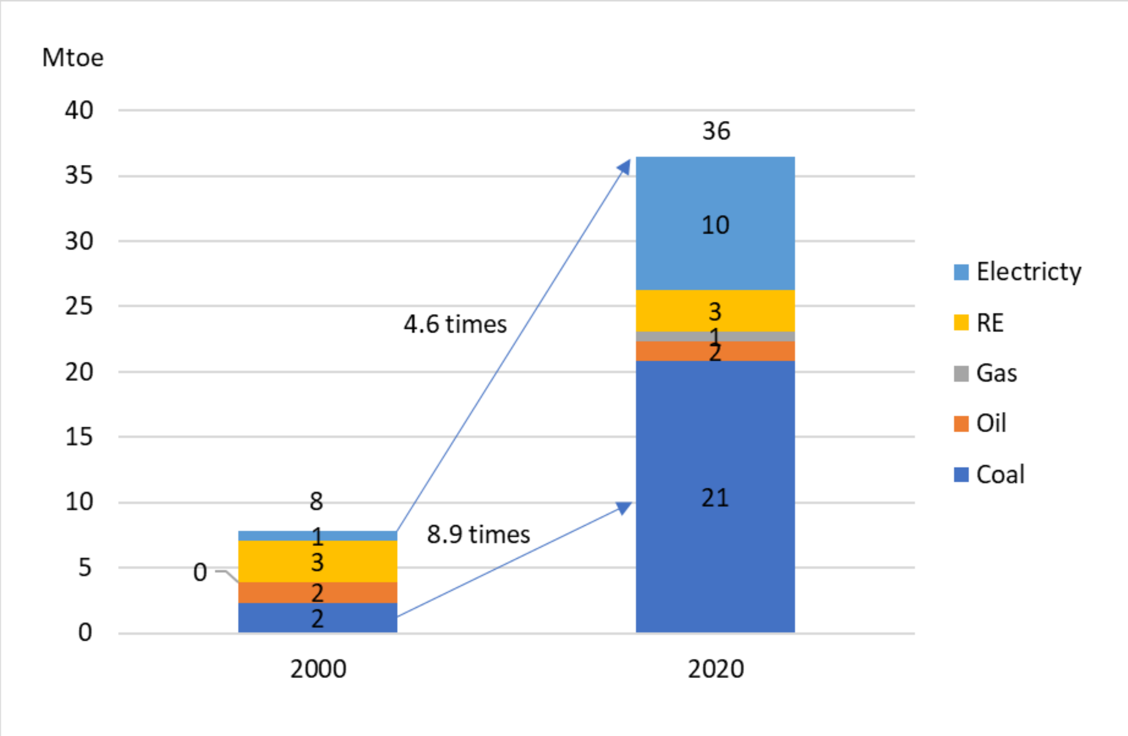
Source: IEA (2022).

6) Energy consumption and efficiency in the industry sector

The final energy consumption in the manufacturing industries and construction sector increased 4.6 times from 8 Mtoe in 2000 to 36 Mtoe in 2020.

In particular, the final energy consumption of coal increased 8.9 times from 2 Mtoe in 2000 to 21 Mtoe in 2020 (Figure 3.74).

Figure 3.74. Final Energy Consumption Transition by Fuel (Viet Nam: 2000 vs 2020)



RE = renewable energy.
Source: IEA (2022).
Note: Totals may not match due to rounding.

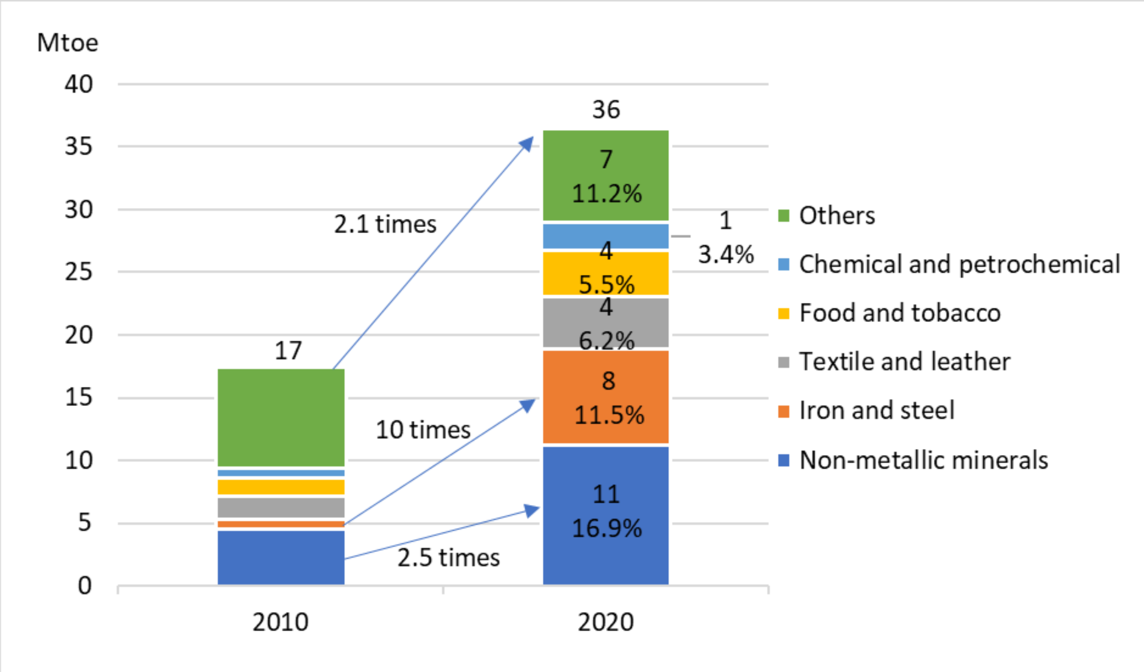
In the IEA World Energy Balance, final energy consumption data for subsectors of the industry sector in Viet Nam are available since 2010.

The final energy consumption in the industry sector increased 2.1 times from 17 Mtoe in 2010 to 36 Mtoe in 2020.

In terms of final energy consumption by subsector in the industry sector, the final energy consumption in the non-metallic minerals subsector increased about 2.5 times from 4.5 Mtoe in 2010 to 11.2 Mtoe in 2020, while the final energy consumption in the iron and steel subsector increased about 10 times from 0.7 Mtoe in 2010 to 7.7 Mtoe in 2020.

In the industry sector, the share by subsector in the final energy consumption in 2020 is 16.9% for the non-metallic minerals subsector and 11.5% for the iron and steel subsector (Figure 3.75).

Figure 3.75. Final Energy Consumption Transition and Share by Industry Subsector (Viet Nam: 2010 vs 2020)



Source: IEA (2022).

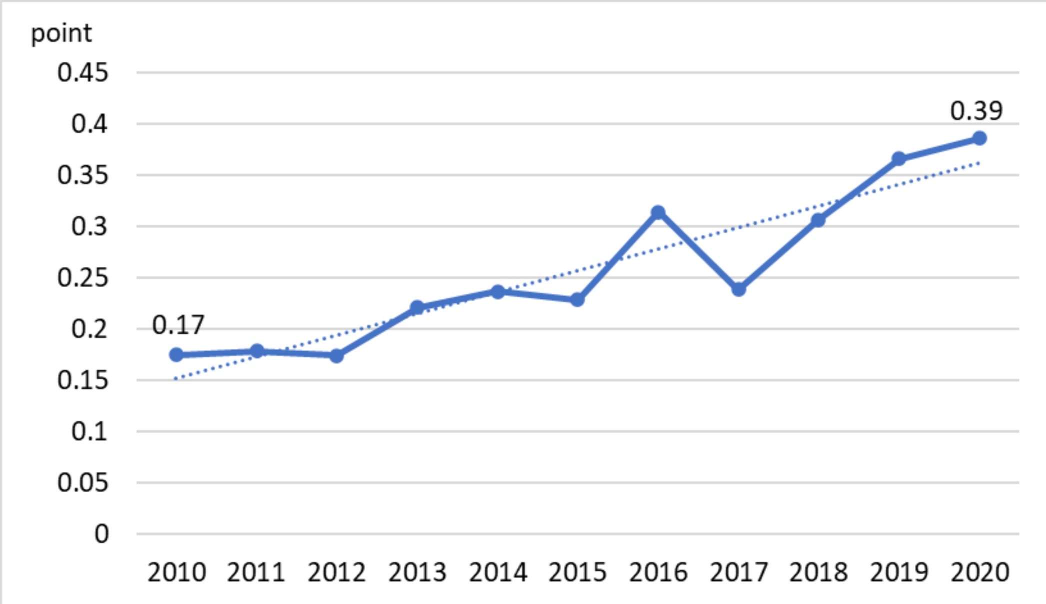
Note: Totals may not match due to rounding.

Next, we consider the iron and steel subsector and the non-metallic minerals subsector, for which statistical data are available.

a) Iron and steel subsector

Figure 3.76 shows the indicator of final energy consumption in the iron and steel subsector divided by crude steel production. The indicator worsened from 0.17 in 2010 to 0.39 in 2020.

Figure 3.76. EE&C Indicator Transition of Iron and Steel Subsector (Viet Nam)

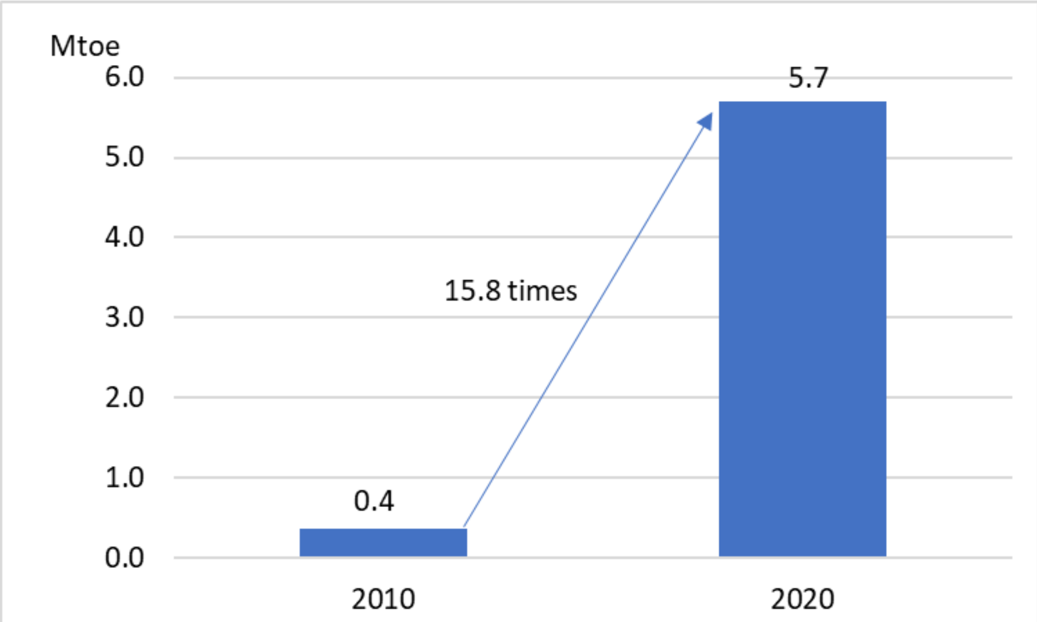


EE&C = energy efficiency and conservation.
Source: IEA (2022) and World Steel Association
Note: The dotted line in the graph is an approximate curve.

In the manufacturing industries of Viet Nam, the energy consumption in the iron and steel subsector steeply increased. In particular, the final energy consumption of coal in the iron and steel subsector increased by 15.8 times from 0.4 Mtoe in 2010 to 5.7 Mtoe in 2020 (Figure 3.77). This growth rate is first and prominent amongst all sectors.

The crude steel production in Viet Nam rose by approximately 5.7 times from 2.7 million tonnes in 2009 to 15.47 million tonnes in 2018, indicating rapid growth in the past 10 years. In 2017, the nation's first integrated blast-furnace steelworks began operation in Hà Tĩnh, which is in the in the middle region of Viet Nam. These circumstances are considered as a factor for the increase of the final energy consumption in the iron and steel subsector.

Figure 3.77. Final Energy Consumption Transition of Coal by Iron and Steel Subsector (Viet Nam: 2010 vs 2020)

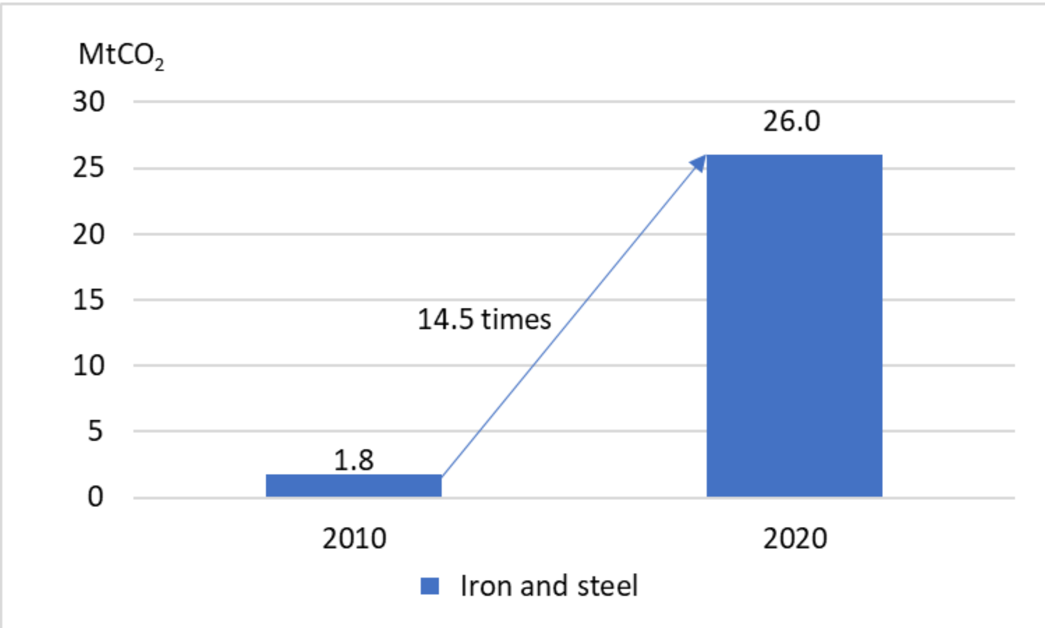


Source: IEA (2022).

In addition, the CO_2 emissions in the iron and steel subsector showed 14.5 times increase from 1.8 $MtCO_2$ in 2010 to 26 $MtCO_2$ in 2020 (Figure 3.78).

The iron and steel subsector is known for its high coal consumption. It is considered that an increase in the consumption of energy such as coal (by 15.8 times) in this sub- sector led to the increase of the CO_2 emissions (by 14.5 times).

Figure 3.78. CO_2 Emissions Transition by Iron and Steel Subsector (Viet Nam: 2010 vs 2020)

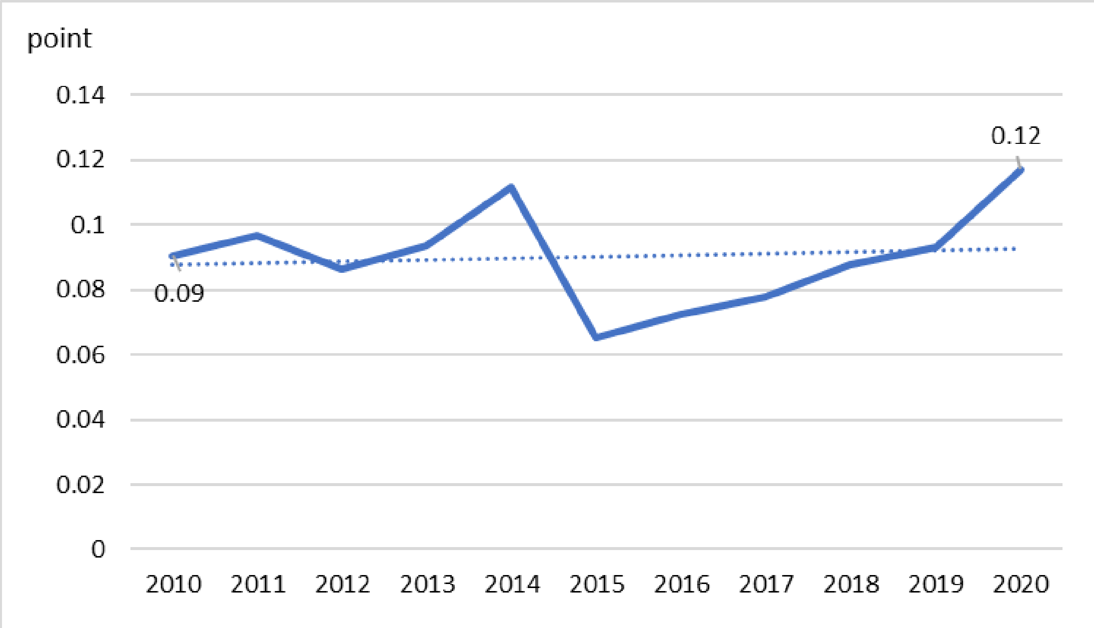


Source: IEA (2022).

b) Non-metallic minerals subsector

Figure 3.79 shows an indicator calculated by dividing the final energy consumption in the non-metallic minerals subsector by the cement production. The indicator improved from 0.09 in 2000 to 0.12 in 2020.

Figure 3.79. EE&C Indicator Transition of Non-Metallic Minerals Subsector (Viet Nam)



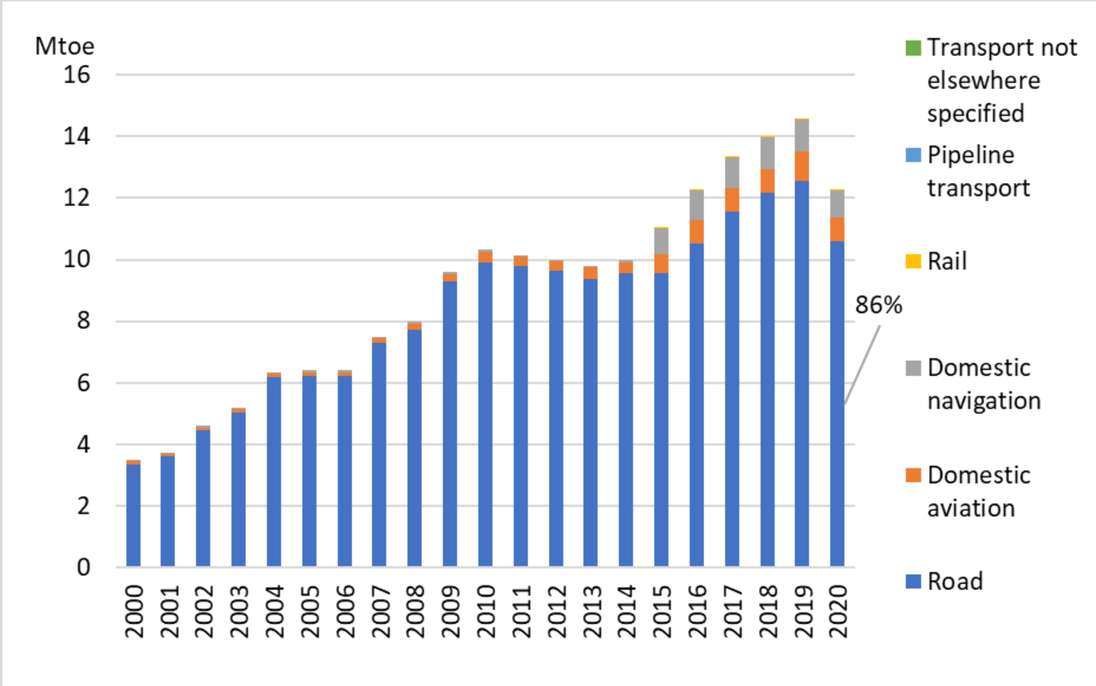
EE&C = energy efficiency and conservation.
Source: IEA (2022) and USGS Cement Statistics and Information https://www.usgs.gov/centers/national-minerals-information-center/cement-statistics-and-information (accessed 23 May 2023).
Note: The dotted line in the graph is an approximate curve.

7) Energy consumption and efficiency in the transport sector

86% of the energy consumption in the transport sector as of 2020 is represented by the road transport (Figure 3.80).

The energy consumption in the road transport sector has continued to rapidly increase over the past 20 years.

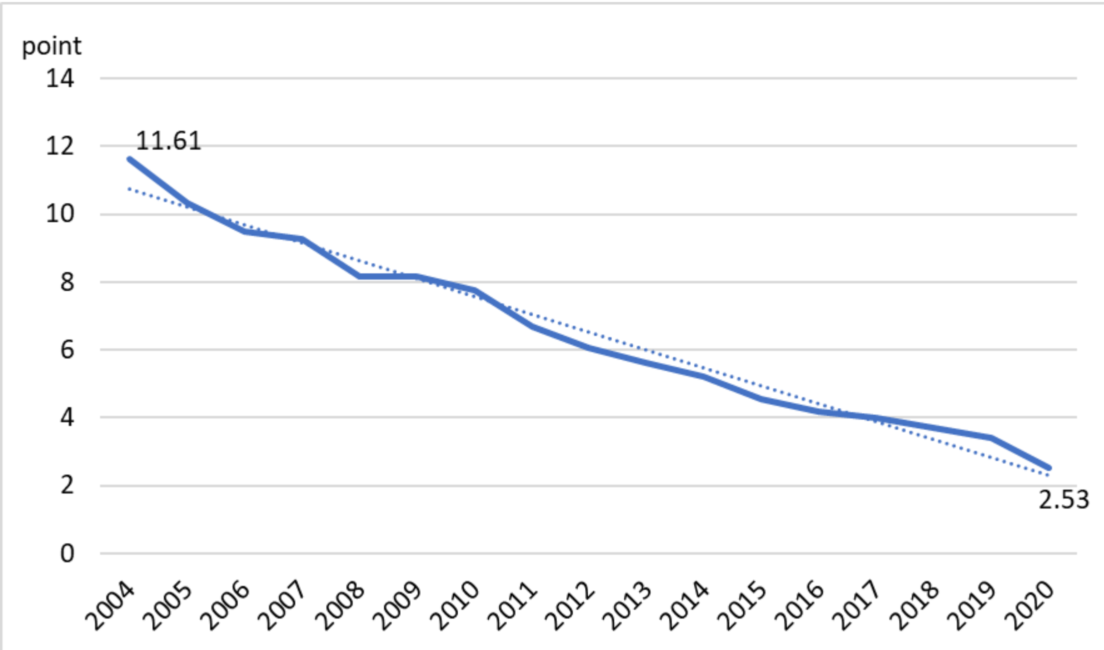
Figure 3.80. Final Energy Consumption Transition by Transport Sector (Viet Nam)



Source: IEA (2022).

Next, we analyse the indicator obtained by dividing final energy consumption in the road transport sector by the number of registered vehicles owned. The indicator of 11.61 in 2000 improved to 2.53 in 2020 (Figure 3.81).

Figure 3.81. EE&C Indicator Transition of Road Transport (Viet Nam)



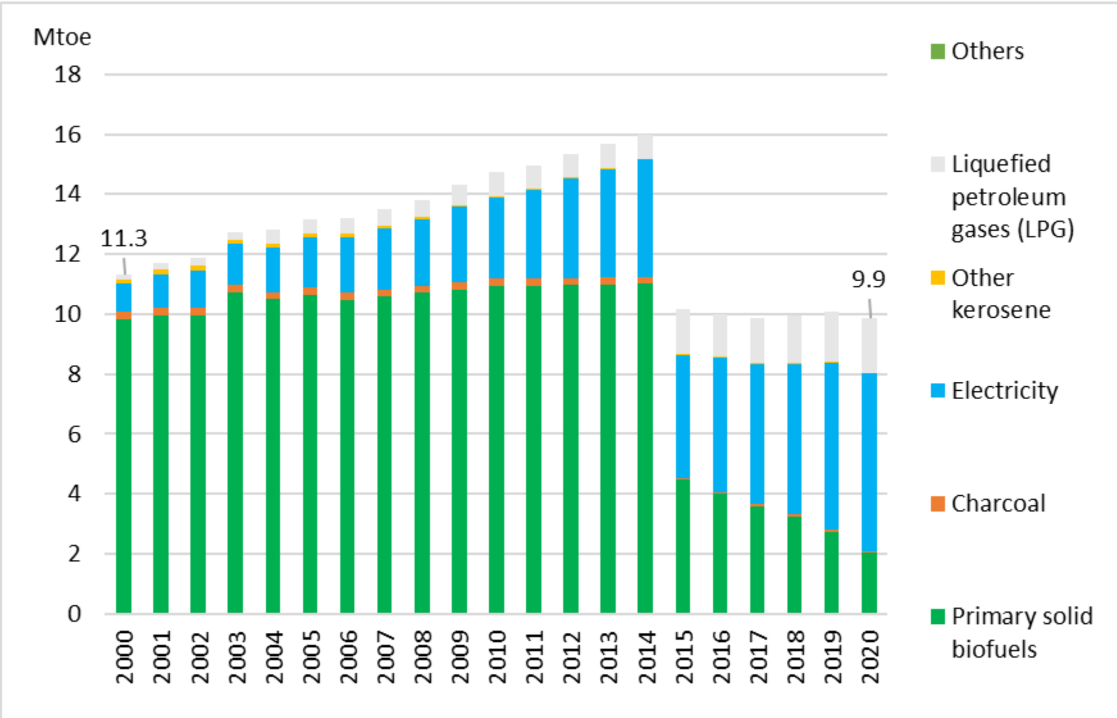
EE&C = energy efficiency and conservation.
Source: IEA (2022) and ASEANStats, https://data.aseanstats.org/ (accessed 4 June 2023).

8) Energy consumption and efficiency in the residential sector

The final energy consumption in the residential sector decreased from 11.3 Mtoe in 2000 to 9.9 Mtoe. However, the consumption of biofuels began to steeply decline in 2015, as shown in the graph. The cause of this is unknown.

An analysis of this breakdown into traditional fuels, such as primary solid biofuels and charcoal, and modern fuels, such as LPG, kerosene, and electricity, shows that the traditional fuels have decreased, but the modern fuels have increased. It is considered that uses of electricity and LPG have increased due to improvement in living standards (Figure 3.82).

Figure 3.82. Final Energy Consumption Transition of Residential Sector (Viet Nam)

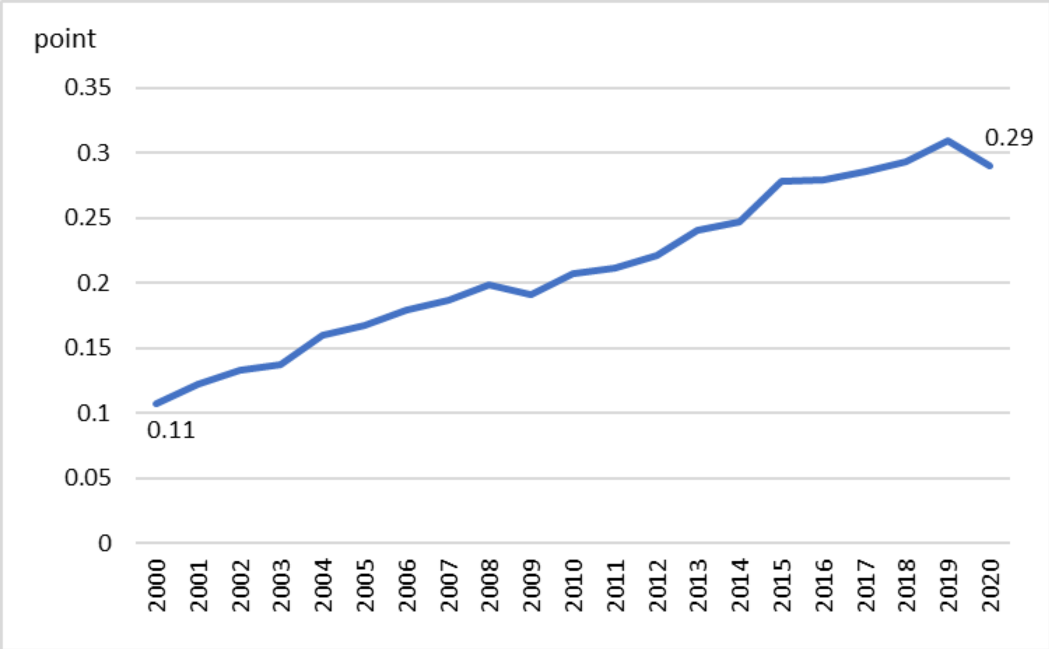


Source: IEA (2022).

Next, we analyse the indicator of final energy consumption of modern energy divided by the number of households. Since statistical data showing the number of households in Viet Nam are not confirmed, a deemed number of households calculated by dividing the population by the average number of people per household is used.

Figure 3.83 shows that the indicator worsens from 0.11 in 2000 to 0.29 in 2022.

Figure 3.83. EE&C Indicator Transition of Residential Sector (Viet Nam)



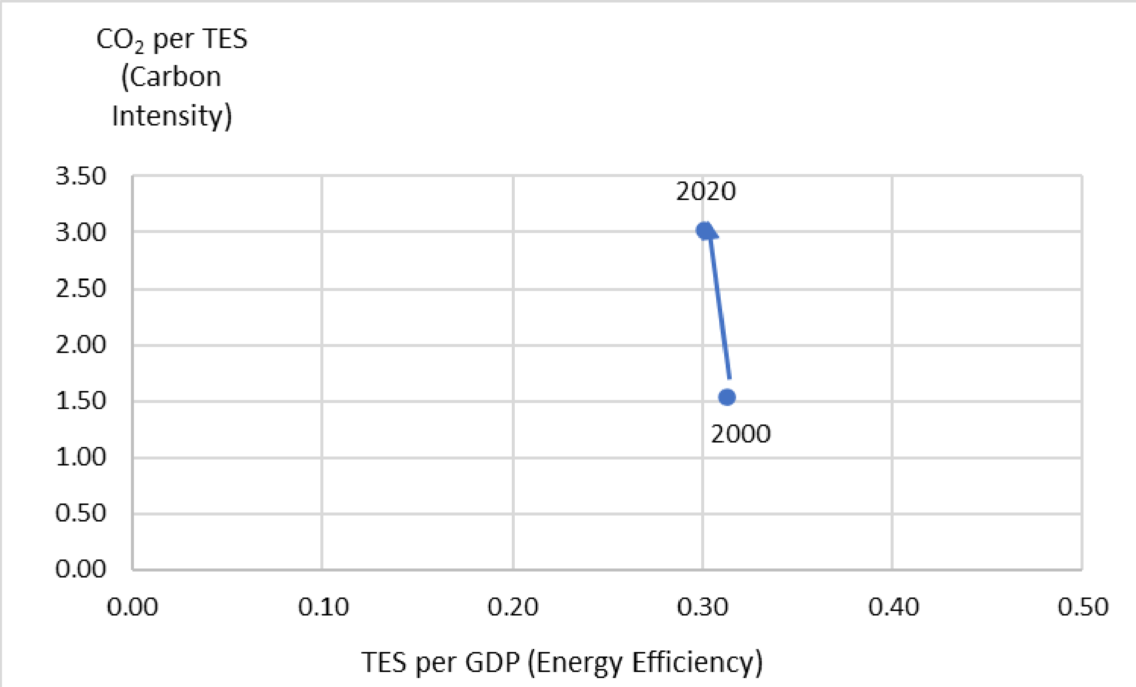
EE&C = energy efficiency and conservation.
Source: IEA (2022) and United Nations.
https://population.un.org/household/#/countries/ (accessed 23 May 2023).

4.2. Indicator of Energy Efficiency

1) Energy efficiency and carbon intensity

As shown in the graph below, TES per GDP, a leading indicator of energy efficiency, changed only slightly over 20 years from 0.31 in 2000 to 0.3 in 2020, indicating that energy conservation has not advanced. On the other hand, CO_2 emissions per TES worsened from 1.54 in 2000 to 3.02 in 2020. In other words, energy conservation has not progressed, and the carbon intensity is deteriorating (Figure 3.84).

Figure 3.84. Energy Efficiency and Carbon Intensity Transition (Viet Nam: 2000–20)



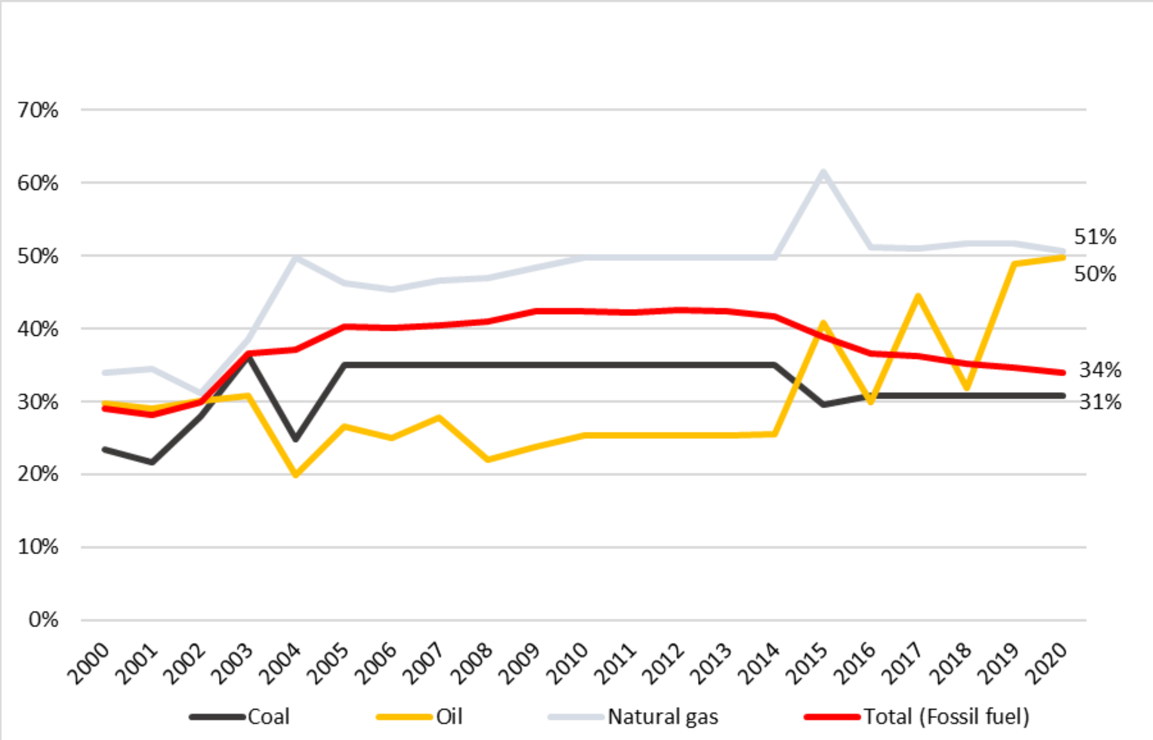
GDP = gross domestic product, TES = total energy supply.
Source: IEA (2022).

2) Power generation efficiency

Over the 20 years, the efficiency of thermal power generation (coal, oil, and natural gas) has generally remained around 38%. As of 2020, the efficiency of thermal power generation (average of coal, oil, and natural gas) is 34%.

The efficiency of coal-fired power generation over the 20-year period generally hovers around 32%, and the efficiency as of 2020 is 31% (Figure 3.85).

Figure 3.85. Thermal Efficiency Transition (Viet Nam:2000–20)



Source: IEA (2022).

4.3. Indicator of CO_2 emissions

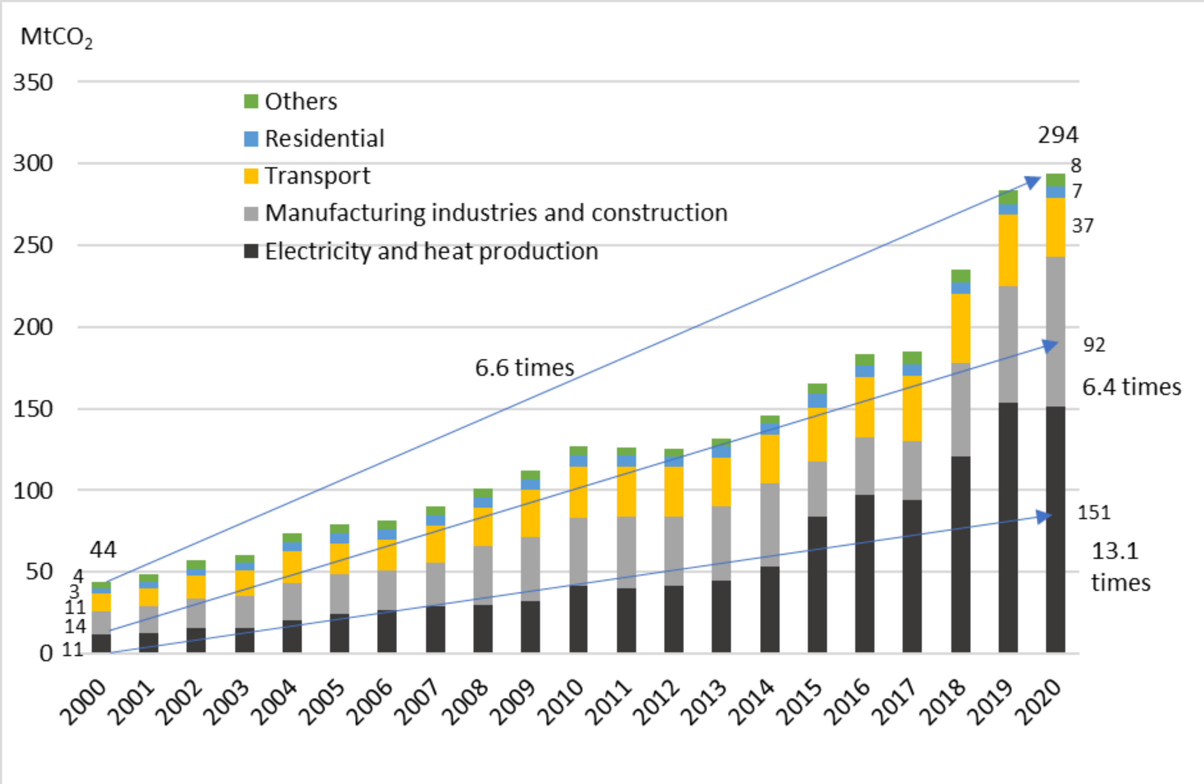
1) Transition in CO_2 emissions by sector

CO_2 emissions increased 6.6 times in 20 years, from 44 $MtCO_2$ in 2000 to 294 $MtCO_2$ in 2020.

CO_2 emissions by sector in 2020 are 151 $MtCO_2$ in the electricity and heat production sector, 92 $MtCO_2$ in the manufacturing industries, 37 $MtCO_2$ in the transport sector, 7 $MtCO_2$ in the residential sector, and 8 $MtCO_2$ in the others.

Comparing CO_2 emissions by sector from 2000 to 2020, we find that the CO_2 emissions in the electricity and heat production sector increased 13.1 times from 11 $MtCO_2$ to 151 $MtCO_2$, that in the manufacturing industries increased 6.4 times from 14 $MtCO_2$ to 92 $MtCO_2$, that in the transport sector increased 3.5 times from 11 $MtCO_2$ to 37 $MtCO_2$, and that in the residential sector doubled from 3 $MtCO_2$ to 7 $MtCO_2$ (Figure 3.86).

Figure 3.86. CO_2 Emissions Transition by Sector (Viet Nam:2000–20)



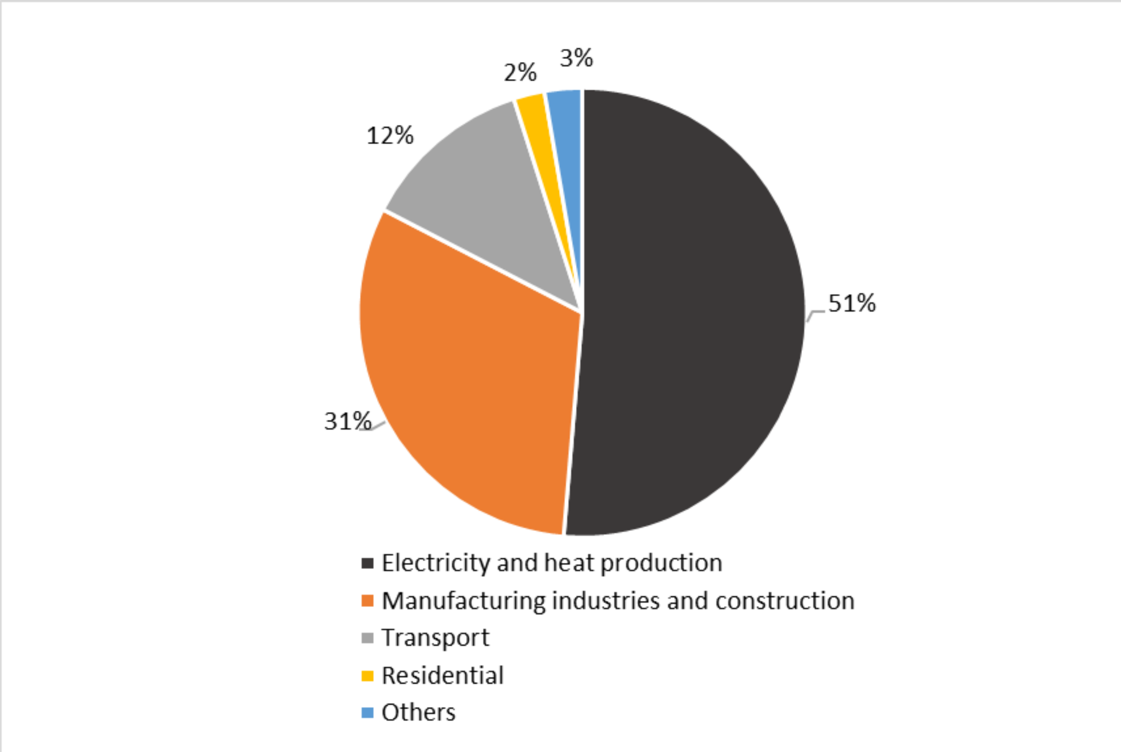
Source: IEA (2022).

Note: Totals may not match due to rounding.

In terms of the share of CO_2 emissions by sector in 2020, the electricity and heat production sector is in first place (51%), followed by the manufacturing industries and construction sector (31%), the transport sector (12%), the residential sector (2%), and others (3%) (Figure 3.87).

In the electricity and heat production sector, the share of power generation from fossil fuels (oil, coal, and natural gas) is high, especially the share of coal-fired power generation (50%). In addition, coal-fired power generation efficiency (31%) is low compared to the OECD average (39%), suggesting that the CO_2 emissions from coal is a major factor for increasing the CO_2 emissions from the electricity and heat production sector.

Figure 3.87. CO_2 Emissions by Sector (Viet Nam: 2020)



Source: IEA (2022).

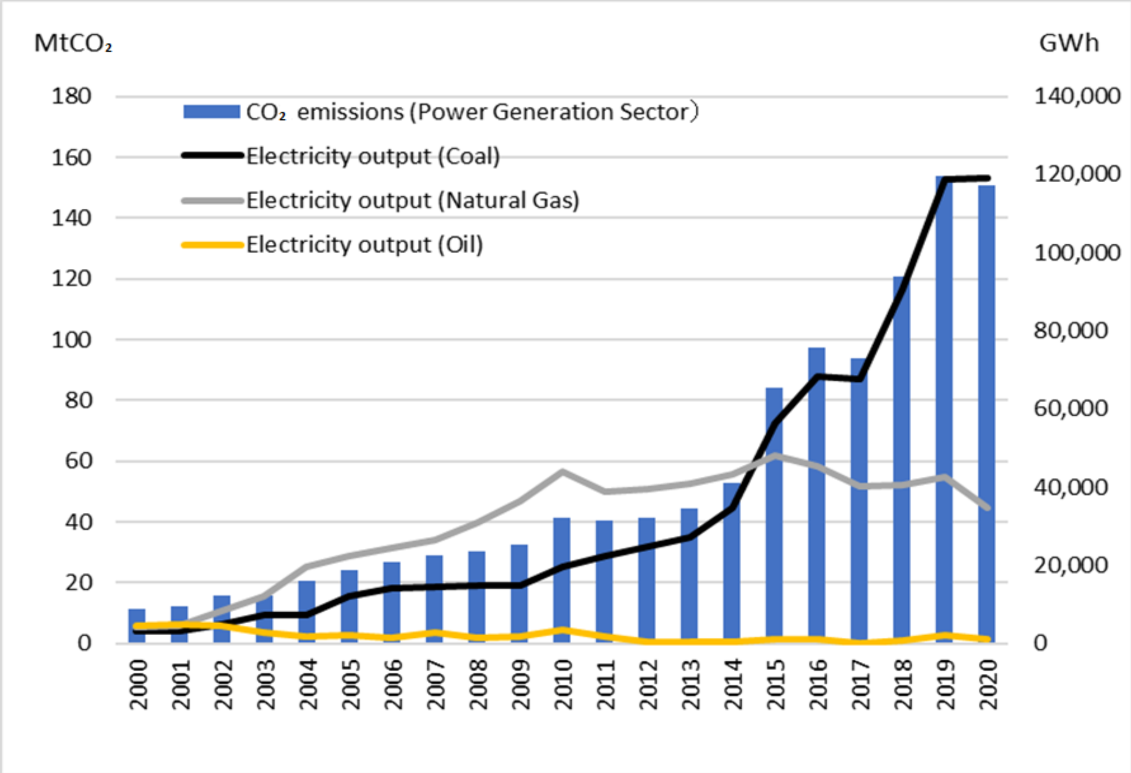
2) CO_2 emissions and coal-fired power generation

We analysed the relationship between the amount of thermal power generation of fossil fuels (oil, coal, and natural gas), which are closely related to CO_2 emissions, and CO_2 emissions from the electricity and heat production sector, in the period of 2000 through 2020.

A graph of CO_2 emissions from the electricity and heat production sector versus oil-, coal-, and natural gas-fired power generation over a 20-year period is shown in Figure 3.88.

The graph indicates a strong correlation between CO_2 emissions and coal-fired power generation in the electricity and heat production sector in Viet Nam.

Figure 3.88. Transition between CO_2 Emissions in Electricity Sector and Coal, Natural Gas, and Oil Electricity Output (Viet Nam: 2000–20)



Source: IEA (2022).

4.4. Summary of Efficiency Metrics

Table 3.4 summarises Viet Nam's energy efficiency indicator.

The difference over the 20 years is that TES per GDP remained unchanged while the EE&C indicator of the iron and steel subsector and that of the residential sector deteriorated. The EE&C indicator of road transport improved significantly. Thermal efficiency (coal-fired) has improved, but efficiency is still low compared to the OECD average.

Table 3.4. Summary of Energy Efficiency Indicator (Viet Nam)

Energy Efficiency Indicator	Viet Nam		
	2000	2020	
TES per GDP	0.31	0.30	Improve
EE&C Indicator of Iron and Steel Sector	0.17	0.39	Worsen
EE&C Indicator of Non-metallic minerals Sector	0.09	0.12	Worsen
EE&C Indicator of Road Transport Sector	11.61	2.53	Improve
EE&C Indicator of Residential Sector	0.11	0.29	Worsen
Thermal Efficiency (Fossil fuel-fired)	0.29	0.34	Improve
Thermal Efficiency (Coal-fired)	0.23	0.31	Improve

EE&C = energy efficiency and conservation, GDP = gross domestic product,
TES = total energy supply.
Source: Author.

4.5. Energy Efficiency Policy

In January 2011, The Law on Energy Efficiency and Conservation (Energy Conservation Law) came into force. The law requires plants and business operators designated for energy management to prepare and submit an energy-conservation annual plan and Five-Year Plan, and report regularly, appoint an energy manager, and conduct an energy audit once every 3 years.

General energy conservation measures in Viet Nam include financial support, labeling systems, formulation of energy conservation plans and establishment of business responsibilities and obligations, designation of 'major energy users' with high annual energy consumption by the Ministry of Commerce and Industry, formulation of annual plans and Five-Year Plans for the rationalisation of energy use, establishment of 'major operations such as energy use' including designation of energy managers, etc. other measures include the obligation to affix energy labels to devices subject to energy labeling, exemption from tariffs on equipment used for energy-saving technology development and energy-related research, and tax incentives to produce energy-saving products.

Industry sector

- Formulation of an annual energy-saving plan
- Introduction of highly energy-efficient equipment
- Implementation of production line maintenance regulations aimed at preventing energy loss, and the use of old technology
- Sequential dismantling of energy-consuming facilities

Commercial and residential sector

- Designing buildings that make use of nature to reduce energy consumption through lighting, ventilation, and air conditioning.
- Prioritising the use of renewable energy and the installation of high efficiency equipment
- The use of natural lighting, ventilation, heat insulation, and energy-saving electrical equipment
- The promotion of restraints on the use of large-capacity facilities during peak hours

Transport sector

- Use LPG, natural gas, electric power, hybrid fuels, and biogas as petroleum substitutes
- Select routes and transportation methods that optimise fuel use
- Develop maintenance and repair regulations from the perspective of fuel reduction
- Introduction, research on fuel-efficient equipment, and introduction of advanced technologies such as the use of alternative fuels such as clean fuels and renewable energy

4.6. CO_2 Emissions Reduction Policy

Viet Nam announced at COP26, which was held in the United Kingdom (UK) in November 2021, that it would aim to achieve carbon neutrality by 2050.

Viet Nam joined a coalition of 190 countries at COP26 that pledged to phase out coal-fired power generation and stop construction of new plants.

Viet Nam revised its NDC in July 2020. In the revised NDC, the GHG reduction target was revised upward to 9%, with domestic self-help efforts by 2030 was set. This is equivalent to a GHG reduction of 83.90 million tonnes. With an international aid added, the reduction rate is 27%, meaning that the country aims at a reduction of 250.80 million tonnes.

Viet Nam will reduce GHG emissions by reducing energy consumption, improving energy efficiency, changing the fuel and energy structure in the industry and transport sectors, promoting renewable energy, and improving cement and chemical production processes.

Specifically, Viet Nam will invest in the renovation of equipment production lines, energy conservation and energy efficiency improvement in public facilities, schools, and hospitals, and promote the shift from conventional fuels to biofuels, natural gas, and electricity. It will also improve the energy efficiency of vehicles.

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Chapter 4

Summary

This chapter summarises and analyses trends common to the four countries studied based on the analysis in the previous chapter and makes sector-specific recommendations.

1. Common Trend

1.1. Energy Efficiency and Carbon Intensity

As shown in Table 4.1, in the 20 years from 2000 to 2020, energy conservation (TES per GDP) progressed in all the four countries studied, but the carbon intensity (CO_2 per GDP) worsened.

Table 4.1. Summary of Energy Efficiency and Carbon Intensity

Indonesia	TES per GDP	CO_2 per TES
2000	0.40	1.64
2020	0.23	2.28
Malaysia	TES per GDP	CO_2 per TES
2000	0.32	2.38
2020	0.27	2.48
Philippines	TES per GDP	CO_2 per TES
2000	0.27	1.71
2020	0.16	2.15
Viet Nam	TES per GDP	CO_2 per TES
2000	0.31	1.54
2020	0.30	3.02

GDP = gross domestic product, TES = total energy supply.
Source: Author.

1.2. Energy Consumption, Energy Efficiency and CO_2 Emissions

Table 4.2 summarises the indicators analysed in Chapter 3. While some indicators improved, some indicators worsened from 2000 to 2020.

We summarise and analyse the common trends in each of the electricity and heat production sector, manufacturing (iron and steel) industries, transport (roads) sector, and residential sector.

1) Electricity sector

The factors behind the worsening of the carbon intensity, despite the progress of energy conservation, include an increase of the coal consumption in TES. From 2000 to 2020, coal consumption increased 5.7 times in Indonesia, 9.4 times in Malaysia, 3.6 times in the Philippines, and 11.6 times in Viet Nam.

The coal-fired electricity generation also increased. From 2000 to 2020, coal-fired electricity generation increased 5.3 times in Indonesia, 11.2 times in Malaysia, 3.5 times in the Philippines, and 38 times in Viet Nam.

Despite that, the efficiency of coal-fired electricity generation is low at 33% in Indonesia, 34% in Malaysia, 32% in the Philippines, and 31% in Viet Nam.

In connection with these circumstances, the CO_2 emissions in the electricity and heat production sector also increased. From 2000 to 2020, the CO_2 emissions in the sector increased 3.6 times in Indonesia, 3.2 times in Malaysia, 3.2 times in the Philippines, and 13.1 times in Viet Nam. Generally, coal is known as having a high CO_2 emissions factor.

Observing from the above, it is considered that the increase of the coal-fired electricity generation in the electricity and heat production sector is related to the increase of the CO_2 emissions in the four countries studied, or to the worsening of the carbon intensity in other words.

2) Iron and steel subsector

In Indonesia and Viet Nam, there is connection between the final energy consumption in the iron and steel subsector and the increase of CO_2 emissions. In addition, steelworks were domestically operating in both countries in the 2010s.

In the 20 years from 2000 to 2020, the final coal energy consumption in this subsector of Indonesia increased 489 times, and the CO_2 emissions in this sector increased 10.7 times.

In the 10 years from 2010 to 2020, the final coal energy consumption in this subsector of Viet Nam increased 15.8 times, and the CO_2 emissions in this sector increased 14.5 times.

Observing from the above, it is considered that the increase in the final energy consumption of coal in the iron and steel subsector in both Indonesia and Viet Nam results in the increase of the CO_2 emissions.

The indicator of EE&C in the iron and steel subsector improved by 0.37 points in the Philippines, but that in Indonesia and Viet Nam worsened, by 0.38 points in 20 years, and by 0.22 points in 10 years, respectively. These figures represent energy consumptions exceeding the crude steel production.

3) Road transport

The final energy consumption in the transport sector increased in 20 years. The consumption increased 2.3 times in Indonesia, 1.9 times in Malaysia, 1.2 times in the Philippines, and 3.5 times in Viet Nam. The road sector accounts for a large portion of the final energy consumption in the transport sector. In the Philippines, where data on the number of vehicles owned are available, the CO_2 emissions, as well as the number of vehicles owned, increased. The energy source of almost all automobiles is fossil fuels. With the progress of motorisation, the number of vehicles owned increased, resulting in an increase of CO_2 emissions in the road transport sector. The country's situation, where vehicles using fossil fuels represent a major portion of the total, while next-generation automobiles such as electric vehicles account for only a small percentage, is understood to be similar to situations of the other studied counties.

4) Residential sector

The final energy consumption in the residential sector in 20 years decreased in Indonesia and Viet Nam and increased in Malaysia and the Philippines.

In Indonesia, traditional energies began to significantly decline around 2010, while modern energies increased. The GDP per capita of Indonesia increased from $1,839 in 2000 to $3,758 in 2020. That of Viet Nam increased from $1,148 in 2000 to $3,318 in 2020. It is considered that, in both countries, electrification has progressed with improvement of living standards, and the number of home appliances used has increased. It is also considered that means of cooking and hot-water supply have been converted from biomass and charcoal to LPG.

In Malaysia, since around 2000, the percentage of traditional energies used has been very small, while the consumption of electricity has continued to increase. The GDP per capita of Malaysia increased from $6,414 in 2000 to $10,620 in 2020. Electrification had already progressed in 2000; therefore, it is considered that even more home appliances have been used with improvement of living standards.

In the Philippines, the consumption of traditional energies has not declined and remained flat, but that of modern energies, electricity, has increased. The GDP per capita of the Philippines increased from $1,831 in 2000 to $3,269 in 2020. It is expected that the consumption of modern energies, mainly electricity and LPG, will continue to increase in the future.

The EE&C indicator of the residential sector of the Philippines has remained unchanged. That of Indonesia improved until 2010, but has been on an upward trend in recent years. That of Malaysia and Viet Nam has continued to increase.

The populations of the four countries have all increased. In addition, the number of households has increased, and the number of home appliances has increased faster than the growth of the population and the number of households. It is considered that the final energy consumption has also increased.

Table 4.2. Summary of Indicator Transition (2000 vs 2020)

Items		Unit	20 Years Transition (2000～2020)			
			Indonesia	Malaysia	Philippines	Viet Nam
Energy Consumption Index	Population	Times	1.3	1.4	1.4	1.2
	GDP	Times	2.6	2.3	2.5	3.5
	GDP per Capita	Times	2.0	1.7	1.8	2.9
	TES	Times	1.5	1.9	1.5	3.4
	of which, amount of fossil fuel	Times	1.8	1.9	1.8	6.2
	of which, fossil fuel dependency	%	11 ↑	0	11 ↑	39 ↑
	of which, coal	Times	5.7	9.4	3.6	11.6
	Electricity Output	Times	3.1	2.6	2.2	9.0
	of which, coal-fire electricity output	Times	5.3	11.2	3.5	38.0
	Final Energy Consumption	Times	1.3	2.1	1.4	2.7
	of which, final energy consumption (Industry)	Times	1.9	1.6	1.4	4.6
	of which, final energy consumption (Iron and Steel)	Times	10.0	NA	1.5	*10.0
	of which, final energy consumption (Non-metallic minerals)	Times	43.0	NA	0.0	*2.5
	of which, final energy consumption (Transport)	Times	2.3	1.9	1.2	3.5
	of which, final energy consumption (Residential)	Times	0.6	1.7	1.3	0.8
	Final energy consumption of Coal by Iron and Steel Sector	Times	489.0	NA	NA	15.8
Energy Efficiency Index	TES per GDP	Point	0.17 ↓	0.05 ↓	0.11 ↓	0.01 ↓
	CO_2 per TES	Point	0.64 ↑	0.1 ↑	0.44 ↑	1.48 ↑
	EE&C Indicator of Iron and Steel Sector	Point	0.38 ↑	NA	0.37 ↓	*0.22 ↑
	EE&C Indicator of Non-metallic minerals Sector	Point	0.04 ↓	NA	NA	*0.03 ↑
	EE&C Indicator of Road Sector	Point	0.35 ↓	0.34↓	1.00 ↓	9.08 ↓
	EE&C Indicator of Residential Sector	Point	0.03 ↑	0.15 ↑	0	0.18 ↑
	Thermal Efficiency fossil fuel-fired	Point	0.03 ↓	0	0.01 ↓	0.05 ↑
	Thermal Efficiency coal-fired	Point	0.02 ↓	0.1 ↓	0.06 ↓	0.08 ↑
CO_2 Emission Index	CO_2 Emission	Times	2.1	2.0	1.9	6.6
	of which, CO_2 emission by Electricity and Heat Production sector	Times	3.6	3.2	3.2	13.1
	CO_2 emission by Iron and steel sector	Times	10.7	NA	1.3	*14.5

EE&C = energy efficiency and conservation, GDP = gross domestic product, TES = total energy supply.
Source: Author.
*Data duration is from 2010 to 2020

1.3. Energy Efficiency and CO_2 Emissions Reduction Policy

1) Carbon neutrality declaration

As shown in Table 4.3, Indonesia declared carbon neutrality in 2060, while Malaysia and Viet Nam declared carbon neutrality in 2050. The Philippines has not declared carbon neutrality.

Table 4.3. Summary of Climate Change Policies

Selected Countries	CN Target Year	2030 GHG Emissions Reduction Target (NDC)				Coal Fired Plant Phase out
		Type of Reduction Target	Target Unconditional	Target Conditional*1	Base Year	
Indonesia	2060	Emissions	29%	41%	BAU	YES*2
Malaysia	2050	Carbon Intensity	45%	NA	2005	YES*2
Philippines	NA	Emissions	2.71%	75%	BAU	YES*2
Viet Nam	2050	Emissions	9%	27%	BAU	YES

BAU = business as usual, GHG = greenhouse gas, NDC = nationally determined contribution.
Source: Author.
*1 ：Conditional targets depend on the availability of international financial support, technical assistance and human resource development.
*2 ：New plants will not be approved.

2) Coal-fired plant phase out and suspension of new coal-fired power construction

Additionally, as shown in Table 4.3, policies common amongst the countries include phase out from coal-fired power generation and halt of the construction of new coal-fired power plants.

PLN will not build any new coal-fired power plants in the future and will phase them out by 2056. Further, Indonesia disclosed its policy for announcing a roadmap toward early shutdown of coal-fired power plants on 16 August 2023. The roadmap will be developed within a framework of the Just Energy Transition Partnership (JETP), which was established under the initiative of Japan and the US as a policy for providing support for transition from coal-fired power generation to renewable energies. JETP is a framework that G7 established in 2022 with the aim of supporting emerging and developing countries for their decarbonisation. Indonesian JETP was announced to coincide with the G20 Summit, which was held in Bali in November 2022, and a group of 10 nations/regions, led by Japan and the US, will release $20 billion publicly and privately in the next 3 years.

Malaysia and the Philippines decided to halt the approval of new coal-fired power plant projects.

Viet Nam pledged at COP26 to abolish coal-fired power generation in stages by 2040.

3) Energy efficiency policy

Indonesia has set a goal of reducing energy intensity by 1% every year from 2014 to 2025.

NEEAP 2016–25 of Malaysia promotes energy audits of buildings and energy-efficient building design (green building), and the country plans to reduce the electricity demand growth by 8% from 2016 to 2025.

In the Philippines, the EEC Act came into effect in May 2019. The Act requires submission of an annual energy consumption report, and an energy audit report will be submitted. In addition, the Philippines utilises consulting on energy conservation using ESCOs.

In Viet Nam, a Law on Energy Efficiency and Conservation (Energy Conservation Law) came into force in January 2011. Plants and business operators designated for energy management are required to prepare and submit an annual plan for energy conservation, A Five-Year Plan, and report regularly, appoint an energy manager, and conduct an energy audit once every 3 years (Table 4.4).

Table 4.4. Summary of Energy Efficiency Policy

Country	Policy
Indonesia	To reduce energy elasticity to less than 1 by 2025 and to reduce the intensity of final energy by 1% per annum until 2025.
Malaysia	Reduce electricity demand growth by 8% from 2016 to 2025. Also, promotion of green building.
Philippines	Annual Energy Consumption Report, Energy Audit Report, ESCOs
Viet Nam	National energy conservation target is set for 2006–2010 as 3%–5%, and for 2010–2015 as 5%–8%. Annual plan, Five-Year Plan, preparation, and submission of regular reports on energy conservation, appointment of energy manager, energy audit once every 3 years.

Source: Author.

2. Proposal

2.1. Electricity Sector

The electricity and heat production sector accounts for the largest share of CO_2 emissions in all the four countries studied. The issues of the electricity and heat production sector is the fact that an increase of the coal-fired power generation has led to an increase of the CO_2 emissions.

Policies common amongst the four countries include phase-out of coal-fired power generation and halt of the construction of new coal-fired power plants. On the other hand, coal-fired electricity generation, which is inefficient, has increased; the CO_2 emissions resulting from the increase have also increased, implying that the countries have a dilemma where even though energy conservation progresses, the carbon intensity worsens.

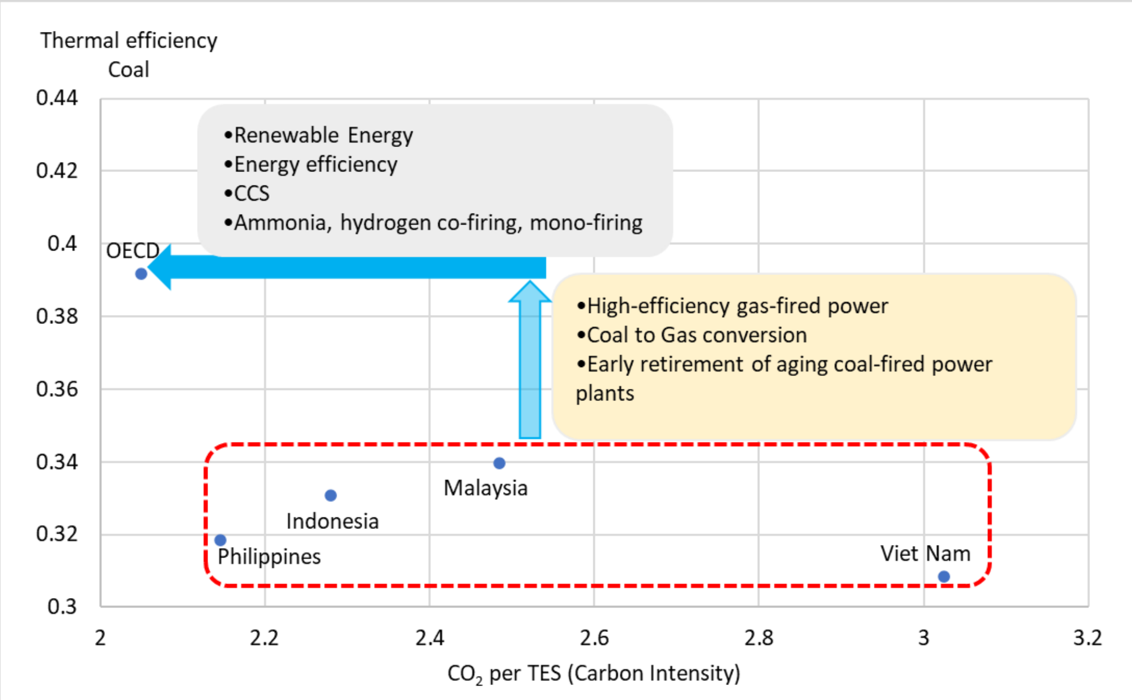
Figure 4.1 shows a matrix in which the horizontal axis represents the carbon intensity, and the vertical axis the efficiency of coal-fired electricity generation. The four countries have higher carbon intensities and lower efficiency of coal-fired electricity generation than OECD countries.

Possible means to raise the level to the OECD level may be divided into measures to increase the power generation efficiency and measures to improve the carbon intensity.

Measures to increase the power generation efficiency include: (a) early retirement of aging coal-fired power plants, and (b) high-efficiency gas-fired power generation.

Measures to improve the carbon intensity include: (c) ammonia, hydrogen co-firing, or mono-firing, and (d) introduction of CCS or renewable energies.

Figure 4.1. Improvement of Power Generation Efficiency and Carbon Intensity



TES = total energy supply, OECD = Organisation for Economic Co-operation and Development.
Source: Author.

Examples can provide international cooperation in coping with these issues include the following four cases.

A) ADB's Energy Transition Mechanism (ETM)

B) Efficiency improvement of coal-fired power generation and conversion to gas

C) Ammonia co-firing

D) CCS demonstration

A) ETM of ADB

ETM is a joint initiative with developing countries to accelerate the transition from fossil fuels to clean energy. Public-private investments from governments, multilateral banks, private investors, and others will fund country-specific ETM funds to phase out coal-fired power early. Under the ETM, ADB signed a memorandum of understanding with PT PLN, Indonesia's state-owned power company, to consider early retirement of Indonesia's Cirebon coal-fired power plant.

B) Efficiency improvement of coal-fired power and conversion to gas-fired plant

Improvement of the efficiency of coal-fired electricity generation requires equipment replacement as it relates to aging. From the aspects of power generation efficiency improvement and carbon intensity reduction, it is important to pursue not only the existing 'Ultra Super Critical' technology for pulverised coal firing, but also the development of new coal-gas firing technologies (Integrated Coal Gasification Combined Cycle, and Integrated Coal Gasification Fuel Cell Combined Cycle).

The CO_2 emissions by combustion of natural gas is less than half that of coal, and natural gas-fired power generation is generally more efficient than coal-fired power generation. Therefore, on the road to carbon neutrality, natural gas can play a transitional binder role until low-carbon technologies such as renewable energy and CCS are introduced on a large scale. Natural gas has the potential to be replaced by non-fossil fuels such as hydrogen in the future. For natural gas-producing countries such as Indonesia and Malaysia, infrastructure development costs such as tanks and piping to power generation facilities can be kept relatively low.

The share of renewable energy in the TES of the four studied countries is currently extremely small, so it is assumed that it will take some time for renewable energy to spread. To catch up with vigorous energy demand, switching to natural gas-fired power can be a highly effective measure.

C) Green/ Blue Ammonia co-firing

The biggest advantage of green/blue ammonia as a fuel is that it is carbon-free. Ammonia does not emit CO_2 when combusted. Ammonia also has the advantage of being easy to transport and inexpensive. The disadvantage of ammonia is that nitrogen oxides are generated during combustion.

When ammonia is co-firing in a boiler for thermal power generation, it can be handled simply by changing the burner. In the case of ammonia co-firing, new equipment and initial investment can be minimised, and there is no need to decommission a thermal power plant. Many of the coal-fired power plants in the four studied countries are relatively new, and this is an effective means of avoiding stranded assets without decommissioning them.

The following are examples of ammonia co-firing demonstrations.

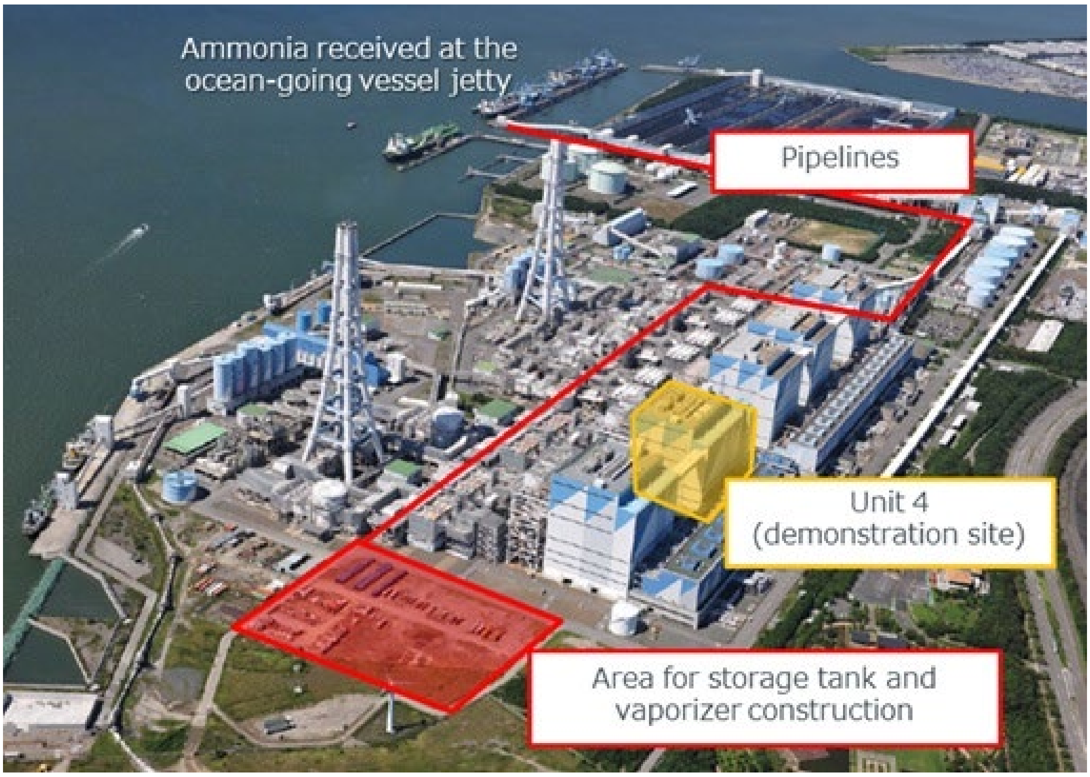
In 2021, JERA power generation company in Japan commenced a demonstration of small-scale coal-ammonia co-firing in collaboration with IHI in Hekinan, Aichi Prefecture, Japan (Figure 4.2). JERA will also commence large-scale fuel ammonia co-firing (heat volume ratio: 20%) in fiscal 2023, a year ahead of schedule (Figure 4.3). In addition, JERA plans to achieve a percentage of ammonia in co-firing at 50% in/after 2030, and 100% ammonia only in/after 2035.

Advantages of ammonia include the fact that existing technology and equipment can be used. Ammonia co-firing can be achieved by slightly improving the burner in the boiler. Although a tank for storing ammonia and a pipeline would separately be required, it would be almost unnecessary to alter any other power generation facilities or the transmission line.

Many of the coal-fired power plants in the four countries studied went on stream relatively recently. Ammonia co-firing can serve as an effective means to advance decarbonisation at low cost and speedily by utilising such existing equipment.

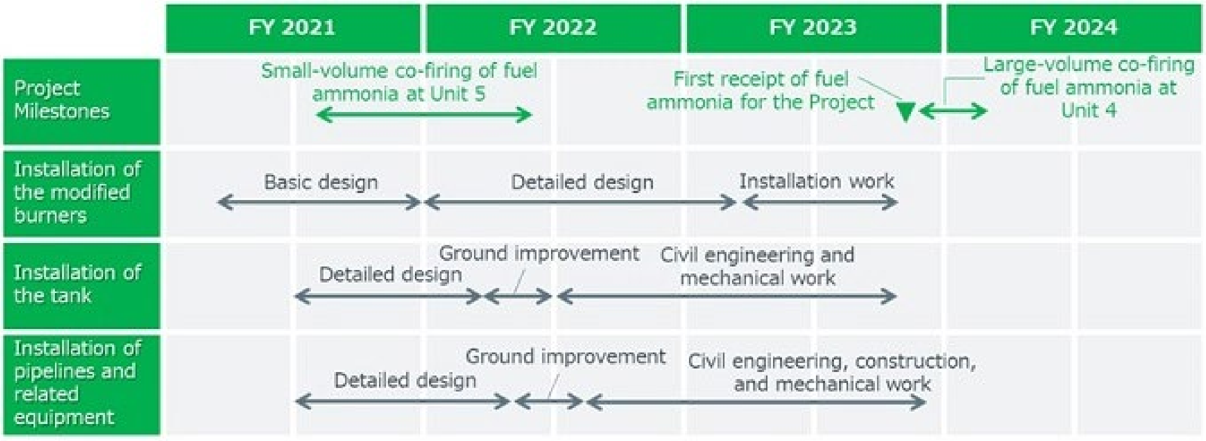
Although it faces challenges in supply chain building, such as joint procurement of ammonia, development of large ammonia carriers, and construction of a safe transport structure, the ammonia co-firing approach is a realistic measure to prevent the existing equipment from becoming a stranded asset.

Figure 4.2. Project Site at the Hekinan Thermal Power Station (Hekinan City, Aichi Prefecture, Japan)



Source: JERA Press Release, 31 May 2022.
https://www.jera.co.jp/en/news/information/20220531_917 (accessed 11 May 2023).

Figure 4.3. Project Schedule at Hekinan



Source: JERA Press Release, 31 May 2022.

Biomass is another co-firing material besides ammonia. Biomass can be co-combusted with coal-fired power and has advantages such as virtually zero CO_2 emissions and the ability to utilise existing facilities. It is a method of generating electricity by combusting and gasifying biological resources such as wood, and the principle is the same as thermal power generation and ammonia power generation. CO_2 is emitted when it is combusted, but biomass fuel absorbs CO_2 during the growth process, so when viewed as a whole, it does not increase the amount of CO_2 in the atmosphere. Since it is not affected by the weather, it can also serve as a backup power source for renewable energy power generation. The four countries studied are rich in biomass resources. Co-firing wood chips, palm stalks, wood pellets, etc. is a practical and fast-acting method.

D) CCS demonstration

The advantage of CCS is that it can significantly reduce CO_2. It is possible to recycle CO_2. CO_2 from the atmosphere can also be captured and stored. Disadvantages include cost reduction at each stage of CO_2 separation, capture, transportation, and storage, construction of a CO_2 value chain, and development of laws.

CCS can be introduced in any field that emits large amounts of CO_2, such as thermal power generation, steel plants, cement production, and waste incineration. The potential for CCS in the four countries studied is high because there are many oil and gas fields.

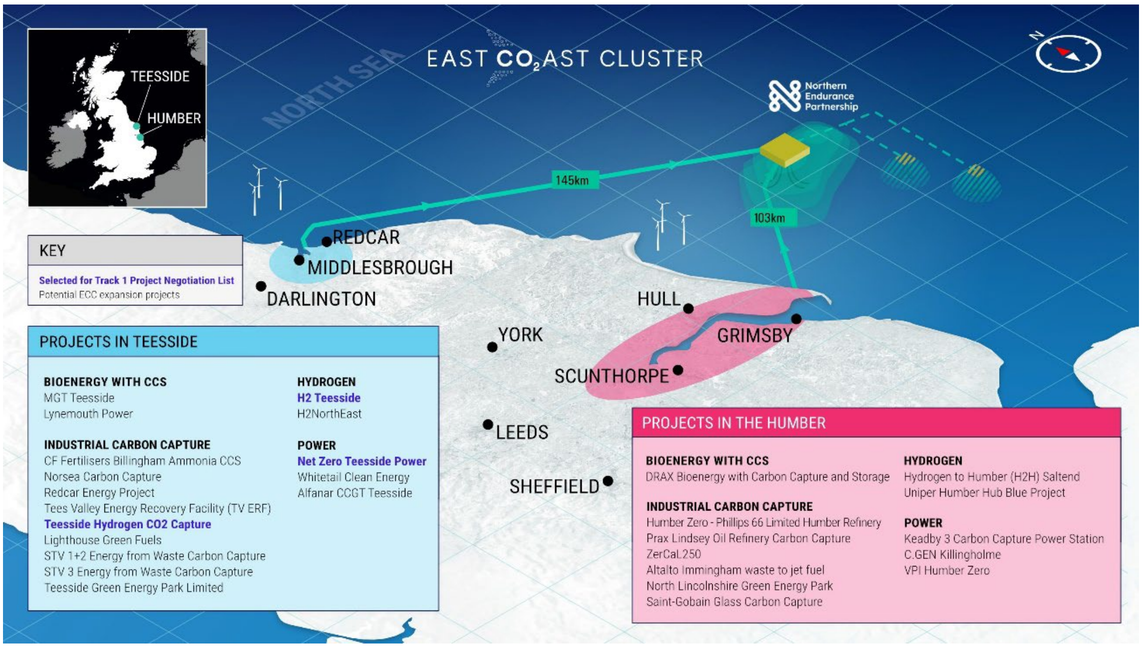
CO_2 is relatively easy to liquefy under high pressure and can be transported. As of September 2022, there are 196 CCS projects in the world. The issue of CCS is the cost, but it is expected that this will be resolved as the number of CCS projects increases and commercialisation progresses.

Regarding CCS, in the US, the Inflation Reduction Act tax credit, which was enacted in 2022, has been expanded to $85 per tonne of CO_2 storage. In Europe, oil- and gas-producing countries along the North Sea (the UK, Norway, and the Netherlands) are taking the lead in promoting CCS. The UK has set a target of 10 million tonnes per year by 2030.

● UK CCS case study: – East Coast Cluster

The East Coast Cluster is a CCS project in an industrial cluster in the eastern part of the UK (Teesside, Humber). The project cuts 50% of its CO_2 emissions for UK industrial clusters. Joint transportation and storage businesses include Net Zero Teesside and Zero Carbon Humber. BP, Eni, Equinor, National Grid, Shell and TotalEnergies set up a storage entity, i.e. the Northern Endurance Partnership (NEP), developing an aquifer in the southern North Sea as a storage site. Planned annual average collection amount is 23Mt/year in 2035. The project is scheduled to start operation in 2027 (Figure 4.4).

Figure 4.4. East Coast Cluster



Source: East coast cluster, https://eastcoastcluster.co.uk/ (accessed 4 June 2023).

● Canada CCS case study: – Quest CCS

Quest CCS in Alberta, Canada started operation in 2015 and captured 7 million tonnes of CO_2 in 7 years until 2022. Quest CCS will capture approximately 1 million tonnes of CO_2 annually from oil sands operations and store the CO_2 in sandstone reservoirs at depths of more than 2 km underground. Quest CCS is the world's first commercial-scale CCS facility applied to an oil sands business. The Quest CCS facility is operated by Shell Canada on behalf of the Athabasca Oil Sands Project. The respective ownership interests of the Project's assets in aggregate, directly and indirectly, are 70% Canadian Natural Resources Limited and an affiliate, 20% Chevron Canada Limited, and 10% Shell Canada Limited through certain subsidiaries (Figure 4.5).

Figure 4.5. Quest Carbon Capture and Storage

Source: Shell Canada Quest Carbon Capture and Storage, https://www.shell.ca/en_ca/about-us/projects-and-sites/quest-carbon-capture-and-storage-project.html (accessed 4 June 2023).

2.2. Iron and Steel Sector

In Indonesia and Viet Nam, the industry sector represents the second-largest CO_2 emissions source behind the electricity and heat production sector. Amongst the industry subsectors, iron and steel shows an especially high increase in coal consumption, and in line with it, the CO_2 emissions are also increasing. This is a result of the industrial policy.

The iron and steel subsector is one of the subsectors facing difficulty in reducing the carbon intensity. To improve the carbon intensity and achieve carbon neutrality in the iron and steel subsector, parallel efforts such as hydrogen reduction using the blast furnace method, expansion of the electric furnace method, and adoption of the direct hydrogen reduction technology would be required.

2.3. Road Transport

In Malaysia and the Philippines, the transport sector's share in CO_2 emissions is the second largest after the electricity and heat production sector. Especially, the CO_2 emissions in the road transport sector account for a large percentage.

As one of the measures to reduce CO_2 emissions in the road transport sector, a shift from vehicles using fossil fuels such as gasoline and diesel oil to next-generation automobiles such as electric vehicles is drawing attention. However, the penetration rate of electric vehicles is currently low in most countries. For example, in the Philippines, of approximately 11.80 million registered cars owned as of 2020, approximately 9.30 million cars are gasoline-powered, and approximately 2.48 million cars are diesel-powered. By contrast, the number of electric vehicles is only 464 (Table 4.5).

Table 4.5. Number of Motor Vehicles Registered by Type and Fuel Used (Philippines)

Year	Grand Total*						
	Gas	Diesel	Compressed Natural Gas (CNG)	Liquified Petroleum Gas (LPG)	Light Electric Vehicles (LEV)	Others	Total
2020	9,312,619	2,478,156	349	34	464	3	11,791,625

Source: Land Transportation Office, Philippines.

As analysed in Chapter 3, the four studied countries have a coal-fired power generation share of more than 50%. It is necessary to consider the popularisation of electric vehicles and the decarbonisation of power sources as a set. If the fuel mix for power generation is mainly fossil fuels, especially if the ratio of coal is high, even if there are no GHG emissions during electric vehicle driving, it will emit GHGs during power generation. Therefore, it is necessary to shift to clean power sources such as renewable energy. Decarbonisation of the road transport is closely linked to decarbonisation of the power generation sector.

In addition, there are two types of decarbonisation regulations for automobiles: regulations on fuel economy and promotion of lower emissions vehicle. The government can impose more stringent standards on fuel economy of new car sales to reduce oil consumption and resulting CO_2 emissions. The latter is to promote the dissemination of new types of vehicles including hybrid vehicles, plug-in hybrid vehicles, and battery electric vehicles that have lower carbon footprints. Supply of these new vehicles are now rapidly growing in the world and ASEAN member countries can enjoy environmental benefits attained by such technologies. In addition, biofuel may be another choice for those countries where supply can be anticipated.

To comprehensively decarbonise road transport, not only the decarbonisation of vehicles, but also the reduction of GHG emissions due to traffic congestion and the improvement of inefficient transportation (single-seat passenger cars), are issues. It is also important to develop urban infrastructure and transform society, such as expanding public transportation, improving road networks, and reducing travel needs due to closer proximity to work and home.

Electrification of automobiles into, for example, electric vehicles not only serve as an environmental and energy measure, but also is intended to create next-generation industries. The electrification aims for decarbonisation where GHG emissions are reduced to net zero through electric vehicle penetration and have the implication of promoting the production of automobiles centering on electric vehicles, the attraction of investments in related parts, and the development of industries. In particular, Indonesia aims at becoming an electric vehicle hub within the ASEAN region and is pursuing electrification and zero-emissions in automobile production.

2.4. Residential Sector

As for the residential sector, while traditional fuels are decreasing, modern energies such as electricity and LPG are increasing, in Indonesia and Viet Nam. Electricity consumption is increasing also in Malaysia and the Philippines.

Energies used at residences are mainly for electricity by appliances such as lightings, air conditioners, TVs and refrigerators, and heat consumptions in hot-water supply and cooking.

As for lighting, energy conservation measures include replacement to light-emitting diode lights, use of illuminance sensors, and replacement of lighting fixtures with controllable illuminance.

For air conditioning, energy conservation measures may include replacement to energy-saving air conditioners, and cleaning of filters. However, top priority should be given to the improvement of the insulation and airtightness performance of residence windows. With residences having good window insulation and airtightness, the air cooled by air conditioning is hard to leak, the air conditioner’s cooling temperature can be set higher, number of air conditioners would be reduced and the operating time is shorter. Institutionalising the display of the energy conservation performance of residences is important also from the viewpoint of forming a stock of high-quality residences. In addition, if a photovoltaic generation system is installed in a residence with high window insulation and airtightness performance, the cool air will be effectively used without leakage.

As for home appliances, it is important to indicate their performance in a manner easy-to-understand for consumers, such as 5-Star Rated Alliances of Malaysia.

The Vauban district (population of about 5,500) in the city of Freiburg (population of about 200,000) in southwestern Germany is an example of the comprehensive development and transformation of the transport and residential sectors. The Vauban district is a natural recycling eco-city completed in 2007. The Vauban district has realised greening, district heating, energy-saving housing, and carport-free (parking lots cannot be built in subdivisions). Specifically, trees that are 1 metre above the ground and have a trunk circumference of more than 80 centimetres cannot be felled. Rooftop greening is obligatory on flat roofs with an angle of 10 degrees or less, and light rail transit tracks are also greened to reduce the heat island effect and reduce the burden of sewage treatment due to rainwater seepage. Heat is supplied to the district using a cogeneration system as an energy source. Buildings also use roofs, walls, and glass with high thermal insulation performance, which reduces energy loss. The collective housing shares a boundary wall, making it difficult for heat to escape from the wall surface. Passive construction, energy-plus construction and the use of solar technology are standard. Private cars are parked in several multi-storey car parks in the district and then walked or cycled to their homes. The Vauban district and the center of Freiburg are connected in about 15 minutes by light rail or bus (Figure 4.6).

It is thought that urban development that integrates the design of transportation and housing infrastructure can be realised in an environment suitable for each country even in the studied countries.

Figure 4.6. Vauban, Freiburg, Germany

Source: Freiburg city HP Quartier Vauban,
https://visit.freiburg.de/en/attractions/quartier-vauban (accessed 6 June 2023).

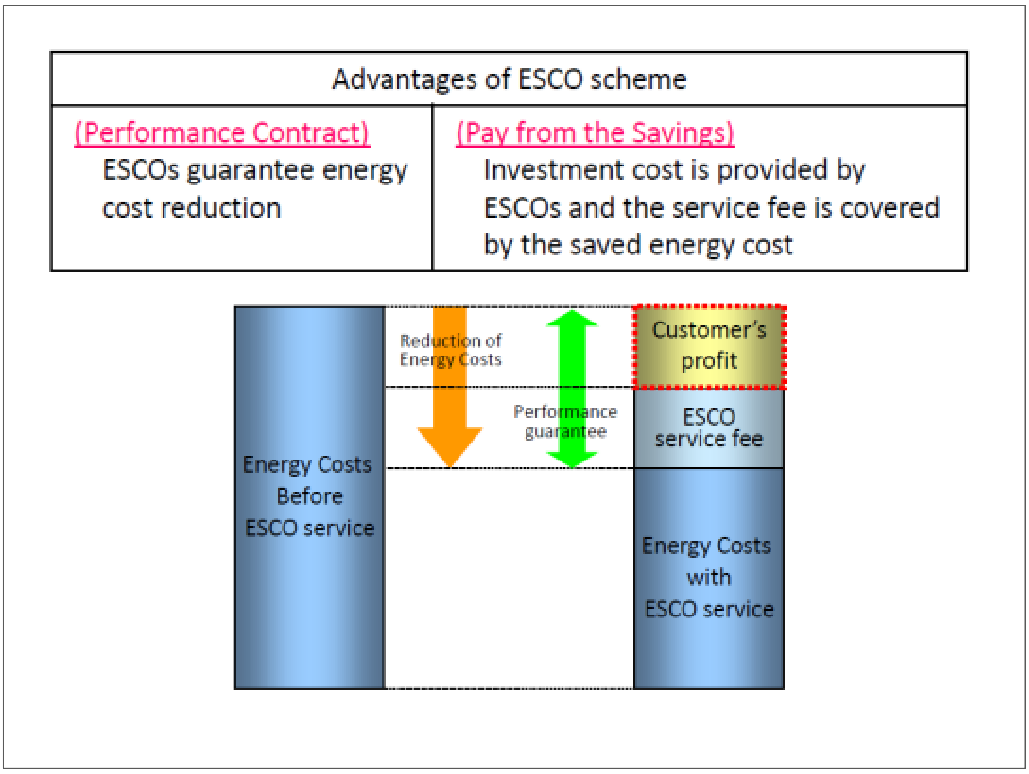
2.5. Energy Efficiency Policy

1) ESCOs

In the Philippines, an ESCO service was effective in power saving through energy conservation consulting. The ESCO service is a project intended to secure all investments and customer benefits with the reduction of utility costs achieved through energy-conserving renovation works, and provides comprehensive services including energy conservation diagnosis, design, execution, operation, management, and funding. The service is characterised by a 'Performance Agreement,' under which the energy conservation effect is guaranteed by the ESCO business operator, and if no effect is obtained, the ESCO business operator will make repayment (Figure 4.6).

The energy conservation consulting service with ESCO will be also effective for countries where energy consumptions are expected to increase in the future, such as Cambodia and the Lao People's Democratic Republic, though they are not amongst the countries studied for this report.

Figure 4.7. ESCO Scheme



ESCO = energy services company.
Source: Japan Association of Energy Service Companies

2) Energy Audit

The energy conservation measures common amongst the four countries include an energy audit. An energy audit is a policy instrument that is adopted in many countries and regions with the aim of improving the energy consumption efficiency of the audited facility/equipment and reducing the GHG emissions. In addition, an energy audit contributes to improving the energy efficiency.

ISO 50001 (energy management system) would help achieve systematic energy management, and support energy conservation and decarbonisation activities. It can also be utilised for the improvement of energy performance in energy conservation, etc., and medium- to long-term energy strategies aimed for CO_2 emissions reduction, etc. The ISO 50001 standard has focused on the improvement of energy performance since its issuance and enables the visualisation of energy performance in energy consumption intensity, energy efficiency, energy consumption (total amount), and energy-derived CO_2 emissions, etc., and the conduct of an analysis using data as an energy review.

2.6. International Cooperation

Representative examples of international cooperation with the countries studied include Asia Zero Emission Community (AZEC). The Japanese government announced an AZEC initiative aimed at encouraging Asian countries to cooperate in decarbonisation and energy transition in January 2022, and held an AZEC cabinet meeting in March 2023. AZEC has conducted activities such as hydrogen, ammonia and CCS demonstration projects, Asia zero-emissions thermal project, project financing, and Asia CCS network.

3. Summary

ASEAN countries are promoting energy efficiency policies to cope with the increase in energy consumption associated with economic development. However, over the 20-year period from 2000 to 2020, countries with large populations and economies, such as Indonesia, Malaysia, the Philippines, and Viet Nam, steadily increased their energy efficiency while their carbon intensity worsened. That is, despite progress in energy conservation, CO_2 emissions are increasing.

In short, the cause of the carbon intensity worsening is coal. In the four countries studied, the electricity and heat production sector is a sector that accounts for the largest CO_2 emissions. In the electricity and heat production sector, the coal-fired electricity generation and the CO_2 emissions have both increased. The four countries studied commonly decided on policies such as phasing out coal-fired power generation and halting the construction of new coal-fired power plants. Measures to fill the gap between the current situation and the future goal include increasing the coal-fired power generation efficiency and improving the carbon intensity. Measures to increase the power generation efficiency include early shutdown of aging coal-fired power plants and conversion to high-efficiency gas-fired power plants. For the improvement of the carbon intensity, there are measures such as ammonia-hydrogen co-firing, ammonia-mono-firing, CCS, and introduction of renewable energies.

In Indonesia and Viet Nam, the manufacturing industries represent the second largest CO_2 emissions behind the electricity and heat production sector. The increase of the coal consumption in the iron and steel subsector is especially notable, and as a result, the CO_2 emissions have increased. In both countries, blast furnaces were put into operation in the 2010s. However, the world iron and steel industry has pursued the transition from the blast furnace method to the direct reduction method or the electric furnace method with the aim of achieving carbon neutral, and the ratio of electric furnaces is expected to grow in the future. Both countries also need to follow such a trend.

In Malaysia and the Philippines, the transport sector (road transport) accounts for the second-largest CO_2 emissions after the electricity and heat production sector. Electrification of automobiles into, for example, electric vehicles not only serve as an environmental and energy measure, but also is intended to create next-generation industries. Both countries are required to achieve conversion and sophistication of the industrial structure by pursuing the production of automobiles centering on electric vehicles, the attraction of investments in related parts, and the development of industries, in addition to aiming for decarbonisation where GHG emissions are reduced to net zero through electric vehicle penetration. Furthermore, Indonesia has abundant resources for batteries, such as nickel, cobalt, and manganese. The country is expected to achieve both decarbonisation and industrial development through electrification and zero-emissions in vehicle production, by aiming to become an electric vehicle hub in the ASEAN region, while ensuring security of such resources.

The CO_2 emissions in the residential sector are smaller than that of the other sector. However, in the Philippines, this sector accounts for the largest final energy consumption, and the third largest in Indonesia and Viet Nam. It is important not only to shift to energy-saving devices, but also to improve the performances of the building frame and residence equipment, such as window insulation and airtightness performance of residences. These improvements would not only improve the energy conservation in this sector, but also contribute to reducing the CO_2 emissions. Installing a photovoltaic generation system in high-performance residences would increase the air conditioning efficiency and raise the energy self-sufficiency rate of residences.

ESCO and Energy Audit would help visualise various energy conditions and contribute to performance improvement in the short term and the long term. They can help achieve systematic energy management, and support energy conservation and decarbonisation activities in both public and private sectors.

To promote the upgrading of coal-fired power generation in ASEAN, decarbonisation of steel, and promotion of electric vehicles and zero-emissions vehicles, it is necessary to pursue not only stop-gap energy conservation policies intended to simply reduce the consumption of fossil fuel energies such as coal, but also energy conservation policies from a broad perspective, including efforts in fields different from those supervised by the Energy Ministry/ Department such as the energy transition financing, technology development, industrial structure transformation, housing performance improvement, and implementation of systematic energy management such as ESCOs and Energy Audit.

Except for the Philippines, the three countries studied have declared they will be carbon neutral in 2050 or 2060. Carbon neutrality must be maintained after it is achieved. These broad policies can help achieve long-term sustainable carbon neutrality. For ASEAN to realise a low-carbon society at an early stage, international cooperation in technology and finance will then be necessary.

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