ERIA Research Project Report 2022 No. 17

Special Report of COVID-19 Impacts on Energy Demand and Energy-Saving Potential in East Asia, 2021

Edited by

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Special Report of COVID-19 Impacts on Energy Demand and Energy-Saving Potential in East Asia, 2021

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This special report was prepared by the Working Group for Analysis of Energy-Saving Potential in East Asia under an energy research project conducted by the Economic Research Institute for ASEAN and East Asia in 2020–2021 to capture the coronavirus disease (COVID-19) pandemic's impact on energy demand and energy-saving potential. The working group members, who represent the participating countries of the East Asia Summit, discussed and agreed on key assumptions and modelling approaches to harmonise forecasting techniques. The assumptions and modelling approaches may differ from those normally used in each country. Therefore, the projections presented here should not be viewed as official.

The findings, interpretations, conclusions, and views expressed in their respective chapters are entirely those of the author/s and do not reflect the views and policies of the Economic Research Institute for ASEAN and East Asia, its Governing Board, Academic Advisory Council, or the institutions and governments they represent. Any error in content or citation in the respective chapters is the sole responsibility of the author/s.

Preface

The Association of Southeast Asian Nations (ASEAN) and East Asia face tremendous challenges in navigating the future energy landscape and in determining how the energy transition will embrace new architectures, including sound policy and technologies, to ensure access to energy that is affordable, secure, and sustainable. The East Asia Summit (EAS) economies have been hit hard by the coronavirus (COVID-19) pandemic, but energy demand growth is expected to bounce back strongly as the economies recover after 2022. All decisions and energy policy measures will need to be weighed against potentially higher energy costs and security risks in the post–COVID-19 era. The Economic Research Institute for ASEAN and East Asia (ERIA) will release its short-term energy outlook for 17 EAS members (EAS17), taking account of the pandemic's impact in a separate report. This report reflects the impacts of the COVID-19 pandemic and the updated energy outlook results.

Although EAS17 countries will rely on fossil fuels until 2050, the energy mix will include more renewables and clean fuels. According to the previous EAS energy outlook, coal was dominant, followed by gas in power generation. However, ASEAN will see a coal-to-gasification trend in the medium term. Coal is declining because of the rapidly increasing use of gas and variable renewable energy following policy changes in EAS17 countries.

To achieve sustainable energy development in EAS17, the clean use of fossil fuel by deploying clean technologies is indispensable to decarbonise emissions. Using renewables; increasing energy efficiency; and employing new energy technologies such as carbon capture, usage, and storage; carbon recycling; and hydrogen should be accelerated, and clean technologies adopted in the medium to long term in EAS17's future energy system. Investment in energy efficiency will help discourage building more power plants.

We hope the report will provide insights into ASEAN and East Asia energy demand brought about by COVID-19 and help countries mitigate problems related to energy security and climate change by showing how a range of energy efficiency goals, action plans, and policies can save energy. The report discusses several key insights for policy development. ERIA will include commercially available energy technologies such as carbon capture, usage, and storage and hydrogen in the next EAS energy outlook model.

Professor Hidetoshi Nishimura
President, Economic Research Institute for ASEAN and East Asia

Acknowledgements

This study is a joint effort of working group members from the East Asia Summit countries; Economic Research Institute for ASEAN and East Asia (ERIA); and The Institute of Energy Economics, Japan (IEEJ). We acknowledge the support from everyone involved. We especially take this opportunity to thank the members of the working group; the ERIA energy team; the International Affairs Division of the Agency for Natural Resources and Energy of Japan's Ministry of Economy, Trade and Industry; and IEEJ's energy outlook-modelling team.

Special acknowledgement goes to Dr. Han Phoumin, Dr. Alloysius Joko Purwanto, Ms. Clara Gillispie, Ms. Cecilya Laksmiwati Malik, and Ms. Hien Dang for their contribution to the technical editing of the report.

The study could not have been realised without the invaluable support and contributions provided by the authors from each country.

Special thanks go to Mr. Stefan Wesiak, chief editor and publication director of ERIA, and his team of editors and publishing staff for helping edit the report and prepare it for publication.

Shigeru Kimura
Leader, Working Group
2022

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Executive Summary

The coronavirus disease (COVID-19) pandemic started in early 2020 and its negative economic impact can still be felt around the world. However, the situation is improving as vaccination becomes more widespread and as people avoid crowding and shift to 'new normal' lifestyles such as work from home. Energy consumption has decreased because lockdowns have shrunk economic activities. Applying East Asia Summit (EAS) energy outlook models to the 17 EAS countries (EAS17), the report analyses COVID-19's impact on industry, transport, and commercial and residential sectors' final energy consumption, focusing on the relationship between economic growth and energy consumption. The negative impacts of COVID-19—lockdowns, work from home, disruption of industrial supply chains—are reflected in economic growth rates.

The section on the Association of Southeast Asian Nations (ASEAN) covers all countries except Brunei Darussalam and Myanmar. The eight countries' 2020 assumed gross domestic product (GDP) growth rates are diverse; Lao People's Democratic Republic and Viet Nam may maintain positive growth but less than 2%, and the other six countries may show negative growth, from –2.0% in Indonesia to –8.3% in the Philippines. The eight countries' weighted average GDP growth rate is estimated at –3.3% in 2020. Oil and electricity are the main sources of energy in the final energy consumption sectors and are, therefore, highly correlated with GDP as an overall economic activity indicator. Oil and electricity consumption in 2020 started decreasing in 2019 because of the economic recession resulting from the COVID-19 pandemic. Consumption of coal and gas is insignificant and not, therefore, correlated with GDP. Only two countries show negative growth of total final energy consumption. One reason is the structure of EAS energy outlook models' energy demand formulas, which consist of the following variables: GDP and relative energy prices. If the lag coefficient is significant, economic recession mitigates the direct reduction of oil and electricity consumption. Crude oil prices slightly lower than in the business-as-usual (BAU) scenario moderate oil consumption reduction. Another reason for negative growth of total final energy consumption is the application of an econometrics approach, which might not be appropriate for analysing economic shocks such as the COVID-19 pandemic. The ASEAN countries will release their 2020 official energy balance tables in the second half of 2022 allowing a comparison of actual energy consumption with the model results to assess the EAS energy outlook models. The analysis shows that the COVID-19 pandemic has had a negative impact on energy consumption because of the economic recession. After the pandemic, energy consumption will spike because of the economic rebound and gradually catch up with BAU energy consumption trends, and the fossil fuel share in 2050 will be more than 80%. ASEAN countries must, therefore, continuously promote energy efficiency and conservation and deploy affordable renewable energy such as hydropower, geothermal, and solar photovoltaic sources. A policy to decrease coal and increase gas consumption is another option to mitigate CO_2 emissions. An integrated liquid natural gas supply chain in ASEAN, such as the Trans-ASEAN Gas Pipeline, will, therefore, be indispensable.

For EAS+7 countries,[1] assumptions of economic damages are different. In 2020, only China is assumed to maintain positive economic growth (2.3%). India's GDP experiences the largest drop among the +7 economies since the country suffered greatly from COVID-19. In 2021, all +7 economies recover owing to vaccine penetration. In 2020, the COVID-19 pandemic has a huge impact on total final energy consumption and total primary energy supply in the +7 economies. Oil demand drops substantially because of major cities' lockdowns and rapid adoption of work from home in all the countries. In the short term, however, the economy rebounds in 2021, and GDP annual average growth rates in 2020–2025 in the COVID-19 scenario exceed those in BAU. Thus, the difference between both scenarios' energy consumption shrinks after 2021. In the long term, until 2050, the pandemic's impact on the economy, energy demand, and demand breakdown is extremely limited. Both scenarios imply that energy consumption in the +7 countries approaches half the world's total final energy demand in 2050 regardless of the COVID-19 pandemic.

Some may argue that the COVID-19 pandemic will help reduce CO_2 emissions, but although the pandemic might have a huge short-term impact on decreasing CO_2 emissions, it is projected to have little long-term impact. This study shows that the pandemic will not sustainably reduce CO_2 emissions. We must, therefore, act to reduce CO_2 emissions in the long run.

[1] EAS plus the Australia, China, India, Japan, Republic of Korea, New Zealand, and the United States.

Chapter 1

Impact of COVID-19 on Energy Demand in ASEAN

Shigeru Kimura
Economic Research Institute for ASEAN and East Asia

1. Background and Purpose

The coronavirus disease (COVID-19) pandemic started spreading worldwide in January 2020 and continues to mutate despite governments' dedicated efforts to control it. The pandemic has brought us many inconveniences: needing to stay home or work from home; maintaining social distance; avoiding crowds at restaurants, theatres, sport events, and other places of entertainment; using face masks; frequently washing our hands and gargling, among others. The pandemic has lowered energy consumption and given rise to negative trends because of the economic recession, although many countries have not yet released their official energy statistics. The Economic Research Institute for ASEAN and East Asia (ERIA) Working Group for Energy Outlook and Energy-Saving Potential in ASEAN and East Asia took up the challenge of measuring COVID-19's negative impacts on energy demand. The working group used energy outlook models of 17 countries of the East Asia Summit (EAS17) to measure short-term impact, in 2020, and long-term impact, up to 2050. Because not all energy outlook results are available, this report covers only eight Association of Southeast Asian Nations (ASEAN) members: Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, the Philippines Singapore, Thailand, and Viet Nam (ASEAN 8). They represented 86% of gross domestic product (GDP) and 91% of total final energy consumption (TFEC) of ASEAN in 2017.

2. Methodology

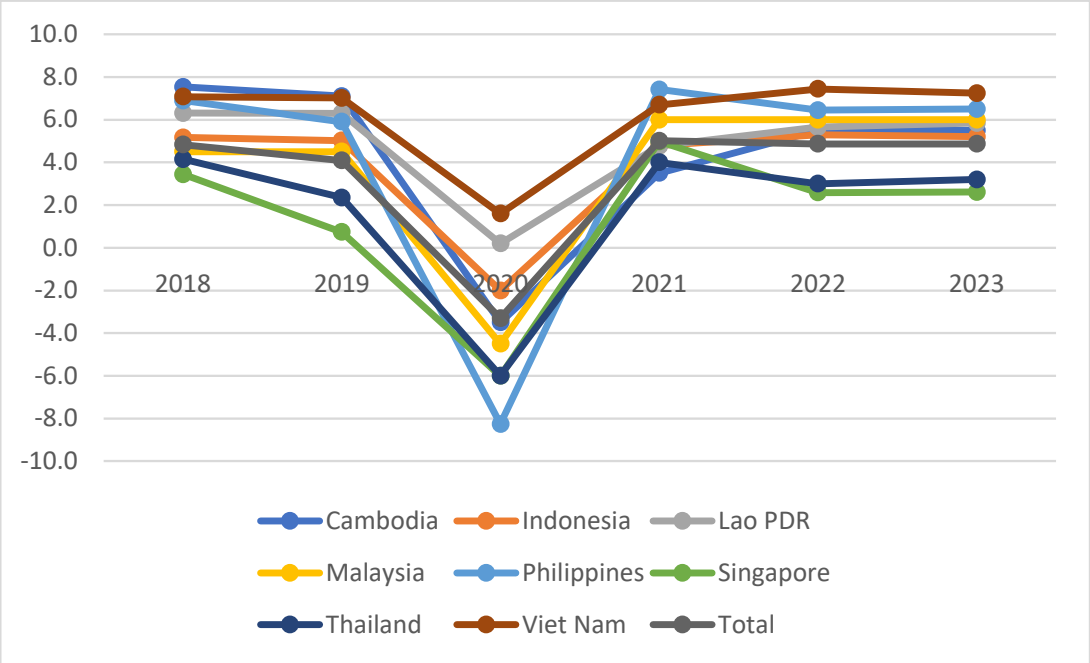
In 2019–2020, the working group updated the energy outlook models using the latest macroeconomic assumptions and energy development plans, including energy-saving and renewable energy deployment targets, to analyse energy-saving potential defined as the business-as-usual (BAU)–alternative policy scenario (APS) of energy demand. Based on BAU, the working group produced another APS: the COVID-19 scenario, which changes GDP and international crude oil prices of BAU because they are influenced by COVID-19. GDP is examined in 2020–2023, referring to sources such as the International Monetary Fund, and crude oil price is reviewed in 2020, based on global oil market information.

3. Assumptions

Assumed 2020 GDP growth rates of the ASEAN 8 are diverse: Lao PDR and Viet Nam may have positive rates but less than 2%, and the other six countries may show negative economic growth, from –2.0% in Indonesia to –8.3% in the Philippines. The weighted average of GDP growth rate of the ASEAN 8 is estimated at –3.3% in 2020. Figure 1.1 shows historical

assumptions of GDP growth rates of the ASEAN 8.

Figure 1.1. Assumptions of Gross Domestic Product Growth Rates, COVID-19 Scenario, 2018–2023



COVID-19 = coronavirus disease, GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic.
Source: Author.

Differences in GDP growth rate assumptions between the BAU and COVID-19 scenarios in all ASEAN countries are shown in Table 1.1. Rebounding economic growth starting in 2020 is indicated in 2020–2025 in the COVID-19 scenario. GDP growth rates are lower than in BAU because Malaysia, Singapore, and Thailand revise their economic growth assumptions after 2030. In 2017–2019, the GDP growth rate in the COVID-19 scenario is higher than in BAU because COVID-19 reflects observed GDP numbers.

Table 1.1. Gross Domestic Product Growth Rate, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

	2017-2019	2020	2020-2025	2025-2030	2040-2050	2040-2050
BAU	3.6	3.6	4.6	4.6	4.3	4.0
COVID-19	4.4	-3.3	4.8	4.4	4.1	3.8

BAU = business as usual, COVID-19 = coronavirus disease.
Source: ERIA (2019).

In 2020, international crude oil prices dropped sharply, so the crude oil assumption for the COVID-19 scenario was reviewed (Table 1.2).

Table 1.2. Crude Oil Price Assumption, Nominal Price, Business-as-Usual vs. Alternative Policy Scenarios, 2018–2050

	2018	2020	2030	2040	2050
BAU	75.1	87.7	126.9	187.2	248.1
APS	72.9	42.5	110.1	157.9	202.2

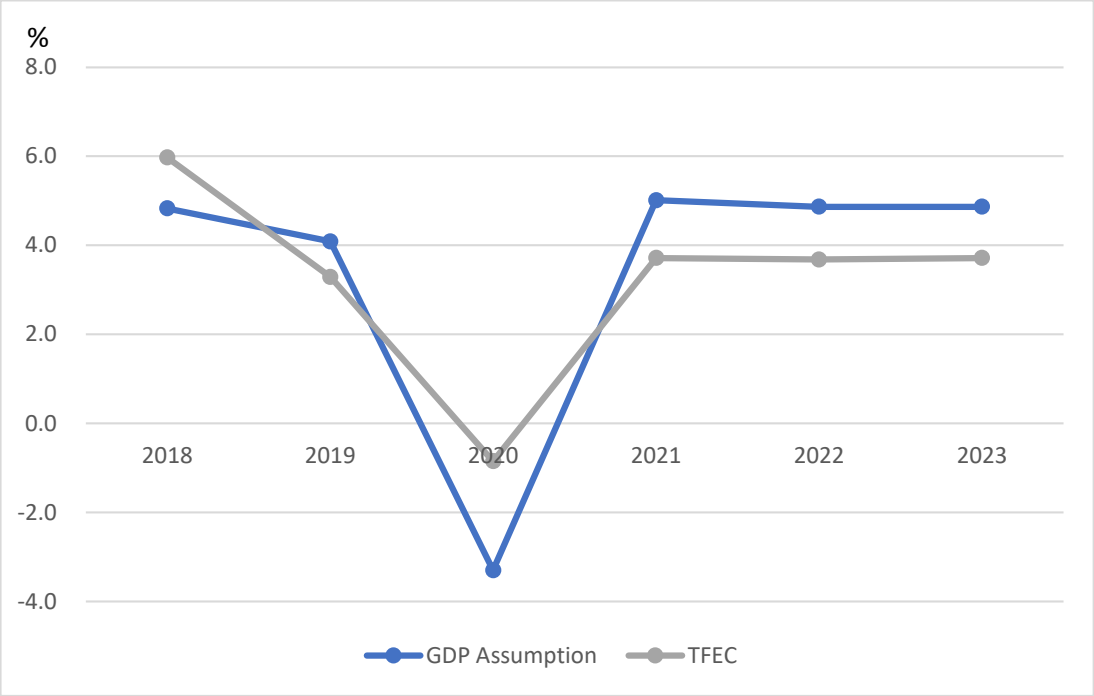
APS = alternative policy scenario, BAU = business as usual.
Source: ERIA (2019).

4. Impact on Final Energy Consumption

4.1. Short-term Impact

Because of negative GDP growth in 2020, TFEC of the ASEAN 8 reaches –0.8%; in 2021, TFEC returns to the original trend of about 4% per annum. Because elasticity—growth rate of TFEC/growth rate of GDP—of the 10 ASEAN countries in 1990–2017 was 0.77, elasticity after 2021 is 0.74–0.76 (Figure 1.2).

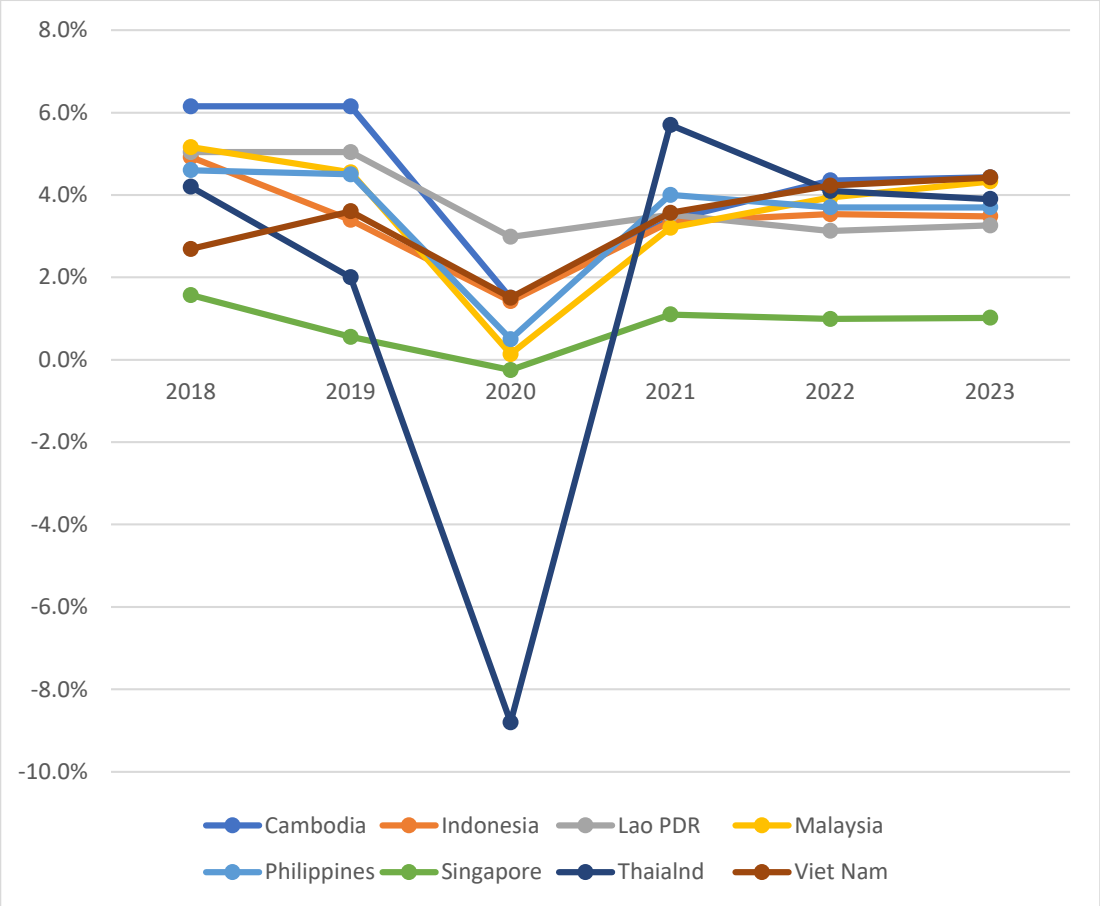
Figure 1.2. Comparison of Gross Domestic Product and Total Final Energy Consumption of All ASEAN Members, COVID-19 Scenario, 2018–2023



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

According to the trial calculation based on assumed GDP growth rate in 2020–2030, the COVID-19 pandemic's impact on ASEAN countries' energy demand might not be serious, except in Thailand. All the ASEAN countries studied, except Lao PDR and Viet Nam, assume negative GDP growth, but only two countries show negative TFEC growth rate in 2020: Singapore and Thailand. Malaysia shows zero increase in TFEC. However, TFEC of the ASEAN 8 rebounds along with economic growth, and TFEC in the COVID-19 scenario returns to the original upward trend, as it does in BAU.

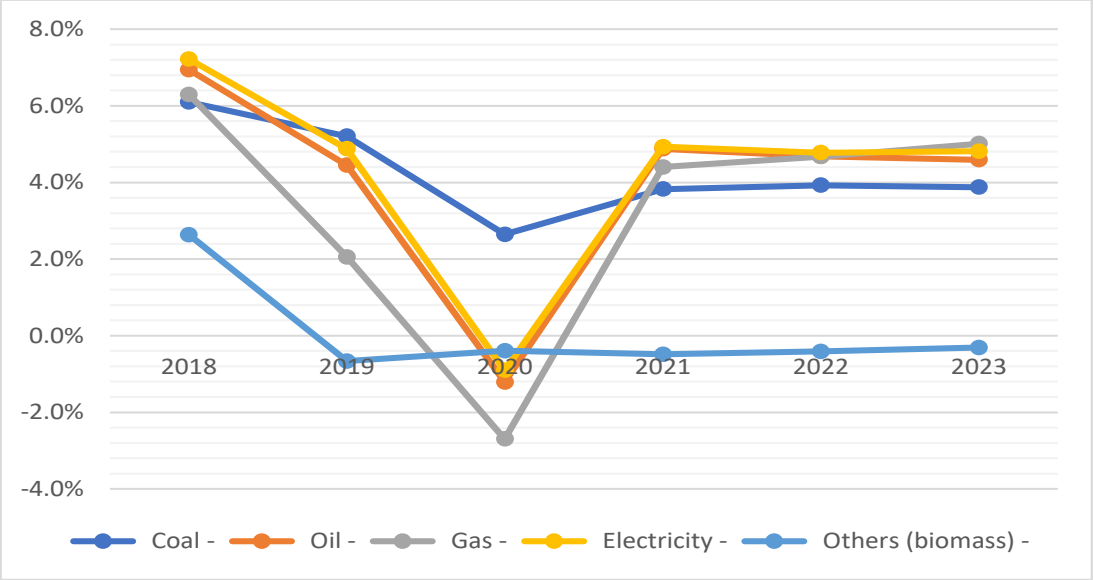
Figure 1.3. Total Final Energy Consumption of Eight ASEAN Countries, COVID-19 Scenario, 2018–2023



ASEAN = Association of Southeast Asian Nations, COVID-19 = coronavirus disease, Lao PDR = Lao People's Democratic Republic, TFEC = total final energy consumption.
Source: Author.

Damage to oil (–1.2%) and electricity (–0.9%) is serious in 2020. Consumption of gas decreases greatly, but only extremely small amounts are used and mainly for feedstock of fertilizer in Indonesia.

Figure 1.4. COVID-19's Impact by Energy Source

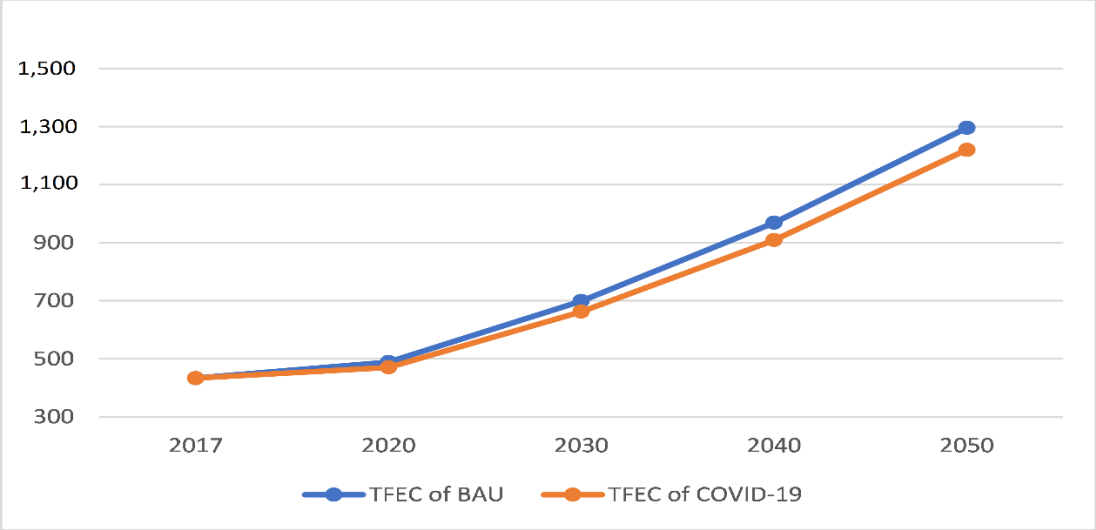


COVID-19 = coronavirus disease.
Source: Author.

4.2. Long-term Impact

TFEC in the COVID-19 scenario is lower than in BAU in 2020–2050 (Figure 1.4). Some countries, such as Malaysia and Thailand, assume higher GDP growth rate than BAU because of an economic rebound in 2021–2030. However, their GDP growth assumptions are lower than in BAU in 2030–2050. The difference between the COVID-19 and BAU scenarios is about 4%. After COVID-19, therefore, TFEC of the ASEAN 8 returns to BAU trends.

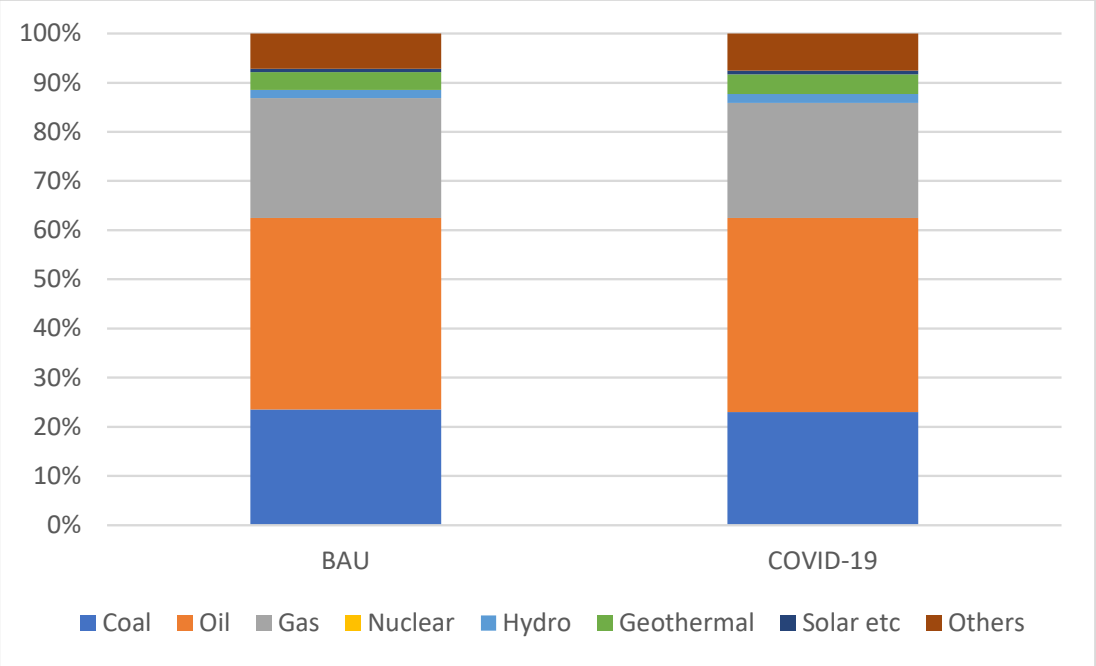
Figure 1.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



BAU = business as usual, COVID-19 = coronavirus disease, TFEC = total final energy consumption.
Source: Author.

The share of the ASEAN 8 in total primary energy supply in 2050 is the same in the BAU and COVID-19 scenarios. The COVID-19 scenario changes BAU's GDP and crude oil price assumptions, so the share of fossil oil in the COVID-19 scenario is 86%, the same as in BAU.

Figure 1.6. Share of Eight ASEAN Countries in Total Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2050



ASEAN = Association of Southeast Asian Nations, BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Key Findings and Recommendations

5.1. Key Findings

The following are the key findings:

(i) Oil and electricity are the main energy sources in final energy consumption and highly correlated with GDP as an overall economic activity indicator. Oil and electricity consumption in 2020 decreases because of the economic recession resulting from the COVID-19 pandemic. The amount of coal and gas in final energy consumption, however, is so small that it has no correlation with GDP.

(ii) Six of the ASEAN 8 assume negative GDP growth in 2020, but only two countries show negative TFEC growth. One reason is the structure of the energy demand formulas used in the EAS energy outlook. They consist of the following variables: GDP, relative energy prices, and lag (–1). When the lag coefficient is significant, economic recession does not directly reduce oil and electricity consumption. A crude oil price assumption slightly lower than in BAU mitigates energy consumption reduction.

(iii) We used an econometrics approach to analyse the impact on energy consumption during the economic recession caused by the COVID-19 pandemic, but the approach might not be appropriate for analysing economic shock. ASEAN countries might release their 2020 official energy balance tables around June–July 2022. Then we may compare actual energy consumption to the model results.

5.2. Recommendations

According to the results of the trial analysis to measure COVID-19 pandemic impacts on energy consumption in ASEAN, using econometric energy outlook models, the COVID-19 pandemic clearly has a negative impact on energy consumption because of the economic recession. After energy consumption in the COVID-19 scenario spikes because of the economic rebound, it gradually catches up with energy consumption trends in BAU. As a result, the fossil fuel share in 2050 is still be more than 80%. Countries must, therefore, promote energy efficiency and conservation and deploy affordable renewable energy such as hydropower, geothermal, and solar photovoltaic sources. A coal-to-gas policy is an option for ASEAN countries to mitigate CO_2 emissions, making an integrated liquid national gas supply chain, such as the Trans-ASEAN Gas Pipeline, indispensable.

Chapter 2

Impacts of COVID-19 on Energy Demand in the Asia-Pacific Countries[2]

Ikarii Ryohei and Endo Seiya

The Institute of Energy Economics, Japan

1. Background and Purpose

The coronavirus disease (COVID-19) pandemic continues to have an extremely large impact on lives and the world economy. To suppress the pandemic, governments have restricted activities, imposed social distancing, and required people to work from home, resulting in significant economic stagnation.

These changes have had a profound impact on energy demand because various industries have been paralyzed, more people stay home, and mobility has been curtailed to an unprecedented extent. Although comprehensive energy statistics have not yet been released for most regions, the Economic Research Institute for ASEAN and East Asia (ERIA), in with collaboration with the ERIA Working Group for Energy Outlook and Energy-Saving Potential in ASEAN and East Asia, estimates the pandemic's impacts. Using the energy outlook model, this chapter focuses on the short-term (2020–2025) and long-term impacts up to 2050 on energy demand in the Asia-Pacific countries (excluding the Association of Southeast Asian Nations [ASEAN]) and seven other countries participating in the working group (Australia, China, India, Japan, Republic of Korea, New Zealand, and the United States [US] [+7]).

2. Methodology

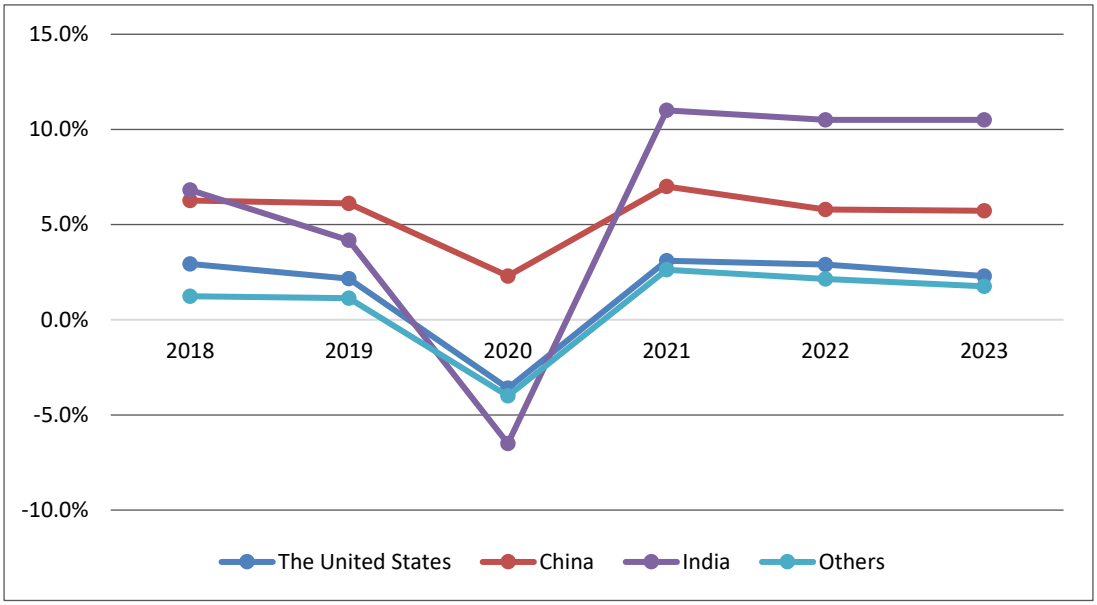
This analysis is based on the East Asia Summit (EAS) energy outlook study (ERIA, 2020). The outlook model computes the energy supply and demand structure by 2050 using econometric methods, based on technological assumptions and the policy outlook of each country. Using this modelling framework, the COVID-19 scenario is added to investigate the effect. In this scenario, assumptions such as gross domestic product (GDP) and energy prices are revised from the business-as-usual (BAU) scenario, taking account of COVID-19's effects. The GDP growth rate in 2020–2025 is revised based on COVID-19's recent impact and the change in several organizations' outlook.

[2] The authors thank all the members of ERIA working group for the helpful discussions about the energy and economic situation in the Asia-Pacific countries. This chapter is a product of ERIA Research Project 2020, Working Group on Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia Region.

3. Assumptions

Assumed economic damage in the +7 countries differ, depending on COVID-19's effects (Figure 2.1). In 2020, only China maintains positive economic growth (2.3%). Remarkably, India's GDP experiences the largest drop among the +7 since the country suffers greatly from COVID-19. In 2021, all the +7 economies recover owing to vaccine penetration.

Figure 2.1. Gross Domestic Product Growth Rates, COVID-19 Scenario, 2018–2023



Source: Authors, based on International Monetary Fund (2020).

Table 2.1 shows the differences in GDP growth rates of the +7 countries between the COVID-19 scenario (–2.3%) and BAU (2.6%). Growth rates are greater in the COVID-19 scenario until 2025 as economies rebound, then economic growth continues at the same rate in both scenarios.

Table 2.1. Gross Domestic Product Growth Rate, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

	2017-2019	2020	2020-2025	2025-2030	2040-2050	2040-2050
BAU	3.4%	2.6%	3.5%	3.3%	3.1%	2.4%
COVID-19	3.4%	-2.3%	3.9%	3.4%	3.1%	2.4%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

COVID-19 causes a significant drop in oil prices (Table 2.2).

Table 2.2. Crude Oil Price Assumptions, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050
(nominal $)

	2018	2020	2030	2040	2050
BAU	75.1	87.7	126.9	187.2	248.1
COVID-19	72.9	42.5	110.1	157.9	202.2

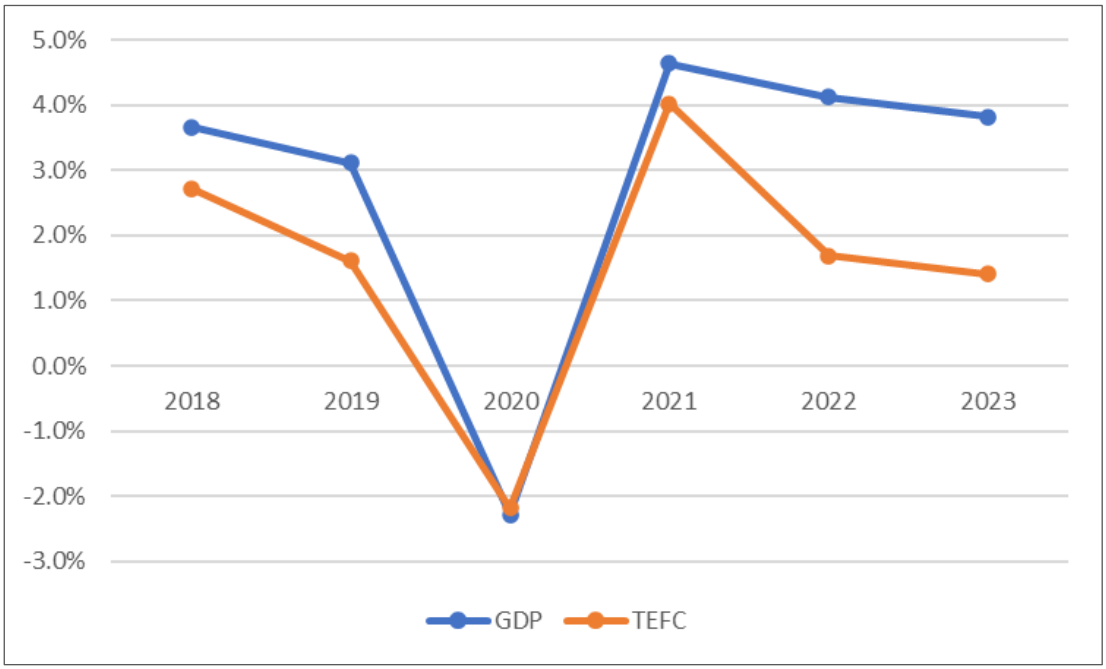
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors, based on ERIA (2019).

4. Impacts on Final Energy Consumption

4.1. Short-term Impacts

Worldwide economic deterioration leads to a sharp drop in total final energy consumption (TFEC) in 2020 in the +7 countries, but strong economic growth causes a rebound in TFEC in 2021 (Figure 2.2). The GDP growth rate in 2020 is –2.3%, leading to TFEC growth rate of –2.2%. With 4.6% GDP growth rate, TFEC rebounds to 4.0% in 2021. Thus, the short-term impact of COVID-19 on TFEC is drastic, especially in 2020 and 2021.

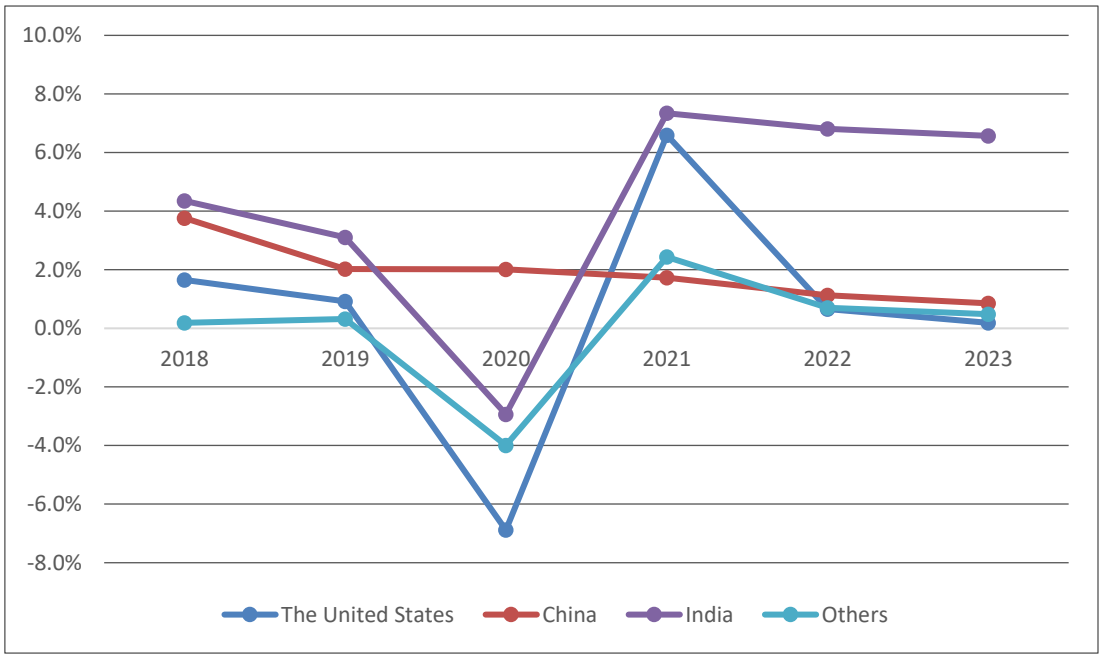
Figure 2.2. Gross Domestic Product and Total Final Energy Consumption Growth Rates, Australia, China, India, Japan, Republic of Korea, New Zealand, and the United States, 2018–2023



GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors, based on International Monetary Fund (2020).

Energy demand in the US, India, and others (Australia, Japan, Republic of Korea, and New Zealand) decreases, while that in China increases in 2020 (Figure 2.3). The TFEC growth rate of the US is –6.9%, India –2.9%, and others –4.0%, while that of China is +2.0% because it is the only country that maintains positive economic growth, at 2.3%, in 2020 with strict measures against COVID-19, such as hard lockdowns.

Figure 2.3. Total Final Energy Consumption, Australia, China, India, Japan, Republic of Korea, New Zealand, and the United States, 2018–2023



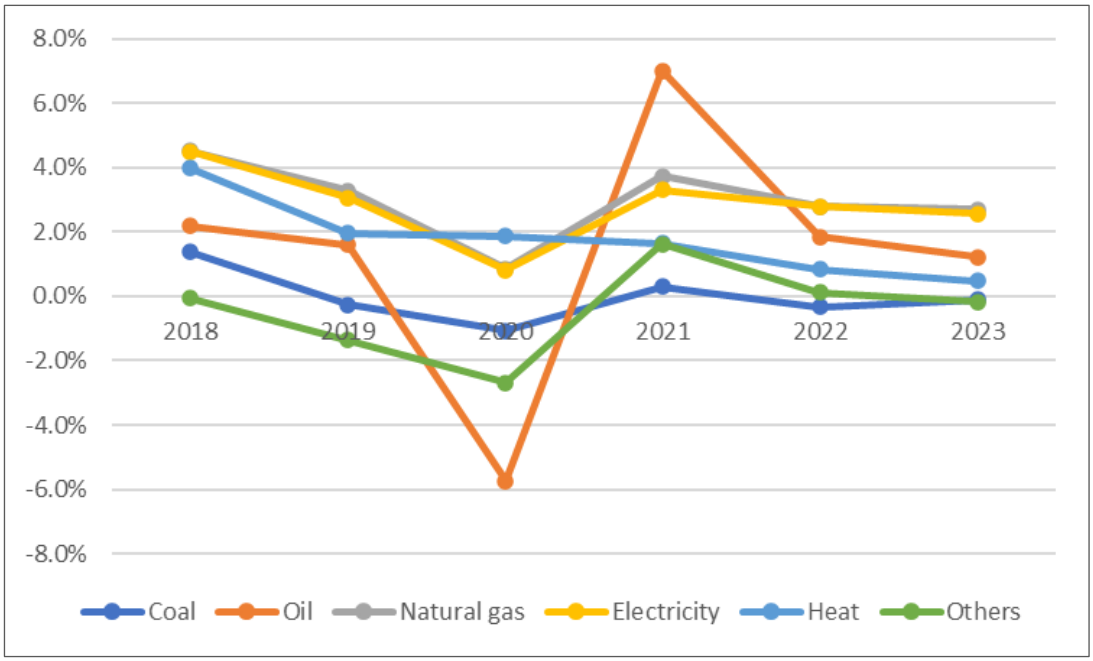
Source: Authors.

In contrast, all TFEC growth rates in 2021 are positive: 7.3% in India, 7.0% in China, 6.6% in the US, and 2.4% in others.

Many developing countries, including ASEAN members, experience negative economic growth rates and positive energy demand at the same time in 2020 because of the inevitable rapid increase in energy demand. India's TFEC drop in 2020, therefore, is remarkable, showing how harsh COVID-19's impacts have been on the economy and energy consumption.

Oil and coal consumption growth rates are considerably negative while natural gas and electricity growth rates are significantly positive in 2020 (Figure 2.4). Oil decreases by 5.7% in the +7 countries, especially because demand from transport drops as a result of lockdowns and telework. Coal declines by 1.1% because of decreased demand from industry. Natural gas, however, increases because of increased demand from the residential and non-energy sectors. Electricity increases mainly because of the hike in residential demand resulting from stay-home policies.

Figure 2.4. Total Final Energy Consumption, by Energy Source, 2018–2023



Source: Authors.

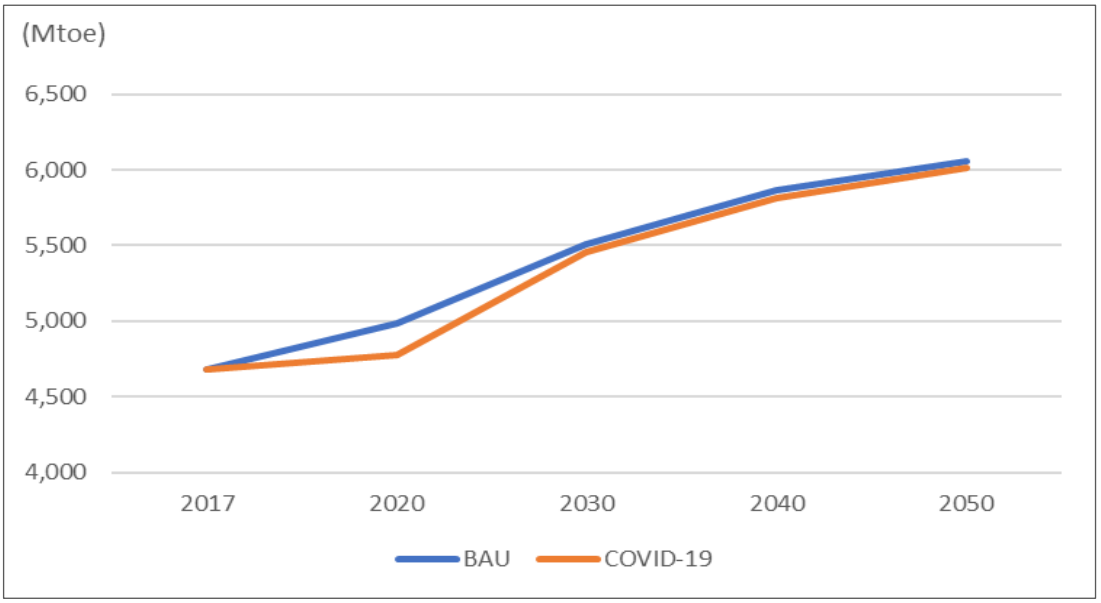
In 2021, oil is expected to rebound by 7% and coal by 0.3%, while natural gas keeps expanding at 3.7% and electricity by 3.3%, based on the +7 countries' economic recovery assumptions.

4.2. Long-term Impact

In the long term, the pandemic may affect energy demand in the +7 countries only slightly compared with its short-term impacts (Figure 2.5). In 2020, the COVID-19 scenario shows that demand is 4.1% less than in BAU. However, in 2050, demand in the COVID-19 scenario is only 0.9% less than in BAU. Energy demand between the two scenarios converges towards 2050.

In both scenarios, total TFEC of the +7 countries in 2050 reaches more than 6,000 million tonnes of oil equivalent or almost half the world's final energy demand in 2050, according to The Institute of Energy Economics, Japan.

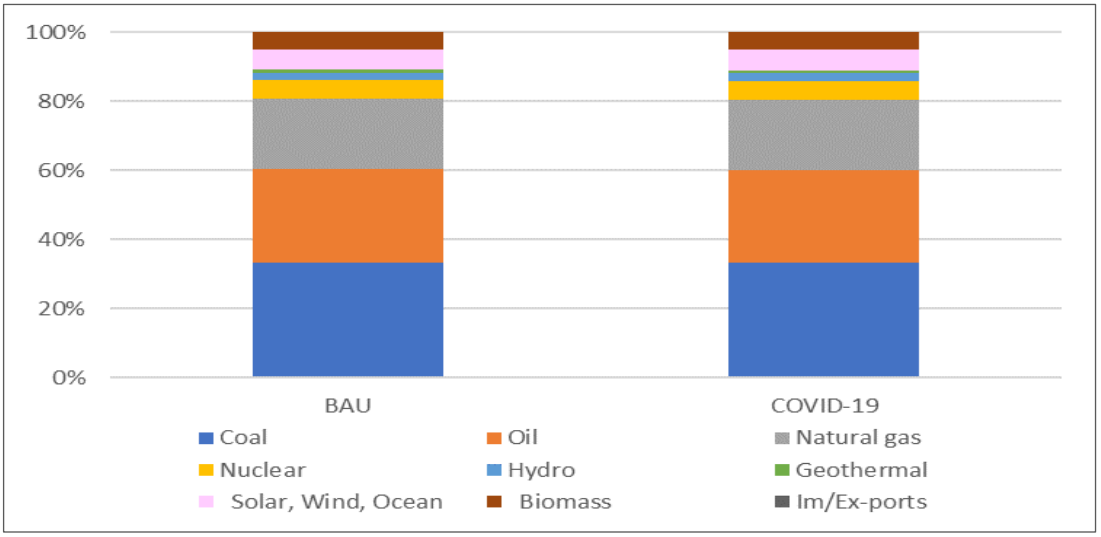
Figure 2.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Authors.

The breakdown of total primary energy supply (TPES) in 2050 is almost the same as in the BAU and COVID-19 scenarios (Figure 2.6).

Figure 2.6. Total Primary Energy Supply Breakdown, Business-as-Usual and COVID-19 Scenarios, in 2050



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Key Findings and Recommendations

5.1. Key Findings

(i) In 2020, the COVID-19 pandemic has a huge impact on GDP, TFEC, and TPES in the +7 countries. Oil demand drops substantially because of lockdowns of major cities and rapid adoption of work from home.

(ii) In the short term, however, the economy rebounds, especially in 2021, and GDP annual average growth rates in 2020–2025 in the COVID-19 scenario exceed those in BAU. Thus, the difference in energy consumption in both scenarios shrinks after 2021.

(iii) In the long term, until 2050, the pandemic's impacts on the economy, energy demand, and demand breakdown are extremely limited. Both scenarios imply that energy consumption in the +7 countries approaches half the world's total final energy demand in 2050 regardless of the COVID-19 pandemic.

5.2. Recommendations

Some may argue that the COVID-19 pandemic would contribute to future CO_2 emission reduction, but this would not be true. The pandemic was supposed to have had a huge impact on decreasing CO_2 emissions in the short term, but COVID-19 is projected to have little impact in the long term. This study shows that the pandemic's impacts would not sustainably reduce CO_2 emissions. Therefore, we need to take action if we want to reduce CO_2 emissions in the long run.

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Chapter 3
Australia Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has wreaked havoc on the global economic system. In Australia, a swift and orderly approach to restricting and quarantining inbound arrivals from overseas—including effective lockdowns, contact tracing, community awareness, health system mobilisation, etc.—were vital for suppressing the domestic spread of the disease. Nonetheless, COVID-19 and formal measures taken to control its spread have had a notable impact on patterns of daily life and economic activity. In 2020, Australia went into its first recession in almost 30 years, although its gross domestic product (GDP) contracted less than in many other developed countries.

Each of these effects has impacted energy use and supply. This chapter analyses the pandemic's impact on near- and long-term energy demand and supply by comparing the results from two scenarios: business-as-usual (BAU) and COVID-19.

2. Macro Assumptions of the COVID-19 Scenario

The quick responses to minimise the pandemic's economic consequences, such as generous fiscal stimulus packages and wage subsidies, were critical for minimising the effects of shutdowns and initial shocks. The COVID-19 scenario assumes that GDP decreases by 0.9% in 2020, in contrast with an expected increase of 2.8% in BAU.[4] However, signs point to the economy entering a recovery period, with strong rebound growth seen in 2020 after the second quarter because of favourable health outcomes of observing COVID-19–safe lifestyles, international border closure, and substantial monetary and fiscal policy support. The GDP growth rate is assumed to continue to rebound in 2021 to 3.8% and gradually slow to 3.1% in 2022 and 3.0% in 2023. Annual GDP growth rates are the same as in the BAU scenario: 2.3% in 2023–2030, 1.9% in 2030–2040, and 1.6% in 2040–2050 (Table 3.1).

[3] The Institute of Energy Economics, Japan.
[4] All data in this chapter, unless otherwise cited, is attributed to the modelling results for Australia of The Institute of Energy Economics, Japan.

Table 3.1. Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	2.8%	2.1%	–0.9%	3.8%	3.1%	3.0%	2.3%	1.9%	1.6%
BAU	2.8%	2.1%	2.8%	2.8%	2.6%	2.6%	2.3%	1.9%	1.6%

BAU = business-as-usual, COVID-19 = coronavirus disease.
Source: Authors, based on International Monetary Fund (2020).

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

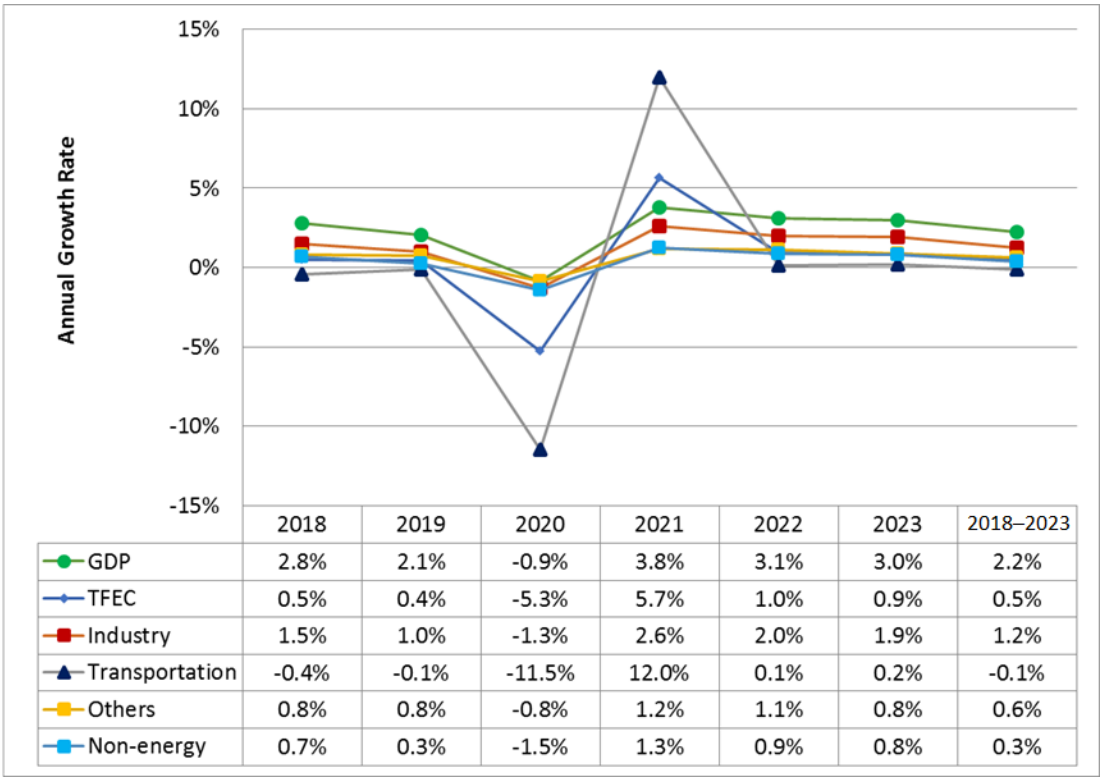
In the COVID-19 scenario, total final energy consumption (TFEC) decreases by 5.3% in 2020 but sharply increase by 5.7% in 2021 (Figure 3.1). Yet, even with this rebounded growth, TFEC increases on average by only 0.5% per year in 2018–2023 (0.7% in BAU).

3.1.1. Final Energy Demand by Sector

In the COVID-19 scenario, transport energy consumption decrease the most, by 11.5% in 2020 (0.2% in BAU). The decrease in transport fuel demand is the result of limited travel and work-from-home arrangements during the lockdown in 2020. However, transport demand increases sharply (12.0%) in 2020–2021 in the COVID-19 scenario, offsetting some of the sharper divergences between the BAU and COVID-19 scenarios. In 2018–2023, transport energy use declines by an average rate of 0.1% per year in both scenarios.

In the COVID-19 scenario, energy consumption in the non-energy sector is the next most impacted, reduced by 1.5% in 2020 (increased by 0.6% in BAU). Industry decreases energy consumption by 1.3% (1.7% in BAU). However, industry increases energy use by 1.2% per year in 2018–2023 (1.5% in BAU). Energy use in the residential and commercial sectors (‘others’) decreases by 0.8% in 2020 (0.9% in BAU) and increases by 0.6% per year in 2018–2023 (0.8% in BAU) (Figure 3.1).

Figure 3.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP	2.8%	2.1%	-0.9%	3.8%	3.1%	3.0%	2.2%
TFEC	0.5%	0.4%	-5.3%	5.7%	1.0%	0.9%	0.5%
Industry	1.5%	1.0%	-1.3%	2.6%	2.0%	1.9%	1.2%
Transportation	-0.4%	-0.1%	-11.5%	12.0%	0.1%	0.2%	-0.1%
Others	0.8%	0.8%	-0.8%	1.2%	1.1%	0.8%	0.6%
Non-energy	0.7%	0.3%	-1.5%	1.3%	0.9%	0.8%	0.3%

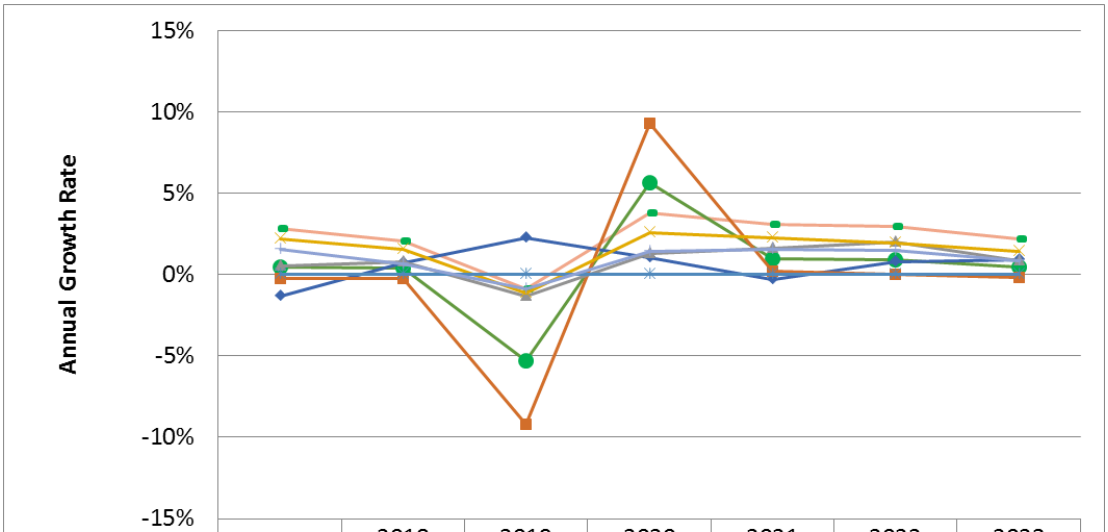
COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

3.1.2. Final Energy Demand by Fuel

The COVID-19 scenario sees the strongest decline in oil consumption. Oil demand decreases by 9.2% in 2020 (0.1% in BAU). The strong decrease in oil demand is caused by reduced transport activities, work from home during the lockdown, and restrictions on international travel. Oil demand increases sharply (9.3%) in 2021 mainly because of the easing of travel restrictions. However, oil use decreases by 0.1% per year in 2018–2023 in the COVID-19 scenario, compared with flat demand growth in 2018–2023 in BAU.

In 2018–2023, demand for coal grows by 0.9% (1.6% in BAU), natural gas by 0.9% (1.1%), and electricity by 1.4% (1.8%) per year. These fuels' relatively low growth rates are caused by the expected closure of some business and industries domestically. 'Others' (e.g. biomass, liquid biofuels, solar hot water) grow by 0.9% per year in 2018–2023 (1.1% in BAU). The slower growth of 'others' is caused by reduced use of biomass in industry as linked to overall reduced industry energy demand (Figure 3.2).

Figure 3.2. Annual Growth Rate of Final Energy Consumption by Fuel, COVID-19 Scenario, 2018–2023



		2018	2019	2020	2021	2022	2023
GDP	2.8%	2.1%	-0.9%	3.8%	3.1%	3.0%	2.2%
TFEC	0.5%	0.4%	-5.3%	5.7%	1.0%	0.9%	0.5%
Coal	-1.4%	0.7%	2.3%	1.1%	-0.3%	0.8%	0.9%
Oil	-0.3%	-0.2%	-9.2%	9.3%	0.2%	0.0%	-0.1%
Natural gas	0.6%	0.8%	-1.3%	1.3%	1.7%	2.0%	0.9%
Electricity	2.2%	1.6%	-1.1%	2.6%	2.2%	1.9%	1.4%
Heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Others	1.5%	0.7%	-0.9%	1.4%	1.5%	1.5%	0.9%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) decreases by 5.3% in 2020 (increases by 0.2% in BAU) but increases by 4.3% in 2021. TPES growth remains flat in 2018–2023 in the COVID-19 scenario (0.3% in BAU) because of slow TFEC growth.

In 2020, primary energy supply of oil decreases the most by 11.1% (0.2% in BAU) because of limited travel activities and remote working arrangements during the lockdown. Oil supply increases sharply by 10.7% in 2021 but declines by an average rate of 0.4% per year in 2018–2023 (0.1% in BAU).

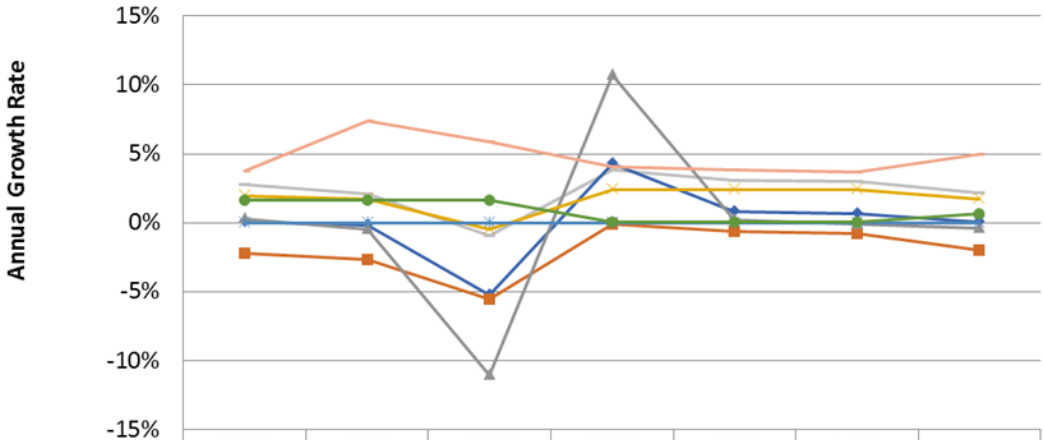
The primary supply of coal declines by 5.5% in 2020 (2.1% in BAU) and by 1.9% per year in 2018–2023 (1.5% in BAU). The changes in coal use are caused by reduced electricity demand during the lockdown, combined with the fall in coal-fired generation and accelerated switching to renewable electricity generation.

Natural gas supply decreases by 0.4% in 2020 (increases by 2.0% in BAU) and increases by an average of 1.7% per year in 2018–2023 (2.0% in BAU). The pandemic is not likely to affect

natural gas supply significantly during this period.

Average annual growth of primary energy supply from 'others', solar, wind, and liquid biofuels is faster in 2018–2023 because of the continuous shift from fossil fuels to renewables (Figure 3.3).

Figure 3.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP	2.8%	2.1%	-0.9%	3.8%	3.1%	3.0%	2.2%
TPES	0.0%	-0.2%	-5.3%	4.3%	0.8%	0.6%	0.0%
Coal	-2.2%	-2.6%	-5.5%	-0.1%	-0.6%	-0.8%	-1.9%
Oil	0.3%	-0.5%	-11.1%	10.7%	0.2%	-0.1%	-0.4%
Natural gas	1.9%	1.7%	-0.4%	2.4%	2.4%	2.4%	1.7%
Nuclear	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hydro	1.7%	1.6%	1.6%	0.1%	0.1%	0.1%	0.7%
Others	3.7%	7.4%	5.9%	4.0%	3.9%	3.7%	5.0%

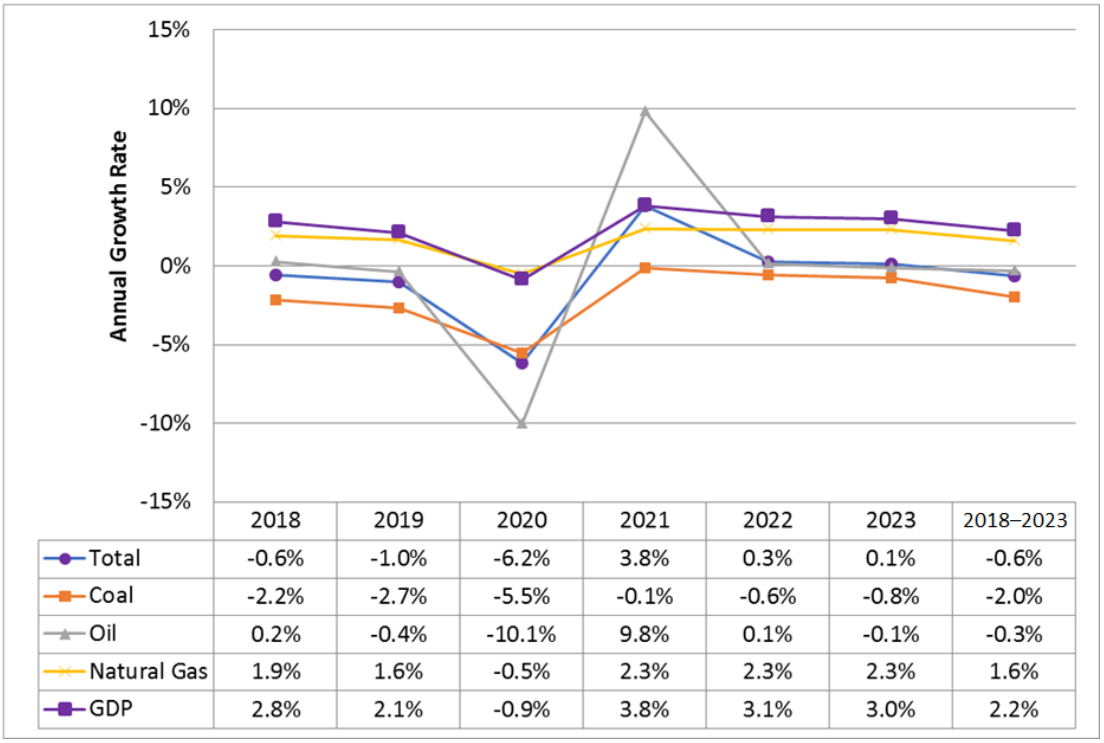
COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Authors.

3.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions decrease by 6.2% in 2020 (0.6% in BAU) and decrease by 0.6% per year in 2018–2023 (0.3% in BAU). The results suggest that the pandemic helps reduce CO_2 emissions (Figure 3.4).

CO_2 emissions decrease the most in coal, by 2.0% per year in 2018–2023 (1.5% in BAU). Emissions from oil decline by 0.3% per year in 2018–2023 (0.1% in BAU). Emissions from natural gas increase by 1.6% per year in 2018–2023 (1.9% in BAU).

Figure 3.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
Total	-0.6%	-1.0%	-6.2%	3.8%	0.3%	0.1%	-0.6%
Coal	-2.2%	-2.7%	-5.5%	-0.1%	-0.6%	-0.8%	-2.0%
Oil	0.2%	-0.4%	-10.1%	9.8%	0.1%	-0.1%	-0.3%
Natural Gas	1.9%	1.6%	-0.5%	2.3%	2.3%	2.3%	1.6%
GDP	2.8%	2.1%	-0.9%	3.8%	3.1%	3.0%	2.2%

GDP = gross domestic product.
Source: Authors.

4. Long-term Impact (2017-2050)

4.1. Final Energy Consumption

TFEC in the COVID-19 scenario increases by an average of 0.2% per year in 2017–2050 (0.3% in BAU) because the economy grows by an annual average rate of 2.0%, nearly the same as in BAU, in 2017–2050. Economic activity grows faster in the COVID-19 scenario because of recovery measures from 2021 to 2023, while GDP grows at similar rates after 2023 in both scenarios, suggesting that the pandemic has limited impact on TFEC and GDP in the long term.

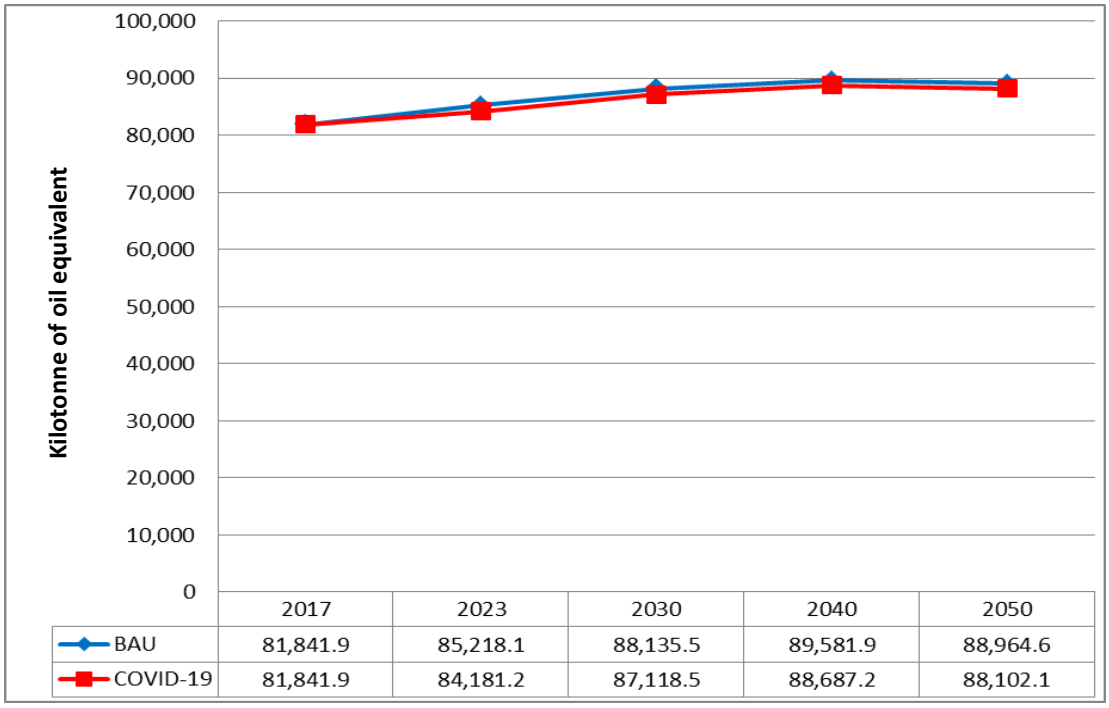
Table 3.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (Billion US$, 2010)	BAU	1,432.7	1,672.7	1,955.5	2,364.7	2,776.2	2.0%
	COVID-19	1,432.7	1,642.5	1,921.1	2,323.1	2,727.4	2.0%
	COVID-19 vs. BAU	0.0	-1.8%	-1.8%	-1.8%	-1.8%	
TFEC (Ktoe)	BAU	81,841.9	85,218.1	88,135.5	89,581.9	88,964.6	0.3%
	COVID-19	81,841.9	84,181.2	87,118.5	88,687.2	88,102.1	0.2%
	COVID-19 vs. BAU	0.0	-1.2%	-1.2%	-1.0%	-1.0%	

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Ktoe = kilotonne of oil equivalent, TFEC = total final energy consumption.
Source: Authors.

Because GDP growth rebounds, TFEC in the COVID-19 scenario approaches BAU with a marginal difference (–1.0%) in 2017–2050 (Figure 3.5).

Figure 3.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

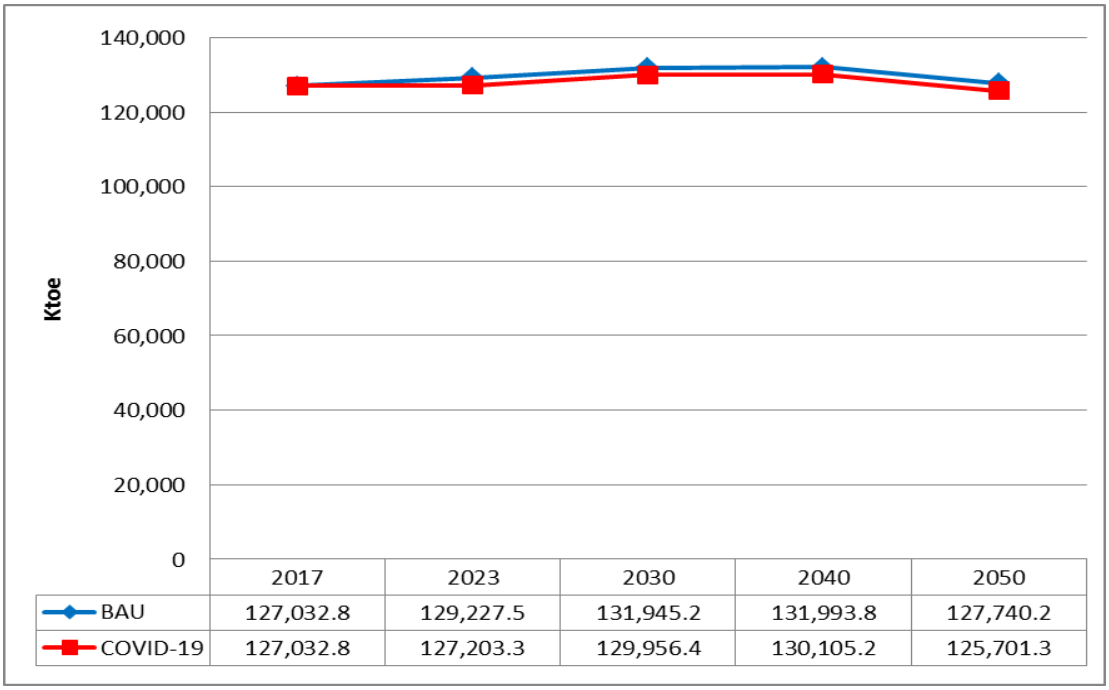


BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.2. Primary Energy Supply

TPES growth remains flat in 2017–2050 in both scenarios, decreasing by only 0.03% per year in the COVID-19 scenario (increasing by 0.02% in BAU). The pandemic thus affects TPES in the long term. Strong economic recovery, along with structural economic changes, flatten TPES growth in the projection period (Figure 3.6).

Figure 3.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



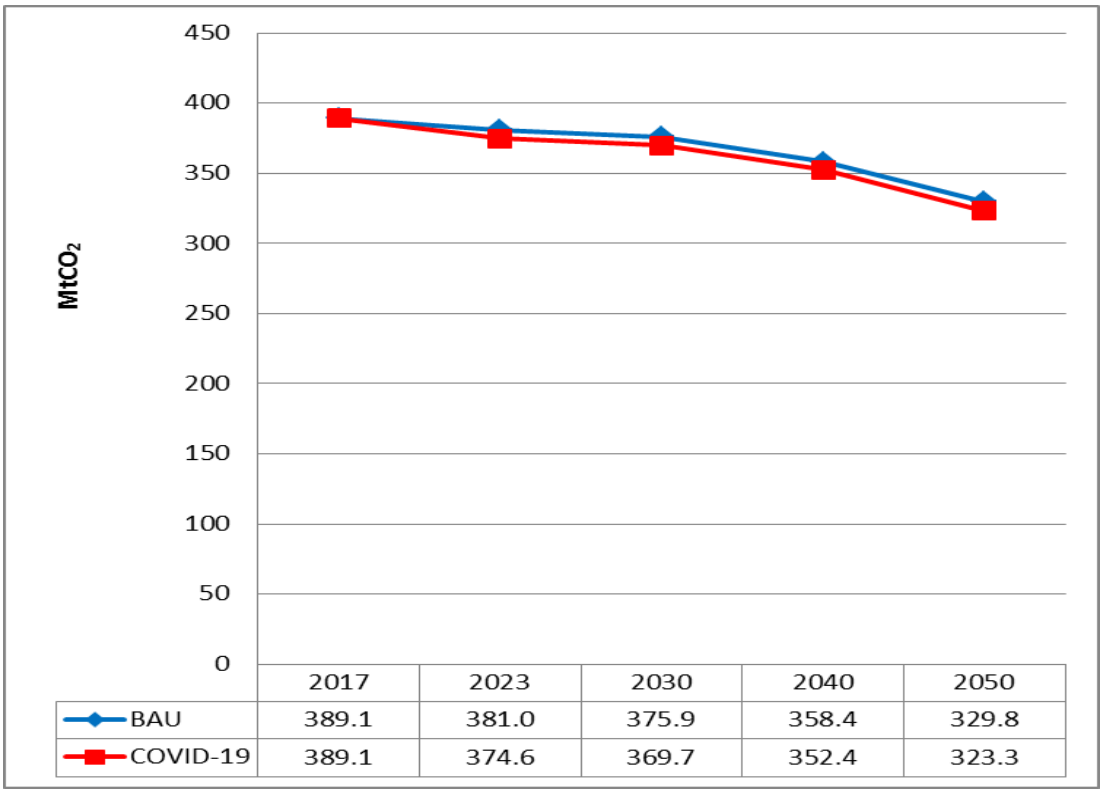
	2017	2023	2030	2040	2050
BAU	127,032.8	129,227.5	131,945.2	131,993.8	127,740.2
COVID-19	127,032.8	127,203.3	129,956.4	130,105.2	125,701.3

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.3. CO_2 Emissions

In both scenarios, CO_2 emissions from domestic energy use decrease in 2017–2050, in the COVID-19 scenario, by 0.6% per year (0.5% in BAU). Energy-related emissions in 2050 are 16.9% lower than in 2017 in the COVID-19 scenario (15.2% in BAU) (Figure 3.7). CO_2 emission reduction levels in both scenarios are insufficient to achieve Australia's 2030 targets for energy-related emission reduction.

Figure 3.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	389.1	381.0	375.9	358.4	329.8
COVID-19	389.1	374.6	369.7	352.4	323.3

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Implications and Policy Recommendations

(i) This chapter suggests that negative growth of GDP in 2020 (–0.9%) reduces Australia's TPES, TFEC, and CO_2 emissions in 2020. Energy consumption in transport decreases significantly, followed by industry. However, energy demand and emissions increase again in 2021 with the economic rebound.

(ii) Transport has more opportunities for energy saving. Promoting remote work in appropriate sectors would put downward pressure on transport fuel use, reducing oil import dependence.

(iii) Unaffected by the pandemic, wind and solar energy supply grows faster in the short term in both scenarios. Adoption of large-scale wind and solar energy supported by energy storage in the long term would play an important role in decarbonising electricity generation.

(iv) The share of natural gas in the primary energy supply increases over the projection period in both scenarios. Natural gas is dominant, followed by oil, in TPES. Coal's dominance declines in the long term, but further reduction of coal use will help achieve emission reduction targets.

(v) The CO_2 emission reduction level in 2030 in both scenarios suggests that further action is needed to achieve Australia's energy-related emission reduction goals.

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Chapter 4

Cambodia Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has had severe socioeconomic impacts on Cambodia, affecting energy demand and supply. Official energy statistics for 2020, however, have not yet been released. This study, therefore, uses the energy outlook model in the business-as-usual (BAU) scenario, which was updated for the 2019 energy outlook (ERIA, 2019), and analyses how energy demand is reduced by COVID-19 in 2020 and how energy demand rebounds after 2020 in the COVID-19 scenario.

2. Macro Assumptions of the COVID-19 Scenario

The annual gross domestic product (GDP) growth rate in the COVID-19 scenario in 2020 decreases by about 3.5% (5.7% in BAU) and rebounds by 3.5% in 2021, 5.5% in 2022, 5.5% in 2023, 5.5% in 2024, and 6.5% in 2025.

In 2023–2030, the GDP growth rate in the COVID-19 scenario is 6.36% per annum (6.8% in BAU). In the long term (2030–2040), GDP growth rate in the COVID-19 scenario is a bit lower than in BAU (Table 4.1).

Table 4.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

Scenario	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	Base year	7.1%	–3.5%	3.5%	5.5%	5.5%	6.36%	6.5%	6.5%
BAU	Base year	7.1%	6.8%	6.5%	6.5%	6.5%	6.8%	6.77%	6.5%

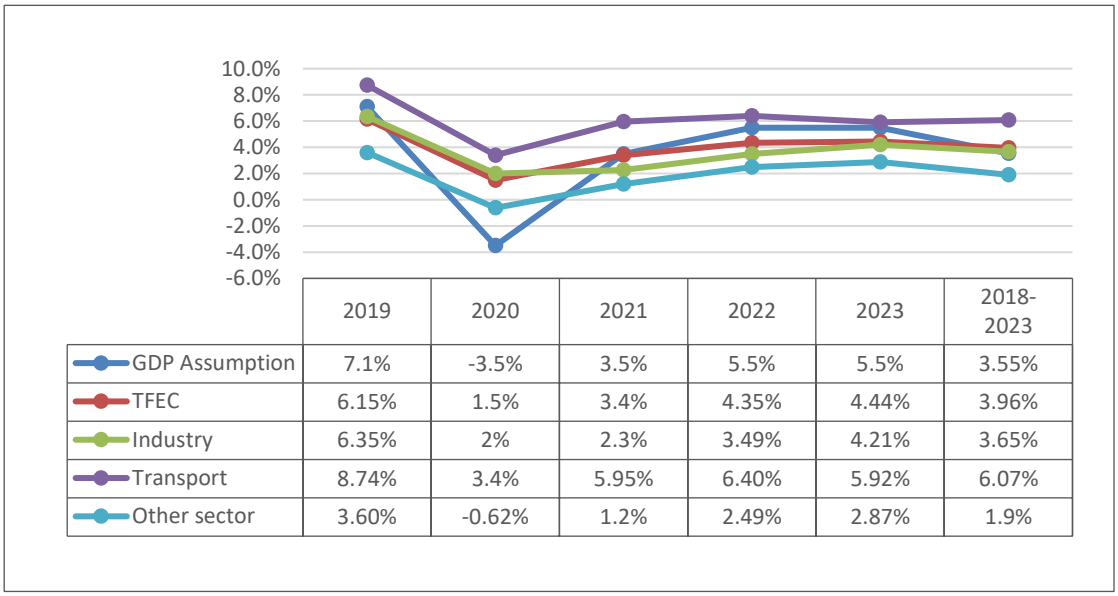
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund and Ministry of Economic and Finance Cambodia data for 2020.

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In the COVID-19 scenario, total final energy consumption (TFEC) by sector and fuel increases on average by 3.96% per year in 2018–2023 (1.27% less than in BAU) and decreases from 4.73 million tonnes of oil equivalent (Mtoe) in BAU to 4.63 Mtoe in the COVID-19 scenario in 2020. In the COVID-19 scenario, transport has the highest growth rate of TFEC at 6.07% per year, followed by industry (3.65%) and 'others' (commercial, residential, and agricultural sectors) (1.9%) in 2018–2023 (Figure 4.1). Coal TFEC has the highest growth rate (13.06% per year), followed by oil (5.05%) and electricity (4.97%) in 2018–2023 (Figure 4.2).

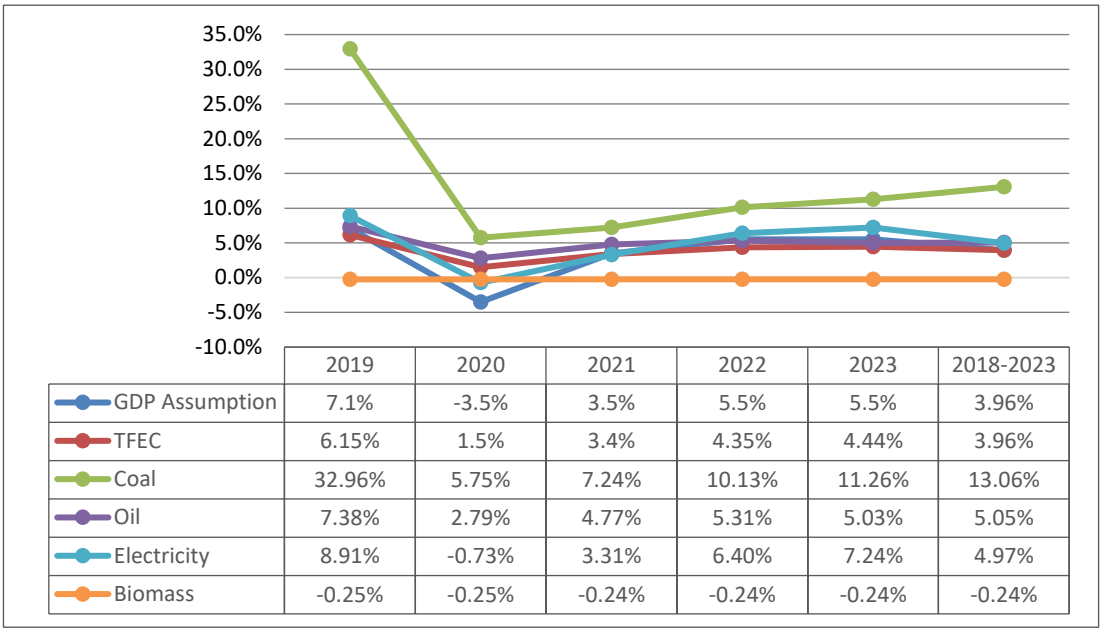
Figure 4.1. Final Energy Consumption Annual Growth Rate, by Sector, 2018–2023



	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	7.1%	-3.5%	3.5%	5.5%	5.5%	3.55%
TFEC	6.15%	1.5%	3.4%	4.35%	4.44%	3.96%
Industry	6.35%	2%	2.3%	3.49%	4.21%	3.65%
Transport	8.74%	3.4%	5.95%	6.40%	5.92%	6.07%
Other sector	3.60%	-0.62%	1.2%	2.49%	2.87%	1.9%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

Figure 4.2. Final Energy Consumption Growth Rate, by Fuel, 2018–2023



	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	7.1%	-3.5%	3.5%	5.5%	5.5%	3.96%
TFEC	6.15%	1.5%	3.4%	4.35%	4.44%	3.96%
Coal	32.96%	5.75%	7.24%	10.13%	11.26%	13.06%
Oil	7.38%	2.79%	4.77%	5.31%	5.03%	5.05%
Electricity	8.91%	-0.73%	3.31%	6.40%	7.24%	4.97%
Biomass	-0.25%	-0.25%	-0.24%	-0.24%	-0.24%	-0.24%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Total Primary Energy Supply

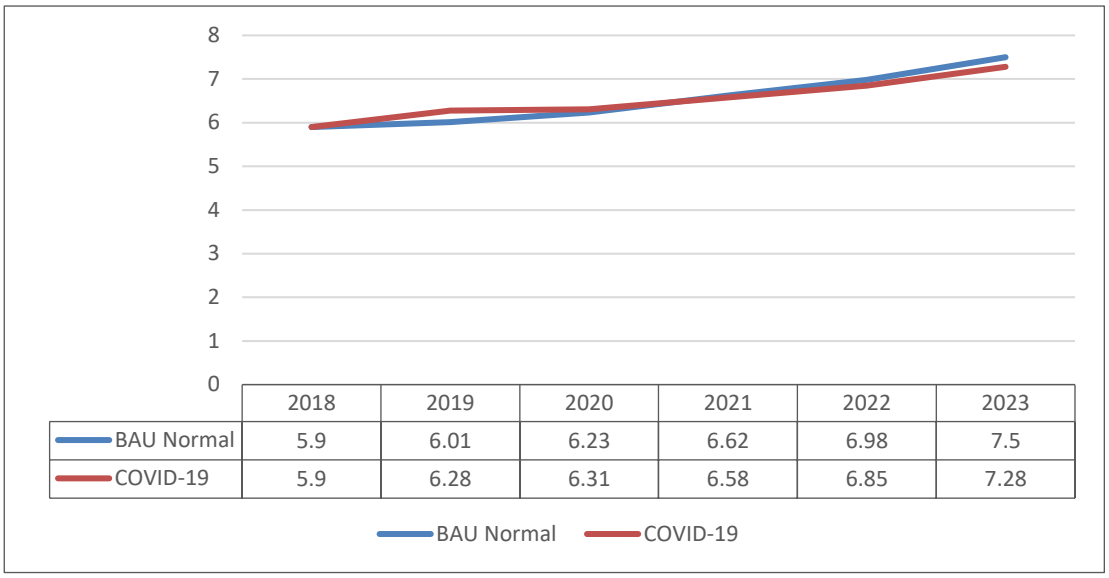
In the COVID-19 scenario, total primary energy supply (TPES) increases by an average of 4.27% per year in 2018–2023, lower only by 0.62% in BAU, reflecting economic recovery after the COVID-19 pandemic.

Table 4.2. Average Annual Growth Rate of Total Primary Energy Supply

TPES (Mtoe)	2018	2019	2020	2021	2022	2023	AAGR, 2018–2023
BAU	5.9	6.01	6.23	6.62	6.98	7.5	4.89%
COVID-19	5.9	6.28	6.31	6.58	6.85	7.28	4.27%

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = millionntonnes of oil equivalent.
Source: Author.

Figure 4.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



GDP = gross domestic product, BAU = business as usual, COVID-19 = coronavirus disease, TPES = total primary energy supply.
Source: Author.

3.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions increase by 5.30% in 2018–2023, 0.09% higher than in BAU.

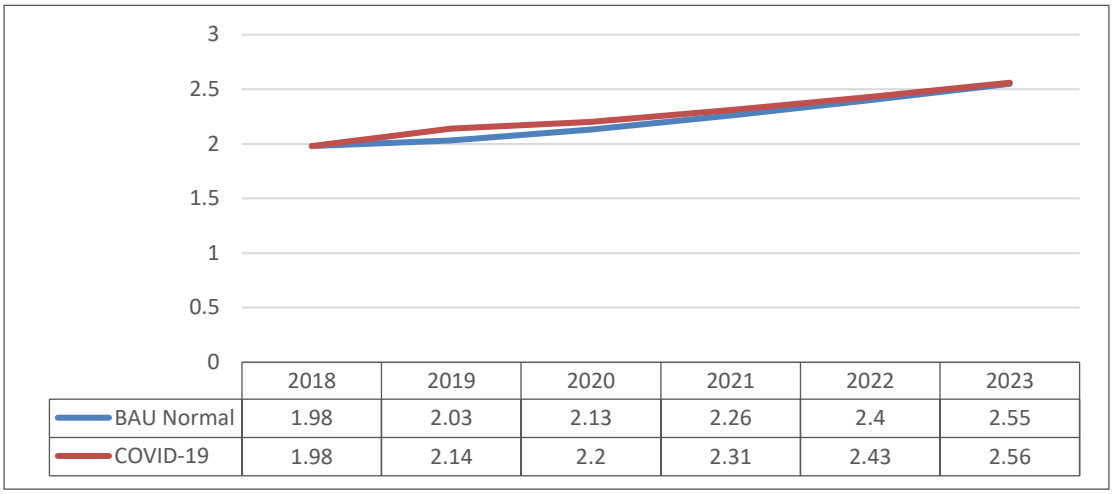
Table 4.3. Average Annual Growth Rate of CO_2 Emissions
(million tonnes carbon equivalent)

	2018	2019	2020	2021	2022	2023	AAGR (2018–2050)
BAU Normal	1.98	2.03	2.13	2.26	2.40	2.55	5.21%
COVID-19	1.98	2.14	2.20	2.31	2.43	2.56	5.30%

AAGR = annual average growth rate, BAU = business as us COVID-19 = coronavirus disease.
Source: Author.

Figure 4.4. CO_2 Emissions, by Source, Business-as-Usual vs. COVID-19 Scenarios, 2018–2023

(million tonnes of carbon dioxide equivalent)



	2018	2019	2020	2021	2022	2023
BAU Normal	1.98	2.03	2.13	2.26	2.4	2.55
COVID-19	1.98	2.14	2.2	2.31	2.43	2.56

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4. Long-term Impact, 2018–2050

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases by an average of 4.9% per year in 2018–2050, 0.59% lower than in BAU, reflecting economic recovery after the COVID-19 pandemic (Table 4.4).

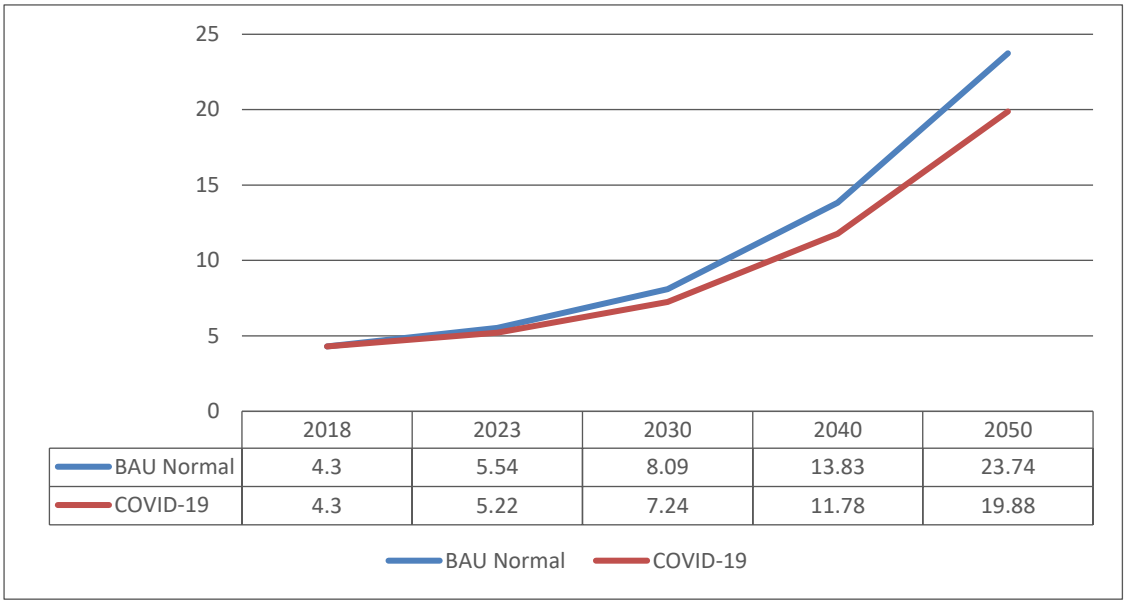
Table 4.4. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

		2018	2023	2030	2040	2050	AAGR (2018–2050)
GDP (KHR trillion, 2010)	BAU	52.97	73.04	115.77	222.88	418.38	6.67%
	COVID-19	52.97	63.06	97.08	182.23	342.07	6%
	Difference	0%	–15.8%	–19.3%	–22.3%	–22.3%	0.67%
TFEC (Mtoe)	BAU	4.3	5.54	8.09	13.83	23.74	5.49%
	COVID-19	4.3	5.22	7.24	11.78	19.88	4.9%
	Difference	0%	–6.1%	–11.7%	–17.14%	–19.4%	0.59%

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Author.

Figure 4.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

(million tonnes of oil equivalent)



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases by 5.15% per year in 2018–2050, 0.61% lower than in BAU, reflecting economic recovery after the COVID-19 pandemic.

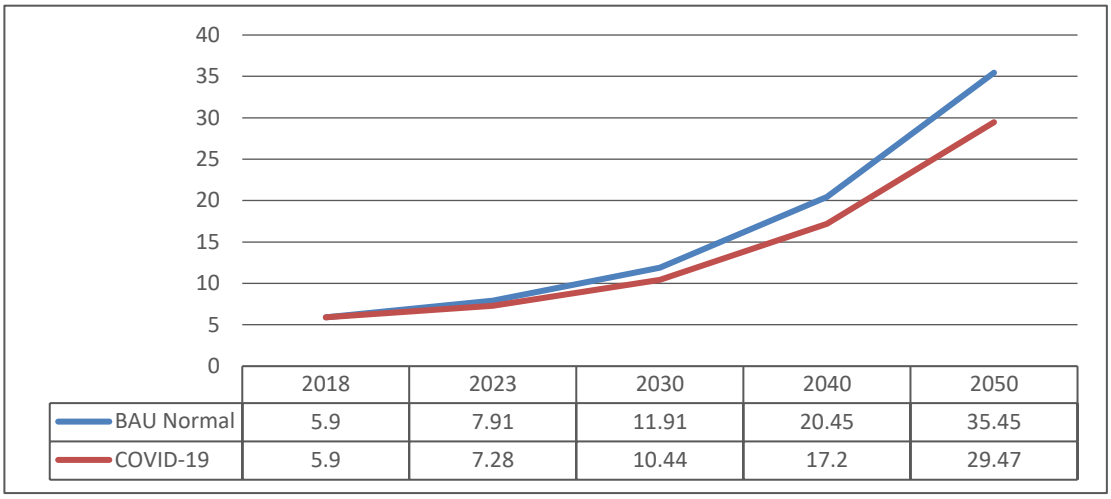
Table 4.5. Average Annual Growth Rate of Total Primary Energy Supply

TPES (Mtoe)	2018	2023	2030	2040	2050	AAGR, 2018–2050
BAU	5.9	7.91	11.91	20.45	35.45	5.76%
COVID-19	5.9	7.28	10.44	17.2	29.47	5.15%

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = million tonnes of oil equivalent.
Source: Author.

Figure 4.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

(million tonnes of oil equivalent)



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions increase by 5.28% in 2018–2050, 0.58% lower than BAU, explaining the slightly decreasing energy supply and demand during the COVID-19 pandemic.

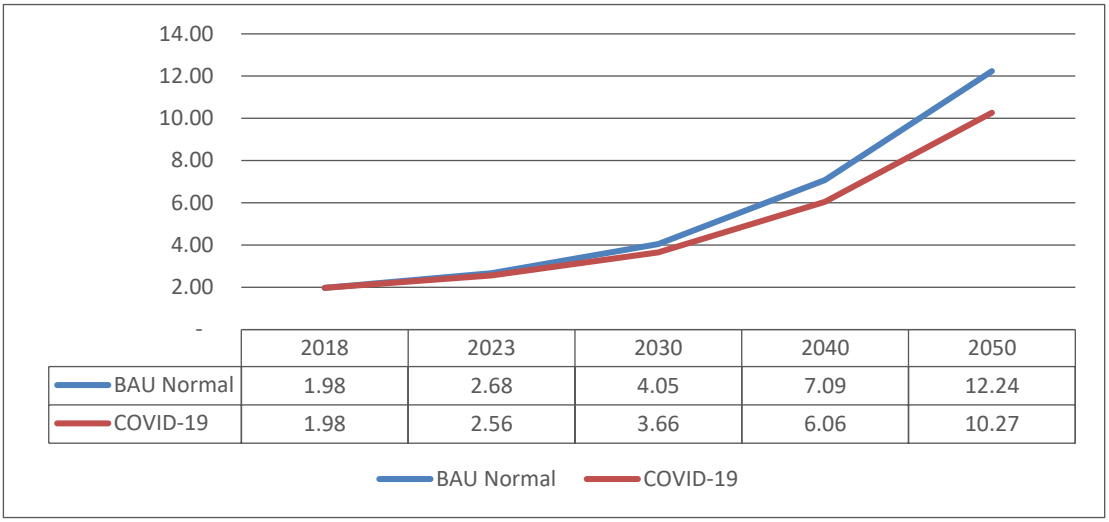
Table 4.6. Average Annual Growth Rate of CO2 emissions in COVID-19 Scenario

(million tonnes carbon equivalent)

	2018	2023	2030	2040	2050	AAGR, 2018–2050
BAU Normal	1.98	2.68	4.05	7.09	12.24	5.86%
COVID-19	1.98	2.56	3.66	6.06	10.27	5.28%

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

Figure 4.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050
(million tonnes of carbon dioxide equivalent)



	2018	2023	2030	2040	2050
BAU Normal	1.98	2.68	4.05	7.09	12.24
COVID-19	1.98	2.56	3.66	6.06	10.27

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

Despite the global pandemic and flash floods in 2020 the International Monetary Fund (IMF) anticipates that Cambodia will rebound to become the third-fastest growing economy in the Association of Southeast Asian Nations (ASEAN) in 2021 and then the region's fastest-growing, by 6.5%, in 2025. Before 2020, when the economy grew by about 7% per annum, electricity demand increased at a much higher rate (15%–23%) than in 2019. If the IMF estimate is correct, rapid growth in electricity demand might be expected and rebound to pre–COVID-19 levels or higher.

The government recognizes that expanding access to modern, affordable, and reliable energy, while lowering greenhouse gas emission intensity, is essential to pursue social and economic development. In recent years, actual electricity demand has exceeded projections and, because of an unexpected drought in 2019, the country faced daily scheduled power cuts for 72 days. Because of the 2019 power shortage and because previous electricity generation planning did not match demand growth, Cambodia prepared a power development master plan in two steps: (i) a short-term master plan to identify urgent projects to generate enough power to mitigate shortages in the near future, and (ii) a development master plan to determine the long-term development vision of the power sector until 2040.

The power development plan has been prepared and steps taken to identify, plan, sign agreements on, and develop projects to prevent a power shortage in the near future. The projects include hydro, coal, and solar power plants. Given Cambodia's solar potential, and as solar power plants need less time than hydro and coal plants to be planned and built, eight solar power plants, with a total capacity of 470 megawatts (MW) were planned in 2019–2021. The first solar power plant (10 MW) was commissioned in 2017 in Svay Rieng Province. Of the

eight solar plants planned, one (90 MW) was commissioned in Kampong Speu Province in 2019. The 60 MW first stage of the 100 MW solar park planned in Kampong Chhanang Province under an Asian Development Bank (ADB)–supported project was tendered by Electricité du Cambodge. A Thailand corporation offered the lowest bid ($0.3877 per kilowatt-hour) and was awarded the contract. The government has started discussing the development of the first wind power project.

The Ministry of Mines and Energy (MME) and ADB are studying a power development plan to integrate more renewable energy and clean energy into the grid system. ADB is supporting the effort through technical assistance (Support for a Sustainable Cambodia Power Sector), funded by the Clean Energy Financing Partnership Facility and the Clean Technology Fund Business Development Facility under the Climate Investment Funds.

The energy generation mix has been based on conventional sources—coal and hydro—but, as the country looks forward to 2040, a wider range of technologies are available. Liquefied natural gas and renewable energy will be crucial after 2027. To lower greenhouse gas emissions, MME is working with ADB to develop a utility-scale battery energy storage system to open opportunities for more variable renewable energy development, while working with different partners on energy efficiency projects.

MME's goal is to maximise the utilization of clean energy and mitigate climate change. At the same time, however, the country needs to ensure that future development reliably meets maximum demand at minimum cost while maintaining energy security. This aspiration is reflected in the 2020–2040 Power Development Plan supported by ADB.

Cambodia is committed to reduce greenhouse gas emissions, including from electricity generation. MME is expecting to support more renewable energy generation and energy-efficient projects, which offer opportunities for private investors and the government to work together to mobilize investments and finance.

The following actions are recommended:

(i) **Establish targets and a road map for energy efficiency and conservation.** The targets should be set up for the short, medium, and long term and focus on buildings and industry. The long-term plan should be based on an assessment of energy-saving potential for all energy sectors, including the residential and commercial sectors, which have large potential for energy saving up to 2050. Some activities can promote energy efficiency and conservation:

(a) Support the development of energy conservation professionals responsible for energy management and operation, verification and monitoring, consultancy and engineering service provision and planning, and supervision and implementation of energy conservation measures.

(b) Support the development of the institutional capability of public and private sector agencies and organisations responsible for planning, supervision, promotion, and implementation of energy conservation measures.

(c) Support the operation of energy service companies to alleviate the technical and financial risks of entrepreneurs wishing to implement energy conservation measures.

(d) Share knowledge related to energy conservation with the public through educational institutions, and foster youth awareness.

(ii) **Require energy labelling for electrical appliances.** Annual growth of residential and commercial electricity demand is projected to be higher than in other sectors. Compulsory energy labelling for electrical appliances could be an effective management measure to generate energy savings.

(iii) **Prioritise the development of advanced hydro and coal thermal power technology.** Hydro and coal thermal power plants will be major power generators up to 2050. Advanced technologies for both resources should be prioritised for energy conservation and emission mitigation.

(iv) **Prioritise renewable energy development.** Renewable energy is important for energy independence, energy security, and greenhouse gas emission abatement. A strategy and mechanisms to support renewable energy development must be established.

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Chapter 5

China Country Report

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1. Background

Since the outbreak of the coronavirus disease (COVID-19) pandemic, the rampant expansion of infection has threatened the global economy, society, and public health. Despite China being hit hardest at the beginning, its responses—such as policies to lock down cities, shut down businesses, and impose social distancing—allowed it to bring the outbreak under control and resume production. As it recovered, China has continued to make significant progress in various areas, such as overall success in poverty alleviation, enhanced vitality in market bodies, outstanding achievements in pollution control, and rapid development in emerging technology industries. Against this background, this chapter assesses the short- and long-term impacts of the COVID-19 pandemic on energy and recommends policies.

2. Macro Assumptions of the COVID-19 Scenario

The COVID-19 pandemic severely inhibited economic growth. Although gross domestic product (GDP) grew by 2.3% in 2020—allowing it to top CNY100 trillion for the first time—growth was more sluggish than in recent years, when it fluctuated at about 6%. However, a sharp economic rebound is expected. The growth rate peaks in 2021—7.0% in the COVID-19 and 10.4% in the business-as-usual (BAU) scenarios—and then slows down in both. In the COVID-19 scenario, the growth rate is 5.8% in 2022 and 5.7% in 2023, above the BAU level. In the short term, the annual growth rate in the COVID-19 scenario is 5.4% during 2020–2030 (5.7% in BAU). In the long term, the growth rate in the COVID-19 scenario gradually converges with that in BAU, indicating that the economy may finally adapt to the pandemic impacts. Economic growth in the two scenarios becomes identical in 2030–2040 (4.1%) and 2040–2050 (2.7%) (Table 5.1). However, in the forecast to 2050, the GDP level in the COVID-19 scenario is constantly lower than in BAU, implying that the pandemic shock is profound.

Table 5.1. Assumptions of Gross Domestic Product and Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2020–2030	2030–2040	2040–2050
COVID-19	6.3%	6.1%	2.3%	7.0%	5.8%	5.7%	5.4%	4.1%	2.7%
BAU	6.3%	6.1%	2.3%	10.4%	5.7%	5.6%	5.7%	4.1%	2.7%

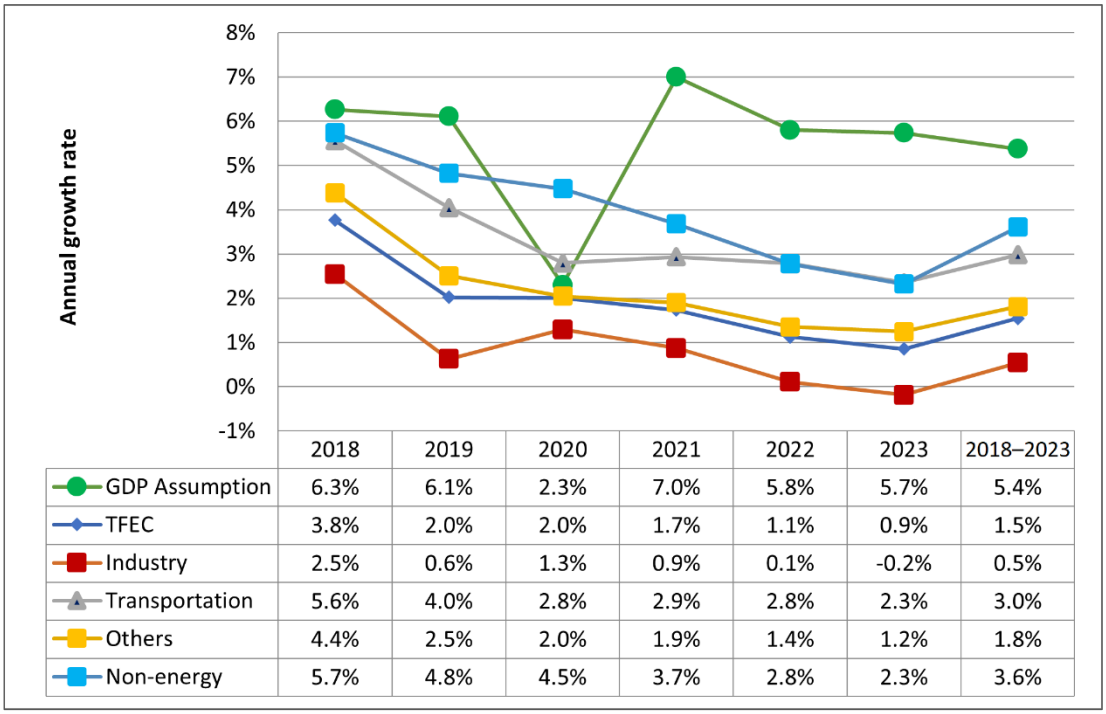
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Economic Research Institute for ASEAN and East Asia, based on International Monetary Fund data for 2020.

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

Figure 5.1 shows the annual growth rate of total final energy consumption (TFEC) by sector from 2018 to 2023 in the COVID-19 scenario. Overall, TFEC increases by 2% in 2020, maintaining the same growth rate as in 2019. TFEC increases by 1.7% in 2021 and 1.1% in 2022 (2.1% and 1.2% in BAU). By 2023, the growth rate of TFEC in the two scenarios tends towards the same level of 0.9%. From 2018 to 2023, TFEC grows at an annual average rate of 1.5% (1.6% in BAU), resulting in a persistent TFEC gap between the scenarios. The lockdown policy and stay-at-home order severely restricted transport, resulting in the most substantial decrease in TFEC growth in transport, from 4.0% in 2019 to 2.8% in 2020. However, industry sees accelerated TFEC growth, from 0.6% in 2019 to 1.3% in 2020. People spending more time at home leads to increased residential energy consumption. From 2018 to 2023, the annual growth rate of TFEC in the non-energy sector is 3.6%, more than in other sectors. TFEC in transport increases by 3.0% and in industry by 0.5% in 2018–2023, while other uses increase by 1.8% per year.

Figure 5.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023

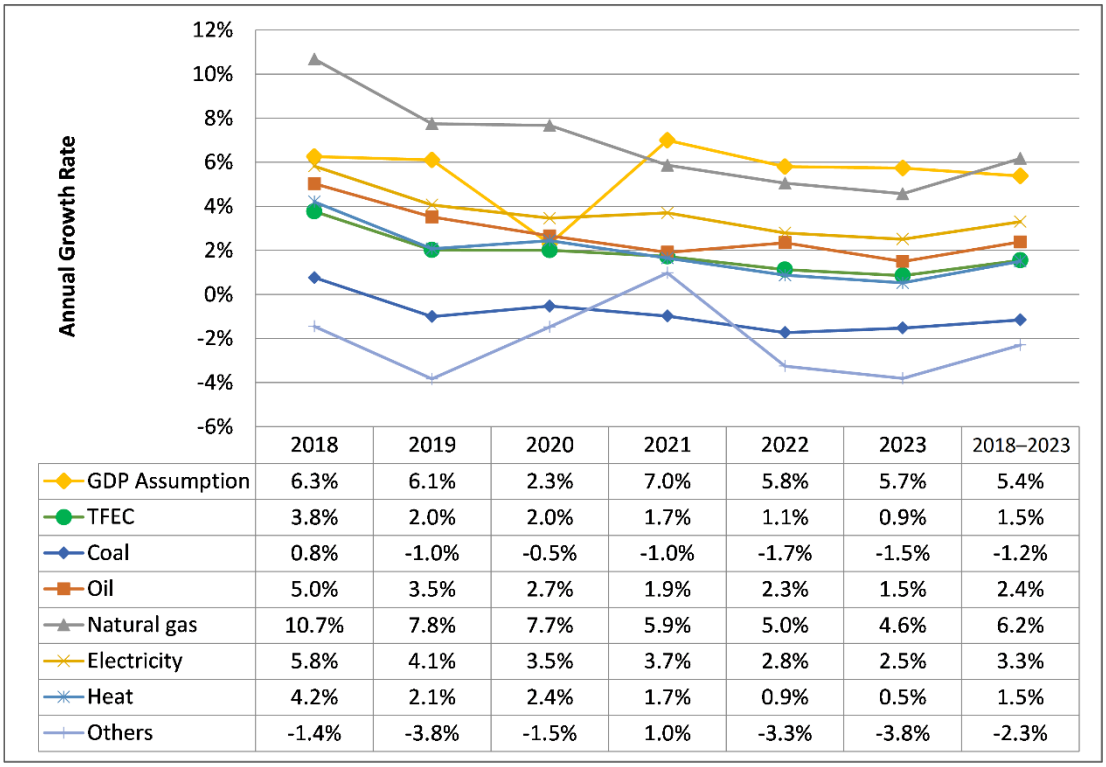


	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.3%	6.1%	2.3%	7.0%	5.8%	5.7%	5.4%
TFEC	3.8%	2.0%	2.0%	1.7%	1.1%	0.9%	1.5%
Industry	2.5%	0.6%	1.3%	0.9%	0.1%	-0.2%	0.5%
Transportation	5.6%	4.0%	2.8%	2.9%	2.8%	2.3%	3.0%
Others	4.4%	2.5%	2.0%	1.9%	1.4%	1.2%	1.8%
Non-energy	5.7%	4.8%	4.5%	3.7%	2.8%	2.3%	3.6%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Economic Research Institute for ASEAN and East Asia.

In the COVID-19 scenario, coal consumption decreases by 1.2% per year in 2018–2023, while TFEC of other sources grows at varying rates (Figure 5.2.). Natural gas consumption expands at an annual growth rate of 6.2% in 2018–2023, followed by electricity (3.3%), and oil (2.4%), while heat consumption grows by 1.5%. Consumption of other energy types, such as biomass, decreases by 2.3% per year. As shares of TFEC, oil is relatively stable, coal declines, and electricity and natural gas rise.

Figure 5.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



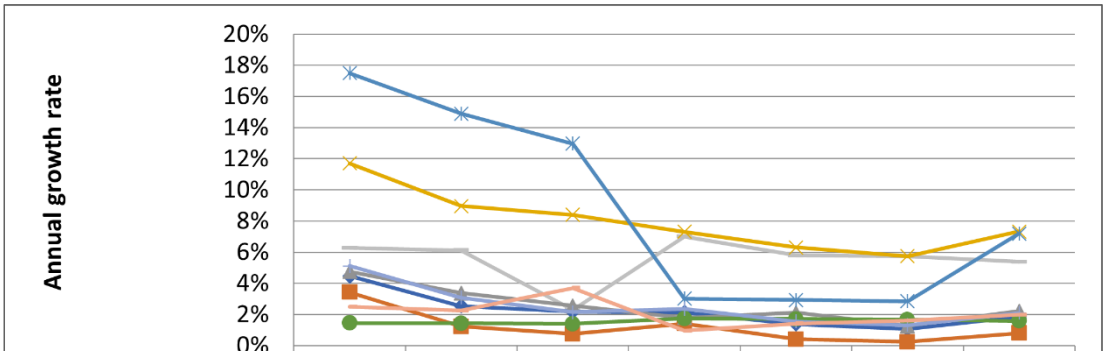
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.3%	6.1%	2.3%	7.0%	5.8%	5.7%	5.4%
TFEC	3.8%	2.0%	2.0%	1.7%	1.1%	0.9%	1.5%
Coal	0.8%	-1.0%	-0.5%	-1.0%	-1.7%	-1.5%	-1.2%
Oil	5.0%	3.5%	2.7%	1.9%	2.3%	1.5%	2.4%
Natural gas	10.7%	7.8%	7.7%	5.9%	5.0%	4.6%	6.2%
Electricity	5.8%	4.1%	3.5%	3.7%	2.8%	2.5%	3.3%
Heat	4.2%	2.1%	2.4%	1.7%	0.9%	0.5%	1.5%
Others	-1.4%	-3.8%	-1.5%	1.0%	-3.3%	-3.8%	-2.3%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Economic Research Institute for ASEAN and East Asia.

3.2. Primary Energy Supply

Figure 5.3 demonstrates the annual growth rate of total primary energy supply (TPES) by source in 2018–2023. In the COVID-19 scenario, TPES increases by 2.2% in 2020 (2.5% in 2019), and by 1.9% per year in 2018–2023 (2.0% in BAU). TPES decreases for coal (0.7% in 2020 from 1.2% in 2019), oil (2.5% from 3.4%), and geothermal energy (2.1% from 3.1%), and is projected to increase by 0.8% for coal, 2.2% for oil, and 2.1% for geothermal in 2018–2023. The growth rates of natural gas, nuclear, and hydro energy are less influenced by events in 2020. As China transitions to clean energy in the industrial and residential sectors, natural gas increases by 7.3% and nuclear supply by 7.2% in 2018–2023, faster than other energy types.

Figure 5.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



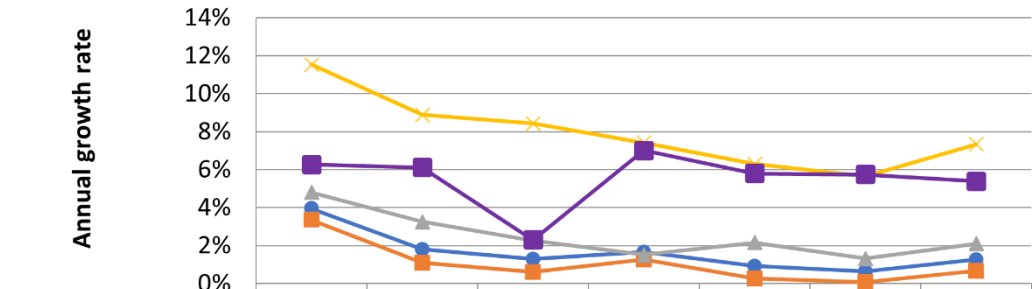
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.3%	6.1%	2.3%	7.0%	5.8%	5.7%	5.4%
TPES	4.5%	2.5%	2.2%	2.1%	1.4%	1.1%	1.9%
Coal	3.4%	1.2%	0.7%	1.4%	0.4%	0.2%	0.8%
Oil	4.7%	3.4%	2.5%	1.8%	2.1%	1.3%	2.2%
Natural gas	11.7%	8.9%	8.4%	7.3%	6.3%	5.7%	7.3%
Nuclear	17.5%	14.9%	13.0%	3.0%	2.9%	2.8%	7.2%
Hydro	1.4%	1.4%	1.4%	1.7%	1.7%	1.7%	1.6%
Geothermal	5.1%	3.1%	2.1%	2.3%	1.6%	1.3%	2.1%
Others	2.5%	2.2%	3.7%	0.9%	1.4%	1.6%	2.0%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Economic Research Institute for ASEAN and East Asia.

3.3. CO_2 Emissions

Because of restricted traffic and industrial activity during the pandemic, China's CO_2 emissions increases by 1.3% in 2020 (1.8% in 2019) (Figure 5.4). CO_2 emissions grow by 1.3% per year in 2018–2023 (1.4% in BAU). CO_2 emissions from coal decrease from 1.1% in 2019 to 0.6% in 2020 and oil from 3.2% to 2.3%. In 2018–2023, CO_2 emissions from coal increase by 0.7% in the COVID-19 scenario (0.8% in BAU). CO_2 emissions from oil in 2018–2023 grow by 2.1% in the two scenarios. CO_2 emissions from natural gas decrease less obviously from 8.9% in 2019 to 8.4% in 2020. In 2018–2023, CO_2 emissions from natural gas grow by 7.3% per year in the two scenarios. The difference in annual growth rate of CO_2 emissions by source in the two scenarios indicates that the pandemic may accelerate coal replacement, with little impact on oil and natural gas in the short term.

Figure 5.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
Total	3.9%	1.8%	1.3%	1.7%	0.9%	0.6%	1.3%
Coal	3.3%	1.1%	0.6%	1.3%	0.3%	0.1%	0.7%
Oil	4.8%	3.2%	2.3%	1.5%	2.1%	1.3%	2.1%
Natural Gas	11.5%	8.9%	8.4%	7.4%	6.3%	5.7%	7.3%
GDP Assumption	6.3%	6.1%	2.3%	7.0%	5.8%	5.7%	5.4%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Economic Research Institute for ASEAN and East Asia.

4. Long-term Impact (2017–2050)

4.1. Final Energy Consumption

The growth rates for GDP and TFEC in the COVID-19 scenario are nearly identical to those in BAU for 2017–2050 (Table 5.2), indicating weakening pandemic influence on energy consumption in the long term. In the COVID-19 scenario, GDP increases by 4.1% per year in 2017–2050 (4.2% in BAU). TFEC grows by 0.4% in the two scenarios.

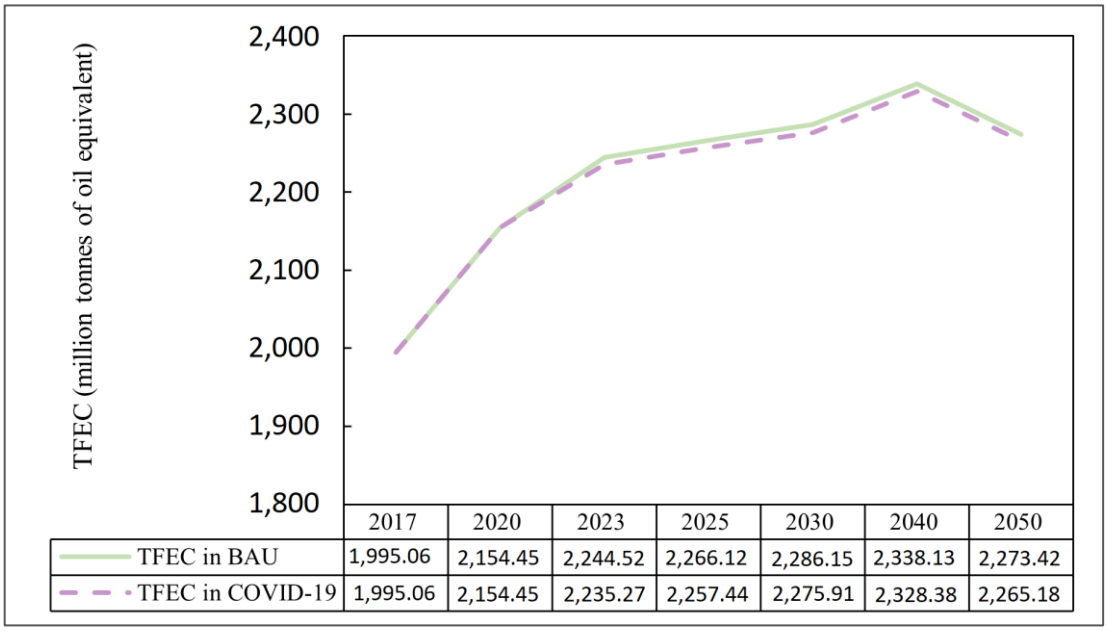
Table 5.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2012–2050)
GDP (constant $ billion, 2010)	BAU	10,161	14,450	20,439	30,536	39,687	4.2%
	COVID-19	10,161	14,029	19,908	29,743	38,657	4.1%
	COVID-19 vs. BAU	0.0	-2.9%	-2.6%	-2.6%	-2.6%	
TFEC (Ktoe)	BAU	1,995,056.9	2,244,523.0	2,286,148.5	2,338,129.8	2,273,418.5	0.4%
	COVID-19	1,995,056.9	2,235,273.8	2,275,905.0	2,328,384.8	2,265,183.0	0.4%
	COVID-19 vs. BAU	0.0	-0.4%	-0.4%	-0.4%	-0.4%	

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Ktoe = kilotonne of oil equivalent, TFEC = total final energy consumption.
Source: Economic Research Institute for ASEAN and East Asia.

After the pandemic, TFEC and GDP in the COVID-19 scenario are lower than in BAU (Figure 5.5). Because of the optimized industry structure and improved energy efficiency, TFEC decreases by about 0.3% per year in 2040–2050 in both scenarios. In 2017–2050, TFEC increases by 0.4% per year in both scenarios. However, identifying when TFEC peaks is a challenge.

Figure 5.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



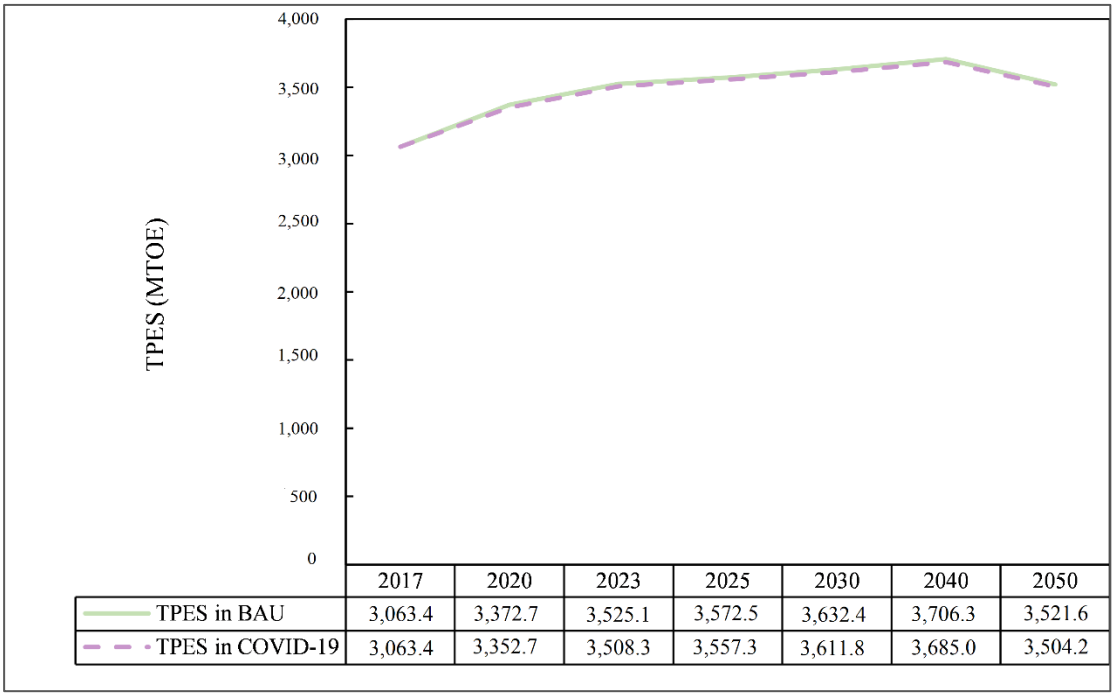
	2017	2020	2023	2025	2030	2040	2050
TFEC in BAU	1,995.06	2,154.45	2,244.52	2,266.12	2,286.15	2,338.13	2,273.42
TFEC in COVID-19	1,995.06	2,154.45	2,235.27	2,257.44	2,275.91	2,328.38	2,265.18

BAU = business as usual, COVID-19 = coronavirus disease, TFEC = total final energy consumption.
Source: Economic Research Institute for ASEAN and East Asia.

4.2. Primary Energy Supply

As the pandemic takes a turn for the better in China, the energy system gradually resumes production. TPES is projected to increase at an average growth rate of 0.42% in 2017–2050 in BAU and 0.41% per year in the COVID-19 scenario. TPES in the two scenarios is similarly close and the peak time is hard to identify based on Figure 5.6.

Figure 5.6. Total Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



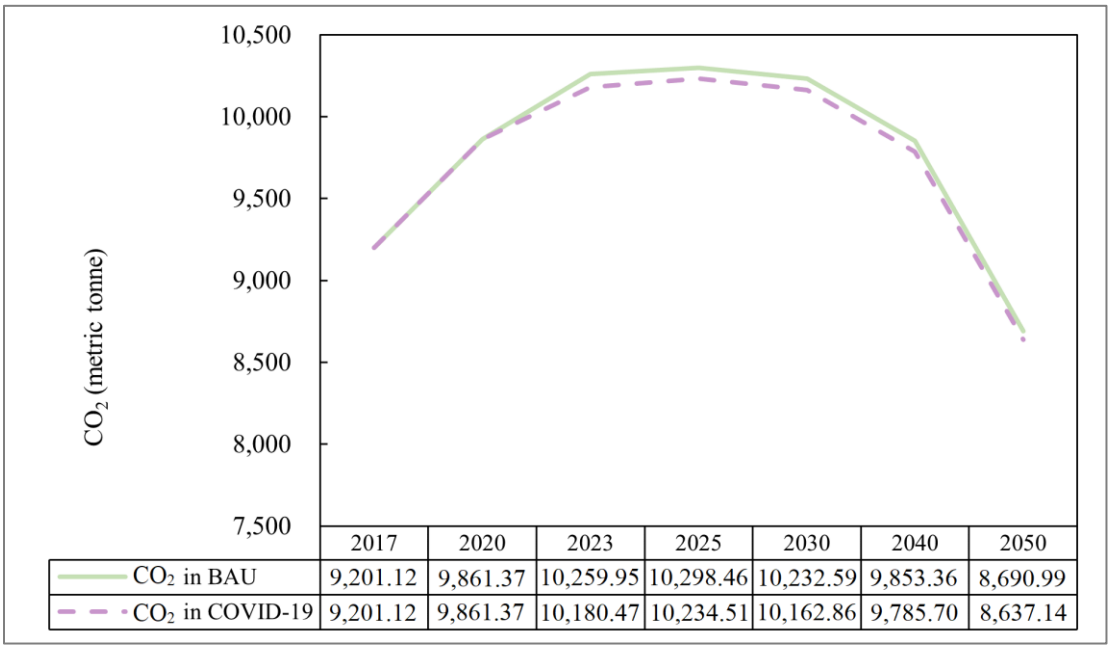
	2017	2020	2023	2025	2030	2040	2050
TPES in BAU	3,063.4	3,372.7	3,525.1	3,572.5	3,632.4	3,706.3	3,521.6
TPES in COVID-19	3,063.4	3,352.7	3,508.3	3,557.3	3,611.8	3,685.0	3,504.2

BAU = business as usual, COVID-19 = coronavirus disease, TPES = total primary energy supply.
Source: Economic Research Institute for ASEAN and East Asia.

4.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions are lower than in BAU (Figure 5.7) and projected to decrease by 0.19% in 2017–2050 (0.17% in BAU). In the long term, the pandemic reduces energy consumption and results in less CO_2 emissions in the COVID-19 scenario than in BAU. CO_2 emissions continue to rise until 2025 (10,234.5 metric tonnes) in the COVID-19 scenario. More efforts are needed to reduce CO_2 emissions to achieve carbon peak before 2030. CO_2 emissions are reduced by 15.6% in 2050 from 2025 levels in the COVID-19 scenario.

Figure 5.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2020	2023	2025	2030	2040	2050
CO_2 in BAU	9,201.12	9,861.37	10,259.95	10,298.46	10,232.59	9,853.36	8,690.99
CO_2 in COVID-19	9,201.12	9,861.37	10,180.47	10,234.51	10,162.86	9,785.70	8,637.14

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Economic Research Institute for ASEAN and East Asia.

5. Implications and Policy Recommendations

The COVID-19 outbreak impaired China's economy and social development. The lockdowns and social distancing severely restricted business, transport, and trade, slowing economic growth in 2020. Energy supply and demand fluctuated significantly in 2020 and threatened energy security. As China recovers, the economic growth rate gap between the COVID-19 and BAU scenarios will narrow. Therefore, the influence of the pandemic on energy may fade in the long term. To achieve carbon peak and carbon neutralization goals, the share of coal in TFEC must continue to decrease, the energy system be decarbonised, and the industry structure optimised. However, the pandemic has profoundly influenced public sentiment, expectations of investors, and basic lifestyles, giving rise to uncertainties in economic recovery. Three policies are, therefore, recommended:

(i) The disruption brought about by the pandemic has not dramatically altered the expected BAU energy trajectory, while China continues to face many post-pandemic uncertainties. To achieve carbon peak and carbon neutrality, the goals of economic growth should shift from total expansion to quality improvement in the post-pandemic era, requiring a clean, efficient, low-carbon energy system. To control carbon emissions and mitigate air pollution, economic growth should be gradually decoupled from fossil energy consumption, requiring upgradation of the energy structure. Therefore, solar and wind energy development should accelerate to meet mounting energy demand. The transition pattern should vary by sector. Specifically, the electrification of vehicles should be encouraged in transport. Traditional fuels such as wood, straw, and coal should be gradually replaced by cleaner energy such as electricity and natural gas in

the residential sector, especially in rural areas. In industry, the increased proportion of cleaner energy should be combined with carbon capture, utilisation, and storage technology to control carbon emissions.

(ii) The pandemic threatened energy security, raising concerns about the security and sustainability of the energy system. Considering the high dependence of oil and natural gas on imports, a stable energy reserve for emergencies is highly significant. The renewable energy sector, however, should guarantee adequate storage of essential raw materials and renewable energy semi-products. Gaining technological independence in renewable production is crucial to maintain energy security.

(iii) The pandemic created sophisticated and non-linear variations in the energy market, such as extreme fluctuation of crude oil prices, suggesting that historical experience cannot be applied to the pandemic situation. Policymakers and researchers should establish a more flexible and comprehensive model to predict energy demand, energy price, and supply ability to formulate a more reasonable and feasible energy policy. The pandemic may affect climate change, which should receive more attention from scholars and policymakers.

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Chapter 6

India Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has significantly challenged the global economy and energy system. The pandemic has grounded economic activities, disrupted livelihoods, affected economies, and stretched health facilities. It has revealed salient lapses and lack of resilience in the design of economic and social systems. It has given rise to new practices and social norms that have greatly impacted energy supply, energy demand, and environmental emissions. Its spatial and temporal implications vary and India has not been exempt from its energy system impacts (Aruga et al., 2020). This chapter examines the short- and long-term implications of the COVID-19 pandemic on India's energy demand and supply using the India energy outlook model,[5] which was updated for *Energy Outlook and Energy Saving Potential in Potential in East Asia, 2019* (ERIA, 2020). The chapter highlights energy-related lessons and emerging opportunities for India's energy sector and economy in a post–COVID-19 era.

2. Macro Assumptions of the COVID-19 Scenario

India's preliminary annual growth rate of gross domestic product (GDP) in 2020 is –6.5% (10.9% in the business-as-usual [BAU] scenario) and rebounds to 11% in 2021, 10.5% in 2022, and 10.5% in 2023. In 2018–2023, the growth rate is 5.7% per annum (7.6% in BAU) (Table 6.1).

In the long term (2017–2050), annual GDP growth rate is 5.6% per annum (5.7% in BAU). For 2017–2023, per annum GDP in COVID-19 scenario is 5.9% (7.5% in BAU) (Table 6.2).

[5] Based on The Institute of Energy Economics, Japan model and assumptions.

Table 6.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2023

	2018	2019	2020	2021	2022	2023	2018–2023
BAU	6.8%	4.2%	10.9%	7.7%	7.7%	7.7%	7.6%
COVID-19	6.8%	4.2%	–6.5%	11.0%	10.5%	10.5%	5.7%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors, based on International Monetary Fund (2020) data.

Table 6.2. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

GDP annual growth rate	2017–2023	2023–2030	2030–2040	2040–2050
BAU	7.5%	6.3%	5.0%	4.0%
COVID-19	5.9%	7.5%	5.0%	4.0%

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Authors, based on International Monetary Fund (2020) data.

Table 6.3. Gross Domestic Product, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050
(US$ billion, 2010)

	2017	2023	2030	2040	2050	AAGR, 2017–2050
BAU	2,651	4,091	6,273	10,518	16,320	5.7%
COVID-19	2,651	3,738	6,190	10,378	16,103	5.6%

AAGR = annual average growth rate, BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors, based on International Monetary Fund (2020) data.

3. Short-term Impact (2018–2023)

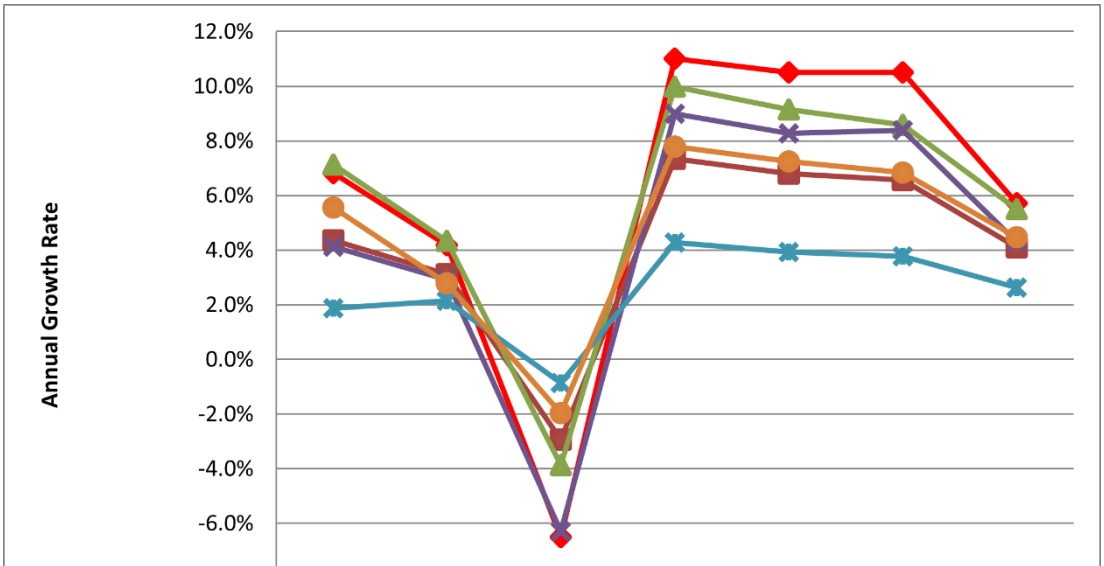
3.1. Final Energy Consumption

In the COVID-19 scenario, GDP is altered relative to BAU to elucidate the negative impacts of COVID-19 on the economy. Figure 6.1 shows that total final energy consumption (TFEC) dropped by 2.9% in 2020. However, it grows at an average annual rate of 4.1% in 2018–2023, about 1 percentage point less than in BAU because of the COVID-19 pandemic's impact in 2020, which affects earlier BAU assumptions.

The largest reduction in energy demand growth rate in 2020 is in transport (–6.3%) because a significant segment of society worked from home to combat the pandemic and, therefore, did not travel as much. Energy demand growth in industry was –3.9%, non-energy –2.0%, and residential and commercial sectors ('others') –0.9%. However, average annual growth rates in 2018–2023 differ from the 2020 trend because of COVID-19–induced changes in each sector. Industry has the largest growth rate per annum (5.5%), followed by non-energy (4.5%),

transport (4.3%), and 'others' (2.6%). Compared with BAU, average growth rates in 2018–2023 are reduced by about 1.5 percentage points for industry, 1.3 for transport, 0.5 for 'others', and 1 for non-energy (Figure 6.1).

Figure 6.1. Annual Growth Rate of Total Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



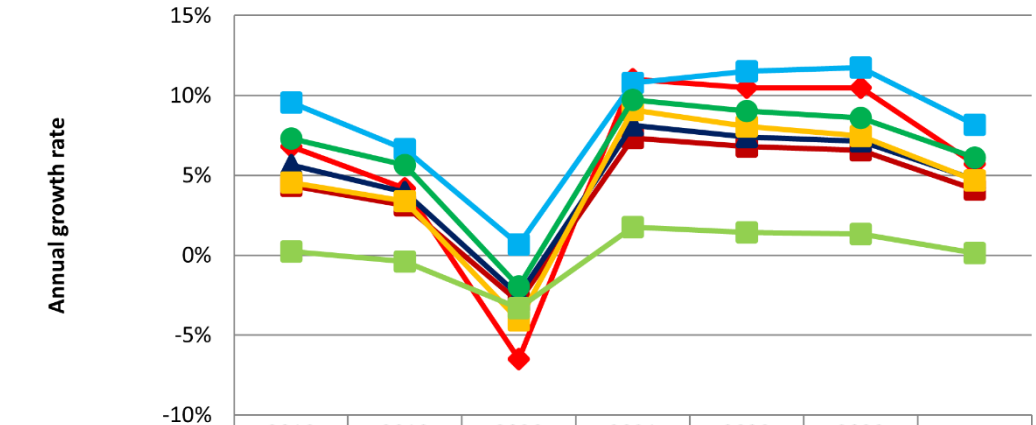
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.8%	4.2%	-6.5%	11.0%	10.5%	10.5%	5.7%
TFEC	4.4%	3.1%	-2.9%	7.3%	6.8%	6.6%	4.1%
Industry	7.1%	4.3%	-3.9%	10.0%	9.1%	8.6%	5.5%
Transportation	4.1%	2.9%	-6.3%	9.0%	8.3%	8.4%	4.3%
Others	1.9%	2.2%	-0.9%	4.3%	3.9%	3.8%	2.6%
Non-energy	5.6%	2.8%	-2.0%	7.8%	7.2%	6.8%	4.5%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

In the COVID-19 scenario, the largest decrease in energy consumption growth rate in 2020 occurs in oil (–4.1%). The automobile sector is dominated by oil-fuelled vehicles. Hence, the strong reduction in oil demand is on account of limited vehicle transport because of COVID-19 restrictions. The second-largest reduction in 2020 is in 'others' (–3.3%), followed by coal (–2.5%), and electricity (–2.0%). No negative growth rate is observed for natural gas, consumption of which grew by 0.6% because of the population increase and residential demand for natural gas irrespective of the pandemic's lockdown effects. For 2018–2023, natural gas has the strongest average growth rate per annum (8.2%), followed by electricity (6.1%) and coal and oil (4.7% each). The average annual growth rate of 'others' in 2018–2023 is about 0.1%. Compared with BAU, these values correspond to reductions of about 1.5 percentage points for coal, 0.9 for oil, 1.5 for natural gas, 1.3 for electricity, and 0.5 for 'others'. Consumption is reduced across all fuels; no energy carrier is immune to the effects of COVID-

19 in the short term. As the economic growth rate of India declines, its energy consumption follows suit (Figure 6.2).

Figure 6.2. Annual Growth Rate of Total Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



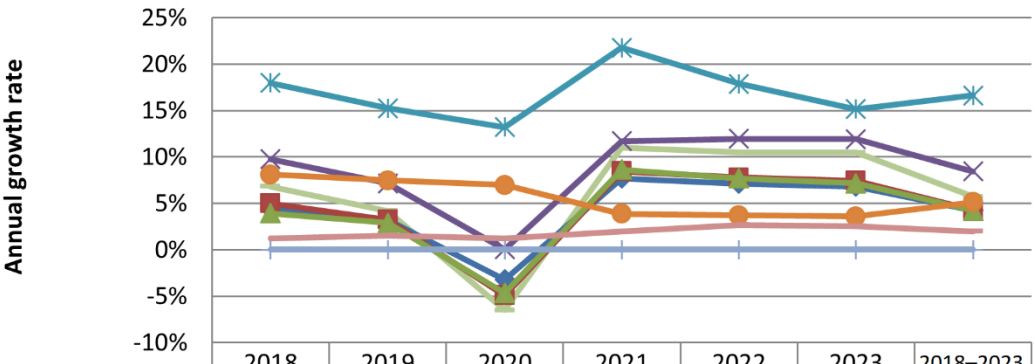
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.8%	4.2%	-6.5%	11.0%	10.5%	10.5%	5.7%
TFEC	4.4%	3.1%	-2.9%	7.3%	6.8%	6.6%	4.1%
Coal	5.7%	4.0%	-2.5%	8.1%	7.4%	7.1%	4.7%
Oil	4.5%	3.4%	-4.1%	9.1%	8.1%	7.5%	4.7%
Gas	9.6%	6.6%	0.6%	10.8%	11.5%	11.7%	8.2%
Electricity	7.3%	5.6%	-2.0%	9.7%	9.0%	8.6%	6.1%
Others	0.2%	-0.4%	-3.3%	1.8%	1.4%	1.3%	0.1%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) declines by 3.2% in 2020 but increases by 4.3% per year in 2018–2023 (5.4% in BAU) (Figure 6.3). In 2020, the primary energy supply growth rate decreases the most for coal (4.9%) and rebounds to 4.3% per year in 2018–2023 (5.8% in BAU). The reason is fluctuation of electricity demand caused by the COVID-19 pandemic after 2020. The oil supply growth rate declines by 4.7% in 2020 and by 4.2% per year in 2018–2023, corresponding to about a 1 percentage point reduction in 2018–2023 compared with BAU. Other primary energy sources' growth rates in 2020 are 0% for natural gas, 13.2% for nuclear, 7% for hydro, and 1.2% for 'others'. In 2018–2023, their average annual growth rates are 8.5% for natural gas, 16.6% for nuclear, 5.1% for hydro, and 2% for 'others'. 'Others' (mostly renewables) continuously add capacity during the pandemic and are not negatively affected by the restrictions.

Figure 6.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



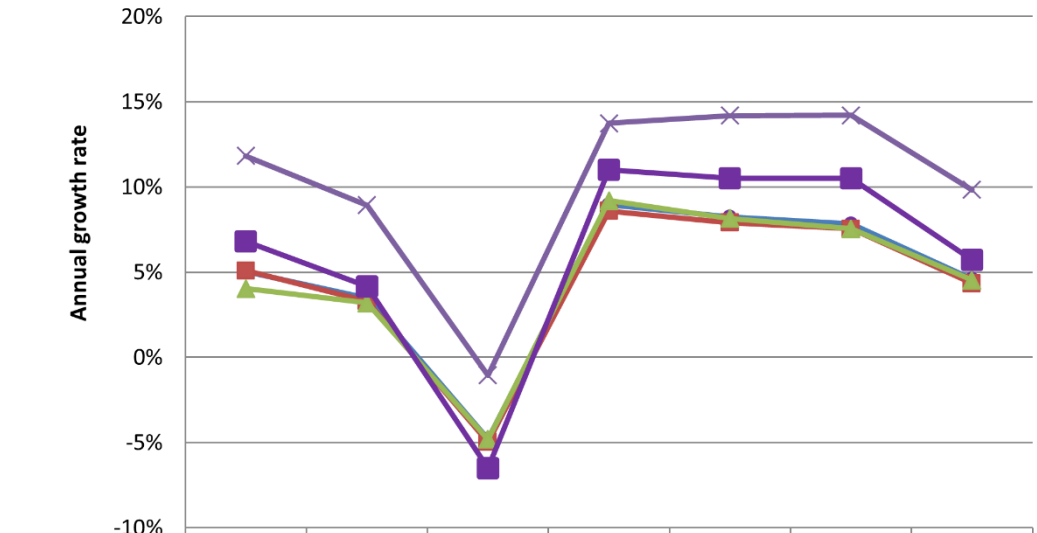
	2018	2019	2020	2021	2022	2023	2018–2023
GDP	6.8%	4.2%	-6.5%	11.0%	10.5%	10.5%	5.7%
TPES	4.4%	3.3%	-3.2%	7.7%	7.1%	6.8%	4.3%
Coal	5.0%	3.2%	-4.9%	8.5%	7.8%	7.4%	4.3%
Oil	3.9%	2.9%	-4.7%	8.6%	7.7%	7.2%	4.2%
Natural gas	9.8%	7.2%	0.0%	11.7%	11.9%	11.9%	8.5%
Nuclear	18.0%	15.2%	13.2%	21.8%	17.9%	15.2%	16.6%
Hydro	8.1%	7.5%	7.0%	3.9%	3.7%	3.6%	5.1%
Geothermal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Others	1.2%	1.5%	1.2%	2.0%	2.7%	2.6%	2.0%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Authors.

3.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions in 2020 fall by 4.8% and then grow by 4.6% per annum in 2018–2023 (about 1.4% less than in BAU) (Figure 6.4). In 2020, coal has the strongest reduction rate, with 5%, followed by oil (4.8%) and natural gas (1.1%). As expected, as coal and oil consumption drop, so do their associated CO_2 emissions. However, in 2018–2023, the growth rate per annum of CO_2 emissions is positive, with natural gas having the strongest growth rate (9.8%), followed by oil (4.5%) and coal (4.3%) These values correspond to reductions in BAU of about 2.1% for natural gas, 1% for oil, and 1.6% for coal. The CO_2 emission reduction is mostly derived from COVID-19's impact. While COVID-19's impact may be negative for economies, it may be climate-friendly.

Figure 6.4. CO_2 Emissions by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
Total	5.0%	3.5%	-4.8%	9.0%	8.2%	7.8%	4.6%
Coal	5.1%	3.3%	-5.0%	8.6%	7.9%	7.5%	4.3%
Oil	4.0%	3.2%	-4.8%	9.2%	8.1%	7.6%	4.5%
Natural Gas	11.8%	8.9%	-1.1%	13.7%	14.2%	14.2%	9.8%
GDP	6.8%	4.2%	-6.5%	11.0%	10.5%	10.5%	5.7%

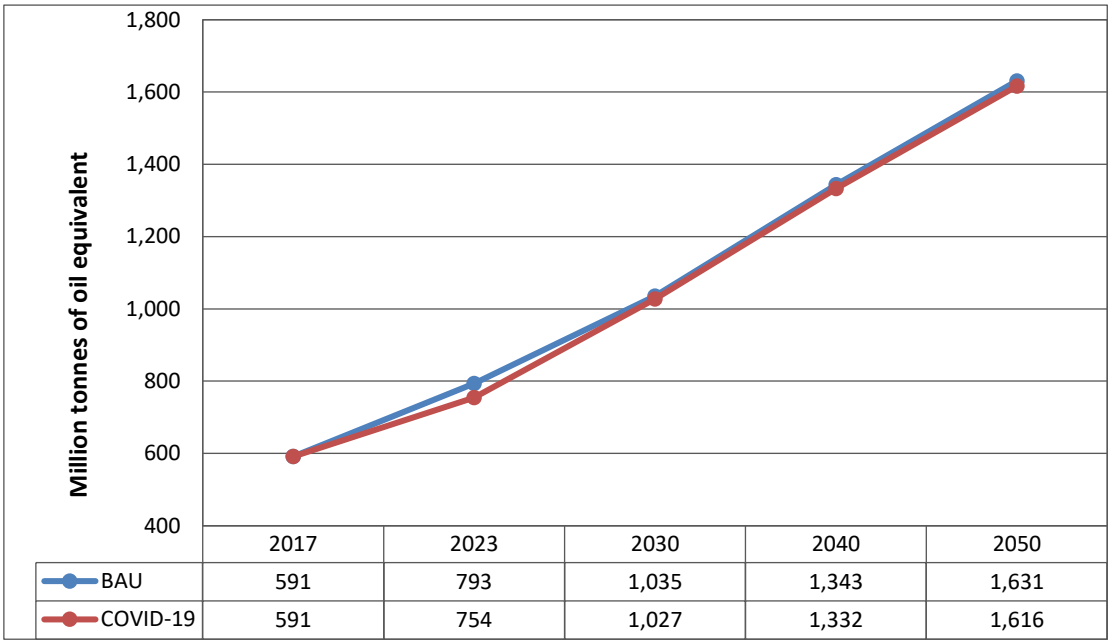
COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Authors.

4. Long-term Impact (2017–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases from 591 million tonnes of oil equivalent (Mtoe) in 2017 to 1,616 Mtoe in 2050, corresponding to an average growth rate of 3.09% per year in 2017–2050 (3.12% in BAU) (Figure 6.5). The increase results from the recovery of economic growth (after COVID-19) at 5.6% (5.7% in BAU). TFEC in the COVID-19 scenario cannot catch up with TFEC in BAU up to 2050 because GDP in the COVID-19 scenario is lower than in BAU.

Figure 6.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



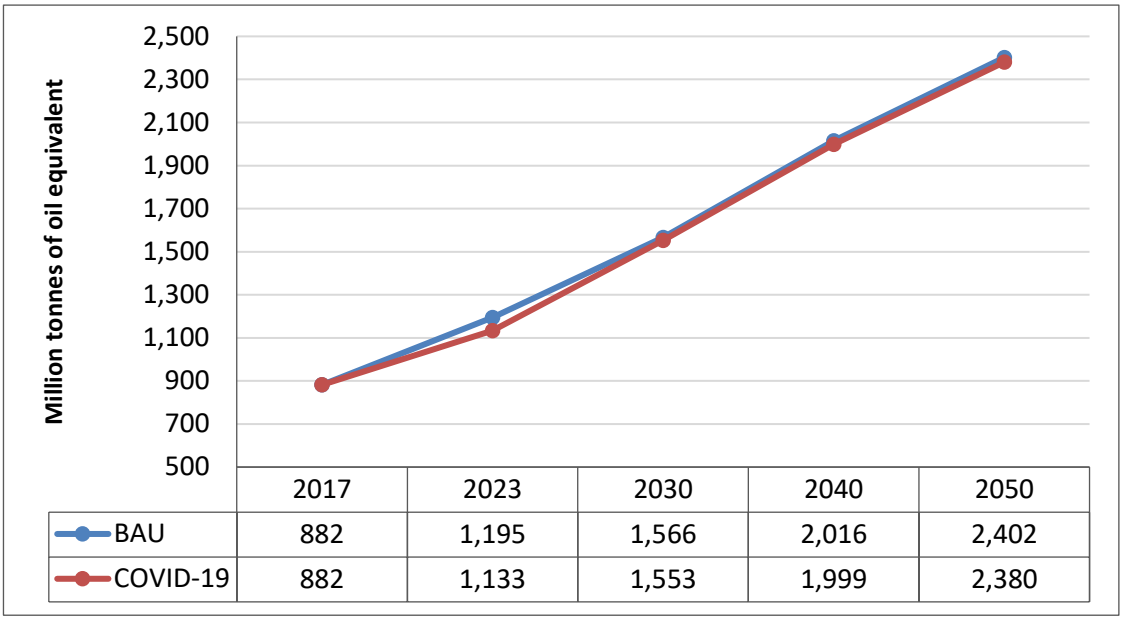
	2017	2023	2030	2040	2050
BAU	591	793	1,035	1,343	1,631
COVID-19	591	754	1,027	1,332	1,616

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases from 882 Mtoe in 2017 to about 2,380 Mtoe in 2050, at an average growth rate of 3.05% per year (3.08% in BAU) (Figure 6.6). The differences are on account of the long-term impacts of COVID-19 on the energy system.

Figure 6.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2030



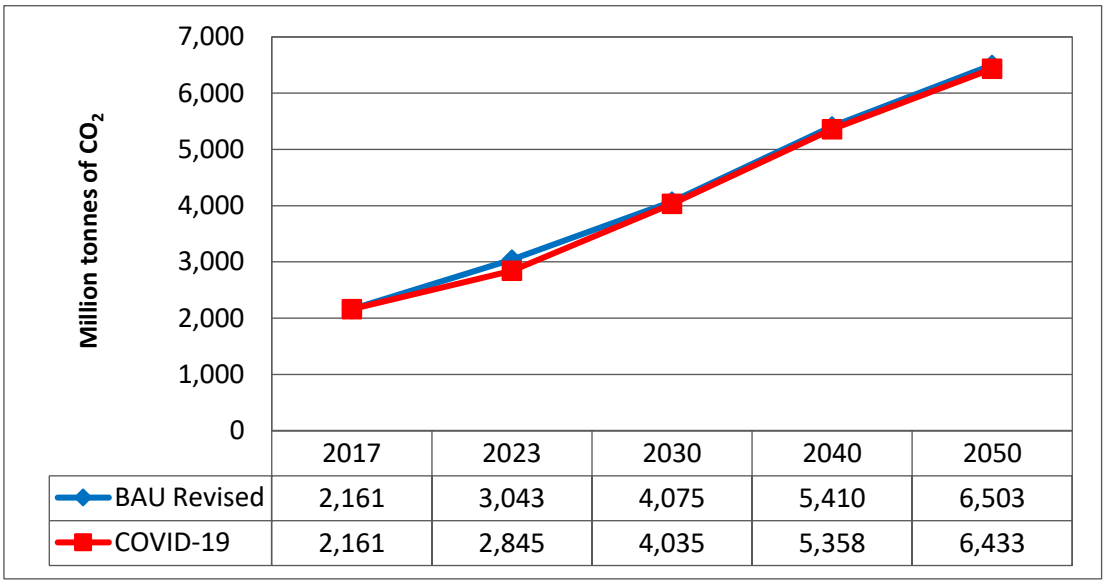
	2017	2023	2030	2040	2050
BAU	882	1,195	1,566	2,016	2,402
COVID-19	882	1,133	1,553	1,999	2,380

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions increase from 2,161 metric tonnes (Mt) in 2017 to about 6,433 Mt in 2050, at an annual rate of 3.36% (3.39% in BAU). The small decline in CO_2 emissions in the COVID-19 scenario results from reduced fossil fuel usage.

Figure 6.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU Revised	2,161	3,043	4,075	5,410	6,503
COVID-19	2,161	2,845	4,035	5,358	6,433

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Implications and Policy Recommendations

As COVID-19 spread worldwide, India was not exempt from high infection rates, and the government imposed several stay-at-home restrictions (Government of India, 2021). Energy consumption plummeted in 2020 because of lockdowns. This chapter investigates the implications of COVID-19 on energy supply–demand mixes and the associated CO_2 emissions. The COVID-19 pandemic significantly impacts the energy system in the short term. In 2020, energy demand drops by 2.9% and supply by 3.2%, while CO_2 emissions fall by 4.8%.

Transport experiences the largest drop in energy consumption mainly because of decreased fuel consumption resulting from shifting to the new normal, such as limited travel and mandatory working from home to combat COVID-19. Private and public passenger vehicles are not in use much, but utilization of freight vehicles is relatively stable because of demand for food and trade. The pandemic experience shows that if India continues to improve digitalizing its economic sectors after the pandemic and promotes remote working, online business, and e-learning, it will achieve long-term energy savings (Madurai Elavarasan et al., 2020). India can reduce its CO_2 emissions through these new-normal practices while sustaining rapid economic growth.

In the long term, TFEC in the COVID-19 scenario will not catch up with TFEC in BAU after 2020 because assumed average annual GDP growth rate in the COVID-19 scenario in 2017–2050 is lower than in BAU despite the rebound projected after 2020. However, the differences in TPES, TFEC, and CO_2 emissions between the COVID-19 and BAU scenarios are not significant. The pandemic is not yet over. India is experiencing a second wave much stronger than first and the analysis here remains uncertain. Overall, it can be argued that the impact on the energy system is not significant in terms of energy supply–demand mixes and environmental

emissions.

Strategic planning of the power system in 2020 faced major impacts on the energy system amidst the lockdown. India saw one of the largest reductions of electricity demand: COVID-19 caused power demand to fall by 28% up to the end of March 2020, according to the Power System Operation Corporation. Under the strict lockdown, which started on 25 March 2020, power demand from hospitals, essential services, and the residential sector was on the rise, while industrial demand and commercial activity dropped substantially. The pandemic has affected the generation mix. Thermal power plants are running at low capacity in the absence of industrial demand, while the share of renewables in the grid has been increasing, mostly because of their must-run status. The pandemic is compelling India to strengthen its ability to maintain security of supply, boost system flexibility, and better integrate its power hardware and software to prepare for potential threats to electricity security (IEA, 2020).

Finally, while it remains uncertain how the energy system will unfold, COVID-19's impact on it seems not significant. However, the impact on job losses remains significant, especially for those in the informal economy. The pandemic's midterm economic impact is unclear and it is, therefore, uncertain how fast the economy will grow. For the time being, the government needs to improve upon the existing stimulus packages to ensure that the pandemic's negative impact is well-managed and reduces the burden on those who have lost their livelihoods.

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Chapter 7
Indonesia Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic disrupted the global energy market, pushing governments to enforce strict lockdown measures that have led to severe economic consequences. In 2020, the hit from COVID-19 tipped Southeast Asia's largest economy—Indonesia—into its first full-year contraction in more than 20 years as its gross domestic product (GDP) shrank by 2% year-to-year. The economy fell into recession in 2020 as it struggled to bring the COVID-19 outbreak under control (World Bank, 2020a). Indonesia recorded the highest number of COVID-19 cases and fatalities in Southeast Asia.

The imposed curfew, mandatory stay-at-home orders, and lockdown of cities reduced energy consumption in all economic sectors. Limiting travel has sharply decreased fuel consumption by transport, especially road transport, and increased residential liquefied petroleum gas and electricity use. Industry and commerce have been consuming less energy with lower production, lower hotel occupancy, closing of malls, work-at-home policies for employees, amongst others.

This chapter analyses the short- and long-term impact of COVID-19 on demand and supply of energy sources and on CO_2 emissions. The COVID-19 scenario was developed based on the business-as-usual (BAU) scenario in the previous Economic Research Institute for ASEAN and East Asia (ERIA) (2020) energy outlook.

2. Macro Assumptions of the COVID-19 Scenario

In April 2020, the World Bank (2020b) produced its Indonesia economic outlook, which assumes 2.1% 2020 GDP growth, much lower than the 5.1% government target in a non-pandemic situation. BAU (ERIA, 2021) adopts 2.1% GDP growth. The current study's BAU adopts GDP growth rates used by ERIA (2021).

The government later revised GDP growth in 2020 to –2.0% and in 2021 to 4.8% (BAPPENAS, 2020), adopted by the current study as the 2020 GDP growth in the COVID-19 scenario. For the rest of the COVID-19 scenario period, the study uses International Monetary Fund GDP growth projections retrieved in 2020 (Table 7.1).

GDP in the COVID-19 scenario improves from 2021 onwards. By 2023, GDP growth reaches 5.2%, slightly lower than in BAU. The long-term GDP growth rate in the COVID-19 scenario is lower than in BAU by about 5% per year. The average annual growth rate of GDP at 5% is in line with the long-term vision of Indonesia becoming a high-income country by 2045 (BAPPENAS, 2019).

Table 7.1. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs, COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2020–2030	2030–2040	2040–2050	2040–2050
COVID-19	5.2%	5.0%	–2.0%	4.8%	5.3%	5.2%	5.0%	4.8%	4.5%	4.6%
BAU	5.2%	5.0%	2.1%	4.3%	5.3%	5.3%	5.3%	4.9%	4.5%	4.8%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020) data.

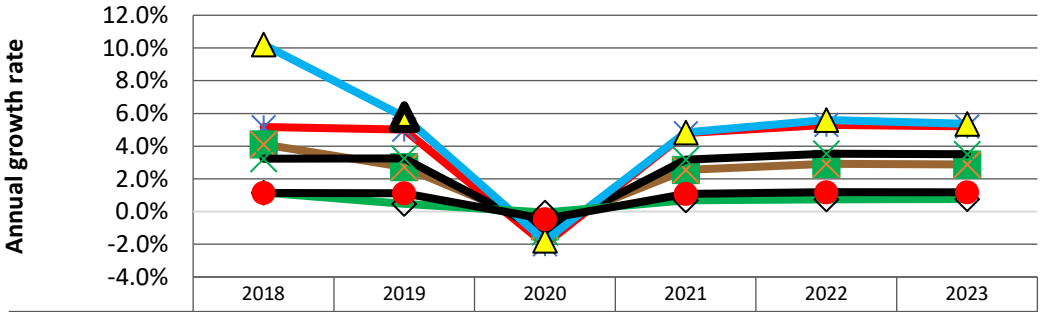
3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In 2018–2023, total final energy consumption (TFEC) grow at an average rate of 2.0% per year (3.1% in BAU). In line with GDP contraction in 2020, TFEC declines by 0.4% in 2020, then the economy gradually improves and TFEC growth returns to 3% per year.

An analysis by sector shows that in 2020, transport experiences the lowest growth at –1.8% (Figure 7.1) because of limited travel under the lockdown policy, which forces people to stay home.

Figure 7.1. Annual Growth Rate of Final Energy Consumption, by Sector, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP	5.2%	5.0%	-2.0%	4.8%	5.3%	5.2%
TFEC	4.1%	2.7%	-0.9%	2.5%	2.9%	2.9%
Industry	3.2%	3.3%	-1.3%	3.2%	3.5%	3.5%
Transport	10.2%	5.8%	-1.8%	4.8%	5.6%	5.4%
Others	1.2%	0.5%	-0.1%	0.7%	0.7%	0.8%
Non-energy	1.1%	1.1%	-0.5%	1.1%	1.2%	1.2%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

In 2020, although COVID-19 significantly reduced transport fuel consumption, conditions improved as the lockdown policy relaxed and focused more on severely affected areas. Businesses and offices that had been closed for almost 6 months in the early part of the pandemic could now operate, although with limited numbers of staff and with strict health protocols in place. By 2021, growth of transport fuel consumption returns to about 4.8% and

reaches 5.4% by 2023 in the COVID-19 scenario. Overall, transport fuel consumption grows by an average of about 3.9% per year in 2018–2023, faster than other final sectors.

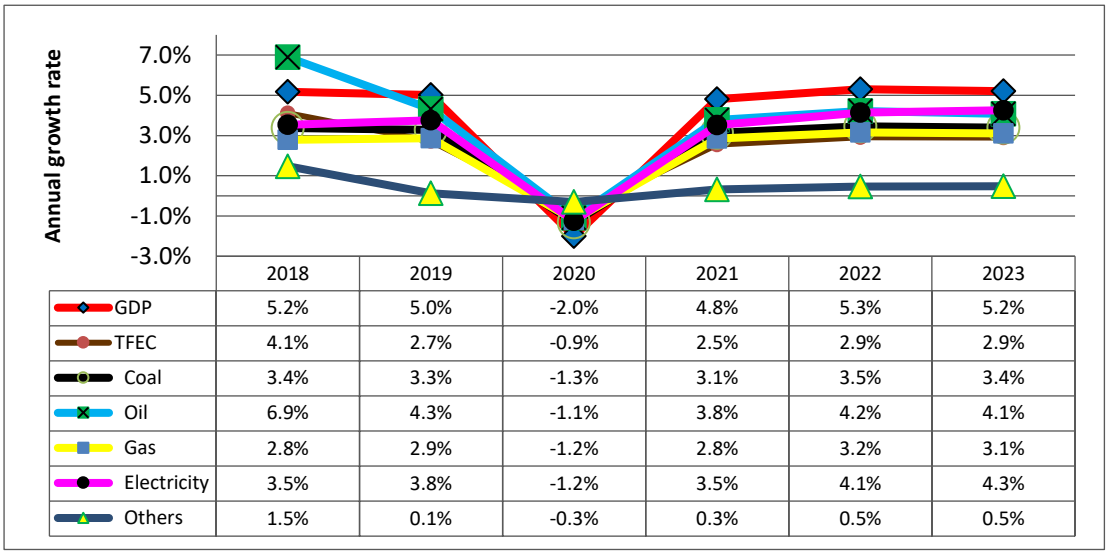
Because people stay home more, residential energy consumption in the COVID-19 scenario grows by 0.2% in 2020 (0.6% in BAU). Households cook more and use air conditioners, lights, and other electrical devices (computers, TVs, amongst others) more. In 2018–2023, residential final energy consumption increases by 0.2% per year (0.7% in BAU).

'Others' consist of the residential, commercial, agriculture, and other sectors. The residential sector's share in TFEC of 'others' is the largest: 86% in the BAU and 87% in the COVID-19 scenarios. The commercial sector share in 2020 reaches 10% and agriculture and non-specified others the rest. 'Others' except the residential sector see growth in energy consumption declining by 1.6% in 2020 in the COVID-19 scenario. Commercial buildings, such as malls, cinemas, and offices, are closed. Hotel occupancy is reduced significantly. Overall energy consumption by 'others' declines by 0.1% in 2020 in the COVID-19 scenario. Although the economy sees some improvement after 2020 and fewer mobility restrictions, the growth of 'others' in 2018–2023 is 0.5%.

The COVID-19 pandemic impacts industry's energy consumption but not as severely as transport's. Industry's final energy consumption declines by 1.3% in 2020 in the COVID-19 scenario. In BAU, industry's final energy consumption is about 4% in 2020, gradually increasing after 2020, and by 2023, its growth reaches 4.2%. Overall, industry's TFEC grows by an average of 2.4% per year in 2018–2023 in the COVID-19 scenario (4% in BAU).

Coal consumption declines by 1.3% in 2020 because of the decrease in construction, resulting in sinking cement and iron and steel production, the top coal consumers. Transport is the largest oil consumer. Combined with the oil consumption by 'others', total oil consumption in the final sector declines by 1.1% yearly. The final sector's natural gas and electricity consumption in 2020 is lower than in 2019. Both natural gas and electricity decline by 1.2%. Other fuels (biomass and biofuel) decline by 0.3% (Figure 7.2).

Figure 7.2. Annual Growth Rate of Final Energy Consumption, by Fuel, 2018–2023



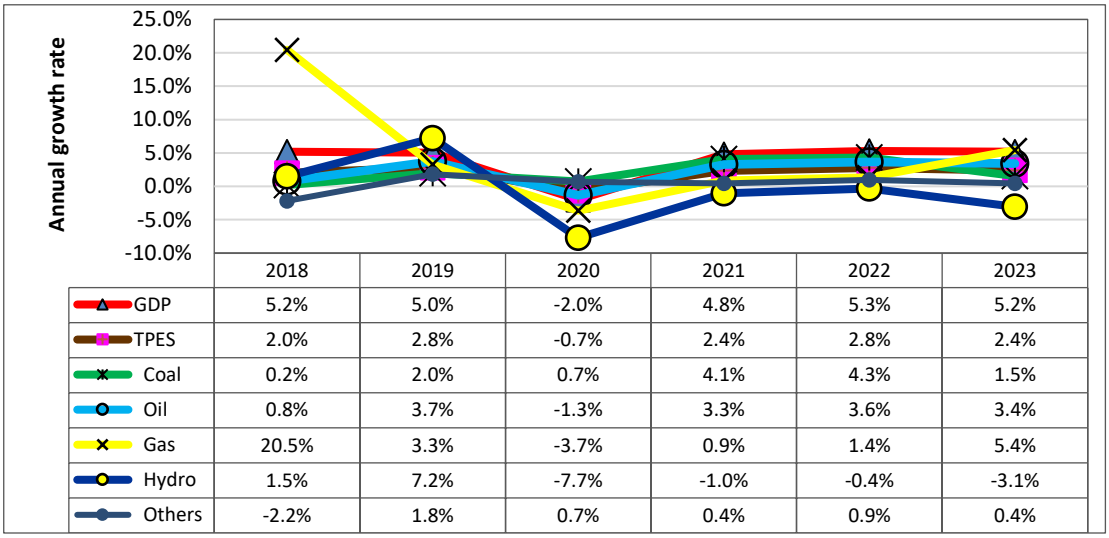
	2018	2019	2020	2021	2022	2023
GDP	5.2%	5.0%	-2.0%	4.8%	5.3%	5.2%
TFEC	4.1%	2.7%	-0.9%	2.5%	2.9%	2.9%
Coal	3.4%	3.3%	-1.3%	3.1%	3.5%	3.4%
Oil	6.9%	4.3%	-1.1%	3.8%	4.2%	4.1%
Gas	2.8%	2.9%	-1.2%	2.8%	3.2%	3.1%
Electricity	3.5%	3.8%	-1.2%	3.5%	4.1%	4.3%
Others	1.5%	0.1%	-0.3%	0.3%	0.5%	0.5%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Primary Energy Supply

Total primary energy supply (TPES) in the COVID-19 scenario declines by 0.7% from 246 million tonnes of oil equivalent (Mtoe) in 2019 to 245 Mtoe in 2020 (Figure 7.3). In BAU, TPES increases by 2.7% to 256 Mtoe in 2020. From 2021 onwards, TPES in the COVID-19 scenario gradually increases to 264 Mtoe by 2023. Although increasing, the average growth of TPES in 2018–2023 is about 2% per year (3% in BAU).

Figure 7.3. Annual Growth Rate of Primary Energy Supply, by Source, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP	5.2%	5.0%	-2.0%	4.8%	5.3%	5.2%
TPES	2.0%	2.8%	-0.7%	2.4%	2.8%	2.4%
Coal	0.2%	2.0%	0.7%	4.1%	4.3%	1.5%
Oil	0.8%	3.7%	-1.3%	3.3%	3.6%	3.4%
Gas	20.5%	3.3%	-3.7%	0.9%	1.4%	5.4%
Hydro	1.5%	7.2%	-7.7%	-1.0%	-0.4%	-3.1%
Others	-2.2%	1.8%	0.7%	0.4%	0.9%	0.4%

GDP = gross domestic product; others = biomass, biofuel, geothermal, solar, and wind; TFEC = total final energy consumption.
Source: Author.

TPES includes fuel input for power generation. Most of the coal supply is used for power generation. Coal input still increases in the COVID-19 scenario because power is generated mainly by coal-fired plants. The increase in 2020 is 1.1% (almost 7% in BAU) since electricity demand in 2020 declines (Figure 7.2). Since coal is consumed by industry and consumption decreases in 2020, total coal supply in 2020 increases by only 0.7%. In 2018–2023, coal supply grows by 2.5% per year (4% in BAU).

Oil supply mainly meets final sector consumption and only a small amount is for power generation. Total oil supply declines by 1.3% in the COVID-19 scenario and grows by 2.5% per year in 2018–2023 (3.5% in BAU).

In the COVID-19 scenario, natural gas supply declines by 3.7% in 2020 and hydro by 7.7%. In BAU, natural gas supply increases by 1.6% in 2020 but hydro decreases by 2.4%. In 2018–2023, natural gas in the COVID-19 scenario reaches 33.0 Mtoe by 2023, growing by an average of 1.4% per year, and hydro declines by 1.1% per year. Natural gas grows by 3.4% per year (37.5 Mtoe in 2023) and hydro by 0.4%.

'Others' include biomass, geothermal, and other renewables (solar, wind, amongst others). They increase by 0.7% in 2020 in the COVID-19 scenario (2.0% in BAU). In the short term, 'others' grow by 0.9% per year in the COVID-19 scenario (1.2% in BAU).

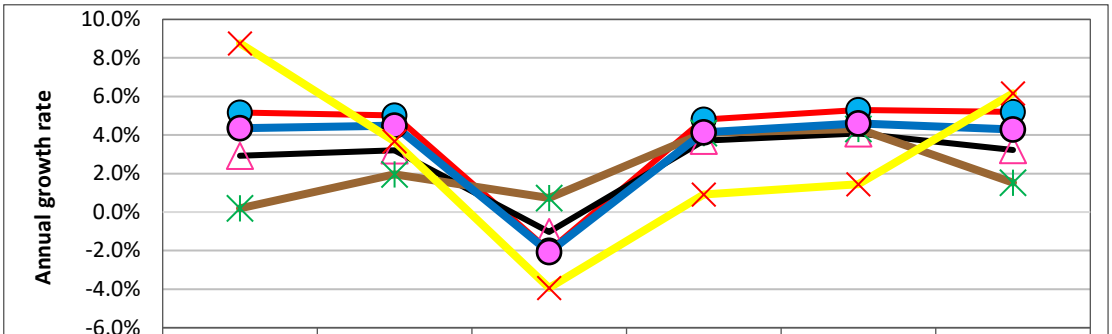
3.3. CO_2 Emissions

Since TPES in the COVID-19 scenario declines in 2020, CO_2 emissions decline, too. CO_2 emissions decline by 1.0% in 2020 in the COVID-19 scenario. CO_2 emissions from oil decline by 3.9% and natural gas by 2.1%. CO_2 emissions from coal increase by 0.7% in line with the increase of coal supply (Figure 7.4).

After 2020, CO_2 emissions increase gradually. In 2018–2023, CO_2 emissions increase by 2.6% per year in the COVID-19 scenario (about 4% in BAU).

CO_2 emissions of coal grow annually by an average of 2.5%, oil by 3.1%, and gas by 0.6%, lower than in BAU. CO_2 emissions in BAU grow by 4% per year for coal and gas and 4.2% for oil.

Figure 7.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP	5.2%	5.0%	-2.0%	4.8%	5.3%	5.2%
CO2	2.9%	3.2%	-1.0%	3.7%	4.1%	3.2%
Coal	0.2%	2.0%	0.7%	4.1%	4.3%	1.5%
Oil	4.4%	4.5%	-2.1%	4.1%	4.6%	4.3%
Gas	8.8%	3.7%	-3.9%	0.9%	1.4%	6.2%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

4. Long-term Impact (2017–2050)

4.1. Final Energy Consumption

In 2020, GDP growth is assumed to reach –0.2%, but long-term average annual growth rate of GDP in the COVID-19 scenario is about 4.6% (4.8% in BAU) (Table 7.2). Similarly, TFEC in the COVID-19 scenario grows more slowly than in BAU. The average annual growth of TFEC is about 3.3% per year in 2017–2019 in the COVID-19 scenario (3.5% in BAU).

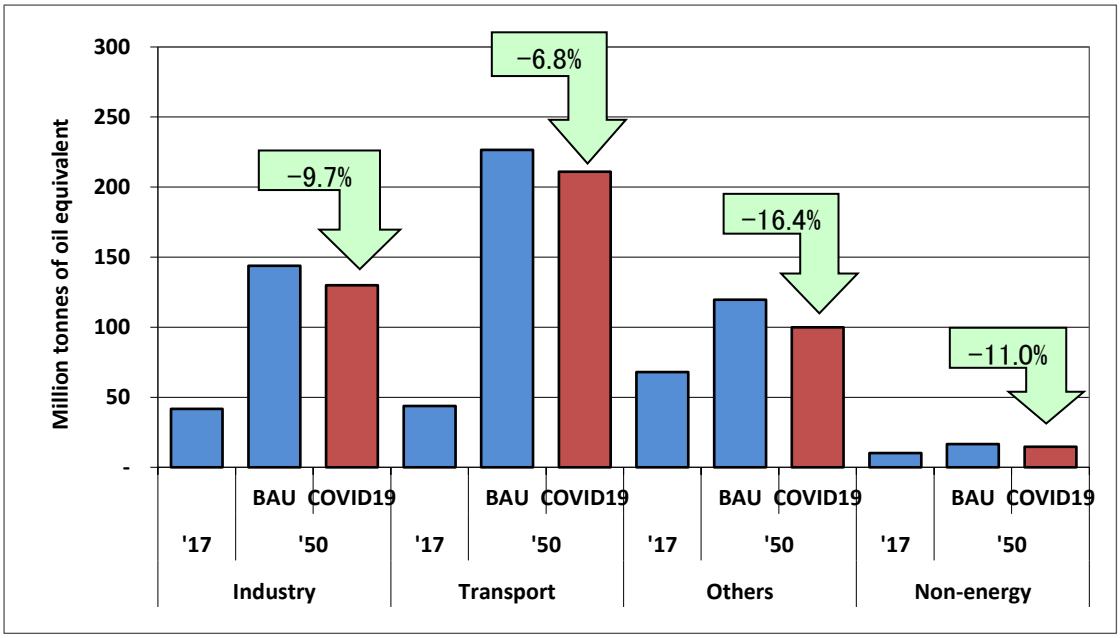
Table 7.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

Parameter	Scenarios	2017	2020	2030	2040	2050	AAGR (2017–2050)
GDP (US$ billion, 2010)	BAU	1,090	1,220	2,038	3,304	5,131	4.8%
	COVID-19	1,090	1,180	1,932	3,087	4,794	4.6%
	COVID-19 vs. BAU	0	–39	–106	–217	–337	–0.2%
TFEC Mtoe)	BAU	164	180	256	361	506	3.5%
	COVID-19	164	173	233	322	455	3.2%
	COVID-19 vs. BAU	0	–7	–24	–39	–51	–0.3%

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Author.

TFEC in 2050 in the COVID-19 scenario is 51 Mtoe lower than in BAU. Thus, the COVID-19 impact in the long term reduces TFEC in 2050 by only 10% compared with BAU. In 2050, the difference in TFEC between the BAU and COVID-19 scenarios is 9.7% for industry, 6.8% for transport, 16.4% for 'others', and 11% for non-energy (Figure 7.5).

Figure 7.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017, 2050

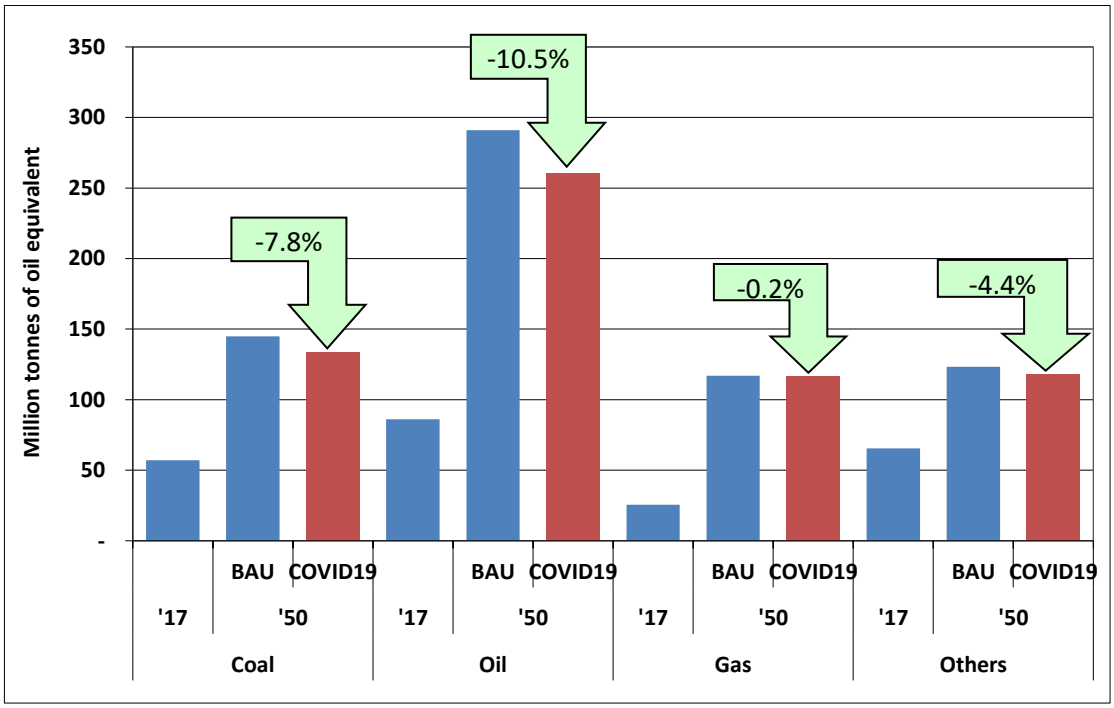


BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

TPES for both scenarios show a similar trend but at a different scale (Figure 7.6). As expected, the COVID-19 scenario has a lower average growth rate at 3% per year (3.3% in BAU), similar to the short-term impact of COVID-19, indicating that the long-term projection heads in the same direction.

Figure 7.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017, 2050

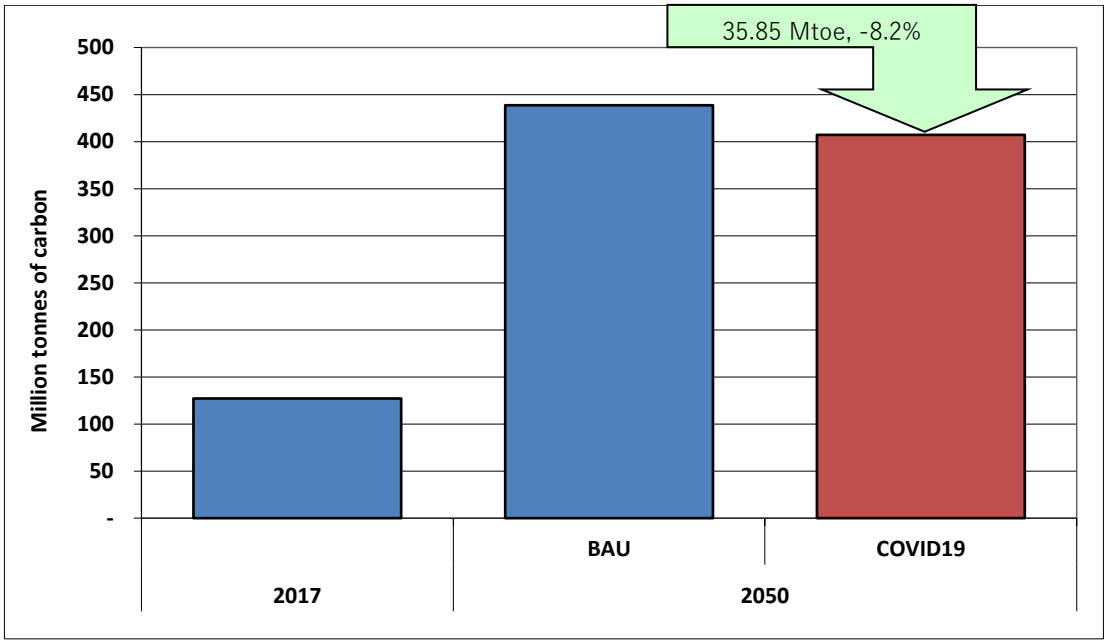


BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2 Emissions

Total emissions in the COVID-19 scenario increase by an average of 3.6% per year in 2017–2050 (3.8% in BAU) because of lower energy power and industry demand. By 2050, the gap between total emissions in the COVID-19 and BAU scenarios is about 36 Mtoe or 8.2% (Figure 7.7), similar to the short-term outcome of about 8% by 2030.

Figure 7.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

The COVID-19 pandemic deflates economic growth to –2.1% in 2020. Policies to slow the spread of the virus—lockdowns, limiting of people's mobility—reduces energy consumption in all sectors. Transport suffers the most, followed by industry. Growing by 4.5% in 2019, transport TFEC is –1.8% in 2020. Growing by 4.1% in 2019, industry TFEC declines by 1.5% in 2020.

The pandemic has a smaller impact on 'others' (residential, commercial, agriculture, and fishing sectors, among others). The pandemic has a positive impact on residential energy consumption because of the work-from-home policy to reduce the spread of COVID-19. The pandemic reduces energy consumption of the remaining 'others', resulting in TFEC much lower than for transport and industry in 2020. Growing by 0.5% in 2019, 'others' TFEC declines by 0.1% in 2020. As GDP growth contracts to –2.1% in 2020, TFEC also declines by 0.9%.

After 2020, the economy starts to improve and the short-term decline in energy demand caused by the virus gradually recovers. By 2023, TFEC grows by about 3%, the same as before the pandemic in 2019. TFEC growth continues as GDP growth reaches projected BAU growth.

These results are based on an econometric approach, which fully depends on the historical correlation between economic growth and energy consumption. The approach is usually appropriate for long-term energy forecasting (more than 15 years). The results should be compared with actual energy consumption after the official publication of energy statistics by the Ministry of Energy and Mineral Resources.

Despite the COVID-19 pandemic, Indonesia will see long-term growth in energy demand. The policies adopted to promote energy efficiency and deployment of renewable energy will continue while Indonesia meets its nationally determined contribution emission targets.

Reduced electricity demand projections induced by the pandemic provide an opening for Indonesia to reassess its capacity expansion plans and existing power plant mix. The country plans much stronger uptake of renewable technologies. In early 2021, the Ministry of Energy and Mineral Resources indicated that it would retire coal-fired power plants that have been operating for more than 20 years and reassess portions of the coal-fired power plant pipeline. These policies and plans are expected to curb future energy demand and CO_2 emissions. To create a more stable and low-risk investment climate for renewable energy, the government should continue to support measures such as tax incentives (exemption from value-added and income taxes for renewable energy developers), deferment of loan repayments, lower increase rates for renewable energy projects, and adjustments to procurement terms (relaxation of the commercial operation date and exemption from penalties).

The pandemic has delayed energy efficiency efforts, particularly in industry. Existing energy efficiency policies include demand-side management, minimum performance standards, and deployment of efficient technology. Despite delays, however, facility and business managers assert that efforts to further increase public and private sector awareness on energy efficiency will still be necessary to support investment, particularly in advanced control systems and digitalization of production processes, such as energy management systems, building automation systems, and virtual desktop infrastructure.

Government support will be required to sustain energy efficiency projects in the post-pandemic era, such as prohibiting procurement and usage of inefficient appliances through regulations that encourage the use of energy-efficient appliances, particularly at the community level. Other support includes bank loan interest reduction and income tax deductions, incentives or disincentives, implementation of more energy efficiency projects in government-owned assets, and optimization of earmarking of the National Economic Recovery fund to be allocated for energy efficiency.

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Chapter 8
Japan Country Report

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1. Background

During the coronavirus disease (COVID-19) pandemic, the government declared in October 2020 that Japan would realize a carbon-neutral, decarbonized society by 2050, reducing total greenhouse gas emissions to zero. In 2020, how did the pandemic affect energy demand in Japan and how will it impact its energy situation? In 2050, will Japan be able to achieve its target? This chapter examines Japan's energy outlook in the short and long terms by comparing the COVID-19 and business-as-usual (BAU) scenarios.

2. Macro Assumptions of the COVID-19 Scenario

In the COVID-19 scenario, the economy declines sharply in 2020 because of the pandemic, gradually recovers by 2023, and returns to BAU levels after 2023 (Table 8.1). The COVID-19 scenario estimates that the gross domestic product (GDP) growth rate in 2020 drops to –5.3% (1.0% in BAU) and rebounds to 2.3% in 2021, 1.7% in 2022, and 1.2% in 2023. After recovery in 2021–2023, growth rates are the same as in BAU. GDP recovers to 2019 levels in 2023.

Table 8.1. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	0.5%	0.7%	–5.3%	2.3%	1.7%	1.2%	0.8%	0.8%	0.7%
BAU	0.5%	0.7%	1.0%	0.5%	0.5%	0.5%	0.8%	0.8%	0.7%

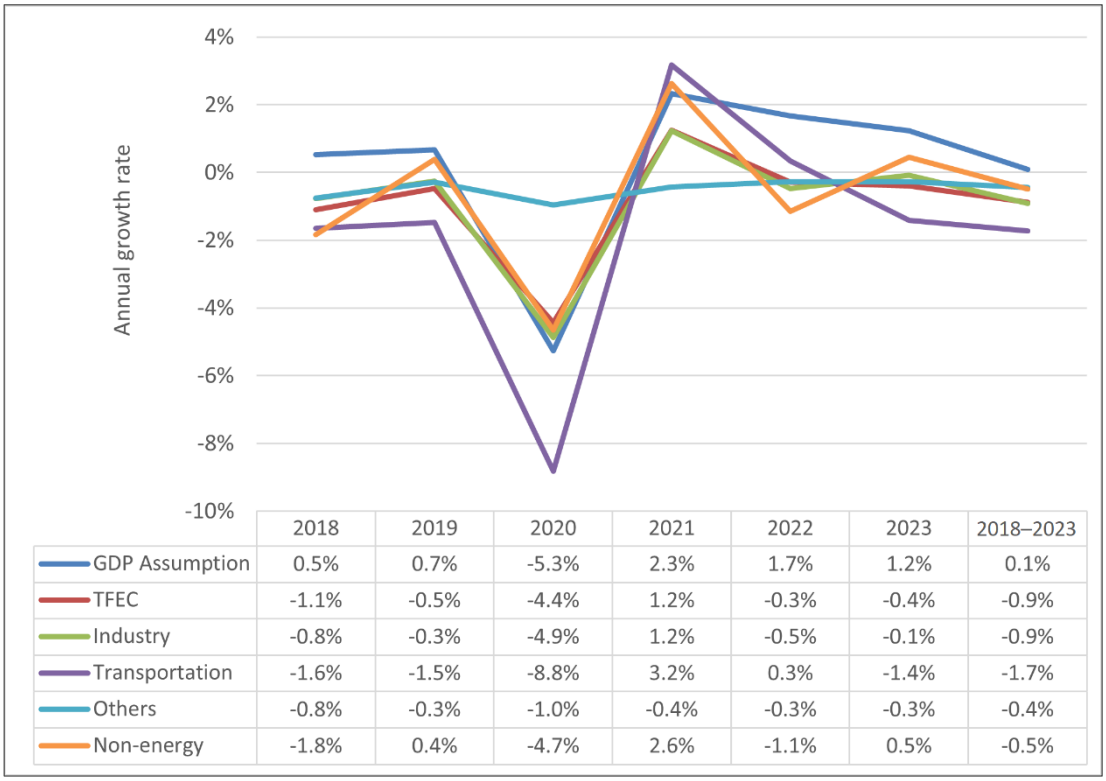
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors, based on International Monetary Fund (2020).

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

The COVID-19 pandemic affected the entire economy and energy demand in 2020 (Figure 8.1). However, after the pandemic, the relationship between economic growth and energy consumption returns to what it was before: negative energy consumption growth and positive economic growth.

Figure 8.1. Annual Growth Rate of Total Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	0.5%	0.7%	-5.3%	2.3%	1.7%	1.2%	0.1%
TFEC	-1.1%	-0.5%	-4.4%	1.2%	-0.3%	-0.4%	-0.9%
Industry	-0.8%	-0.3%	-4.9%	1.2%	-0.5%	-0.1%	-0.9%
Transportation	-1.6%	-1.5%	-8.8%	3.2%	0.3%	-1.4%	-1.7%
Others	-0.8%	-0.3%	-1.0%	-0.4%	-0.3%	-0.3%	-0.4%
Non-energy	-1.8%	0.4%	-4.7%	2.6%	-1.1%	0.5%	-0.5%

COVID-19 = coronavirus disease; GDP = gross domestic product; others = agricultural, commercial. and residential sectors; TFEC = total final energy consumption.
Source: Authors.

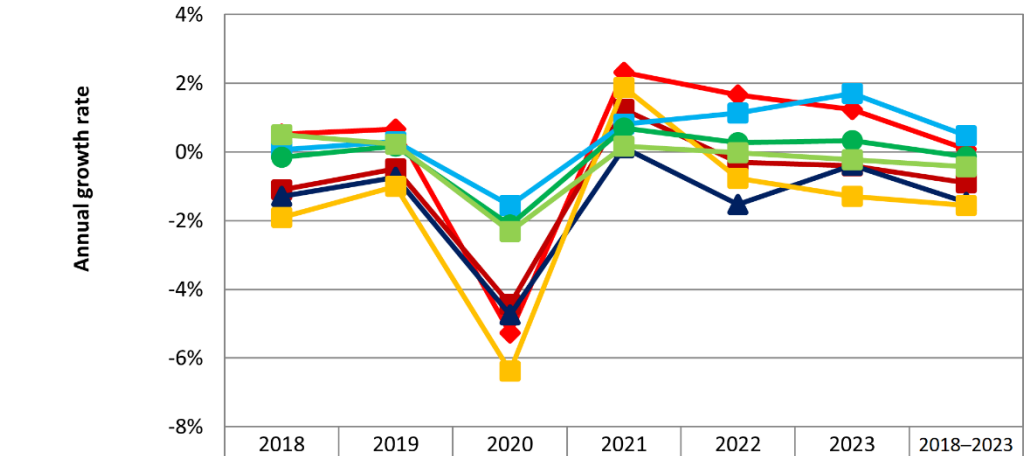
Economic growth rates were slightly positive in 2018 (0.5%) and 2019 (0.7%), but energy saving, mainly in transport and industry, led to negative growth of total final energy consumption (TFEC) in 2018 (–1.1%) and 2019 (–0.5%). In 2020, the economic growth rate is estimated to massively decrease to –5.3% and TFEC growth rate to drop to –4.4% because of all sectors' negative growth. In 2021, the economic growth rate rebounds to 2.3% and TFEC increases by 1.2%. In 2022 and 2023, GDP growth rates stay positive and TFEC growth rates become negative again.

In the COVID-19 scenario, economic growth and energy consumption decouple in 2018 and 2019 but move in the same direction in 2020 (negative) and 2021 (positive), but start decoupling again after 2021, suggesting that COVID-19's impact on TFEC is tentative only when COVID-19 infections are widespread.

In the COVID-19 scenario, transport energy demand drops the most, by 8.8%, in 2020 compared with the previous year. A state of emergency has been declared four times in Tokyo – April–May 2020 and January–March, April–June, and July–August 2021 – causing many people to work and study at home. They rarely drive cars; seldom use international and domestic airlines; and infrequently take commuter trains, subways, and buses.

In the COVID-19 scenario, oil final energy consumption is most drastically reduced, by 6.4%, in 2020 compared with the previous year mainly because energy demand drops in transport (Figure 8.2). In contrast, consumption of electricity and gas does not decrease as much because of higher residential demand, since people stay home, using lighting, cooking gas, and air conditioning.

Figure 8.2. Annual Growth Rate of Total Final Energy Consumption, by Source, COVID-19 Scenario, 2018–2023



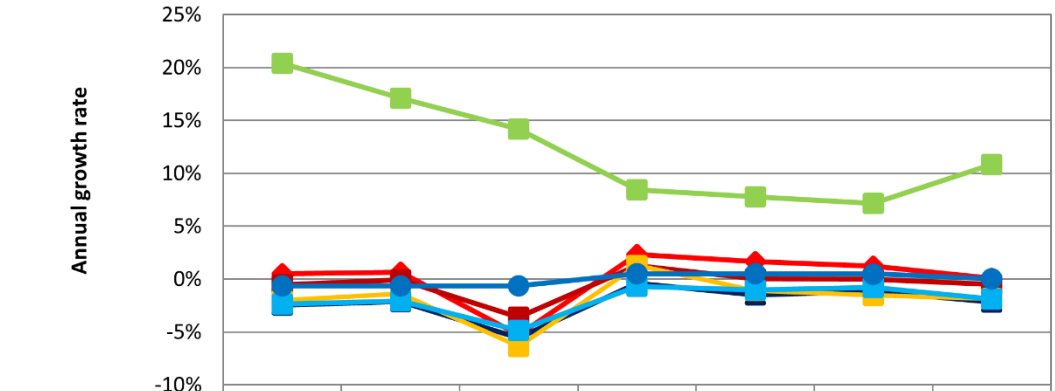
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	0.5%	0.7%	-5.3%	2.3%	1.7%	1.2%	0.1%
TFEC	-1.1%	-0.5%	-4.4%	1.2%	-0.3%	-0.4%	-0.9%
Coal	-1.3%	-0.7%	-4.7%	0.1%	-1.5%	-0.4%	-1.5%
Oil	-1.9%	-1.0%	-6.4%	1.9%	-0.8%	-1.3%	-1.6%
Natural gas	0.1%	0.3%	-1.6%	0.8%	1.1%	1.7%	0.5%
Electricity	-0.2%	0.2%	-2.1%	0.7%	0.3%	0.3%	-0.1%
Others	0.5%	0.2%	-2.3%	0.2%	0.0%	-0.2%	-0.4%

COVID-19 = coronavirus disease, GDP = gross domestic product; others = heat, renewables, etc.; TFEC = total final energy consumption.
Source: Authors.

3.2. Primary Energy Supply

In the COVID-19 scenario, GDP drops in 2020 and rebounds in 2021, and total primary energy supply (TPES) decreases by 3.6% in 2020 compared with the previous year and recovers by 1.3% in 2021 (Figure 8.3). Although GDP growth rates in 2022 and 2023 are positive, TPES is unchanged, with an annual growth rate of 0.0% in both years.

Figure 8.3. Annual Growth Rate of Primary Energy Supply by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	0.5%	0.7%	-5.3%	2.3%	1.7%	1.2%	0.1%
TPES	-0.5%	-0.1%	-3.6%	1.3%	0.0%	0.0%	-0.5%
Coal	-2.4%	-2.1%	-5.6%	-0.4%	-1.5%	-1.2%	-2.2%
Oil	-2.0%	-1.4%	-6.4%	1.3%	-1.1%	-1.5%	-1.9%
Natural gas	-2.4%	-2.1%	-4.9%	-0.7%	-1.0%	-0.8%	-1.9%
Hydro	-0.6%	-0.6%	-0.6%	0.5%	0.5%	0.5%	0.0%
Others	20.4%	17.1%	14.2%	8.4%	7.7%	7.2%	10.9%

COVID-19 = coronavirus disease; GDP = gross domestic product; others = geothermal, solar, wind, biomass, waste, etc.; TPES = total primary energy supply.
Source: Authors.

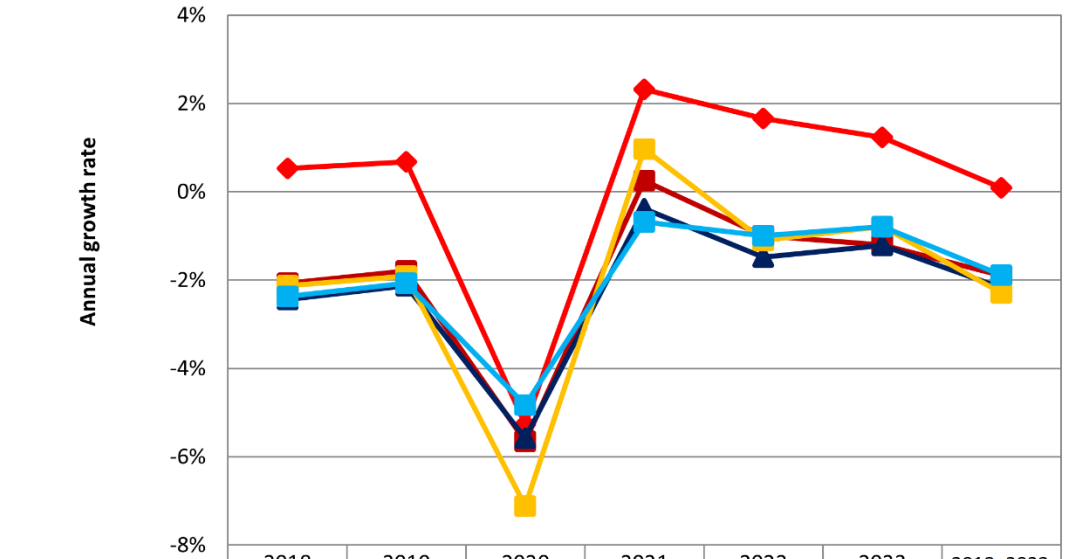
Annual growth rates of TPES are estimated to be always higher than those of TFEC in 2018–2023 mainly because the electrification rates gradually rise.

Among energy sources in 2020, oil supply reduces most sharply along with TFEC mainly because of the drop in transport demand. Coal decreases since industrial demand falls. Natural gas significantly declines because demand for electricity and non-energy decreases. Others' growth rate, however, is positive because renewables and nuclear grow even during the COVID-19 pandemic.

3.3. CO_2 Emissions

CO_2 emission growth rates in 2018 and 2019 are about –2.0%, –5.6% in 2020, and 0.2% in 2021 (Figure 8.4), then about –1.0% in 2022 and 2023.

Figure 8.4. CO_2 Emissions by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	0.5%	0.7%	-5.3%	2.3%	1.7%	1.2%	0.1%
Total	-2.1%	-1.8%	-5.6%	0.2%	-1.0%	-1.2%	-1.9%
Coal	-2.4%	-2.1%	-5.6%	-0.4%	-1.5%	-1.2%	-2.2%
Oil	-2.1%	-1.9%	-7.1%	1.0%	-1.1%	-0.8%	-2.3%
Natural gas	-2.4%	-2.1%	-4.8%	-0.7%	-1.0%	-0.8%	-1.9%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Authors.

CO_2 emission growth rates are negative except in 2021 and always much lower than GDP growth rates in 2018–2023 because of decreasing use of fossil fuels such as coal, oil, and natural gas, which are partially replaced with non-fossil fuels such as renewable energy, including solar, wind, and biomass.

Nonetheless, as of 1 April 2021, Japan's existing official target of energy-originated CO_2 emission reduction by 2030, which is 25% reduction compared with the 2013 level, would be still challenging. This chapter shows that CO_2 is reduced by more than 28 million tonnes, and the reduction rate is 5.6% in 2020 compared with the previous year. However, the reduction rate in 2020 compared with the 2013 level is only 18%. Japan's new 2050 carbon neutrality target is, therefore, ambitious.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the long term, the COVID-19 pandemic has a limited impact on GDP and TFEC. In the COVID-19 scenario, the GDP growth rate is 0.6% annually on average in 2017–2050 (0.7% in BAU). The TFEC annual growth rate is –0.8% during the same period in both scenarios. In 2050, GDP decreases by 2.6% from the BAU level while TFEC declines by 1.2%.

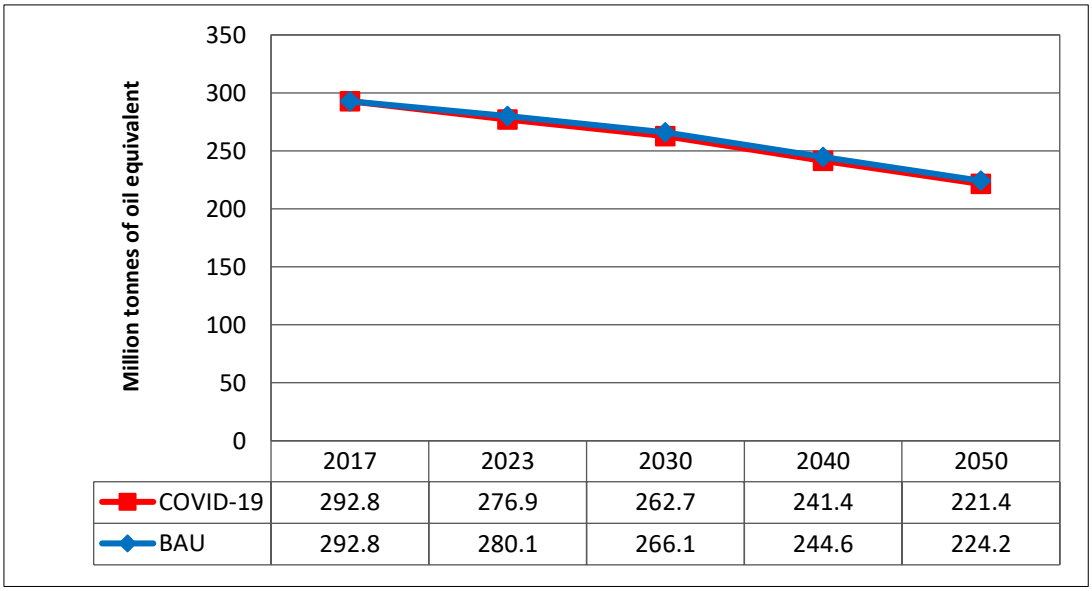
Table 8.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (US$ billion, 2010)	COVID-19	6,157.7	6,215.7	6,588.6	7,103.9	7,586.4	0.6%
	BAU	6,157.7	6,395.9	6,762.4	7,291.3	7,786.5	0.7%
	COVID-19 vs. BAU	-	–2.8%	–2.6%	–2.6%	–2.6%	-
TFEC (Mtoe)	COVID-19	292.8	276.9	262.7	241.4	221.4	–0.8%
	BAU	292.8	280.1	266.1	244.6	224.2	–0.8%
	COVID-19 vs. BAU	-	–1.1%	–1.3%	–1.3%	–1.2%	-

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Authors.

Figure 8.5 shows that the pandemic has only slight impacts on TFEC in the long term. In the COVID-19 scenario, TFEC declines by 1.1% in 2023, by 1.3% in 2030, by 1.3% in 2040, and by 1.2% in 2050 from BAU levels.

Figure 8.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

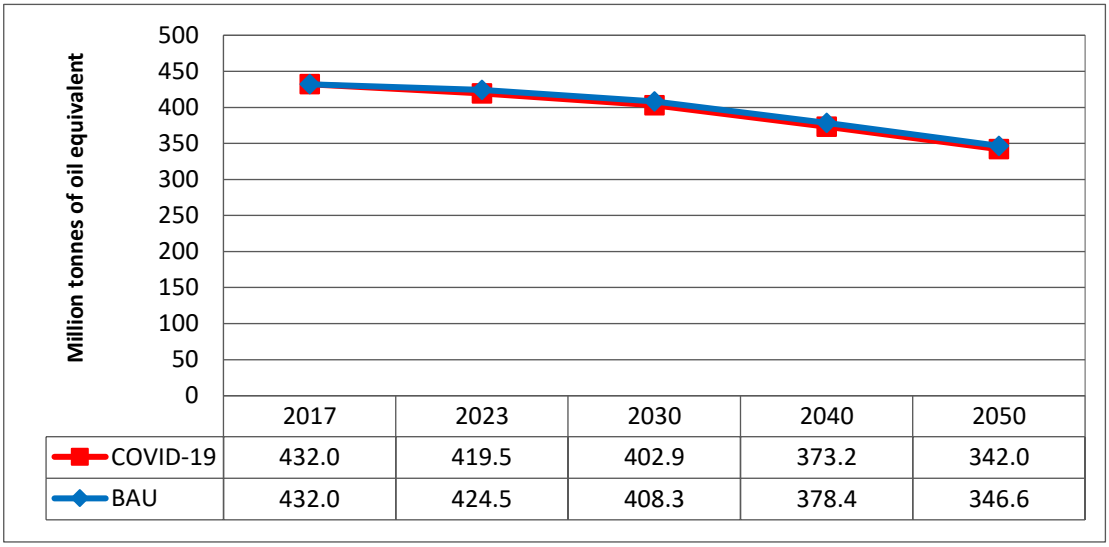
Demand in industry declines by 1.9%, in transport by 0.6%, in 'others' (residential, commercial, agricultural, etc.) by 1.1%, and in the non-energy sector by 1.3% from BAU levels in 2050.

Demand for coal decreases by 1.0%, for oil by 1.3%, and for electricity by 1.6%, while demand for natural gas slightly increases by 0.1% because of a small rise in residential demand from BAU levels in 2050.

4.2. Primary Energy Supply

Like TFEC, TPES is not much affected by the pandemic in the long term (Figure 8.6). In the COVID-19 scenario, TPES decreases by 1.2% in 2023, by 1.3% in 2030, by 1.4% in 2040, and by 1.3% in 2050 from BAU levels. The annual growth rate of TPES in 2017–2050 is –0.7% on average in both COVID-19 and BAU scenarios.

Figure 8.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
COVID-19	432.0	419.5	402.9	373.2	342.0
BAU	432.0	424.5	408.3	378.4	346.6

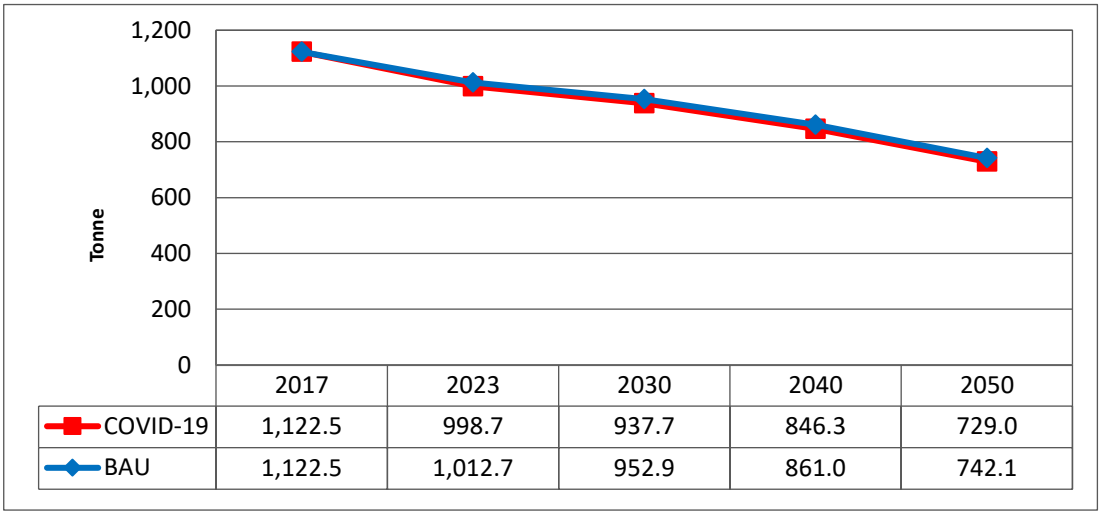
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

The pandemic reduces coal by 2.3%, oil by 1.3%, natural gas by 1.9%, and others (solar, wind, biomass, waste, etc.) by 0.3% from BAU levels in 2050.

4.3. CO_2 Emissions

The COVID-19 pandemic decreases energy-related CO_2 emissions only slightly from BAU levels in the long term (Figure 8.7). Energy-related CO_2 emissions decrease by an average rate of 1.3% per year in 2017–2050 (1.2% in BAU).

Figure 8.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
COVID-19	1,122.5	998.7	937.7	846.3	729.0
BAU	1,122.5	1,012.7	952.9	861.0	742.1

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

As a result, energy-related CO_2 emissions in 2050 are reduced by 41% in the COVID-19 scenario from the 2013 CO_2 emission level (40% in BAU). The long-term effect of the pandemic is only a 1 percentage point reduction. Japan's carbon neutrality will not be achieved only because of the pandemic.

5. Implications and Policy Recommendations

In 2020, the COVID-19 pandemic had a huge impact on GDP, TFEC, TPES, and CO_2 emissions, especially in transport, leading to massive oil demand reduction. In the short-term COVID-19 scenario, the economy recovers to pre-pandemic levels by 2023 and energy consumption levels approach BAU. In the long term, by 2050, the COVID-19 pandemic does not much affect the economy and energy demand. In both BAU and COVID-19 scenarios, therefore, CO_2 emission reduction levels in 2050 are insufficient to realize Japan's new carbon-neutral target.

Japan relies heavily on fossil fuels that cause CO_2 emissions, but its way of consuming energy is starting to change. Japan aims to save more energy on the demand side and to enhance decarbonization of energy sources on the supply side.

On the demand side, further energy efficiency improvements are being pursued in all sectors. Japan already has one of the best energy intensities per unit of GDP.

On the supply side, Japan has started to decarbonize the economy and society. First, Japan is considering introducing renewables and nuclear energy as much as possible, especially in the power sector, since they do not emit CO_2. Second, Japan has started to plan to import decarbonized fossil fuels such as blue hydrogen and blue ammonia with carbon capture and storage, carbon capture, and utilisation, and enhanced oil recovery, which can be used not only in the power sector but also in industry and transport. Third, Japan is considering

introducing CO_2 transport to inject captured CO_2 into underground wells inside and outside the country, and introducing methanation, a method of producing carbon-free natural gas by synthesizing carbon with hydrogen.

Its carbon-neutral policy is challenging, but Japan is determined to do all it can to mitigate climate change while promoting energy security and economic efficiency.

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Chapter 9
Republic of Korea Country Report

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1. Background

In 2020 and 2021, the coronavirus disease (COVID-19) pandemic had an unprecedentedly huge impact on the world economy. Consequently, the need for sustainable development and a balanced ecosystem was imprinted in people's mindsets. Each country, including the Republic of Korea (henceforth, Korea), has declared its carbon-neutral goal and promotes a departure from the centralised energy supply system. Korea is building the foundation for an inclusive energy transition and clean energy system through policies such as the Green New Deal and Carbon Neutral.

2. Macro Assumptions of the COVID-19 Scenario

Korea's economy grew at an annual average growth rate (AAGR) of 5% in 1990–2017. However, it fell to –1.6% in 2020 because of the COVID-19 pandemic (Table 9.1). The economy is projected to rebound and grow by 2.3% in 2021 as it gradually recovers. The trend is expected to continue until 2025, with an AAGR of 2.5% in 2021–2025.

A longer-term projection shows a slight downward trend, with AAGR slowing but remaining positive. Gross domestic product (GDP) AAGRs are projected to be the same as those in the business-as-usual (BAU) scenario: 2.1% in 2023–2030, 1.6% in 2030–2040, and 0.7% in 2040–2050 (Table 9.1).

Table 9.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

Year	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050	2017–2050
COVID-19	2.7%	2.0%	–1.6%	2.3%	2.8%	2.4%	2.0%	1.6%	0.7%	1.4%
BAU	2.7%	2.0%	3.4%	2.9%	2.8%	2.9%	2.1%	1.6%	0.7%	1.6%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020).

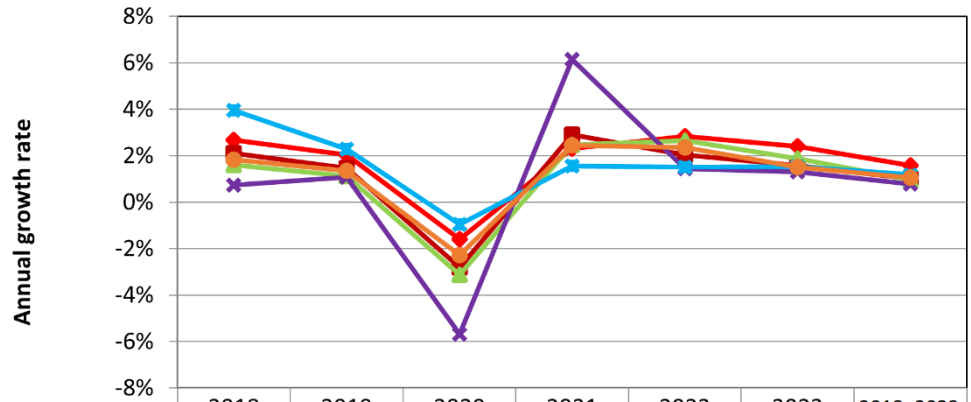
3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In the COVID-19 scenario (Figure 9.1), based on GDP, total final energy consumption (TFEC) decreases by 2.8% in 2020 or by 6.8% less than in the business as usual (BAU) scenario. However, as real GDP is expected to grow by 2.3% in 2021, gradually recovering from the impact of COVID-19, TFEC increases by 2.9% in 2021, 2.0% in 2022, and 1.6% in 2023.

Transport decreases the most, by 5.7% in 2020 or by 6.8% less than in BAU, mainly because of social distancing, which resulted in massive cancellation of mass transit and air travel caused by an abrupt decrease in domestic and overseas demand (Table 9.2). However, in 2018–2023, transport increases by an AAGR of 0.8% (1.1% in BAU). The increase is followed by the decrease in industry, with an energy consumption growth rate of 3.1% in 2020 (5.4% in BAU) and non-energy use with 2.3% (4.1% less than in BAU). 'Others' (residential and commercial sectors) decrease by 1.0% in 2020 (1.9% less than in BAU).

Figure 9.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	2.7%	2.0%	-1.6%	2.3%	2.8%	2.4%	1.6%
TFEC	2.1%	1.5%	-2.8%	2.9%	2.0%	1.6%	1.0%
Industry	1.6%	1.1%	-3.1%	2.5%	2.6%	1.9%	1.0%
Transportation	0.7%	1.1%	-5.7%	6.1%	1.4%	1.3%	0.8%
Others	3.9%	2.3%	-1.0%	1.6%	1.5%	1.5%	1.2%
Non-energy	1.8%	1.3%	-2.3%	2.4%	2.4%	1.5%	1.1%

GDP = gross domestic production, others = residential and commercial, TFEC = total final energy consumption.
Source: Author, based on International Monetary Fund (2020).

Table 9.1. Total Final Energy Consumption, by Sector, COVID-19 vs. Business-as-Usual Scenarios, 2020

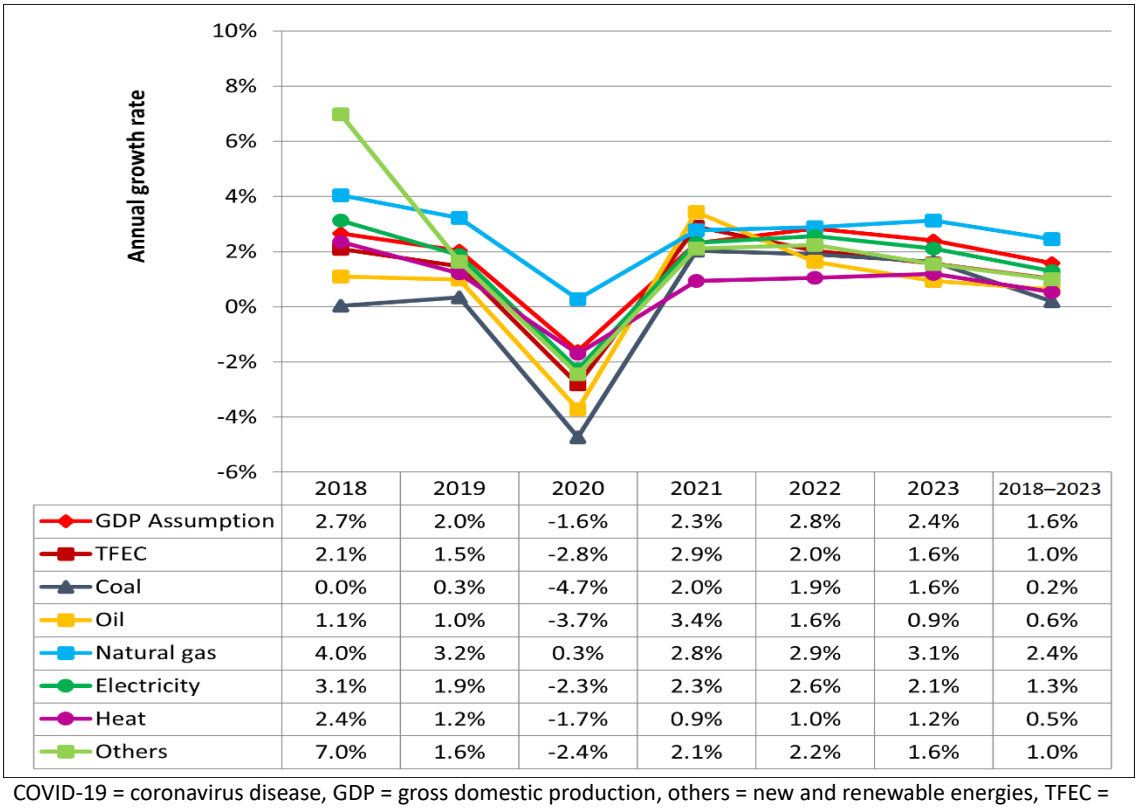
(million tonnes of oil equivalent)

	BAU (A)	COVID-19 (B)	(B-A)/A (%)
Industry	50.9	48.2	–5%
Transportation	36.7	34.2	–7%
Others	50.1	49.1	–2%
Non-energy	55.2	53.0	–4%

BAU = business as usual, COVID-19 = coronavirus disease, others = residential and commercial.
Source: Author.

The biggest decrease in TFEC in the COVID-19 scenario is for coal, with 4.7% in 2020, or 7.3% less than in BAU (Table 9.3). Coal has a marginal share (4.6%) in TFEC. However, oil has the largest share (52%) in TFEC in 2019, with a decrease of 3.7% (4.9% less than in BAU) in 2020, followed by electricity with 2.3% and heat with 1.7%. In contrast, natural gas is only slightly affected by the COVID-19 pandemic, increasing by 0.3% in 2020. TFEC of 'others', which include new and renewable energies, decreased by 4.4% less than in BAU. Only natural gas shows an increase despite the impact of COVID-19, which, however, is 1.9% less than in BAU.

Figure 9.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	2.7%	2.0%	-1.6%	2.3%	2.8%	2.4%	1.6%
TFEC	2.1%	1.5%	-2.8%	2.9%	2.0%	1.6%	1.0%
Coal	0.0%	0.3%	-4.7%	2.0%	1.9%	1.6%	0.2%
Oil	1.1%	1.0%	-3.7%	3.4%	1.6%	0.9%	0.6%
Natural gas	4.0%	3.2%	0.3%	2.8%	2.9%	3.1%	2.4%
Electricity	3.1%	1.9%	-2.3%	2.3%	2.6%	2.1%	1.3%
Heat	2.4%	1.2%	-1.7%	0.9%	1.0%	1.2%	0.5%
Others	7.0%	1.6%	-2.4%	2.1%	2.2%	1.6%	1.0%

COVID-19 = coronavirus disease, GDP = gross domestic production, others = new and renewable energies, TFEC = total final energy consumption.
Source: Author.

Table 9.3. Final Energy Consumption, by Fuel, Business-as-Usual vs. COVID-19 Scenarios, 2020

(million tonnes of oil equivalent)

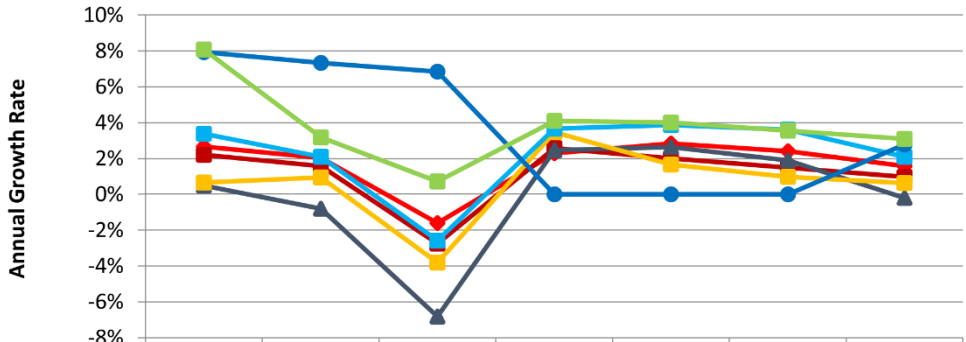
	BAU (A)	COVID-19 (B)	(B-A)/A (%)
Coal	8.9	8.2	–7%
Oil	100.6	95.7	–5%
Natural gas	24.3	23.9	–2%
Electricity	48.3	46.2	–4%
Heat	5.3	5.2	–2%
Others	5.5	5.3	–4%

BAU = business as usual, COVID-19 = coronavirus disease, others = renewables and waste.
Source: Author.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) decreases by 2.7% in 2020 or a 4.5% drop from that in BAU. The largest decline occurs in coal, with 6.8% in 2020 (0.1% in BAU) and rebounds by up to 2.4% in 2021, slowing in 2022–2023. Oil follows a path similar to that of coal, but other fuels such as natural gas and renewable energy slowly increase or stay at the same level (Figure 9.3).

Figure 9.3. Annual Growth Rate of Primary Energy Supply, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	2.7%	2.0%	-1.6%	2.3%	2.8%	2.4%	1.6%
TPES	2.2%	1.6%	-2.7%	2.6%	2.0%	1.5%	1.0%
Coal	0.5%	-0.8%	-6.8%	2.4%	2.6%	1.9%	-0.2%
Oil	0.7%	0.9%	-3.8%	3.5%	1.7%	1.0%	0.6%
Natural gas	3.4%	2.1%	-2.6%	3.7%	3.9%	3.6%	2.1%
Hydro	7.9%	7.3%	6.8%	0.0%	0.0%	0.0%	2.8%
Others	8.1%	3.2%	0.7%	4.1%	4.0%	3.5%	3.1%

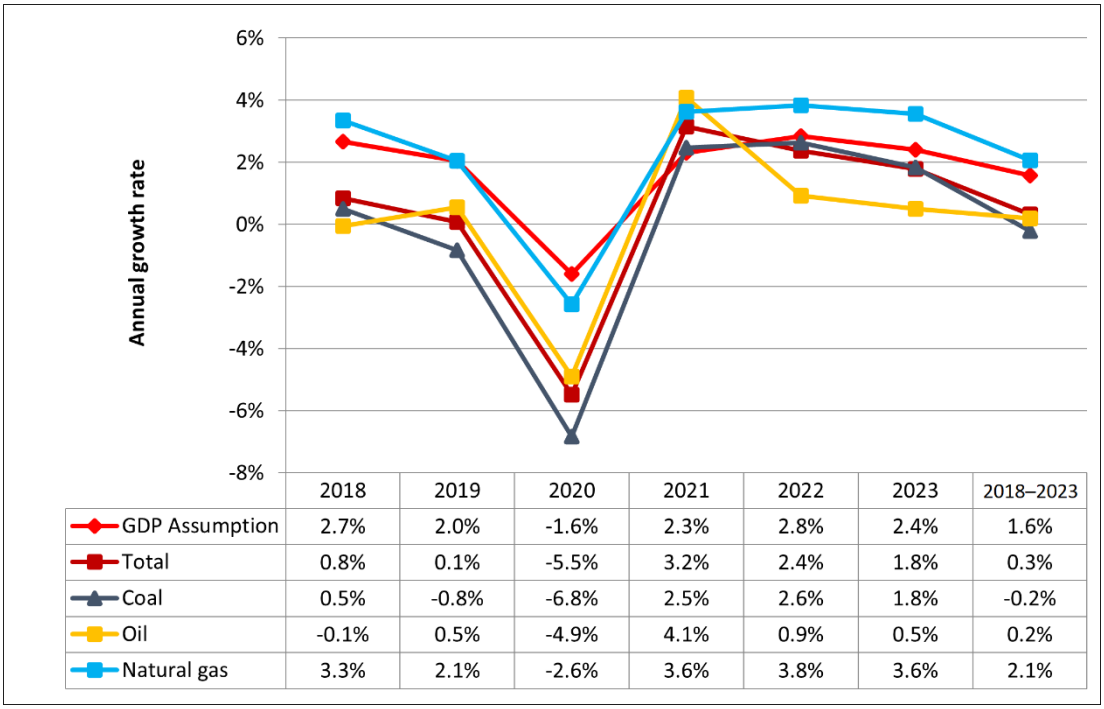
COVID-19 = coronavirus disease; GDP = gross domestic product; others = other renewables, waste, electricity, and heat; TPES = total primary energy supply.
Source: Author.

3.3. CO_2 Emissions

In the COVID-19 scenario, greenhouse gas (GHG) emissions drop sharply by 5.5% in 2020 (increase by 0.5% in BAU), then increase by 3.2% in 2021, 2.4% in 2022, and 1.8% in 2023. GHG emissions increase at an AAGR of 0.3% in 2018–2023.

Coal sees the largest reduction in GHG emission growth rate, with 6.8% in 2020 (0.1% in BAU) and increasing by 0.3% per annum in 2018–2023, followed by oil with a 4.9% reduction in 2020 and an increase of 0.2% per annum, and natural gas with a 2.6% reduction in 2020 and an increase of 2.1% per annum. The positive growth of hydro and 'others' (mainly renewable energy), which do not emit GHGs, may largely help reduce GHG emissions.

Figure 9.4. CO_2 Emissions, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	2.7%	2.0%	-1.6%	2.3%	2.8%	2.4%	1.6%
Total	0.8%	0.1%	-5.5%	3.2%	2.4%	1.8%	0.3%
Coal	0.5%	-0.8%	-6.8%	2.5%	2.6%	1.8%	-0.2%
Oil	-0.1%	0.5%	-4.9%	4.1%	0.9%	0.5%	0.2%
Natural gas	3.3%	2.1%	-2.6%	3.6%	3.8%	3.6%	2.1%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the longer term, the global economy is expected to recover from the impact of the COVID-19 pandemic. GDP is projected to return nearly to BAU, slightly slowing by 1.4% per annum. TFEC is projected to increase by 0.4% per annum in 2017–2050, 0.1% lower than in BAU, which confirms the continuous decoupling of GDP and energy consumption (Table 9.4).

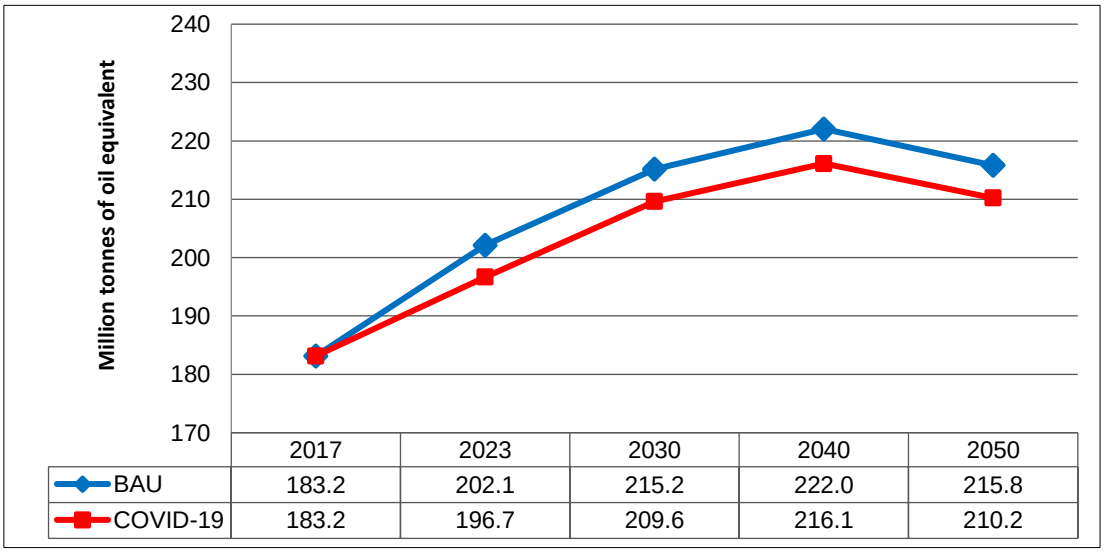
Table 9.4. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (US$ billion, 2010)	BAU	1,345.9	1,586.9	1,829.6	2,135.2	2,299.9	1.6%
	COVID-19	1,345.9	1,494.7	1,712.4	1,998.5	2,152.6	1.4%
	COVID-19 vs. BAU	0.0%	–5.8%	–6.4%	–6.4%	–6.4%	
TFEC (Mtoe)	BAU	183.2	202.1	215.2	222	215.8	0.5%
	COVID-19	183.2	196.7	209.6	216.1	210.2	0.4%
	COVID-19 vs. BAU	0.0%	–2.7%	–2.6%	–2.7%	–2.6%	

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic production, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Author.

As the global economy gradually recovers from the COVID-19 pandemic, TFEC will increase, peaking by 2040 then declining until 2050 (Figure 9.5). The differences in TFEC between the COVID-19 and BAU scenarios are not significant (2%–3%), indicating that the pandemic's impact is only short term.

Figure 9.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

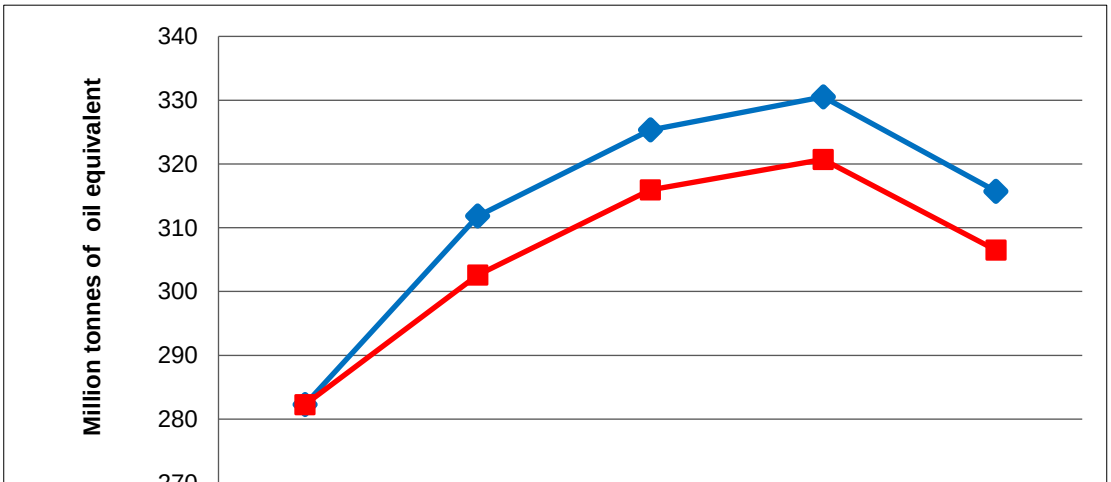


BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

In the long-term COVID-19 scenario, primary energy supply follows the pattern of final energy consumption and is expected to increase by an AAGR of 0.2% in 2017–2050. TPES in the COVID-19 scenario shows the same pattern as in BAU after 2023, when the economy and energy demand return to normal (Figure 9.6).

Figure 9.6. Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	282.3	311.8	325.3	330.5	315.7
COVID-19	282.3	302.6	315.9	320.7	306.5

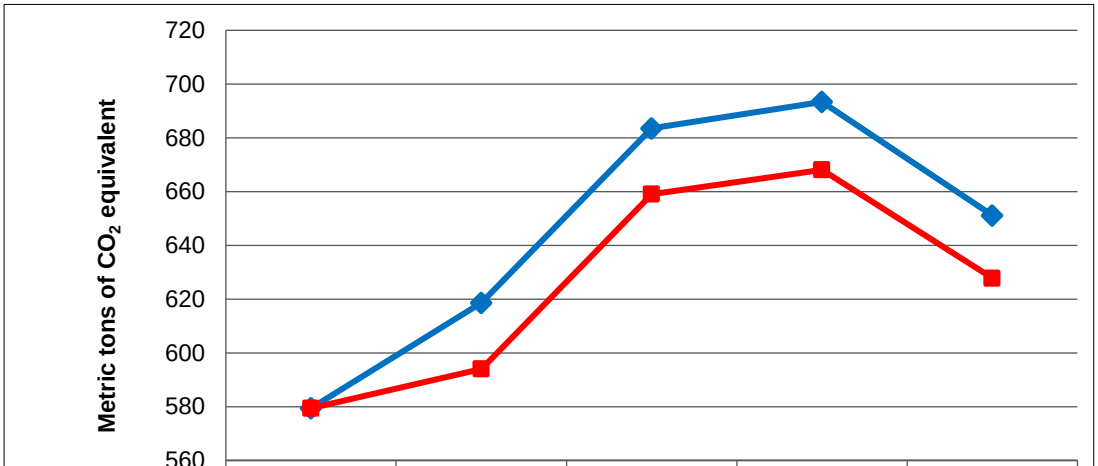
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2 Emissions

Based on previous primary energy consumption by fuel type in the COVID-19 scenario, projected GHG emissions follow the pattern of TPES, increasing and then peaking by 2040, thereafter decreasing until 2050 with an AAGR of 0.2% in 2017–2050 (0.4% in BAU). However, after 2023, the AAGR in the COVID-19 scenario is 0.20% (0.19% in BAU) (Figure 9.7).

As a result, energy-related CO_2 emissions in 2050 increase by only 8.4% in the COVID-19 scenario from 2017 (12.4% in BAU), indicating that the pandemic has a limited long-term impact on reducing CO_2 emissions, with a margin of 4.0%. The government, therefore, must transform the energy system with green energy options, such as energy efficiency on the demand side and new and renewable energy on the supply side, to realise the goal of carbon neutrality (net-zero emissions) by 2050.

Figure 9.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	579.4	618.6	683.6	693.4	651.1
COVID-19	579.4	594.0	659.0	668.1	627.8

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

COVID-19 has delivered an unprecedented socio-economic shock to Korea, with a huge negative impact on GDP, energy demand and supply, and CO_2 emissions. The economy will recover to pre–COVID-19 levels after 2023, returning to BAU. In the long term, by 2050, following the path of economic growth and energy consumption in BAU, the COVID-19 scenario will not affect the existing trend of energy consumption and CO_2 emissions.

On 14 July 2020, the government, to overcome the economic recession caused by the COVID-19 pandemic and to promote energy transition, announced the Green New Deal, the Korean version of the European Green Deal (11 December 2019). The European Union announced the European Green Deal Investment Plan and the Just Transition Mechanism, with a budget of EUR1 trillion for the following 10 years. The government, however, will invest KRW73.4 trillion in economic recovery by 2025. This ambitious plan to invigorate business includes the largest national investment amongst the major economies.

The Green New Deal includes three key projects: Green Transition of Infrastructures, Low-carbon and Decentralised Energy, and Innovation in the Green Industry. Low-carbon and Decentralised Energy includes the following:

(i) building a smart grid for more efficient energy management (demand-side policy),
(ii) promoting renewable energy use and supporting a fair transition (supply-side policy), and
(iii) expanding the supply of electric and hydrogen vehicles (mobility policy).

Through the Green New Deal, the government plans to move towards a carbon-neutral (net-zero) society by supporting ongoing policies such as the 2030 target for GHG emission

reduction and the plan to have renewables account for 20% of the country's generation capacity by 2030, along with continuous implementation of the Hydrogen Economy Roadmap.

The Green New Deal needs to be augmented not only to respond to the economic crisis but also to pursue the long-term transformation of the energy system to overcome the climate crisis. Many critics argue that the Green New Deal is merely an expansion and reorganisation of existing businesses and is insufficient in differentiation and cost-effectiveness.

The Green New Deal could, therefore, be better designed to consider Korea's unique conditions, such as the market mechanism, industrial structure and capacity, and institutional arrangements. The plan should integrate the '5Ds' – decarbonisation, decentralisation, digitalisation, deregulation, and democracy – to comprehensively address all aspects of the economy, energy, and the environment.

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Chapter 10
Lao People's Democratic Republic Country Report

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1. Background

The COVID-19 pandemic has severely affected economic growth in the Lao People's Democratic Republic (Lao PDR), which declined from about –0.6% to –2.4% in 2020. Services, including travel and tourism, have been hit hard by lockdown measures, while remittances, a vital source of income for many, have dried up. The unemployment rate rose to 25% in May 2020 from 16% at the end of 2019. These negative impacts have affected energy demand and supply in the short and long term. Lao PDR must evaluate the impacts of COVID-19 on energy demand and supply for the medium term (2020–2023) and long term (2020–2050).

2. Macro Assumptions of the COVID-19 Scenario

This chapter revises two key assumptions of the COVID-19 scenario: gross domestic product (GDP) growth rate and the crude oil price (Table 10.1). In 2019–2023, the pandemic disrupts the annual growth rate of GDP and the crude oil price. In 2020, GDP grows by 0.2% and the crude oil price by –35%. GDP grows faster than in the business-as-usual (BAU) scenario (by about 0.4%) as does the crude oil price (by about 1%).

Table 10.1. Assumptions of Gross Domestic Product and Crude Oil Price, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

Projection Period	GDP Growth Rate (%)	Japan's Crude Oil Price Growth Rate (%)
BAU Scenario		
2018–2019	7.1	8.4
2019–2020	6.4	7.7
2020–2023	6.4	4.3
2023–2050	5.9	3.4
COVID-19 Scenario		
2018–2019	5.2	–12.6
2019–2020	0.2	–35.2
2020–2023	5.1	13.9
2023–2050	6.3	4.4

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author, based on International Monetary Fund and The Institute of Energy Economics, Japan 2020 data.

3. Short-term Impact (2019–2023)

3.1. Final Energy Consumption

The annual average growth rate (AAGR) of total final energy consumption (TFEC) in BAU from 2019 to 2023 increases by about 4.5% per annum and in the COVID-19 scenario by about 3.2% per annum (Table 10.1). Energy consumption decreases from 3,867.3 kilotonnes of oil equivalent (Ktoe) to 3,681.3 Ktoe in 2023. Solid fuel consumption decreases the most, by 2.8%, followed by petroleum (2.6%), electricity (0.9%), and biomass (0.1%).

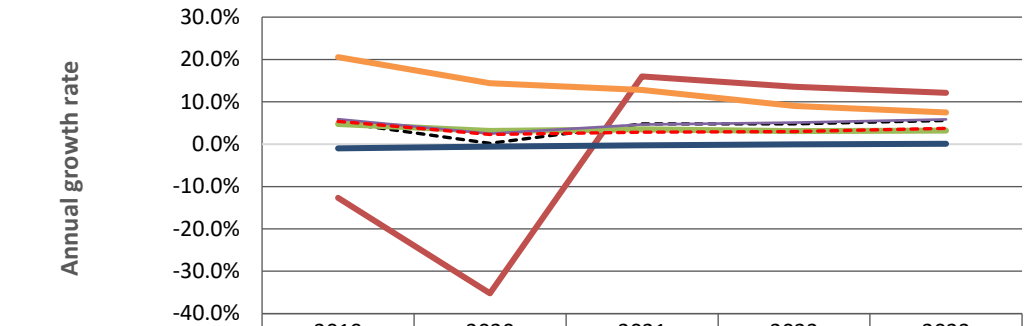
Table 10.2. Annual Growth Rate of Total Final Energy Consumption, by Fuel, Business-as-Usual vs. COVID-19 Scenarios, 2019–2023

Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
TFEC	4.5%	3.2%	1.3%
Solid Fuels	7.3%	4.5%	2.8%
Petroleum	5.4%	3%	2.4%
Electricity	11.8%	10.9%	0.9%
Others (biomass)	–0.1%	–0.2%	0.1%

BAU = business as usual, COVID-19 = coronavirus disease, TFEC = total final energy consumption.
Source: Author.

Annual growth rates of solid fuels and petroleum have a greater impact than those of other fuels in 2020 because of city lockdowns and less travel (Figure 10.1). Some industries stopped operating at the beginning of the COVID-19 pandemic. However, electricity consumption might not decrease because many people work from home and use electricity.

Figure 10.1. Annual Growth Rate of Total Final Energy Consumption, by Fuel, COVID-19 Scenario, 2019–2023



	2019	2020	2021	2022	2023
GDP	5.2%	0.2%	4.8%	4.8%	5.6%
Crude Oil Price	-12.6%	-35.2%	16.0%	13.6%	12.1%
TFEC	4.8%	3.2%	3.5%	3.1%	3.2%
Solid Fuels	5.9%	2.5%	4.7%	5.1%	5.8%
Petroleum	5.4%	2.3%	2.9%	3.0%	3.7%
Electricity	20.6%	14.4%	12.8%	9.0%	7.5%
Others (Biomass)	-1.0%	-0.6%	-0.3%	-0.1%	0.1%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

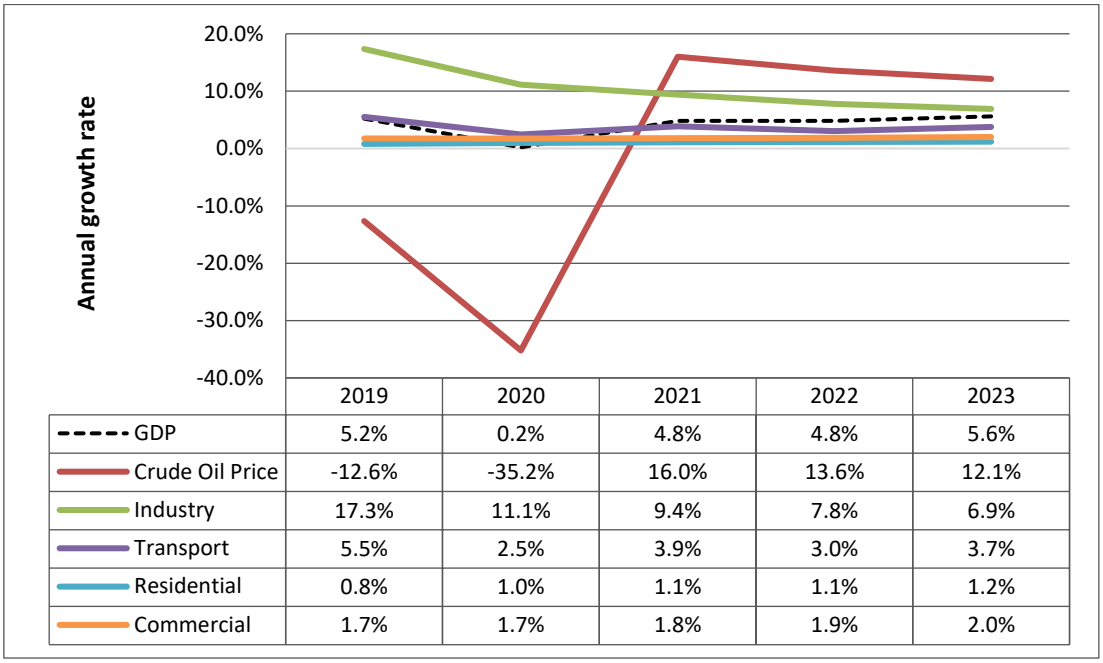
The annual growth rate of transport decreases more than that of other sectors (by about 2.4%), followed by industry (1.7%) and the commercial sector (0.7%) (Table 10.3).

Table 10.3. Annual Growth Rate of Total Final Energy Consumption, by Sector, Business-as-Usual vs. COVID-19 Scenarios, 2019–2023

Sector	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
Industry	10.5%	8.8%	1.7%
Transport	5.7%	3.3%	2.4%
Residential	1.2%	1.1%	0.1%
Commercial	2.6%	1.9%	0.7%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

Figure 10.2. Annual Growth Rate of Total Final Energy Consumption, by Sector, COVID-19 Scenario, 2019–2023



	2019	2020	2021	2022	2023
GDP	5.2%	0.2%	4.8%	4.8%	5.6%
Crude Oil Price	-12.6%	-35.2%	16.0%	13.6%	12.1%
Industry	17.3%	11.1%	9.4%	7.8%	6.9%
Transport	5.5%	2.5%	3.9%	3.0%	3.7%
Residential	0.8%	1.0%	1.1%	1.1%	1.2%
Commercial	1.7%	1.7%	1.8%	1.9%	2.0%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

3.2. Primary Energy Supply

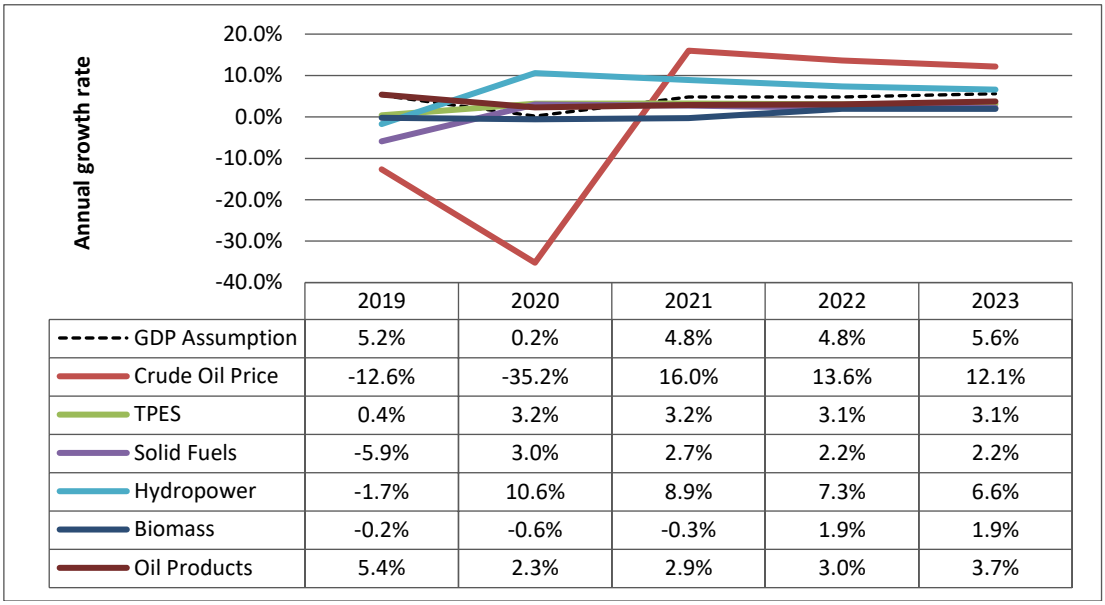
The annual growth rate of total primary energy supply (TPES) in BAU from 2019 to 2023 increases by about 3.9% per annum and in the COVID-19 scenario by about 3.1%. Primary consumption of petroleum decreases more than for other fuels (by 2.5%), followed by coal (0.3%), hydro (0.2%), and biomass (0.1%) (Table 10.4).

Table 10.4. Annual Growth Rate of Total Primary Energy Supply, by Fuel, Business-as-Usual vs. COVID-19 Scenarios, 2019–2023

Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
TPES	3.9%	3.2%	0.8%
Solid fuels	2.8%	2.5%	0.3%
Petroleum	5.4%	3%	2.5%
Hydro	8.6%	8.3%	0.2%
Others (biomass)	0.9%	0.7%	0.1%

BAU = business as usual, COVID-19 = coronavirus disease, TPES = total primary energy supply.
Source: Author.

Figure 10.3. Annual Growth Rate of Total Primary Energy Supply, by Fuel, COVID-19 Scenario, 2019–2023



	2019	2020	2021	2022	2023
GDP Assumption	5.2%	0.2%	4.8%	4.8%	5.6%
Crude Oil Price	-12.6%	-35.2%	16.0%	13.6%	12.1%
TPES	0.4%	3.2%	3.2%	3.1%	3.1%
Solid Fuels	-5.9%	3.0%	2.7%	2.2%	2.2%
Hydropower	-1.7%	10.6%	8.9%	7.3%	6.6%
Biomass	-0.2%	-0.6%	-0.3%	1.9%	1.9%
Oil Products	5.4%	2.3%	2.9%	3.0%	3.7%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Author.

The COVID-19 pandemic affects oil supply but not coal and hydro because most coal is domestically supplied to Hongsa Lignite Thermal Power Plant in Xayaburi Province and about 70% of hydropower is exported.

3.3. CO_2 Emissions

The annual growth rate of total CO_2 emissions in BAU from 2020 to 2023 increases by about 3.3% per annum and in the COVID-19 scenario by about 2.6% per annum (a difference of 0.17 metric tonnes of CO_2 [Mton-CO_2] in 2023). CO_2 emissions from oil products decrease by 2.4% (0.11 Mton-CO_2) in 2023 and from solid fuels by 0.3% (0.06 Mton-CO_2) in 2023 (Table 10.5).

Table 10.5. Annual Growth Rate of CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2019–2023

Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
Total	3.3%	2.6%	0.7%
Solid fuels	2.8%	2.5%	0.3%
Petroleum	5.4%	3%	2.4%

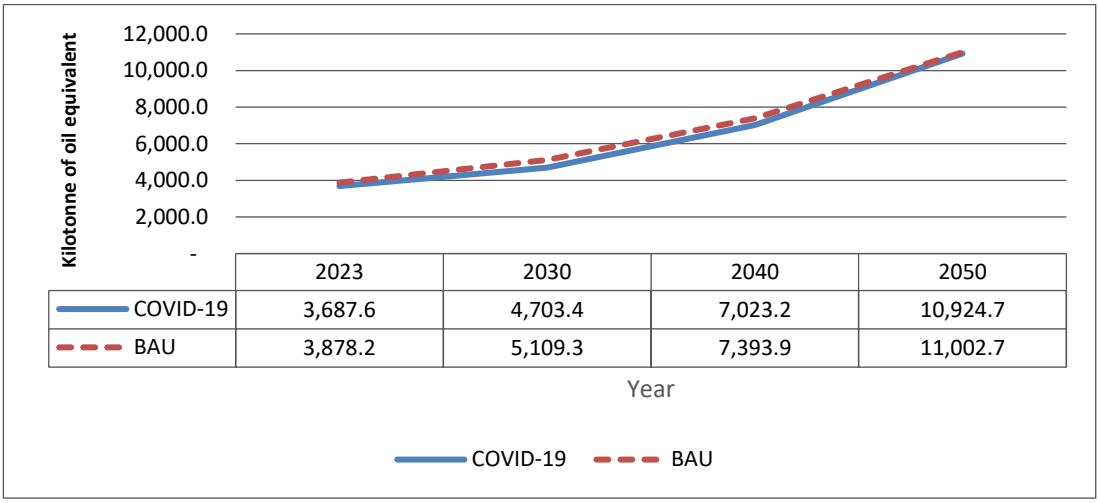
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the long term, TPEC in the BAU and COVID-19 scenarios are not much different. In the COVID-19 scenario, TPEC is lower than in BAU by 8% in 2030, 5% in 2040, and 1% in 2050 (Figure 10.4).

Figure 10.4. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

The annual GDP growth rate in the COVID-19 scenario in 2019–2023 is lower than in BAU. But in 2023–2050, GDP grows more than in BAU by about 0.4% per annum. Therefore, the AAGR of TFEC in the COVID-19 scenario increases by 4.1%, or by 0.2% more than in BAU. The AAGR in the COVID-19 scenario increases more than in BAU by about 0.4% for solid fuels, 0.4% for petroleum fuels, and 0.1% for electricity fuel (Table 10.6).

Table 10.6. Annual Growth Rate of Total Final Energy Consumption, by Fuel, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050

Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
GDP assumption	5.9%	6.3%	–0.4%
Crude oil	3.45%	4.43%	0.98%
TFEC	3.9%	4.1%	–0.2%
Solid fuels	6.4%	6.8%	–0.4%
Petroleum	4.8%	5.2%	–0.4%
Electricity	5.1%	5.2%	–0.1%
Others (biomass)	0.8%	0.8%	0%

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

The AAGR of energy consumption by transport increases rapidly beyond BAU by about 0.4%, followed by industry (0.2%) and the commercial sector (0.1%). The AAGR of energy consumption by the residential and agriculture sectors increases at the same rate as in BAU (Table 10.7).

Table 10.7. Annual Growth Rate of Total Final Energy Consumption, by Sector, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050

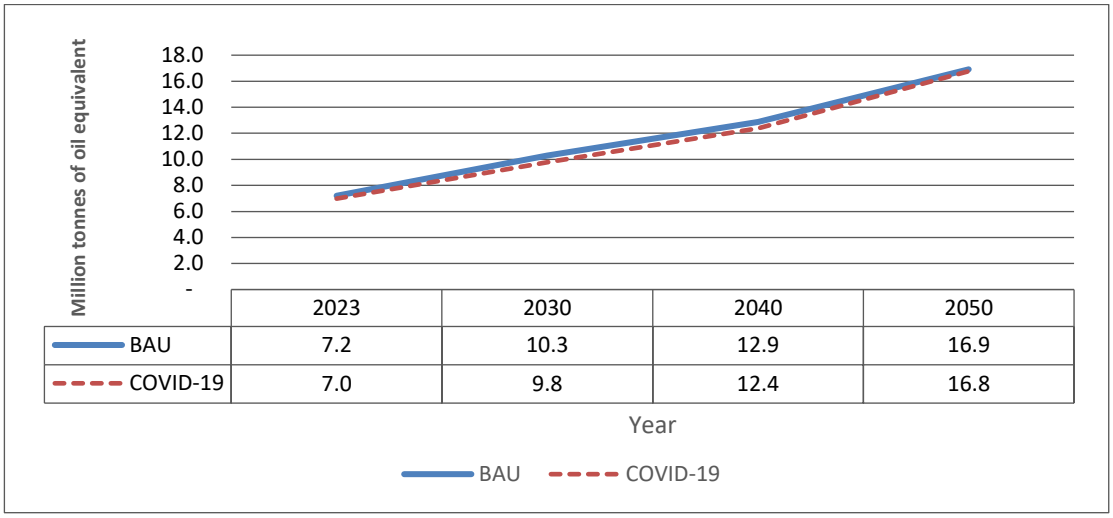
Sector	Annual Growth Rate		
	BAU Scenario	COVID-19-19 Scenario	Reduction
Industry	5.7%	5.9%	–0.2%
Transport	4.6%	5.0%	–0.4%
Residential	1.3%	1.3%	0.0%
Commercial	3.8%	3.8%	–0.1%
Agriculture	6.0%	6.0%	0.0%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

The results of the TPES outlook in 2023–2050 in the BAU and COVID-19 scenarios are not much different. Energy consumption is lower in the COVID-19 scenario than in BAU by 5% (0.51 million tonnes of oil equivalent [Mtoe]) in 2030, 3.9% (0.5 Mtoe) in 2040, and 0.9% (0.15 Mtoe) in 2050 (Figure 10.5).

Figure 10.5. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050



BAU = business as usual, COVID-19 = coronavirus disease, Ktoe = thousand tons of oil equivalent.
Source: Author.

The annual growth rate of total primary energy consumption in BAU in 2023–2050 increases by about 3.2% per annum or 0.1% less than in the COVID-19 scenario. Petroleum primary supply in BAU is lower than in the COVID-19 scenario. Solid fuel such as coal is 0.1% lower in BAU than in the COVID-19 scenario. Hydropower and biomass grow at the same rate in BAU (Table 10.8).

Table 10.8. Annual Growth Rate of Total Primary Energy Supply, by Fuel, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050

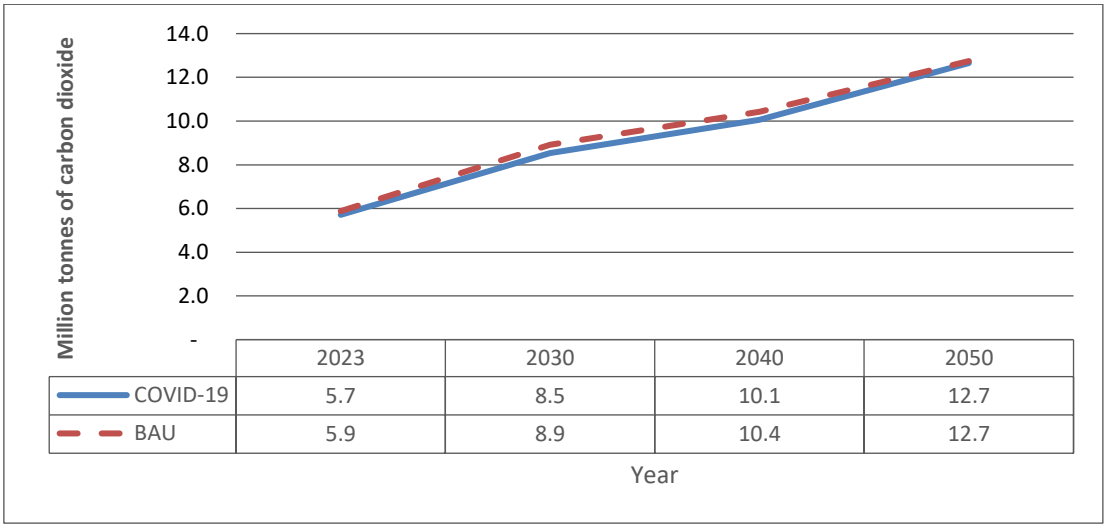
Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
GDP assumption	5.9%	6.3%	–0.4%
Crude oil	3.45%	4.43%	0.4%
TPES	3.2%	3.3%	–0.1%
Solid fuels	2.2%	2.3%	–0.1%
Petroleum	4.8%	5.2%	–0.4%
Hydro	1.7%	1.7%	0%
Others (biomass)	1.1%	1.1%	0%

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Author.

4.3. CO_2 Emissions

CO_2 emissions in the COVID-19 scenario are lower than in BAU by about 4% (0.38 Mton-CO_2) in 2030, 4% (0.37 Mton-CO_2) in 2040, and 1% (0.09 Mton-CO_2) in 2050. But the annual growth rate of CO_2 emissions in the COVID-19 scenario is higher than in BAU by about 0.1% (Figure 10.6).

Figure 10.6. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050



BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

Table 10.9. Annual Growth Rate of CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2023–2050

Item	Annual Growth Rate		
	BAU Scenario	COVID-19 Scenario	Reduction
Total	2.9%	3%	–0.1%
Solid fuels	2.2%	2.3%	–0.4%
Petroleum	4.8%	5.2%	–0.1%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

The COVID-19 pandemic has severely affected economic growth, which declined by about 0.6% to 2.4% in 2020. Services, including travel and tourism, have been hit hard by lockdown measures, while remittances, a vital source of income for many, have dried up. The unemployment rate rose to 25% in May 2020 from 16% at the end of 2019.

In the COVID-19 scenario, based on GDP and crude oil price assumptions estimated by the International Monetary Fund and The Institute of Energy Economics, Japan (2020), the AAGR of TFEC decreases by 1.3% per annum in 2019–2023. TFEC decreases by 5%, from 3,867 Ktoe to 3,681 Ktoe in 2023. The AAGR of TPES decreases by 0.8% per annum. TPES decreases by 3%, from 7,192 Ktoe to 6,974 Ktoe in 2023. The AAGR of CO_2 emissions decreases by 0.7% per annum. CO_2 emissions decrease by 2.8%, from 5.9 Mt-CO_2 to 5.7 Mt-CO_2, in 2023. In 2023–2050, the growth rate of GDP rebounds faster than in BAU. Therefore, the AAGR of TFEC increases beyond the BAU scenario of 0.2%. TFEC decreases by 0.9% or 96.57 Ktoe in 2050. The AAGR of TPES increases beyond the BAU scenario of 0.1% per annum. TPES decreases by 0.01% or equivalent to 1 Mtoe in 2050. The AAGR of CO_2 emissions increases beyond the BAU scenario of 0.1%, decreasing to 0.9% or 0.11 Mtoe in 2050.

The COVID-19 pandemic has interrupted TFEC and primary energy supply and contributed significantly to energy saving and CO_2 emission reduction in Lao PDR, where, as in the rest of the world, lockdown measures have reduced travel and resulted in more people working from home. However, Lao PDR still needs to implement measures such as energy efficiency and conservation on the demand side and highly efficient thermal power plants.

The lesson learnt from the COVID-19 pandemic is that Lao PDR must activate economic growth by promoting agricultural production and internal tourism and reduce dependence on imported goods. To continue energy saving and CO_2 emission reduction, Lao PDR must promote remote working, online business, e-learning, and electric vehicles.

Chapter 11
Malaysia Country Report

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1. Background

To control the outbreak of the coronavirus disease (COVID-19) pandemic, Malaysia's government announced a series of lockdowns, which limited business operations and kept people at home, lowering energy consumption.

2. Macro Assumptions of the COVID-19 Scenario

The economy contracted by 8.3% in the first half of 2020 and by 17.1% in the second quarter, but is expected to contract more slowly in the second half of the year because of stimulus packages. The economy is expected to contract by 4.5% in 2020.

In 2017–2020, in the COVID-19 scenario, growth is 1.41% per year (4.05% in BAU). In 2020–2030, gross domestic product (GDP) increases by 4.60% per year (3.76% in BAU). Economic growth is the same as in BAU in 2030–2040 (2.89%) and 2040–2050 (2.43%) (Table 11.1).

Table 11.1. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

	1990–2017	2017–2020	2020–2030	2030–2040	2040–2050	2017–2050
COVID-19	5.69%	1.41%	4.60%	2.89%	2.43%	3.13%
BAU	5.69%	4.05%	3.76%	2.89%	2.43%	3.12%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020) data.

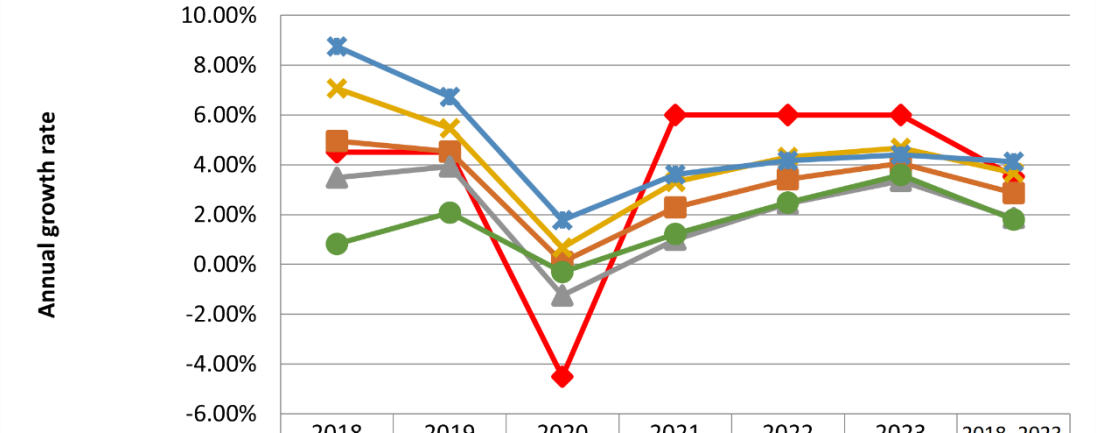
3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

To observe the impacts of the COVID-19 pandemic on total final energy consumption (TFEC), this chapter applied revised and updated assumptions for GDP growth rates. In 2018–2023, the average annual growth rate (AAGR) of TFEC in the COVID-19 scenario is 2.87% per year (3.93% in BAU) (Figure 11.1).

In 2020, industry experiences the lowest growth, at –1.24%, followed by non-energy, at –0.31%. Transport recorded lower growth (0.66%) than in the previous year (5.46%). 'Others'—the residential, commercial, and agriculture sectors—grow by 1.78% in 2020, lower than in previous year (6.73%).

Figure 11.1 Annual Growth Rate of Total Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



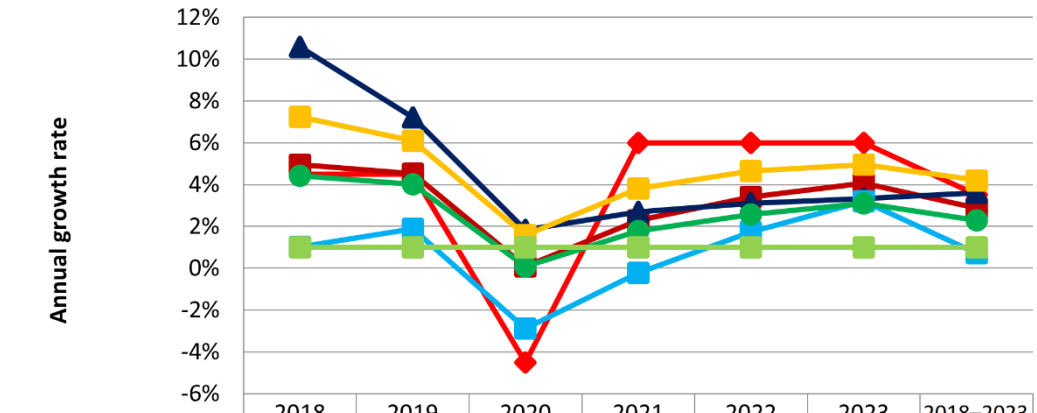
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	4.50%	4.50%	-4.50%	6.00%	6.00%	6.00%	3.52%
TFEC	4.95%	4.53%	0.09%	2.30%	3.41%	4.06%	2.87%
Industry	3.48%	3.92%	-1.24%	0.99%	2.43%	3.35%	1.87%
Transportation	7.07%	5.46%	0.66%	3.30%	4.31%	4.69%	3.67%
Others	8.74%	6.73%	1.78%	3.62%	4.17%	4.40%	4.13%
Non-energy	0.81%	2.07%	-0.31%	1.23%	2.49%	3.59%	1.81%

COVID-19 = coronavirus disease; GDP = gross domestic product; others = residential, commercial, and agriculture sectors; TFEC = total final energy consumption.
Source: Author.

Although energy consumption growth follows GDP, COVID-19 impacted them differently. Early data show that industry and non-energy are greatly impacted. High-energy–intensive industry was shut down because of lockdowns, which immediately slowed energy use. Lower growth of final energy consumption for transport was mainly caused by negative growth of gasoline consumption in 2020 resulting from fewer vehicles in use as people were required to stay home. However, diesel consumption remained positive even with lower growth in 2020 as it was used mainly to fuel vehicles delivering goods. During the lockdown, the vehicles remained operational to deliver food. 'Others' saw mixed results during the lockdown. In the residential sector, electricity use is expected to increase as people were instructed to work and study at home. In the commercial sector, hospitals' energy consumption remains strong while hotels and retail posted lower growth rates. New energy demand came from delivery services for goods and food. Private vehicle registration saw negative growth, but motorcycles posted high growth rates. Transport, therefore, remains positive despite its lower growth rate.

Analysis of TFEC based on type of fuel shows that only natural gas is expected to register negative growth in 2020 because it is the main fuel for industry and non-energy. Coal consumption, mainly used for cement and steel production, records lower growth in 2020 at 1.8% than in 2019 at 7.2%. Cement manufacturers will reduce production in the absence of additional demand. The growth of electricity demand remains positive, with a lower rate in 2020 as a mixture of impacts were observed across all sectors. For example, electricity demand in industry decreases in 2020 but not in the residential sector (Figure 11.2).

Figure 11.2. Annual Growth Rate of Total Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



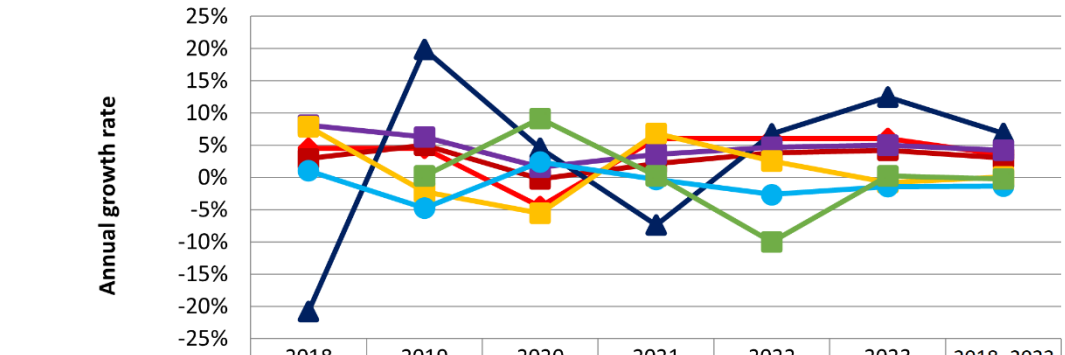
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	4.5%	4.5%	-4.5%	6.0%	6.0%	6.0%	3.5%
TFEC	5.0%	4.5%	0.1%	2.3%	3.4%	4.1%	2.9%
Coal	10.6%	7.2%	1.8%	2.7%	3.1%	3.3%	3.6%
Oil	7.2%	6.1%	1.6%	3.8%	4.6%	4.9%	4.2%
Gas	1.0%	1.9%	-2.9%	-0.2%	1.7%	3.2%	0.7%
Electricity	4.4%	4.0%	0.1%	1.8%	2.6%	3.1%	2.3%
Others	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) in 2020 is expected to decline by 0.2%. The reduction of TPES in 2020 followed GDP, which is expected to decrease by 4.5%. Natural gas contributed the most to the reduction as it is dropped by 5.6% in 2020. Consumption of natural gas is expected to decrease in the transformation process and final energy use. Demand for natural gas is especially lower for power, industry, and non-energy. TPES for oil recorded lower growth in 2020 (1.6%) than in 2019 (6.3%). The lower growth rate for oil resulted from weak demand in transport. As for coal, demand from power and manufacturing remains strong, although with a lower growth rate, despite the pandemic. In the short run, TPES grows by about 3.0% per year in 2018–2023, mainly because of coal (Figure 11.3).

Figure 11.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	4.5%	4.5%	-4.5%	6.0%	6.0%	6.0%	3.5%
TPES	2.9%	5.0%	-0.2%	2.1%	3.8%	4.2%	3.0%
Coal	-20.8%	19.9%	4.5%	-7.4%	6.7%	12.4%	6.9%
Oil	8.1%	6.3%	1.6%	3.6%	4.7%	5.0%	4.2%
Natural gas	7.9%	-2.3%	-5.6%	6.8%	2.5%	-0.8%	0.0%
Hydro	1.1%	-4.8%	2.4%	-0.3%	-2.7%	-1.4%	-1.4%
Others		0.2%	9.1%	0.2%	-10.0%	0.2%	-0.2%

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

Elasticity between TPES and GDP is less than 1, which shows that energy use is efficient. To recover, Malaysia must maintain a lower energy growth rate while attaining a higher economic growth rate. Malaysia is on track for economic recovery and likely to rebound strongly backed by various policy measures. The government believes the economy can return to 2019 levels by mid-2021, supported by, among others, improving external demand amidst a technology upcycle, more targeted containment measures, a well-structured COVID-19 vaccine rollout, and gradual recovery in labour market conditions.

3.3. CO_2 Emissions

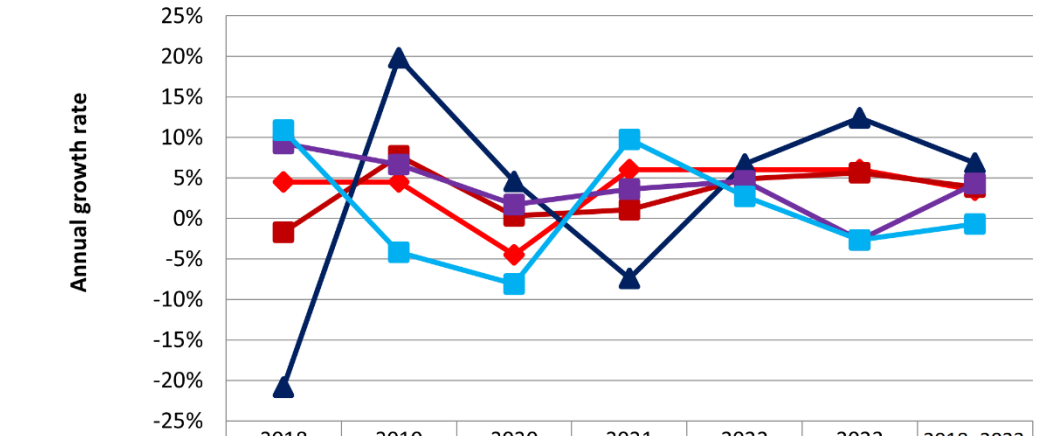
In the Malaysia Third Biennial Update Report to the United Nations Framework Convention on Climate Change, 2016, the energy sector was the largest contributor of greenhouse gas GHG) emissions, accounting for 79.4% of total emissions. Electricity and heat production contributed the most CO2 emissions (39% of the total), followed by road transport (21%) and manufacturing and construction (9%).

The AAGR of CO_2 emissions is about 3.9% per year (Figure 11.4), much higher than that of GDP since natural gas and not coal accounts for most of the reduction. The AAGR of CO_2 from natural gas is expected to decrease by 0.7% per year in 2018–2023. However, the AAGR of coal increases by 6.9% per year and emissions from oil by 4.3% per year in 2018–2023.

Malaysia intends to reduce its GHG emissions intensity of GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. The reduction consists of 35% on an unconditional basis

and a further 10% is conditional upon receipt of climate finance, technology transfer, and capacity building from developed countries.

Figure 11.4. CO_2 Emissions, by Sources, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	4.5%	4.5%	-4.5%	6.0%	6.0%	6.0%	3.5%
Total	-1.7%	7.7%	0.3%	1.1%	4.9%	5.6%	3.9%
Coal	-20.8%	19.9%	4.5%	-7.4%	6.7%	12.4%	6.9%
Oil	9.2%	6.7%	1.7%	3.6%	4.7%	-2.6%	4.3%
Natural gas	10.9%	-4.2%	-8.1%	9.8%	2.7%	-2.6%	-0.7%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

The Ministry of Environment and Water is spearheading efforts towards a sustainable Malaysia by 2030 through 26 initiatives based on four pillars: strengthening of governance, green growth, strategic collaboration, and social inclusion, covering the atmosphere (air), hydrosphere (water), lithosphere (land), and biosphere (living beings).

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

The economy, it is hoped, will recover quickly through the government's vaccination programme, which will impact energy supply and demand. The GDP AAGR is the same in the BAU and COVID-19 scenarios in 2017–2050. In BAU, projected GDP increases by 3.12% per year and in the COVID-19 scenario by 3.13%. By 2050, the difference between GDP in the BAU and COVID-19 scenarios is only 0.36%, showing that the pandemic's economic impact is not crucial in the long run (Table 11.2).

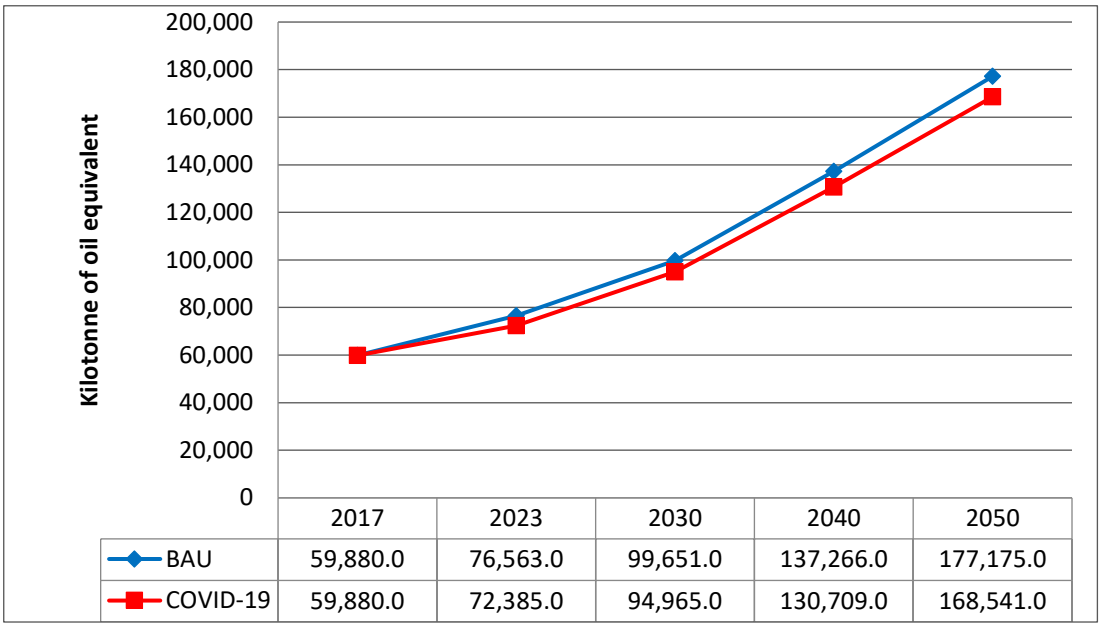
Table 11.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual and COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (constant US$ billion, 2010)	**BAU**	365.57	460.41	593.84	789.49	1,003.74	3.12%
	COVID-19	364.57	452.83	595.99	792.34	1,007.36	3.13%
	COVID-19 vs. BAU	0.00%	-1.65%	0.36%	0.36%	0.36%	
TFEC (Ktoe)	**BAU**	59,880	76,563	99,651	137,266	177,175	3.34%
	COVID-19	59,880	72,385	94,965	130,709	168,541	3.19%
	COVID-19 vs. BAU	0.00%	-5.46%	-4.70%	-4.78%	-4.87%	

BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Ktoe = kilotonne of oil equivalent, TFEC = total final energy consumption.
Source: Author.

The AAGR of TFEC in BAU is 3.34% per year and in the COVID-19 scenario 3.19% per year in 2017–2050. Because of the pandemic, the difference in TFEC in 2050 between the two scenarios is significant at about 4.87%, with TFEC more fragile than GDP in the face of the pandemic because of the use of energy for daily life (Figure 11.5).

Figure 11.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	59,880.0	76,563.0	99,651.0	137,266.0	177,175.0
COVID-19	59,880.0	72,385.0	94,965.0	130,709.0	168,541.0

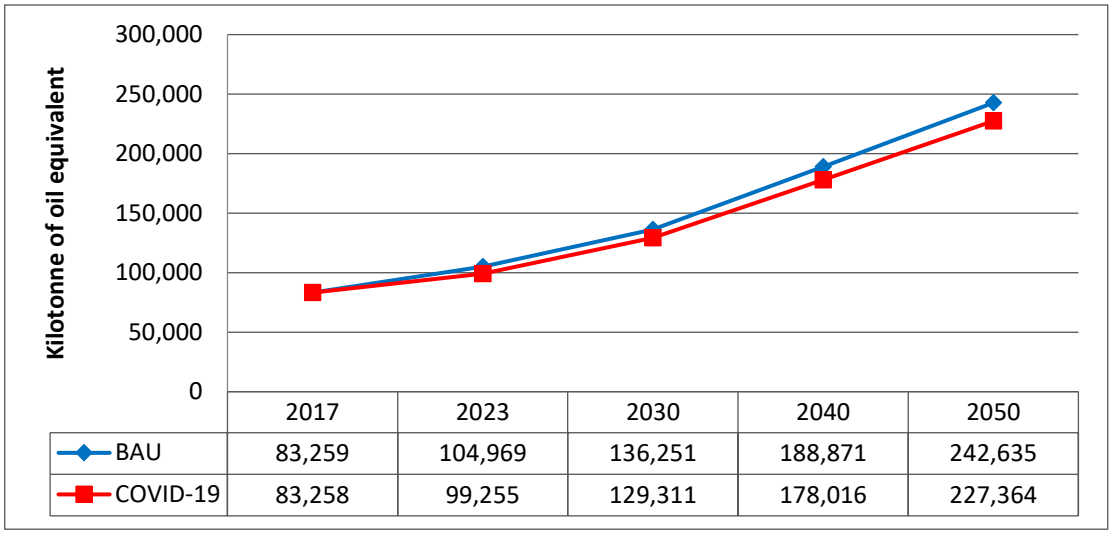
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

Figure 11.5 shows TFEC trends from 2017 to 20250 in the BAU and COVID-19 scenarios. The COVID-19 scenario presented at the lower bound of the graph shows the impact of COVID-19 on TFEC. As a result, AAGR is slightly lower in the COVID-19 scenario than in BAU in the long run.

4.2. Primary Energy Supply

TPES is similar in both scenarios but at a different scale (Figure 11.6). AAGR is lower in the COVID-19 scenario (3.09% per year) than in BAU (3.29%). In 2023–2050, the difference between the COVID-19 and BAU scenarios is only about 5%–6% and can be considered low impact.

Figure 11.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	83,259	104,969	136,251	188,871	242,635
COVID-19	83,258	99,255	129,311	178,016	227,364

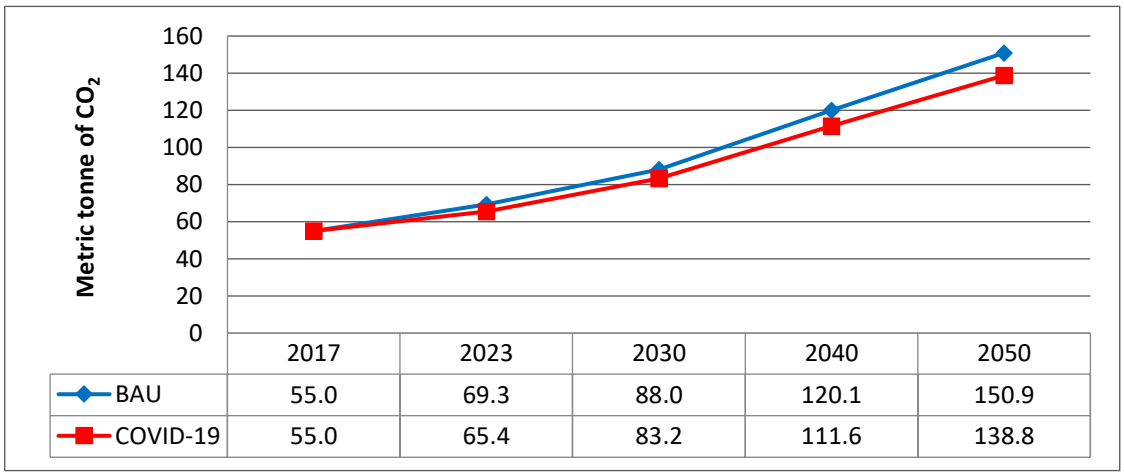
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2 Emissions

In the COVID-19 scenario, total emissions are slightly lower than in BAU (Figure 11.7). In 2050, the gap between total emissions of the two scenarios is 8.7% but only 6.0% in 2023.

Total emissions in the COVID-19 scenario increase by 2.85% per year in 2017–2050 (3.11% in BAU) because of lower energy demand from the power and industry sectors, which will indirectly help meet the carbon intensity commitment by 2030.

Figure 11.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	55.0	69.3	88.0	120.1	150.9
COVID-19	55.0	65.4	83.2	111.6	138.8

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

The COVID-19 pandemic has undeniably had a large impact on health, society, and the economy. The government needs an economic recovery plan.

According to the model, residential electricity consumption should increase during the pandemic as people are ordered to stay home. However, the model shows a drop as the demand equation only relates to GDP. As GDP is assumed to decline, consumption follows the same trend. In the case of the residential sector, an extra parameter is needed to determine the real impact of energy usage during the pandemic; neither GDP nor income per capita is a significant parameter.

In the commercial sector, tourism is one of the most affected areas. In some countries such as Malaysia, however, hotels are used as quarantine centres so hotel energy usage is not entirely zero. Since not all commercial activities are not operational, commercial energy consumption remains positive despite the lower growth rate.

In transport, the major drop is from gasoline. Despite people staying home and not using their vehicles, high demand for delivery services for goods and food saw gasoline demand rise for two-wheelers. Online shopping is a new trend and creates new energy demand. The result is that transport energy demand that was expected to decline increases but at a lower volume.

Industry is correlated with GDP and is expected to decrease. The mandatory shutdowns of factories saw companies suffer huge losses, unable to pay salaries, and letting some of their workers go. The unemployment rate is increasing and people find it difficult to survive. The government introduced many kinds of stimulus packages. Many people switched from industry to commercial jobs, which will have an impact on energy consumption in the near future.

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Chapter 12
Myanmar Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has brought with it economic and social problems. Vaccines will be available soon, but Myanmar will not be safe immediately. With the cessation of all international trade, large, small, and medium-sized enterprises have reduced their operations and trade has declined significantly. Businesses are adapting their operations and management to the new normal, but the virus has taken a toll on the economy and reversed development in just a few months. Declining demand has hit manufacturing and the jobs it created. This chapter uses the energy outlook business-as-usual (BAU) scenario to assess the pandemic's impact on energy demand. The COVID-19 scenario estimates how much energy demand is expected to decline in 2020 and how it will recover after 2020.

2. Macro Assumptions of the COVID-19 Scenario

The average annual gross domestic product (GDP) growth rate decreases from 6.9% in BAU to 2.0% in the COVID-19 scenario in 2020, returning to 5.7% in 2021, 6.2% in 2022, and 6.4% in 2023 (Table 12.1).

The average annual GDP growth rate in 2023–2030 is marginally higher than in BAU. In 2030–2040, the economic growth rate is 5.7 % and in 2040–2050 5.3%.

Table 12.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2018–2023	2023–2030	2030–2040	2040–2050
BAU	7.00%	7.00%	6.90%	6.90%	6.90%	6.90%	6.90%	6.4%	5.5%	5.00%
COVID-19	6.40%	6.50%	2.00%	5.70%	6.20%	6.40%	5.30%	6.5%	5.7%	5.30%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020) and Institute of Energy Economics, Japan (2020).

3. Short-term Impact (2018–2023)

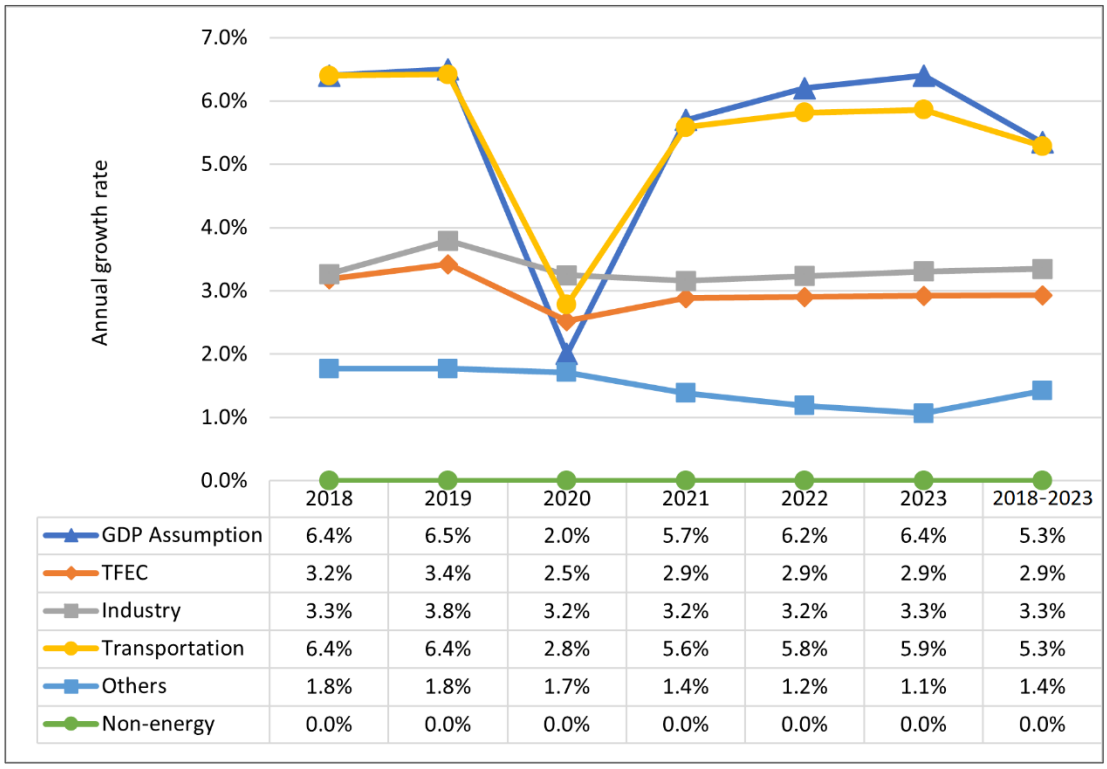
3.1. Final Energy Consumption

In the COVID-19 scenario (Figure 12.1), total final energy consumption (TFEC) steadily declines by an average of 2.9% per year in 2018–2023 (3.2% in BAU) because the pandemic

reduces the TFEC growth rate from 3.2% in BAU to 2.5% in 2020.

The transport energy consumption growth rate falls sharply to 2.8% in 2020 (6.5% in BAU) because people are required to work from home and is 5.3% per year in 2018–2030 (6.54% in BAU). Industry grows by 3.2% (3.35% in BAU) in 2020 and by 3.3% per year (3.45% in BAU) in 2018–2023. 'Others' (residential, commercial, agricultural sectors, amongst others) are the lowest at 1.7% in 2020 and 1.4% per year in 2018–2023 (4.59% in BAU), but not much different than the 1.8% in 2019 (Figure 12.1).

Figure 12.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023

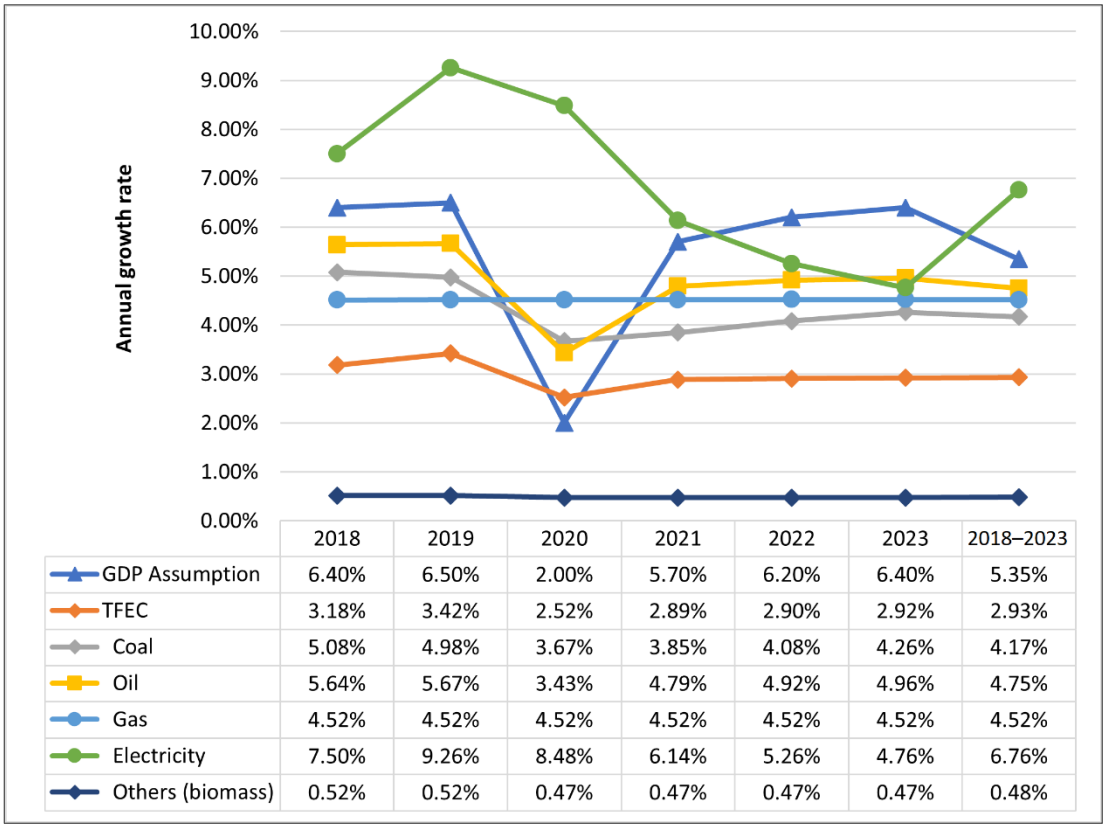


	2018	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	6.4%	6.5%	2.0%	5.7%	6.2%	6.4%	5.3%
TFEC	3.2%	3.4%	2.5%	2.9%	2.9%	2.9%	2.9%
Industry	3.3%	3.8%	3.2%	3.2%	3.2%	3.3%	3.3%
Transportation	6.4%	6.4%	2.8%	5.6%	5.8%	5.9%	5.3%
Others	1.8%	1.8%	1.7%	1.4%	1.2%	1.1%	1.4%
Non-energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

Coal energy consumption grows by 3.67% (5.15% in BAU) in 2020 and by 4.17% per year in 2018–2023 (5.11% in BAU). Electricity consumption grows by 8.48% (7.6% in BAU) in 2020, slightly decreasing to 6.76% (7.17% in BAU) in 2018–2023. In 2020, oil consumption significantly decreases by 3.43% (5.24% in BAU) and continues to decline by 4.75% per year in 2018–2023 (5.34% in BAU). Natural gas consumption growth rates are the same in the COVID-19 and BAU scenarios. 'Others' (mostly biomass) are hardly affected by COVID-19 because of the continuous shift from biomass to conventional fuels such as oil and electricity even in the pandemic (Figure 12.2).

Figure 12.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



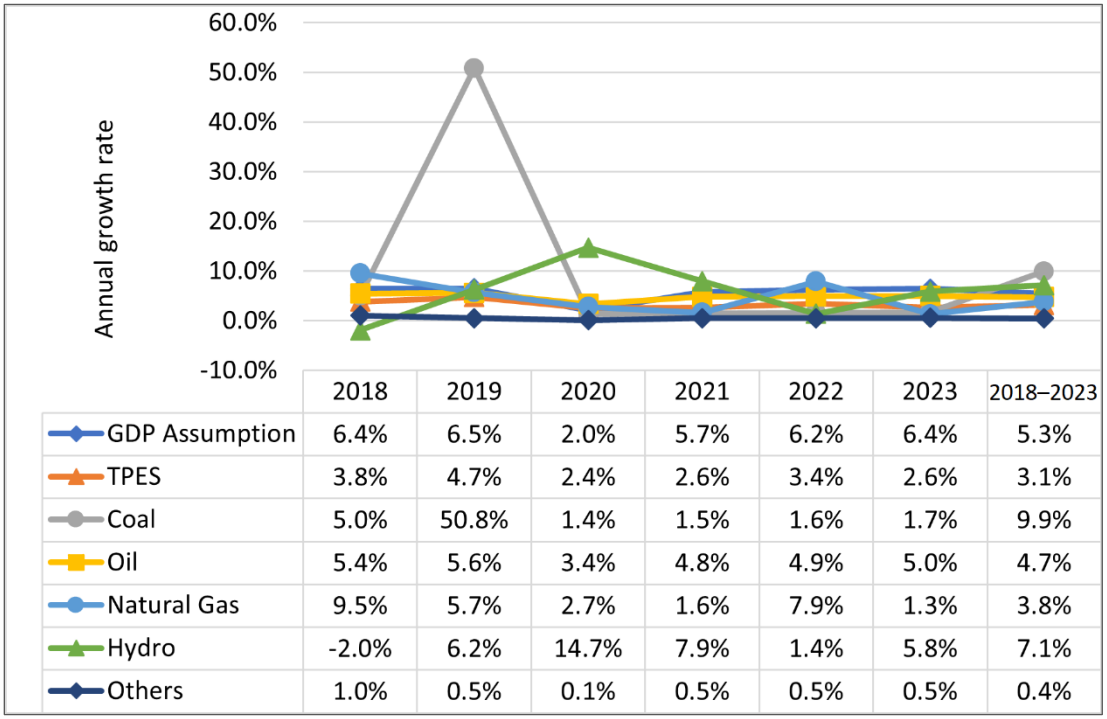
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.40%	6.50%	2.00%	5.70%	6.20%	6.40%	5.35%
TFEC	3.18%	3.42%	2.52%	2.89%	2.90%	2.92%	2.93%
Coal	5.08%	4.98%	3.67%	3.85%	4.08%	4.26%	4.17%
Oil	5.64%	5.67%	3.43%	4.79%	4.92%	4.96%	4.75%
Gas	4.52%	4.52%	4.52%	4.52%	4.52%	4.52%	4.52%
Electricity	7.50%	9.26%	8.48%	6.14%	5.26%	4.76%	6.76%
Others (biomass)	0.52%	0.52%	0.47%	0.47%	0.47%	0.47%	0.48%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) steadily decreases by 2.4% (2.75% in BAU) in 2020 and continues to do so by 3.1% per year in 2018–2023 (3.41% in BAU) (Figure 12.3). In 2020, coal energy supply grows by 1.4% (1.93% in BAU) and decreases slightly by 0.4% in 2018–2023. Coal spiked in 2019 because a new coal power plant opened in Myanmar. Oil consumption, however, decreases by 3.4% (5.17% in BAU) in 2020. In 2018–2023, coal declines by 4.7% (5.31% in BAU). Natural gas grows by 2.7% in 2020 (1.97% in BAU) and by 3.8% per year in 2018–2023 (4.05% in BAU). 'Others' (mostly biomass) decrease by 0.1% in 2020 (0.48% in BAU) and by 0.4% per year in 2018–2023 (0.5% in BAU).

Figure 12.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



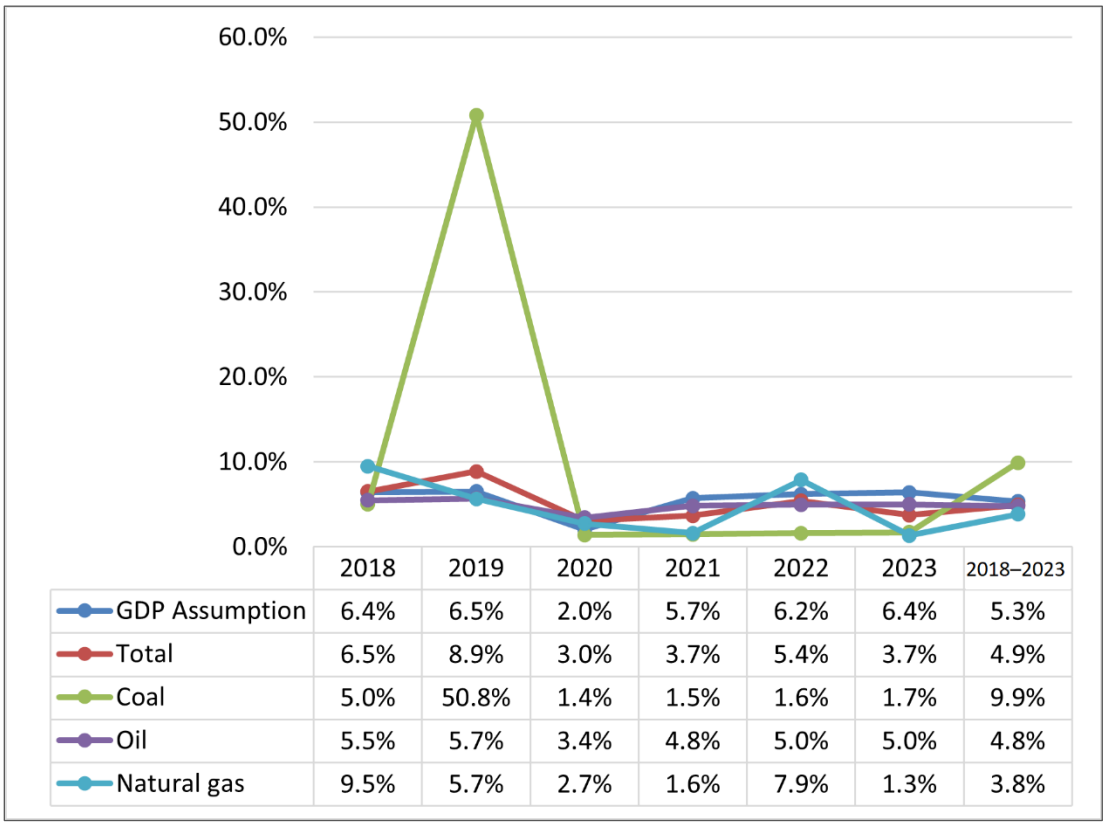
	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.4%	6.5%	2.0%	5.7%	6.2%	6.4%	5.3%
TPES	3.8%	4.7%	2.4%	2.6%	3.4%	2.6%	3.1%
Coal	5.0%	50.8%	1.4%	1.5%	1.6%	1.7%	9.9%
Oil	5.4%	5.6%	3.4%	4.8%	4.9%	5.0%	4.7%
Natural Gas	9.5%	5.7%	2.7%	1.6%	7.9%	1.3%	3.8%
Hydro	-2.0%	6.2%	14.7%	7.9%	1.4%	5.8%	7.1%
Others	1.0%	0.5%	0.1%	0.5%	0.5%	0.5%	0.4%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Author.

3.3. CO_2 Emissions

In the COVID-19 scenario, greenhouse gas (GHG) emissions decrease by 3.0% in 2020 (4.03% in BAU) and steadily decrease by 4.9% per year in 2018–2023 (5.39% in BAU) (Figure 12.4). Oil-related GHG emissions decrease by 3.4% in 2020 (5.20% in BAU) and by 4.8% per year in 2018–2023 (5.35% in BAU). Natural gas and coal decrease, too, but not as much as oil. Coal emissions continue to decline by 1.4% in 2020 (1.93% in BAU) and by 9.9% in 2018–2023 (10.29% in BAU). Coal emissions spiked in 2019 for the same reason that TPES did. Natural gas emissions decrease slightly by 3.8% in 2018–2030 (4.05% in BAU) but grow steadily by 2.7% in 2020 (1.97% in BAU). CO_2 emissions decreased mainly because of the pandemic.

Figure 12.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018–2023
GDP Assumption	6.4%	6.5%	2.0%	5.7%	6.2%	6.4%	5.3%
Total	6.5%	8.9%	3.0%	3.7%	5.4%	3.7%	4.9%
Coal	5.0%	50.8%	1.4%	1.5%	1.6%	1.7%	9.9%
Oil	5.5%	5.7%	3.4%	4.8%	5.0%	5.0%	4.8%
Natural gas	9.5%	5.7%	2.7%	1.6%	7.9%	1.3%	3.8%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases by an average growth rate of 2.84% per year in 2017–2050 (2.89% in BAU) because the economy recovers after the pandemic and grows by 5.7% (5.79% in BAU) (Table 12.2).

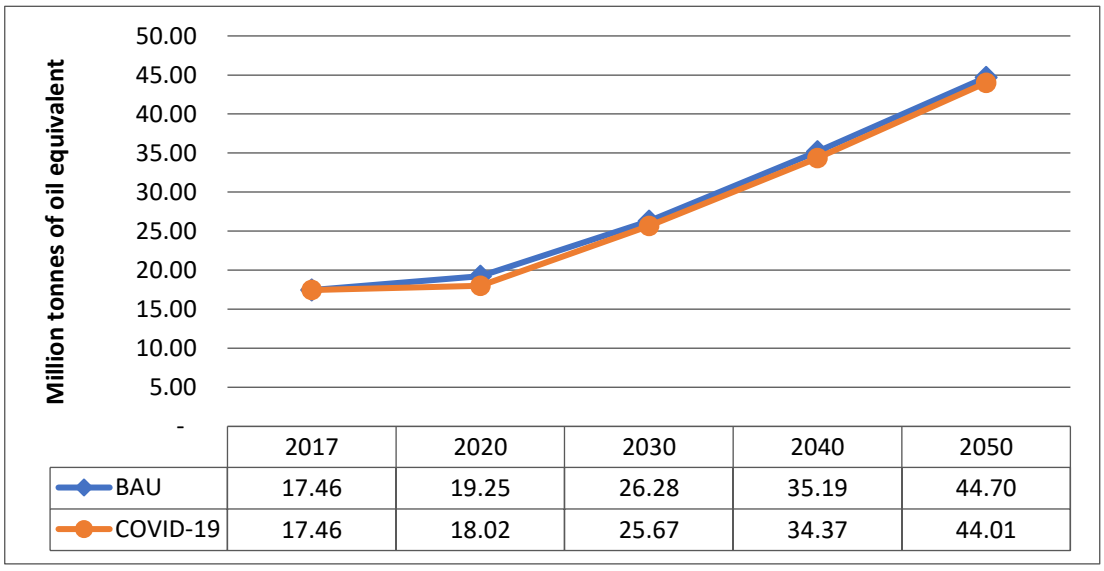
Table 12.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR 2017–2050
GDP (constant US$ billion, 2010)	BAU	79.50	97.29	183.29	312.67	509.31	5.79%
	COVID-19	79.50	91.88	170.54	295.75	495.69	5.70%
	COVID-19 vs. BAU	0.00%	–5.96%	–6.96%	–5.41%	–2.67%	-0.09%
TFEC (Mtoe)	BAU	17.46	19.25	26.28	35.19	44.70	2.89%
	COVID-19	17.46	19.10	25.67	34.37	44.01	2.84%
	COVID-19 vs. BAU	0.00%	–0.77%	–2.37%	–2.39%	–1.56%	-0.05%

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Author.

The above calculation results show that TFEC in the COVID-19 scenario cannot catch up with TFEC in BAU by 2050 because GDP in the COVID-19 scenario is lower than in BAU. TFEC in the COVID-19 scenario, however, may catch up with BAU after 2050 because GDP rebounds in 2021–2050 (Figure 12.5).

Figure 12.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

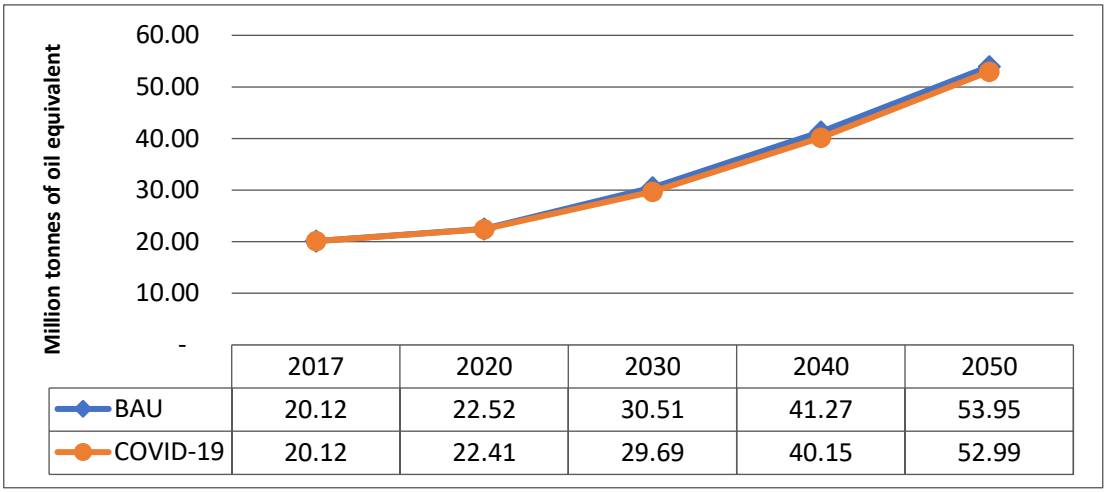


BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = million tonnes of oil equivalent.
Source: Author.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases at an average growth rate of 3.0% per year in 2017–2050. Like TFEC, TPES in the COVID-19 scenario is the same as in BAU after 2030 because of GDP's strong recovery in 2021–2030 (Figure 12.6).

Figure 12.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



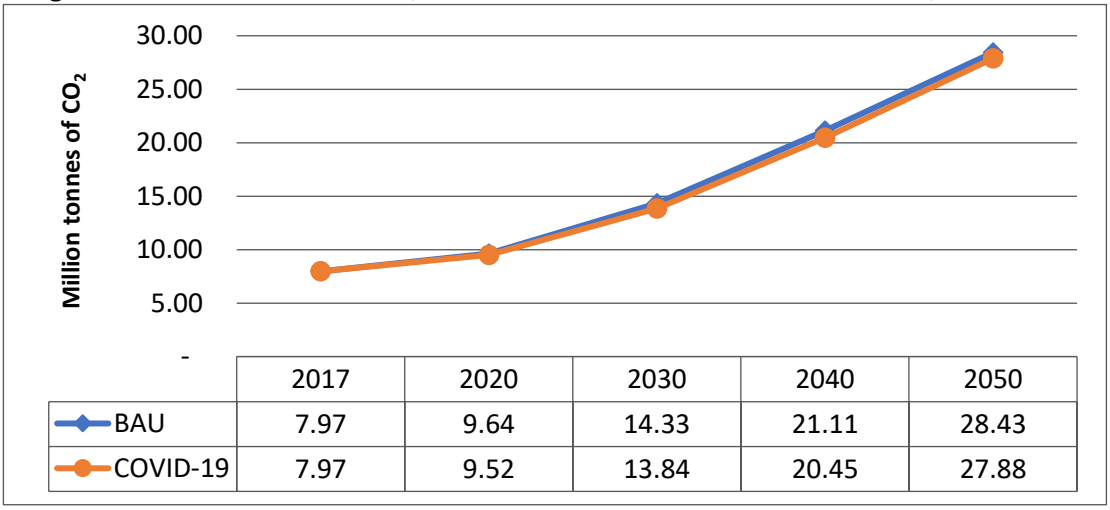
	2017	2020	2030	2040	2050
BAU	20.12	22.52	30.51	41.27	53.95
COVID-19	20.12	22.41	29.69	40.15	52.99

BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = million tonnes of oil equivalent.
Source: Author.

4.3. CO_2 Emissions

In the BAU and COVID-19 scenarios, GHG emissions increase by 3.9% in 2017–2050. CO_2 emissions in the COVID-19 scenario are almost the same as in BAU after 2030 (Figure 12.7).

Figure 12.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2020	2030	2040	2050
BAU	7.97	9.64	14.33	21.11	28.43
COVID-19	7.97	9.52	13.84	20.45	27.88

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

Because of the COVID-19 pandemic, the economy slowed; businesses closed down; millions of workers were laid off; consumer confidence in the market plummeted; and GDP, exports, imports, and investment declined. The government is considering economic recovery packages to help revive local economies, restore decent jobs, and promote sustainable environment.

In 2020–2023, COVID-19 has a negative impact on TFEC, TPES, and CO_2 emissions but it differs across sectors. By 2050, TFEC in the COVID-19 scenario matches that in BAU.

Residential energy consumption increases because of restrictions on travel in cities and mandatory work from home, but energy consumption does not decline as a result of falling GDP. One reason is that biomass is the dominant residential energy source and not linked with economic growth. Residential electricity consumption increases, however, because of orders to stay home, which is why electricity consumption is not affected much in 2020.

The commercial sector ceased to exist during the pandemic. Commercial buildings such as shopping malls and restaurants are closed and hotels operate only as quarantine centres. Offices are open only half the time. Many commercial establishments such as restaurants still depend on biomass, however, mitigating the decline in energy consumption.

Transport energy consumption is significantly reduced because of less freight forwarding, fewer family trips during holidays, and suspension of highway operations. Food delivery services by bicycle and motorcycle emerged but only in cities.

While some small and medium-sized factories have been shut down, with negative impacts on energy consumption, the pandemic has not had much impact on industry. Myanmar has no heavy industry, only light industries such as textile and leather, food processing, printing, amongst others.

In the COVID-19 scenario, CO_2 emissions from energy consumption are not significantly reduced compared with BAU because of higher electricity demand in which generation mostly consumes gas. Thus, further mitigation measures need to be continued. The government should focus on providing a source of much-needed revenue and widening fiscal reform to restore financial stability while respecting the environment, biodiversity, and natural capital.

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Chapter 13
New Zealand Country Report

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1. Background

New Zealand's population was about 5.1 million as of 31 December 2020 (Statistics New Zealand, 2021. Although the country has some light and heavy industry, foreign trade is heavily dependent on agriculture, tourism, forestry, and fishing. In 2020, nominal gross domestic product (GDP) was about US$180.7 billion or about US$35,400 per capita.[6]

The coronavirus disease (COVID-19) pandemic has significantly affected the economy, including transport and households. New Zealand has managed the COVID-19 outbreak with relative success, using measures such as immediate response to the outbreak and enforcement of a lockdown under alert level 4, border closure, and social distancing.

This chapter compares the COVID-19 and business-as-usual (BAU) scenarios, analysing the impacts of the pandemic on the energy outlook in 2020 and beyond.

However, because official energy statistics for 2020 were not yet available as of this writing, estimated energy consumption in 2020 was used.

2. Macro Assumptions of the COVID-19 Scenario

In the COVID-19 scenario, GDP decreases by 4.8% in 2020 (New Zealand Institute of Economic Research, 2020) (3.7% in BAU), then rebounds by 5.4% in 2021, 4.1% in 2022, and 3.0% in 2023 (IMF, 2020).

After 2023, the GDP growth rate in 2023–2030 is 2.0% per year (1.9% in BAU) and increases by 1.5% per year in 2030–2040 and 1.1% per year in 2040–2050 (Table 13.1).

Table 13.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	2.5%	2.2%	–4.8%	5.4%	4.1%	3.0%	2.0%	1.5%	1.1%
BAU	2.5%	2.2%	3.7%	2.8%	2.5%	2.5%	1.9%	1.5%	1.1%

BAU = business as usual, COVID-19 = coronavirus disease.
Sources: Authors, based on International Monetary Fund (2020) and New Zealand Institute of Economic Research (2020).

[6] All United States dollars are in constant 2010 values unless specified.

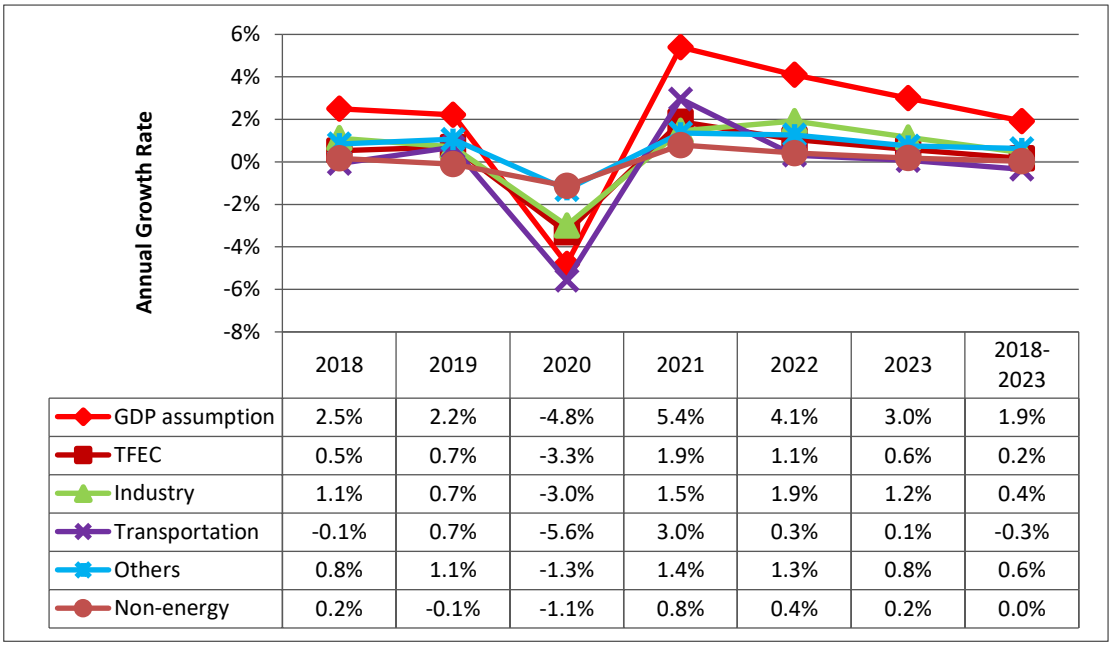
3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In the COVID-19 scenario, total final energy consumption (TFEC) decreases by 3.3% in 2020, mainly because the lockdown under alert level 4 closed businesses and restricted travel. Transport energy consumption falls the most, by 5.6%, in 2020. Industry falls by 3.0%; agriculture, commercial, and residential ('others') sectors by 1.3%; and non-energy by 1.1% in 2020 (Figure 13.1).

In the COVID-19 scenario, the growth rate of TFEC bounces back to 1.9% in 2021, 1.1% in 2022, and 0.6% in 2023. In 2018–2023, TFEC grows by an average rate of 0.2% per year in 2018–2023 (0.6% in BAU).

Figure 13.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023

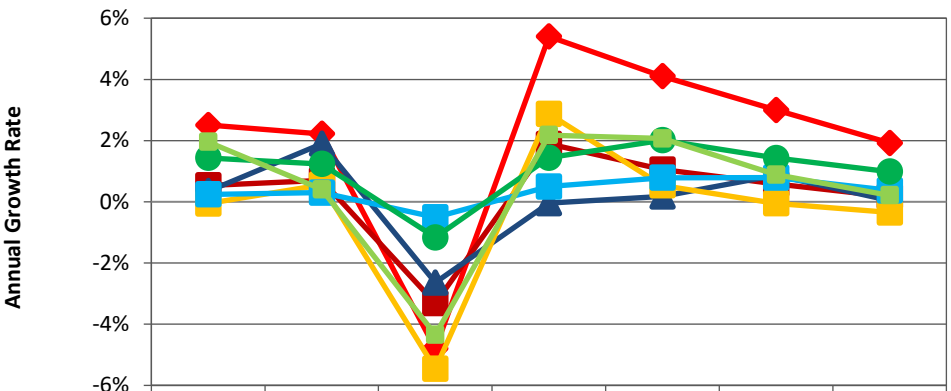


	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	2.5%	2.2%	-4.8%	5.4%	4.1%	3.0%	1.9%
TFEC	0.5%	0.7%	-3.3%	1.9%	1.1%	0.6%	0.2%
Industry	1.1%	0.7%	-3.0%	1.5%	1.9%	1.2%	0.4%
Transportation	-0.1%	0.7%	-5.6%	3.0%	0.3%	0.1%	-0.3%
Others	0.8%	1.1%	-1.3%	1.4%	1.3%	0.8%	0.6%
Non-energy	0.2%	-0.1%	-1.1%	0.8%	0.4%	0.2%	0.0%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

In the COVID-19 scenario, oil consumption falls by 5.5% in 2020 mainly because the lockdown under alert level 4 lowers transport energy demand. Light vehicle flows are lower than earlier in 2020. Other energy sources (heat, geothermal, solar, biogas, and woody biomass) decrease by 4.3% and coal consumption by 2.6% in 2020. Electricity consumption decreases by 1.2% and gas by 0.5% in 2020. Electricity and gas consumption do not decrease more than oil consumption because people stay home, using energy for cooking, lighting, and heating (Figure 13.2).

Figure 13.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	2.5%	2.2%	-4.8%	5.4%	4.1%	3.0%	1.9%
TFEC	0.5%	0.7%	-3.3%	1.9%	1.1%	0.6%	0.2%
Coal	0.3%	1.9%	-2.6%	0.0%	0.2%	0.9%	0.0%
Oil	-0.1%	0.6%	-5.5%	2.9%	0.5%	-0.1%	-0.3%
Natural gas	0.2%	0.3%	-0.5%	0.5%	0.8%	0.8%	0.4%
Electricity	1.4%	1.2%	-1.2%	1.4%	2.0%	1.4%	1.0%
Others	2.0%	0.4%	-4.3%	2.2%	2.1%	0.9%	0.2%

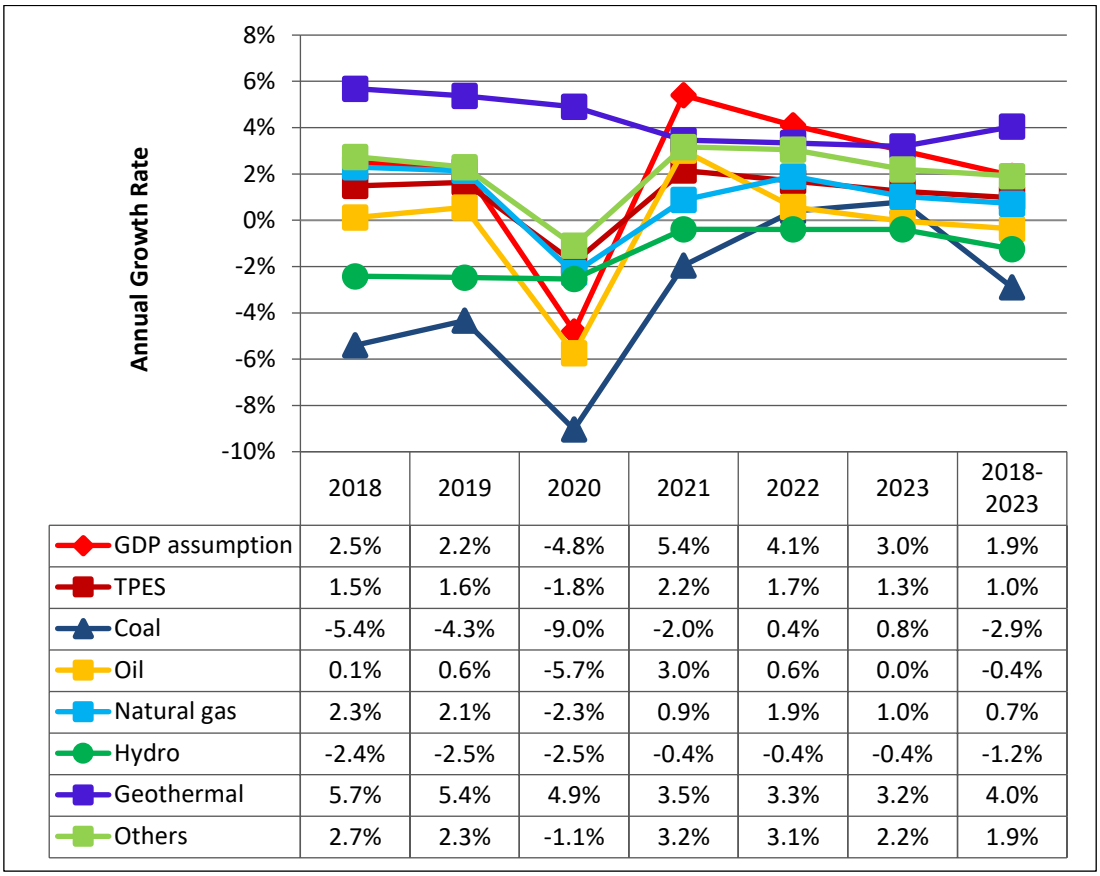
COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) drops by 1.8% in 2020 (increases by 2.0% in BAU). Coal decreases the most, by 9.0% (5.7% in BAU). Oil decreases by 5.7% (increases by 0.3% in BAU), natural gas decreases by 2.3% (increases by 4.4% in BAU), hydro decreases by 2.5% (2.5% in BAU), and other primary energy sources (biomass, solar, wind, liquid biofuels) decrease by 1.1% (increase by 3.4% in BAU). In contrast, geothermal energy use for electricity generation is only slightly affected by the pandemic and grows by 4.9% in 2020 (5.1% in BAU) compared with 5.4% in 2019.

In 2018–2023, TPES in the COVID-19 scenario increases by an average of 1.0% per year. Coal decreases by an average of 2.9% per year and hydro by 1.2%, while geothermal energy use for electricity generation grows by 4.0% per year (Figure 13.3).

Figure 13.3. Annual Growth Rate of Primary Energy Supply, by Fuel, COVID-19 Scenario, 2018–2023



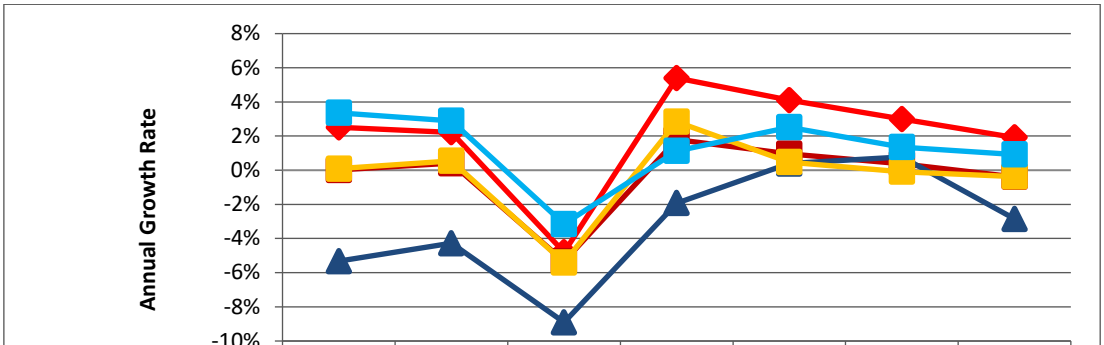
	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	2.5%	2.2%	-4.8%	5.4%	4.1%	3.0%	1.9%
TPES	1.5%	1.6%	-1.8%	2.2%	1.7%	1.3%	1.0%
Coal	-5.4%	-4.3%	-9.0%	-2.0%	0.4%	0.8%	-2.9%
Oil	0.1%	0.6%	-5.7%	3.0%	0.6%	0.0%	-0.4%
Natural gas	2.3%	2.1%	-2.3%	0.9%	1.9%	1.0%	0.7%
Hydro	-2.4%	-2.5%	-2.5%	-0.4%	-0.4%	-0.4%	-1.2%
Geothermal	5.7%	5.4%	4.9%	3.5%	3.3%	3.2%	4.0%
Others	2.7%	2.3%	-1.1%	3.2%	3.1%	2.2%	1.9%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Authors.

3.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions decrease by 5.3% in 2020 (0.7% in BAU). Energy-related CO_2 emissions from coal decrease by 8.9%, from oil by 5.4%, and from natural gas by 3.2% in 2020. In 2018–2023, energy-related CO_2 emissions drop by an average of 0.4% per year (increase by 0.3% in BAU) reflecting the effects of the lockdown in March 2020 (Figure 13.4).

Figure 13.4. CO_2 Emissions, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	2.5%	2.2%	-4.8%	5.4%	4.1%	3.0%	1.9%
Total	0.0%	0.4%	-5.3%	1.8%	1.0%	0.4%	-0.4%
Coal	-5.3%	-4.3%	-8.9%	-1.9%	0.4%	0.8%	-2.9%
Oil	0.1%	0.5%	-5.4%	2.8%	0.5%	-0.1%	-0.4%
Natural gas	3.4%	2.9%	-3.2%	1.1%	2.5%	1.4%	0.9%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Authors.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, GDP grows by an average of 1.6% per year in 2017–2050 (1.7% in BAU). TFEC in both the COVID-19 and BAU scenarios decreases by an average of 0.3% per year in 2017–2050. In the COVID-19 scenario, GDP decreases by 3.6% and TFEC by 1.8% in 2050.

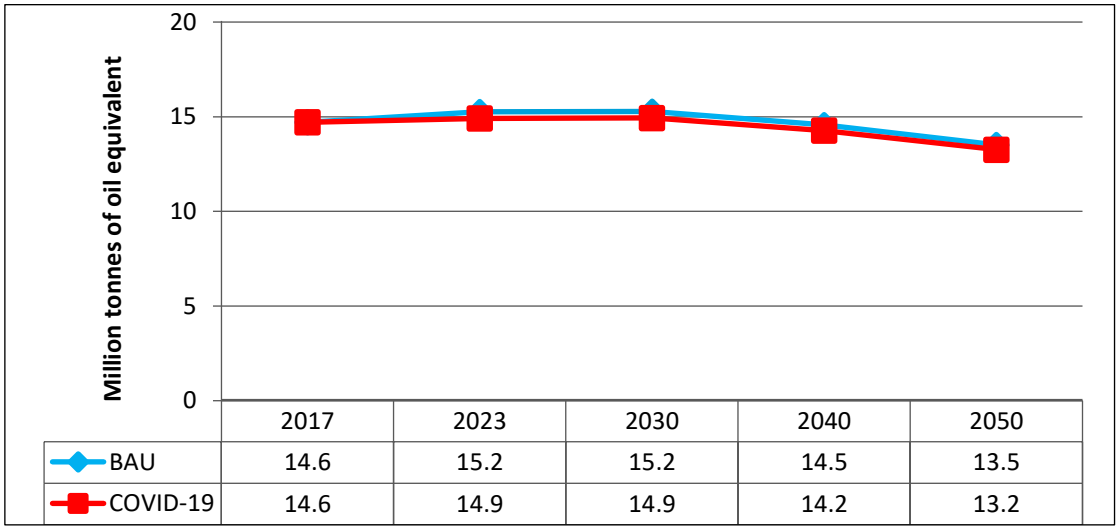
Table 13.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (constant US$ billion, 2010)	BAU	181.1	212.7	243.2	280.9	314.6	1.7%
	COVID-19	181.1	204.2	234.5	270.8	303.3	1.6%
	COVID-19 vs BAU	0.0%	–4.0%	–3.6%	–3.6%	–3.6%	
TFEC (Mtoe)	BAU	14.6	15.2	15.2	14.5	13.5	–0.3%
	COVID-19	14.6	14.9	14.9	14.2	13.2	–0.3%
	COVID-19 vs BAU	0.0%	–2.3%	–2.2%	–2.0%	–1.8%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Authors.

TFEC remains lower in the COVID-19 scenario than in BAU through 2050, with a difference between the two scenarios of 2.3% by 2023, 2.2% by 2030, 2.0% by 2040, and 1.8% by 2050 (Table 13.2, Figure 13.5). TFEC in the COVID-19 scenario does not bounce back to the same level as BAU by 2050 because the COVID-19 outbreak reduces demand for final energy consumption.

Figure 13.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	14.6	15.2	15.2	14.5	13.5
COVID-19	14.6	14.9	14.9	14.2	13.2

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

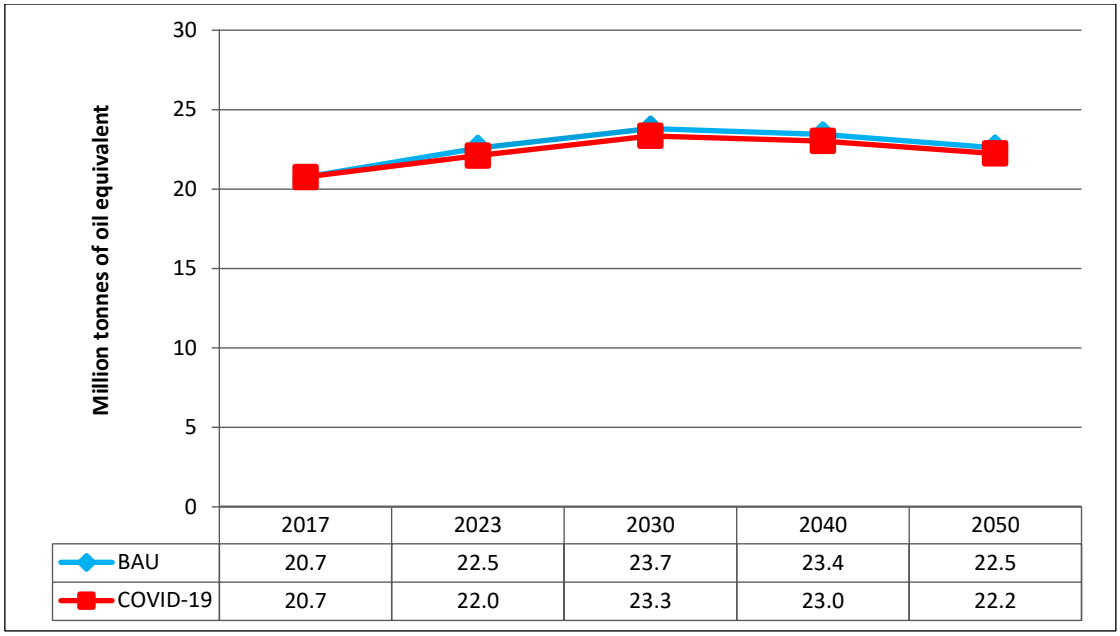
4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases by an average of 0.2% per year in 2017–2050 (0.3% in BAU). The pace of TPES growth is only slightly affected by the pandemic, but in absolute terms the cumulative impact is moderately larger.

TPES in the COVID-19 scenario is 2.1% less than in BAU in 2023, and while the gap narrows, it does not close through 2050: 2.0% in 2030, 1.8% in 2040, and 1.6% in 2050 (Figure 13.6).

In the COVID-19 scenario, natural gas decreases by 5.0%, oil by 1.9%, other primary energy sources (biomass, solar, wind, liquid biofuels, biogas) by 1.6%, coal by 0.5%, and geothermal by 0.1% in 2050 compared with BAU.

Figure 13.6. Total Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	20.7	22.5	23.7	23.4	22.5
COVID-19	20.7	22.0	23.3	23.0	22.2

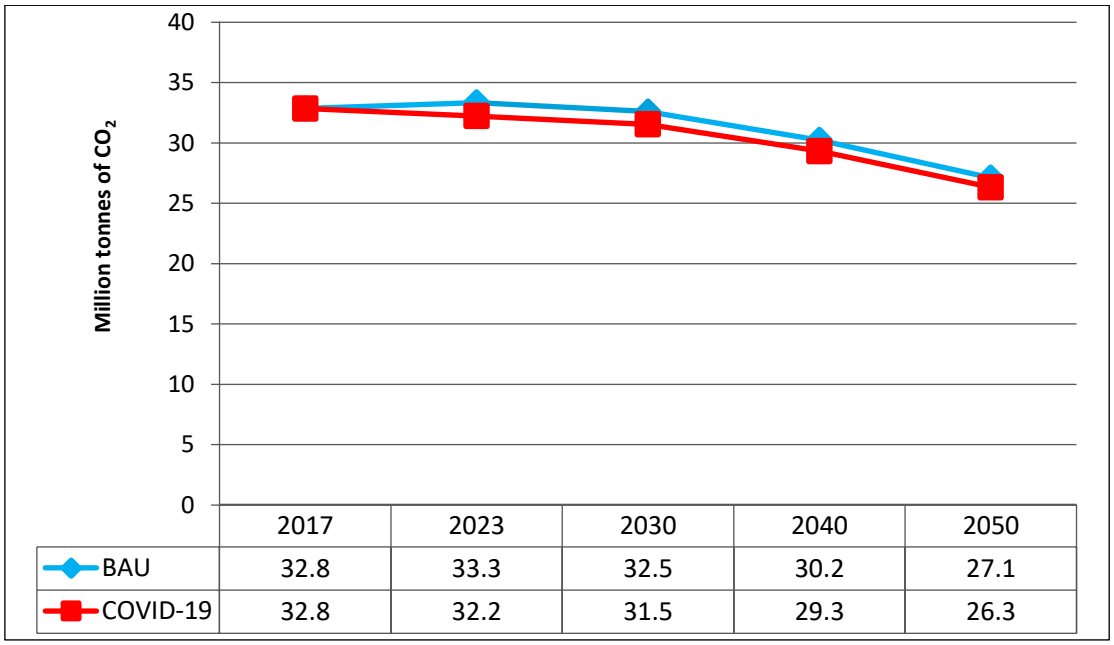
BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.4. CO_2 Emissions

In the COVID-19 scenario, energy-related CO_2 emissions decrease by an average of 0.7% per year in 2017–2050 (0.6% in BAU) (Figure 13.7).

Energy-related CO_2 emissions from oil reduce by 0.9% per year in 2017–2050 in both BAU and COVID-19 scenarios. Emissions from coal decline by 0.8% per year in BAU and by 0.9% in the COVID scenario.

Figure 13.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	32.8	33.3	32.5	30.2	27.1
COVID-19	32.8	32.2	31.5	29.3	26.3

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Implications and Policy Recommendations

In 2011, New Zealand set an ambitious goal to generate 90% of its electricity from renewable sources by 2025 and to reduce greenhouse gas emissions by 30% in 2005–2030 and by 50% in 1990–2050. The New Zealand Energy Efficiency and Conservation Strategy 2017–2022, titled 'Unlocking Our Energy Productivity and Renewable Potential' (June 2017) aims to turn the country into an energy-productive and low-emission economy by encouraging businesses, individuals, and public sector agencies to help unlock renewable energy, energy efficiency, and productivity potential.

The strategy has three priority areas:

(i) renewable and efficient use of process heat,[7]
(ii) efficient and low-emission transport, and
(iii) innovative and efficient use of electricity.

It has targets for promoting renewable energy and reducing greenhouse gas emissions.

By December 2020, New Zealand was generating about 84% of its electricity from renewable sources (Ministry of Business, Innovation and Employment, Markets Team, Evidence and Insights Branch (2021), *Energy in New Zealand*, New Zealand (2021).

In the COVID-19 scenario, energy consumption is 4.3% lower than in BAU in 2020, a result that should be compared with actual energy consumption after the release of official energy statistics.

[7] Energy used as heat in industry and commerce.

In 2020, GDP growth rate in the COVID-19 scenario declines by 4.8% (increases by 3.7% in BAU) (The New Zealand Institute of Economic Research, <2020 then TFEC declines by 3.3%.

In the long term, TFEC is slightly lower in the COVID-19 scenario than in BAU in 2050 but almost at the same level in BAU in 2000. In the COVID-19 scenario, GDP grows by 1.6% per year in 2017–2050 (1.7% in BAU).

In the COVID-19 scenario, New Zealand significantly reduces energy-related CO_2 emissions by 19.9% in 2017–2050 (17.5% in BAU).

Energy-related CO_2 emissions decline because of less fuel consumption for transport and process heat resulting from travel restrictions and working from home during the COVID-19 outbreak in 2020; the shift to more energy-efficient vehicles, particularly electric vehicles; the switch from thermal generation to renewable energy in electricity generation; and the use of efficient appliances.

Transport and process heat account for the largest energy use and carbon savings; 51% of energy-related emissions come from transport (The Energy Efficiency and Conservation Authority New Zealand Annual Report, For the Year ended June 2021) and 40% from business, mainly the burning of fossil fuels for process heat.

The government has committed to reaching net-zero emissions of long-lived gases by 2050 and to reducing biogenic (plant and animal) methane emissions by 24%–47% by 2050. In January 2021, the Climate Change Commission (2021) provided the first draft advice to government and set out the direction of policy to meet the targets. The commission delivered the finalised advice to the minister of climate change and then tabled it in Parliament in June 2021. In 2022, Climate Change Commission has received additional funding to help the Government to make sound decisions on how Aotearoa New Zealand can meet its emissions reductions targets and adapt to the impacts of climate change.

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The historical energy data (except for estimated 2020 energy consumption) was sourced from Ministry of Business, Innovation and Employment, Markets Team, Evidence and Insights Branch (2021), *Energy in New Zealand*.

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Chapter 14
Philippines Country Report

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1. Background

In 2020, a whole-of-government response took urgent measures to contain or prevent the spread of the coronavirus disease (COVID-19), mitigate its effects, and prevent serious disruption of government and community functions (Government of the Philippines, 2020 [8 March]). On 11 March, the World Health Organization (WHO) declared a COVID-19 pandemic (WHO, 2020).

1.1. Lockdowns in Metro Manila and Luzon

Metro Manila, the centre of the pandemic, was locked down twice in 2020. From 15 March to 16 April, it was placed under community quarantine, restricting movement for the general population and limiting movement for essential workers such as medical workers, security personnel, and selected economic workers. From 17 March to 30 April, the whole of Luzon was put under the stricter enhanced community quarantine (ECQ) (Government of the Philippines, 2020b).

Road, air (domestic and international), and domestic sea travel were restricted with a few exceptions. Essential commercial establishments such as those providing food and medicine could operate. Other services were allowed to operate but only with a skeletal workforce and strict observation of minimum health protocols.

After balancing social, economic, and security factors against the COVID-19 epidemiological trend, the government gradually eased ECQ but extended it until 31 May 2020 in areas with high risk of infection and transmission. On 1 June, Metro Manila and nearby provinces were downgraded to general community quarantine (GCQ) to recover economic activity. However, in August, Metro Manila and nearby provinces were put under ECQ for 2 weeks to curb rising cases of COVID-19 and strengthen the health-care system's capacity. Granular lockdowns were imposed in Metro Manila for the rest of the year. Some provinces in the Visayas and Mindanao, specifically in Metro Cebu and Metro Davao, were locked down as COVID-19 cases rose. But the rest of the country was under GCQ.

1.2. Energy Supply and Demand Impacts of Lockdowns Caused by COVID-19

This chapter examines the impacts of curtailed economic activity on energy supply and demand. The official power statistics for 2020 and the partial energy statistics for oil and other fuels are used to validate the model's assumptions.

2. Macro Assumptions of the COVID-19 Scenario

The gross domestic product (GDP) assumptions used in the COVID-19 scenario (2018–2023) are based on *World Economic Outlook* (International Monetary Fund [IMF], 2020). The 2020 GDP assumptions, however, use the actual 9.5% GDP contraction based on *National Accounts of the Philippines* (Philippine Statistics Authority [PSA], 2020).

The GDP assumptions for 2021–2023 from the IMF (2020) are more conservative than the GDP growth targets set by the Philippines' economic managers (8.0%–10.0% to rebound to pre-pandemic economic growth).

Table 14.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	6.9%*	6.0%*	–9.5%*	7.4%	7.4%	6.5%	6.5%	5.4%	5.2%
BAU	6.9%	5.9%	5.6%	5.6%	5.6%	5.6%	5.4%	5.2%	5.2%

BAU = business as usual, COVID-19 = coronavirus disease.
*Actual.
Source: Authors, based on International Monetary Fund (2020).

In the COVID-19 scenario, the value of goods and services slightly decreases compared with the business-as-usual (BAU) scenario in the short term but rebounds after 2030.

Table 14.2. Assumptions of Gross Domestic Product, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050
(constant PHP trillion)

	2018	2019	2020	2021	2022	2023	2030	2040	2050
COVID-19	9.3	9.8	8.9	9.5	10.3	10.9	16.3	28.0	48.4
BAU	9.3	9.8	10.4	10.9	11.6	12.2	17.8	30.1	50.0

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author (2020).

The crude oil price estimates from the Japan cost, insurance, and freight (2018 US$/barrel) in nominal price were used in the COVID-19 scenario to reflect the nominal value effect of the price.

Table 14.3. Assumptions of Crude Oil Price, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

(US$/barrel in nominal price)

	2018	2019	2020	2021	2022	2023	2030	2040	2050
COVID-19	72.9	64.3	40.9	46.4	51.8	56.9	86.8	102.2	107.3
BAU	71.0	73.9	77.0	79.8	82.7	85.7	110.0	150.0	185.0

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author (2020).

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In 2018–2023, the annual average growth rate of total final energy consumption (TFEC) decreases from 3.5 million tonnes of oil equivalent (Mtoe) in BAU to 1.2 Mtoe in the COVID-19 scenario.

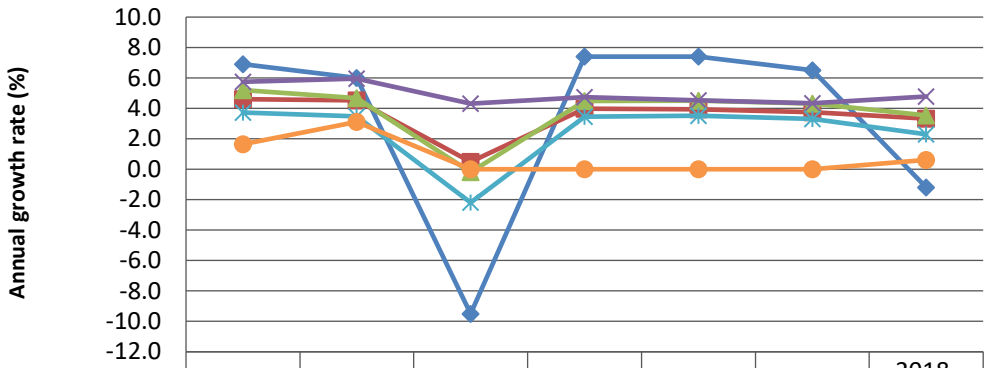
'Others' are the most affected in 2020, with growth of –2.2% because of reduced energy demand in the commercial (–4.1%), residential (–1.3%), and agriculture (–1.8%) sectors. Reduced demand can be attributed to the lockdowns and reduced operations capacity of commercial establishments, including those engaged in accommodation and food services, real estate and ownership dwellings, transport and storage, and education, to cite a few.

Industry demand growth rate falls from 4.2% in BAU to –0.2% in the COVID-19 scenario in 2020 because of sluggish growth of manufacturing and construction based on actual data (PSA, 2020.

Transport demand, however, decreases by only 1.7 kilotonnes of oil equivalent compared with BAU and grows by 4.3% in the COVID-19 scenario.

On average, all sectors have positive growth in the short term.

Figure 14.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP (%)	6.9	6.0	-9.5	7.4	7.4	6.5	-1.2
TFEC	4.6	4.5	0.5	4.0	3.9	3.8	3.3
Industry	5.2	4.7	-0.2	4.5	4.5	4.3	3.5
Transportation	5.7	6.0	4.3	4.7	4.5	4.3	4.8
Others	3.7	3.5	-2.2	3.4	3.5	3.3	2.3
Non-energy	1.6	3.1	0.0	0.0	0.0	0.0	0.6

GDP = gross domestic product; others = commercial, residential, and agriculture sectors; TFEC = total final energy consumption.
Source: Authors.

Based on actual GDP in 2020, the impact may be greater on some sectors. Transport does not follow the negative trend in GDP growth despite restrictions on public road transport and substantial decrease in demand. Air transport contracts significantly because of travel restrictions within the country and abroad.

'Others' – the residential, commercial, and agriculture sectors – experience varying degrees of impact as demand shifts. The residential sector exhibits positive demand growth compared with projected demand growth of –1.3% as about 70%–80% of white-collar workers worked from home.

The commercial sector contracts by 4.1% but might contract more because it is the most badly hit by lockdowns and restrictions. In 2019, services accounted for 61.0% of overall GDP, followed by industry at 30.2% and agriculture at 8.8% (O'Neill, 2021), while Metro Manila had the largest share of services at 42.7% (PSA, 2020).

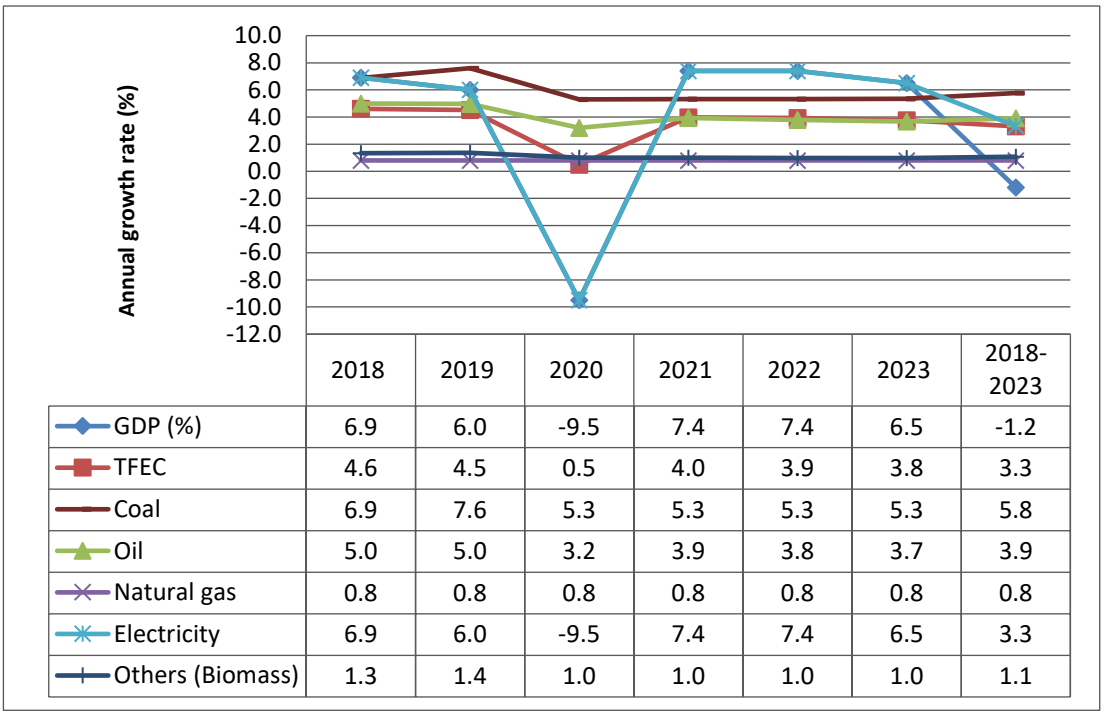
During the community quarantine, the government identified the establishments that could operate in a limited capacity, such as food services. A great number of entertainment hubs and establishments closed because they had little or no revenue. Hotels, rental accommodation services, and other ancillary services such as restaurants, cafes, gyms, spas, and the like, were significantly affected as they were not allowed to operate. Although the government later converted some hotels into quarantine centres for returning overseas

Filipino workers, the hotels and accommodation services operated only in limited capacity (Government of the Philippines, 2020 [15 October]).

The sectors' negative growth in final energy consumption per fuel can be largely attributed to the decline of electricity demand, which followed the GDP growth trend. Electricity demand growth falls from 5.6% (8.0 Mtoe) in BAU to –9.5% (6.8 Mtoe) in the COVID-19 scenario in 2020 (Figure 14.2). Coal's growth rate decreases by 2.3% from 7.6% in 2019 to 5.3% in 2020, which can be correlated to the trend of electricity demand as coal consumption is mostly used for power generation.

The oil demand growth rate decreases from 5.3% in BAU to 3.2% in the COVID-19 scenario in 2020, which can be attributed to decrease in demand for road transport diesel and gasoline and for air transport jet-A1 fuel. Actual oil demand may have negative growth compared with the 2020 projection.

Figure 14.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP (%)	6.9	6.0	-9.5	7.4	7.4	6.5	-1.2
TFEC	4.6	4.5	0.5	4.0	3.9	3.8	3.3
Coal	6.9	7.6	5.3	5.3	5.3	5.3	5.8
Oil	5.0	5.0	3.2	3.9	3.8	3.7	3.9
Natural gas	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Electricity	6.9	6.0	-9.5	7.4	7.4	6.5	3.3
Others (Biomass)	1.3	1.4	1.0	1.0	1.0	1.0	1.1

GDP = gross domestic product, TFEC = total final energy consumption.
Source: Authors.

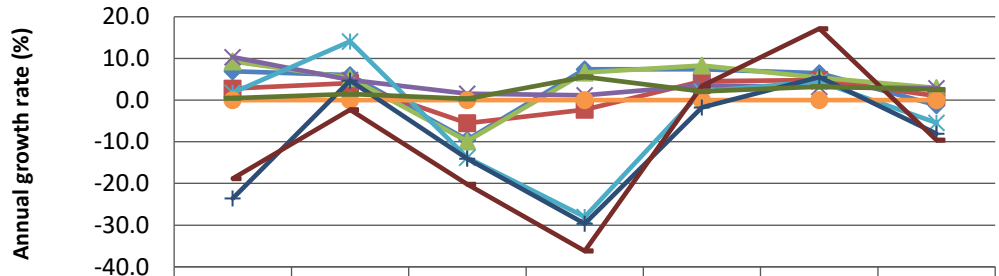
3.2. Primary Energy Supply

Total primary energy supply (TPES) grows more slowly in the short term by 1.0% in the COVID-19 scenario (2.0% in BAU). All fuel sources have negative growth, except oil and biomass,

because of the large decrease in electricity demand.

Oil demand declines but growth remains positive at 1.6% in 2020 because transport consumption of gasoline and diesel picked up as restrictions were gradually lifted and mobility increased. Coal remains the top source of power generation in the short term even with growth declining steeply by 9.9% in 2020. Coal's actual share in gross power generation stands at 57.2% in 2020 (Department of Energy, 2020.

Figure 14.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP (%)	6.9	6.0	-9.5	7.4	7.4	6.5	-1.2
TPES	2.8	4.1	-5.5	-2.3	4.6	4.8	1.0
Coal	9.3	5.3	-9.9	6.6	8.3	5.4	2.9
Oil	10.3	4.8	1.6	1.2	3.6	3.2	2.8
Natural gas	1.7	14.1	-13.8	-28.0	2.1	4.5	-5.5
Nuclear	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydro	-23.6	4.7	-14.0	-29.6	-1.7	5.5	-8.1
Geothermal	-18.8	-2.3	-20.2	-36.2	3.4	17.2	-9.6
Others	0.5	1.5	0.3	5.6	2.1	3.3	2.5

GDP = gross domestic product; others = commercial, residential, and agriculture sectors; TPES = total primary energy supply.
Source: Authors.

Geothermal growth drops the most, by 20.2%, in the COVID-19 scenario (6.6% in BAU). In 2020, hydro's annual average growth rate is –14.0% and natural gas' –13.8%. Although renewable energy–based sources must meet a certain percentage for dispatch in the wholesale electricity market, non-renewable sources as baseload supply are prioritised. In 2020, 20%–30% or about 3,000 megawatts of actual peak demand were shaved off the Luzon grid alone during the lockdown (Medenilla, 2020). Electricity consumption decreased from 106,041 gigawatt hours (GWh) in 2019 to 101,756 GWh in 2020. The residential sector accounted for the lion's share at 33.7% (34,292 GWh), a 12.0% increase from the previous year. However, industrial consumption decreased by 9.0% and commercial consumption by 19% (Department of Energy, (2020. With depressed electricity demand, all fuel sources for

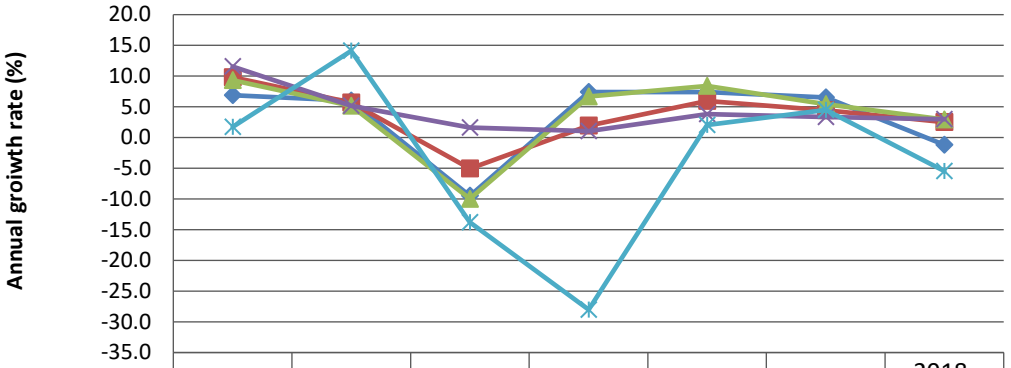
power generation face stiffer competition to be dispatched in the power market.

The primary energy supply gradually rebounds in 2021 and all sources have positive growth in 2023 as the economy starts to open up.

3.3. CO_2 Emissions

Because of lower energy consumption, greenhouse gas emissions in the COVID-19 scenario grow by 2.5% in 2018–2023 (3.7% in BAU scenario). In 2020, the largest decrease in growth is from natural gas (13.8%) followed by coal (10.0%) and oil (1.6%), following the trend in TPES.

Figure 14.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP (%)	6.9	6.0	-9.5	7.4	7.4	6.5	-1.2
Total	9.8	5.7	-5.1	1.9	6.0	4.4	2.5
Coal	9.3	5.2	-10.0	6.7	8.4	5.4	2.9
Oil	11.6	5.1	1.6	1.0	3.8	3.3	3.0
Natural Gas	1.7	14.1	-13.8	-28.0	2.1	4.5	-5.5

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Authors.

4. Long-term Impact (2023–2050)

The COVID-19 scenario has a more moderate impact in the long term than in the short term. The average annual growth rate of GDP output decreases from 5.5% in BAU to 5.3% in the COVID-19 scenario in 2017–2050. The decline is reflected in TFEC, where long-term average growth rate drops from 3.6% in BAU to 3.5% in the COVID-19 scenario. Recovery is slow in the short term from 2023. However, the average annual growth rates for TPES and CO_2 emissions are the same in BAU (3.5%) and the COVID-19 scenario (4.3%) in 2017–2050 (Table 14.4).

Table 14.4. Gross Domestic Product Compared with Total Final Energy Consumption, Total Primary Energy Supply, and CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

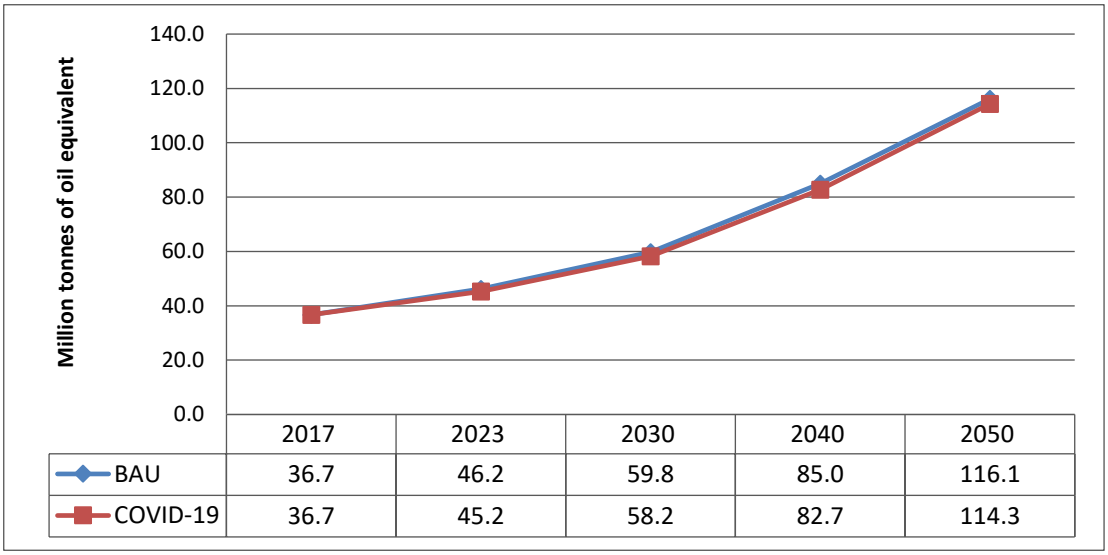
Indicator	Scenario	2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (constant PHP trillion)	BAU	8.7	12.2	17.8	30.1	50.0	5.5
	COVID-19	8.7	10.9	16.3	28.0	48.4	5.3
	COVID-19 vs. BAU (% change)	0.0	–10.7%	–8.4%	–7.0%	–3.2%	
TFEC (Mtoe)	BAU	36.7	46.2	59.8	85.0	116.1	3.6
	COVID-19	36.7	45.2	58.2	82.7	114.3	3.5
	COVID-19 vs. BAU (% change)	0.0	–2.2%	–2.6%	–2.7%	–1.6%	
TPES (Mtoe)	BAU	56.0	63.6	83.7	118.3	176.7	3.5
	COVID-19	56.0	60.6	79.8	113.4	172.6	3.5
	COVID-19 vs. BAU (% change)	0.0	–4.7%	–4.6%	–4.1%	–2.3%	
CO_2 emissions (Mt-C)	BAU	32.1	42.2	56.9	86.4	130.5	4.3
	COVID-19	32.1	39.9	53.9	82.4	127.7	4.3
	COVID-19 vs. BAU (% change)	0.0	–5.5%	–5.2%	–4.6%	–2.2%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mt-C = million metric tonnes of CO_2 equivalent, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption, TPES = total primary energy supply.
Source: Authors.

4.1. Final Energy Consumption

TFEC in the COVID-19 scenario catches up with BAU by 2030 and reaches 114.3 Mtoe, lower than BAU by 1.6%. The gap is widest by 2040 at 2.7% before it shrinks to 1.6% in 2050 (Figure 14.5).

Figure 14.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



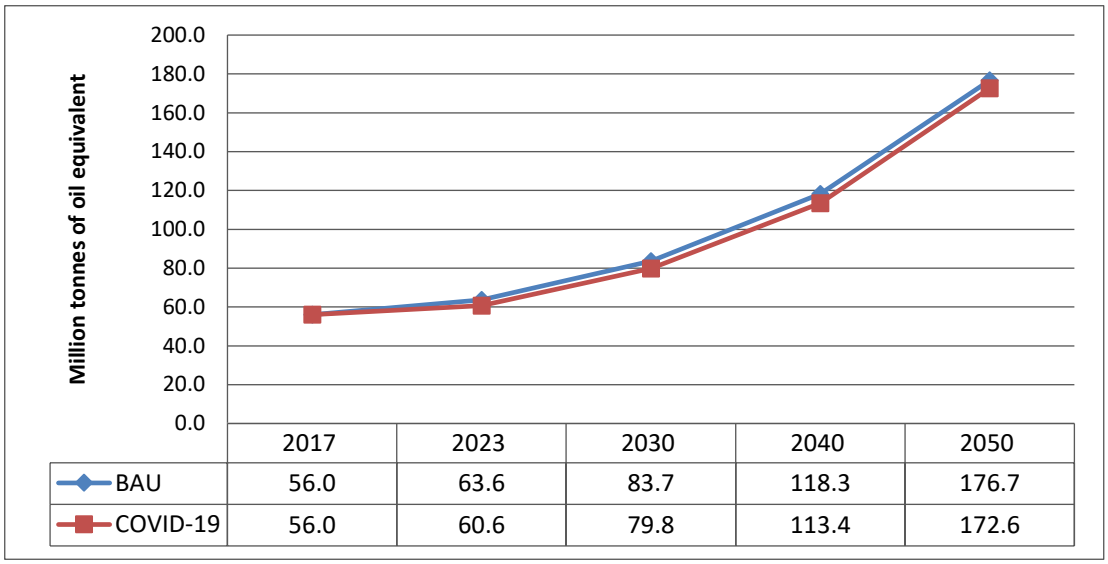
	2017	2023	2030	2040	2050
BAU	36.7	46.2	59.8	85.0	116.1
COVID-19	36.7	45.2	58.2	82.7	114.3

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.2. Primary Energy Supply

TPES increases by an average of 3.6% per year in 2017–2050 in the BAU and COVID-19 scenarios and is slightly lower than in BAU with a –2.3% change in output in 2050 (Figure 14.6).

Figure 14.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



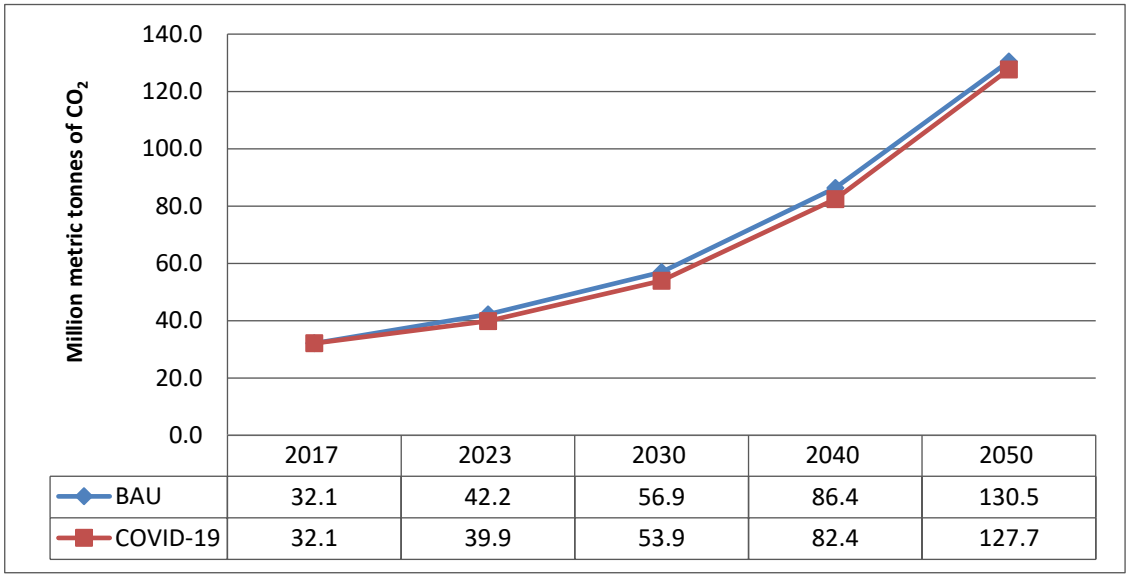
	2017	2023	2030	2040	2050
BAU	56.0	63.6	83.7	118.3	176.7
COVID-19	56.0	60.6	79.8	113.4	172.6

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

4.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions grow more slowly than in BAU, by an average of 4.3%, in 2017–2050. CO_2 emissions are 127.7 Mtoe by 2050 (Figure 14.7).

Figure 14.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	32.1	42.2	56.9	86.4	130.5
COVID-19	32.1	39.9	53.9	82.4	127.7

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Implications and Policy Recommendations

The COVID-19 pandemic is a "black swan" event that has resulted in the deepest and worst economic downturn since the 1980s. The Philippines was the fastest-growing economy in the Association of Southeast Asian Nations (ASEAN) pre-pandemic. In 2020, however, the economy contracted by 9.5%, with the lowest growth in Southeast Asia. The government implemented health protocols and lockdowns, but prolonged restrictions have suppressed economic activity, leading to economic recession.

With GDP growth rate as a major indicator, the estimates adopted from IMF (2020) projections are conservative estimates in the short and long term. To see the varying impacts of this indicator, a higher GDP estimate may be used to force short-term recovery and achieve pre-pandemic economic levels. GDP higher than 6.5% can be targeted in 2023–2030.

Price drives energy demand. Economic restrictions bring down energy consumption, lowering energy demand. Although energy demand generally follows the GDP trend, this may not be the case in an economic shock such as the COVID-19 scenario. For example, the shift in sector demand is not driven by price or other economic indicators per se but is a forced change resulting from pandemic requirements. Work from home increased residential consumption regardless of the price of electricity. Hence, actual data must be used to further understand the COVID-19 scenario's real effect on sector and fuel demand. Projections for primary energy supply's reaction to the GDP growth rate may also differ from actual 2020 data.

In the long term, TFEC does not rebound to BAU given the GDP estimates because of the strong negative impact of the COVID-19 scenario in 2020. However, the scenarios' estimates are extremely close by 2040. TPES grows at a similar pace as TFEC, by an average of 3.5%, in the COVID-19 scenario. Emission reductions are a positive impact, with estimated avoided greenhouse gas emissions as much as 2.8 million metric tonnes of CO_2 in 2050.

The plans, programs, and strategies in the Philippine Energy Plan 2018–2040 should be reviewed and updated, considering the impacts of the COVID-19 pandemic. Economic agencies' requirements for economic recovery plans and policies to spur growth may be higher to meet the country's energy needs. More energy is required to meet such ambitious economic targets. The energy sector must gear up and perform better than it did pre-pandemic. During the recession, the government should consider restructuring the economy to make it more resilient, robust, and responsive to shocks.

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Chapter 15
Singapore Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has had many economic and social impacts on Singapore, which are closely associated with changes in energy demand and supply. To what extent the pandemic has affected the energy system, therefore, must be quantified to facilitate policy development. This chapter develops a scenario that allows such an assessment based on Singapore's Low Emissions Analysis Platform.

2. Macroeconomic Assumptions of the COVID-19 Scenario

Annual gross domestic product (GDP) growth rate in 2020 is preliminarily projected to decrease by 6% (increase by 4% in the business-as-usual [BAU] scenario) and then to increase by 5% in 2021 and 2.6% in 2022 and 2023.

In 2023–2030, the growth rate is 2.4% per year, lower than in BAU. In 2030–2040 economic growth is 2.2% and in 2040–2050 2.0% (Table 15.1).

Table 15.1. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	4.4%	0.7%	–6.0%	5.0%	2.6%	2.6%	2.4%	2.2%	2.0%
BAU	4.2%	3.1%	4.0%	4.0%	3.9%	3.8%	3.5%	3.0%	2.5%

BAU = business as usual, COVID-19 = coronavirus disease.
Sources: Author, based on International Monetary Fund (2020).

3. Short-term Impact (2018–2023)

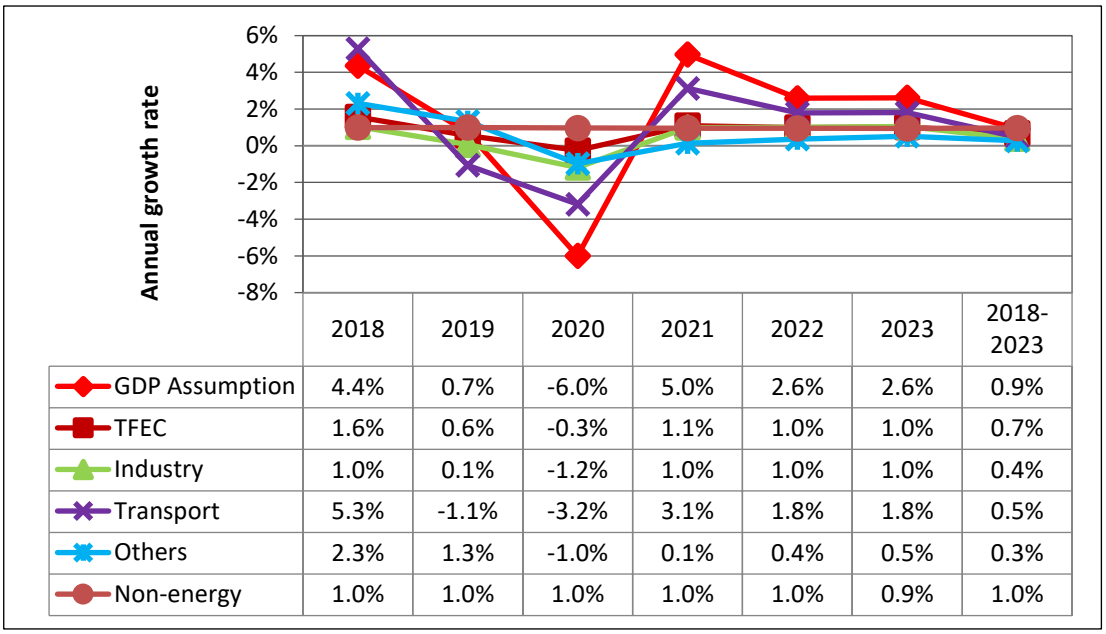
3.1. Final Energy Consumption

In the COVID-19 scenario, GDP sharply decreases by 6.0% in 2020 and starts increasing after 2020. Total final energy consumption (TFEC) increases by an average of 0.7% per year in 2018–2023 (1.3% in BAU). In 2020, TFEC decreases by 0.3% because of the COVID-19 pandemic (increases by 1.2% in BAU).

The strongest decrease in energy consumption growth rate is in transport, at 3.2% in 2020

(an increase of 2.5% in BAU) and an increase of 0.5% per year in 2018–2023 (2.6% in BAU), because of limited travel imposed by circuit-breaker measures and work from home. Industry energy consumption decreases by 1.2% in 2020 (0.9% in BAU) and increases by 0.4% per year in 2018–2023 (1.2% in BAU). Residential and commercial ('others') energy consumption decreases by 1.0% in 2020 (1.7% in BAU) and increases on average by 0.3% per year in 2018–2023 (1.8% in BAU). Non-energy use increases by 1.0% in 2020 and by 1.0% on average per year in 2018–2023, close to the increases in BAU (Figure 15.1).

Figure 15.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023

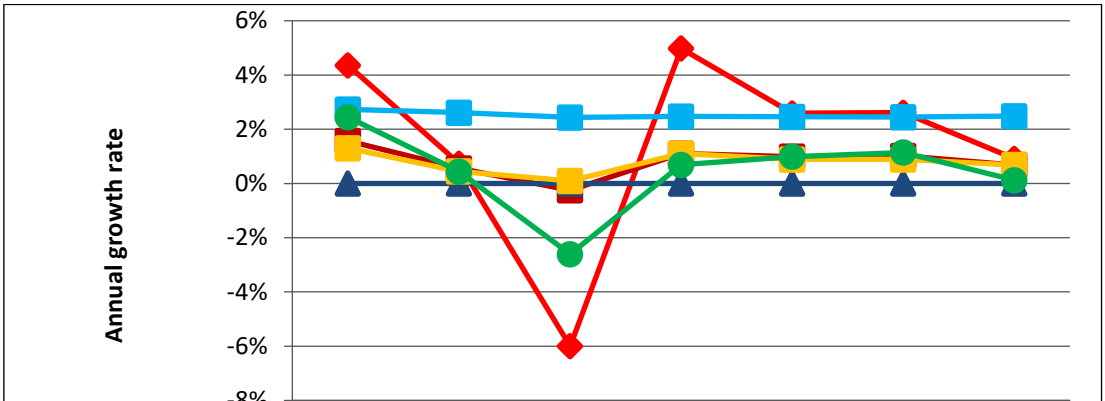


	2018	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	4.4%	0.7%	-6.0%	5.0%	2.6%	2.6%	0.9%
TFEC	1.6%	0.6%	-0.3%	1.1%	1.0%	1.0%	0.7%
Industry	1.0%	0.1%	-1.2%	1.0%	1.0%	1.0%	0.4%
Transport	5.3%	-1.1%	-3.2%	3.1%	1.8%	1.8%	0.5%
Others	2.3%	1.3%	-1.0%	0.1%	0.4%	0.5%	0.3%
Non-energy	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	1.0%

COVID-19 = coronavirus disease, GDP = gross domestic product, others = residential and commercial sectors, TFEC = total final energy consumption.
Source: Author.

In the COVID-19 scenario, the strongest decrease in TFEC is in electricity, by 2.6% in 2020 (an increase of 1.5% in BAU), with average annual growth of 0.1% in 2018–2023 (2.0% in BAU). Coal consumption remains unchanged. Oil product consumption increases by 0.1% in 2020. Natural gas consumption, however, increases by 2.4% in 2020 (2.6% in BAU) and grows on average by 2.5% per year in 2018– 2023 (2.6% in BAU) (Figure 15.2).

Figure 15.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



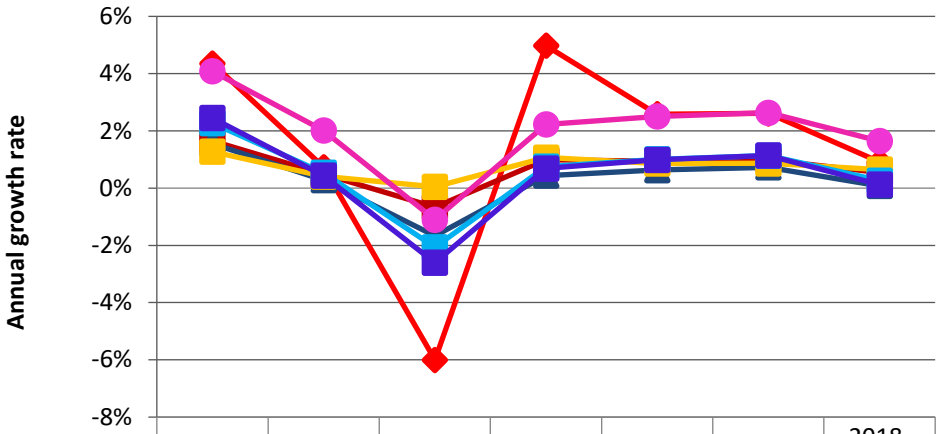
	2018	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	4.4%	0.7%	-6.0%	5.0%	2.6%	2.6%	0.9%
TFEC	1.6%	0.6%	-0.3%	1.1%	1.0%	1.0%	0.7%
Coal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Oil	1.3%	0.4%	0.1%	1.1%	0.9%	0.9%	0.7%
Natural gas	2.7%	2.6%	2.4%	2.5%	2.5%	2.4%	2.5%
Electricity	2.4%	0.4%	-2.6%	0.7%	1.0%	1.1%	0.1%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) drops by 0.7% in 2020 (increases by 1.2% in BAU) and increases by 0.5% per year in 2018–2023 (1.3% in BAU) (Figure 15.3). The strongest decrease in primary energy supply growth rate is in biomass, by 2.6% in 2020 (an increase of 1.5% in BAU), which rebounds to 0.1% per year in 2018–2023 (2% in BAU). Natural gas decreases by 2.1% in 2020 (1.4% in BAU) and increases by 0.3% per year in 2018–2023 (1.8% in BAU). Coal decreases by 1.7% in 2020 (1% in BAU) and increases by 0.1% per year in 2018–2023 (1.3% in BAU). Renewables (solar energy and municipal solid waste) decrease by 1.1% in 2020 (3.1% in BAU) and increase by 1.6% per year in 2018–2023 (3.5% in BAU).

Figure 15.3. Annual Growth Rate of Primary Energy Supply, by Fuel, COVID-19 Scenario, 2018–2023



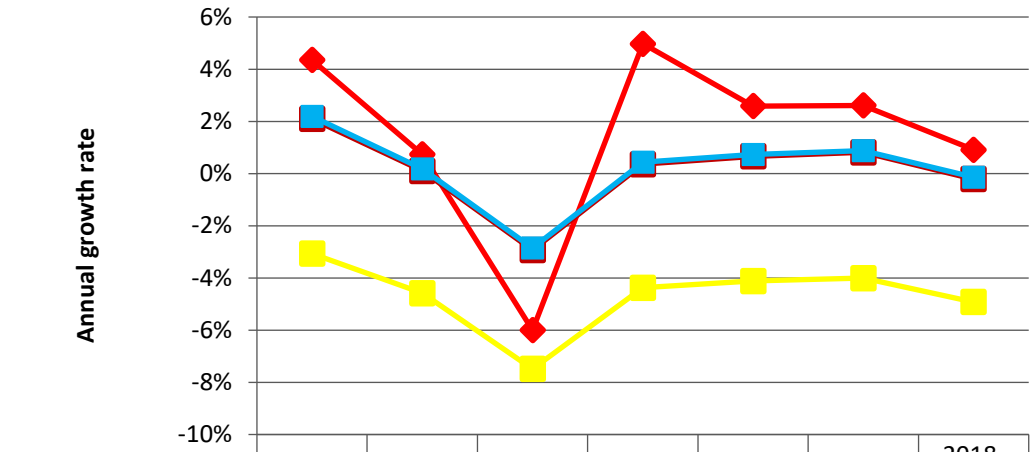
	2018	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	4.4%	0.7%	-6.0%	5.0%	2.6%	2.6%	0.9%
TPES	1.6%	0.5%	-0.7%	1.0%	0.9%	1.0%	0.5%
Coal	1.6%	0.3%	-1.7%	0.4%	0.6%	0.7%	0.1%
Oil	1.3%	0.4%	0.0%	1.1%	0.9%	0.9%	0.7%
Natural gas	2.3%	0.5%	-2.1%	0.8%	1.0%	1.1%	0.3%
Renewables	4.1%	2.0%	-1.1%	2.2%	2.5%	2.6%	1.6%
Biomass	2.4%	0.4%	-2.6%	0.7%	1.0%	1.1%	0.1%

COVID-19 = coronavirus disease, GDP = gross domestic product, renewables = solar energy and municipal solid waste, TPES = total primary energy supply.
Source: Author.

3.3. CO_2 Emissions

In the COVID-19 scenario, greenhouse gas (GHG) emissions from the power sector decrease by 2.9% in 2020 (increase by 1.2% in BAU) and decrease on average by 0.2% per year in 2018–2023 (increase by 1.6% in BAU). GHG emission growth decreased most for oil products, by 7.5% in 2020 (3.6% in BAU) and by an average of 4.9% per year in 2018–2023 (3.2% in BAU), followed by natural gas, by 2.9% in 2020 (1.2% increase in BAU) and by an average of 0.1% per year in 2018–2023 (1.7% increase in BAU). CO_2 emissions decreased mainly because of COVID-19 (Figure 15.4).

Figure 15.4. CO_2 Emissions, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP Assumption	4.4%	0.7%	-6.0%	5.0%	2.6%	2.6%	0.9%
Total	2.1%	0.1%	-2.9%	0.4%	0.7%	0.8%	-0.2%
Oil	-3.1%	-4.6%	-7.5%	-4.4%	-4.1%	-4.0%	-4.9%
Natural gas	2.2%	0.2%	-2.9%	0.4%	0.7%	0.9%	-0.1%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases by an average of 1.0% per year in 2017–2050 (1.7% in BAU) (Table 15.2).

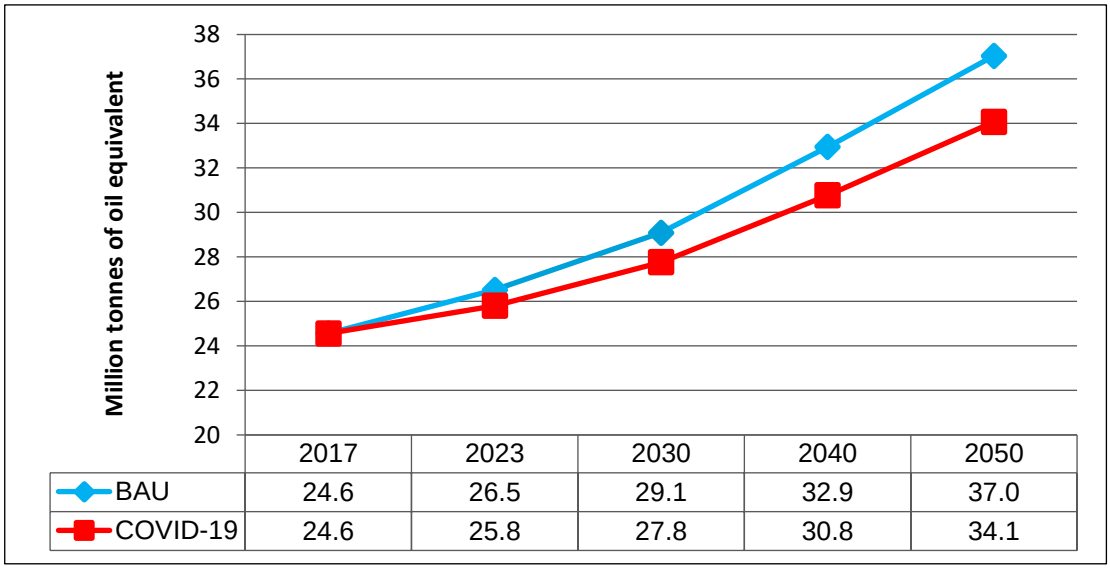
Table 15.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (US$ billion, 2010)	**BAU**	452.1	566.4	722.1	969.7	1236.8	1.7%
	COVID-19	452.1	493.7	584.0	725.9	884.9	1.0%
	COVID-19 vs BAU	0.0%	–12.8%	–19.1%	–25.1%	–28.5%	
TFEC (Mtoe)	**BAU**	24.6	26.5	29.1	32.9	37.0	0.5%
	COVID-19	24.6	25.8	27.8	30.8	34.1	0.4%
	COVID-19 vs BAU	0.0%	–2.7%	–4.6%	–6.6%	–8.0%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Source: Author.

The above calculation results show that TFEC in the COVID-19 scenario will be smaller than in BAU because the decrease in GDP resulting from COVID-19 reduces demand for final energy consumption (Figure 15.5).

Figure 15.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



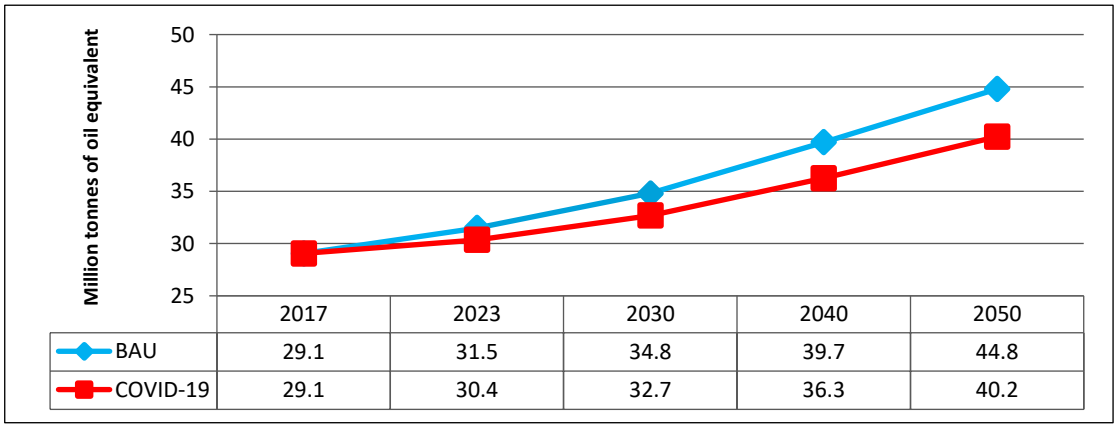
	2017	2023	2030	2040	2050
BAU	24.6	26.5	29.1	32.9	37.0
COVID-19	24.6	25.8	27.8	30.8	34.1

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

TPES in the COVID-19 scenario increases on average by 1.0% per year in 2017–2050 (1.3% in BAU). Like TFEC, TPES in the COVID-19 scenario is smaller than in BAU in 2017–2050 (Figure 15.6).

Figure 15.6. Total Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



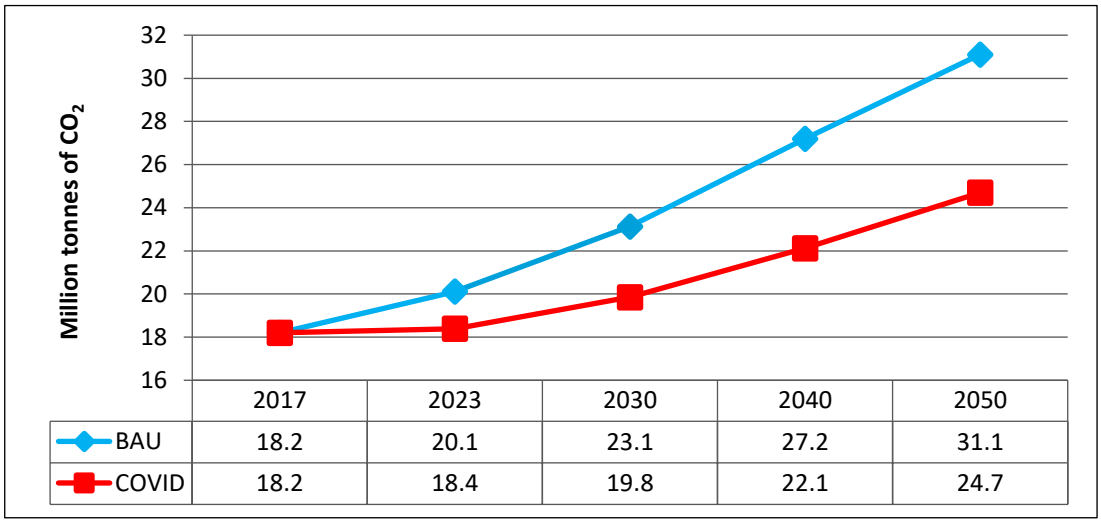
	2017	2023	2030	2040	2050
BAU	29.1	31.5	34.8	39.7	44.8
COVID-19	29.1	30.4	32.7	36.3	40.2

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2 Emissions

In the COVID-19 scenario, GHG emissions increase on average by 0.9% per year in 2017–2050 (1.6% in BAU). Similarly, CO_2 emissions are lower than those in BAU (Figure 15.7).

Figure 15.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU	18.2	20.1	23.1	27.2	31.1
COVID	18.2	18.4	19.8	22.1	24.7

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Authors.

5. Implications and Policy Recommendations

The COVID-19 pandemic has led to significant social and economic impacts on Singapore's economy. Since the beginning of the pandemic, Singapore has taken measures to deal with it, such as border control, safe social distancing, quarantine, circuit breaker, work from home, and enhanced health-care capacity. The government's effective measures to combat the virus include virus testing and TraceTogether apps. The measures, however, have reduced domestic production. More importantly, the pandemic has reshaped the global supply chains to which Singapore belongs. The negative economic effects of COVID-19 on global production networks have overflowed to Singapore. In 2020, GDP is estimated to decrease by about 6.0%.

The decline in economic growth lowers demand for energy. The decline of GDP growth in 2020 affects energy consumption, and the dynamics of energy supply and demand are closely associated with post-pandemic economic recovery. The decline of GDP growth (6.0% in 2020) leads to a decline of energy consumption (0.3% of TFEC and 0.7% of TPES in 2020). Transport TFEC is the most affected, decreasing by 3.2% because of travel restrictions and circuit-breaker measures. CO_2 emissions in the COVID-19 scenario drop by 2.9% in 2020.

In the long term, TFEC in the COVID-19 scenario does not catch up with TFEC in BAU after 2020 because of lower long-term GDP projections. In the COVID-19 scenario, TFEC in 2050 reaches 34.1 million tonnes of oil equivalent, about 8.0% lower than in BAU.

CO_2 emission reductions from energy consumption in the COVID-19 scenario are significant (about 24.7 metric tonnes of CO_2 [$MtCO_2$] in 2050) (about 31.1 $MtCO_2$ in BAU). In the COVID-

19 scenario, the average annual growth of CO_2 emissions is about 0.9% in 2017–2050 (about 1.6% in BAU).

The pandemic confirms the importance of technologies. Singapore will continue to strengthen digitalisation in the post-pandemic period, for example, through the Smart Nation initiative and strategic national research and development planning. Such efforts will shape how economic activities are organised, such as remote working, e-learning, and online business, which, in turn, will have important implications for long-term planning of energy and infrastructure. The pandemic also highlights the importance of resilient and diversified energy supply chains, which calls for better regional and international cooperation, such as the Association of Southeast Asian Nations (ASEAN) Power Grid.

Chapter 16
Thailand Country Report

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1. Background

In 2020, the coronavirus disease (COVID-19) pandemic impacted the world. Thailand's first confirmed case of COVID-19 was a traveller from abroad on 13 January 2020, but the virus started spreading widely at the beginning of March. The government locked the country down in late March. The price was economic slowdown and near standstill until mid-June; 3,135 were infected and 58 died. The energy outlook in the COVID-19 scenario was inevitably reshaped.

2. Macro Assumptions of the COVID-19 Scenario

The lockdown had a direct impact on transport and the residential and commercial sectors. Industry production declined because of low domestic demand resulting from the severe economic downturn and slow exports.

Gross domestic product (GDP) in the COVID-19 scenario has much lower short- and long-term growth rates than in the business-as-usual (BAU) scenario (Table 16.1). However, the Office of the National Economic and Social Development Council has periodically revised GDP outlook. GDP in BAU in 2018 and in the COVID-19 scenario in 2020 are completely different.

Table 16.1. Assumptions of Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2020-2030	2030–2040	2040–2050
COVID-19	4.2%	2.3%	-6.0%	4.0%	3.0%	3.0%	3.1%	2.8%	2.7%
BAU	4.2%	2.3%	3.9%	3.9%	3.9%	3.9%	3.8%	3.6%	3.6%

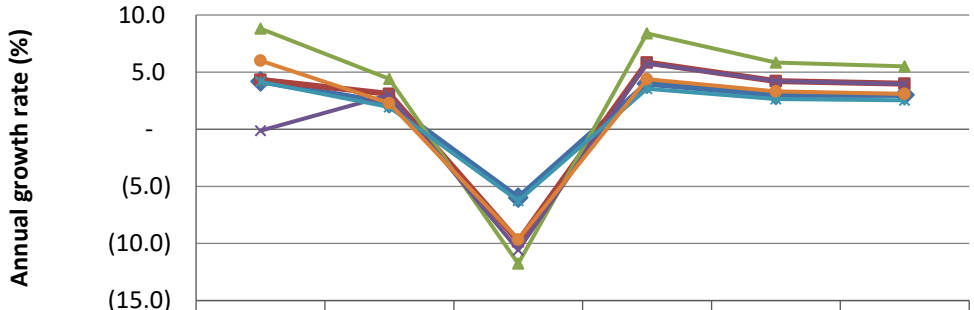
BAU = business as usual, COVID-19 = coronavirus disease.
Sources: Office of the National Economic and Social Development Council (2018).

3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

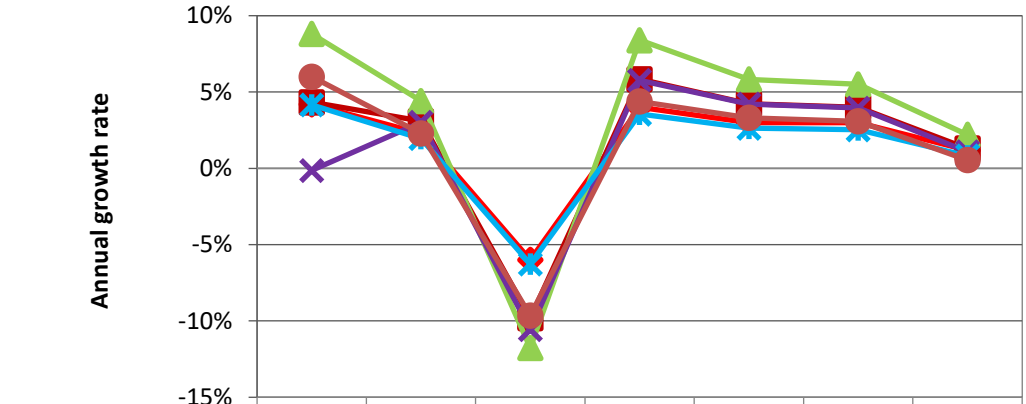
In the COVID-19 scenario, total final energy consumption (TFEC) grows by 1.3% per annum on average (4.2% in BAU) from 89.0 million tonnes of oil equivalent (Mtoe) to 94.9 Mtoe in 2018–2023 (109.3 Mtoe in 2023 in BAU) (Figure 16.1). In the COVID-19 scenario, energy consumption declines sharply by about 9.8% on average in 2020: by 11.8% in industry, 10.6% in transport, 6.3% in 'others' (agriculture, commercial, and residential sectors), and 9.6% in non-energy use. Industry energy consumption is about 25.2 Mtoe in 2020, compared with 28.5 Mtoe in 2019, and 30.5 Mtoe in 2023. Its average growth rate is about 2.2% (30.5 Mtoe) per annum in 2018–2023 (6.1% [36.8 Mtoe] in BAU). Transport energy consumption in the COVID-19 scenario decreases by 10.6% from 29.5 Mtoe in 2019 to 26.4 Mtoe in 2020 (increases by 4.6% from 29.5 Mtoe to 30.9 Mtoe in BAU). Transport energy consumption grows by 1.1% per year on average in 2018–2023 (4.0% in BAU). In the COVID-19 scenario, energy consumption by 'others' decreases by 6.3% from 21.4 Mtoe in 2019 to 20.1 Mtoe in 2020 (increases by 3.1% from 21.4 Mtoe to 22.1 Mtoe in BAU). Energy consumption by 'others', especially the commercial and residential sectors, was estimated to grow at the average rate of 0.8% per year in 2018–2023 (2.7% in BAU).

Figure 16.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP Assumption	4.2	2.3	(6.0)	4.0	3.0	3.0
TFEC	4.3	3.1	(9.8)	5.8	4.2	4.0
Industry	8.8	4.4	(11.8)	8.4	5.8	5.5
Transport	(0.1)	3.0	(10.6)	5.8	4.2	4.0
Other Sectors	4.2	1.9	(6.3)	3.6	2.6	2.5
Non Energy Use	6.0	2.3	(9.6)	4.4	3.3	3.1

Figure 16.1. Continued

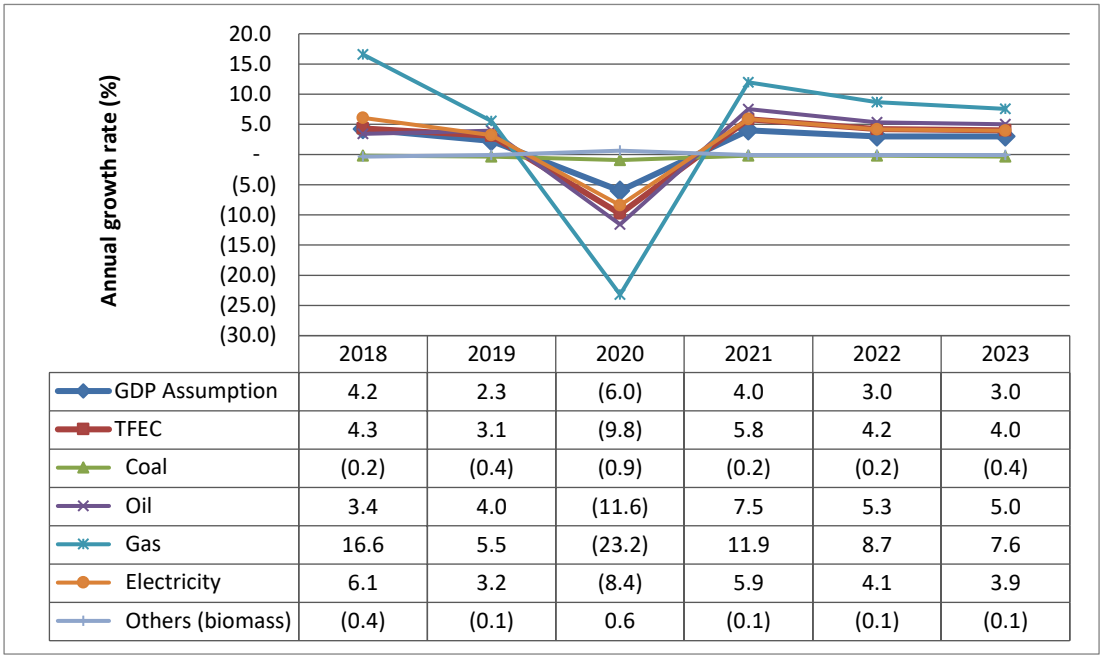


	2018	2019	2020	2021	2022	2023	2018-23
GDP Assumption	4.2%	2.3%	-6.0%	4.0%	3.0%	3.0%	1.2%
TFEC	4.3%	3.1%	-9.8%	5.8%	4.2%	4.0%	1.3%
Industry	8.8%	4.4%	-11.8%	8.4%	5.8%	5.5%	2.2%
Transportation	-0.1%	3.0%	-10.6%	5.8%	4.2%	4.0%	1.1%
Others	4.2%	1.9%	-6.3%	3.6%	2.6%	2.5%	0.8%
Non-energy	6.0%	2.3%	-9.6%	4.4%	3.3%	3.1%	0.5%

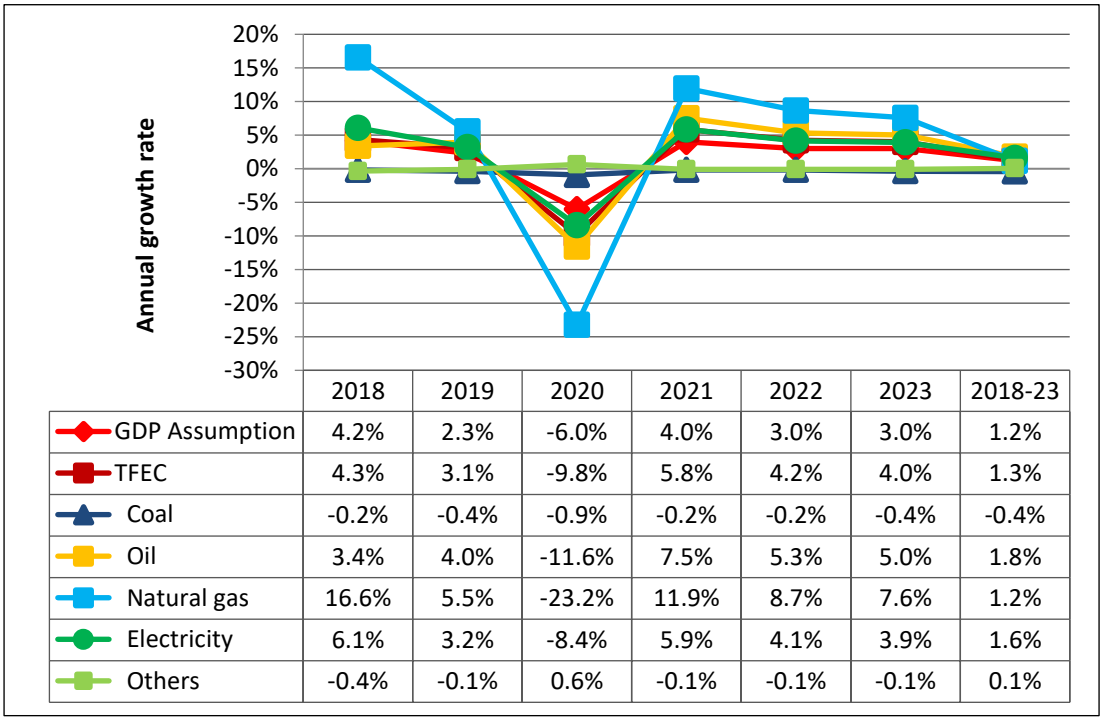
COVID-19 = coronavirus disease; GDP = gross domestic product; others = agriculture, commercial, and residential sectors; TFEC= total final energy consumption.
Sources: Author; GDP from the Office of the National Economic and Social Development Council (2018.

In the COVID-19 scenario, consumption declines for every type of energy (Figure 16.2). In 2020, natural gas decreases by 23.2%, oil by 11.6%, electricity by 8.4%, and coal by 0.9%, but other fuels increase by 0.6%. In 2018–2023, oil grows by an average of 1.8% per year (5.4% in BAU), electricity by 1.6% (4.5%), natural gas by 1.2% (6.2%), 'others' by 0.1% (0.1%), and coal by –0.4% (–0.3%). In 2020, consumption of oil is 8.0 Mtoe (11.3 Mtoe in BAU), electricity 40.0 (48.1), natural gas 15.0 (17.3), 'others' 5.4 (5.4), and coal 14.3 (14.2).

Figure 16.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP Assumption	4.2	2.3	(6.0)	4.0	3.0	3.0
TFEC	4.3	3.1	(9.8)	5.8	4.2	4.0
Coal	(0.2)	(0.4)	(0.9)	(0.2)	(0.2)	(0.4)
Oil	3.4	4.0	(11.6)	7.5	5.3	5.0
Gas	16.6	5.5	(23.2)	11.9	8.7	7.6
Electricity	6.1	3.2	(8.4)	5.9	4.1	3.9
Others (biomass)	(0.4)	(0.1)	0.6	(0.1)	(0.1)	(0.1)



	2018	2019	2020	2021	2022	2023	2018-23
GDP Assumption	4.2%	2.3%	-6.0%	4.0%	3.0%	3.0%	1.2%
TFEC	4.3%	3.1%	-9.8%	5.8%	4.2%	4.0%	1.3%
Coal	-0.2%	-0.4%	-0.9%	-0.2%	-0.2%	-0.4%	-0.4%
Oil	3.4%	4.0%	-11.6%	7.5%	5.3%	5.0%	1.8%
Natural gas	16.6%	5.5%	-23.2%	11.9%	8.7%	7.6%	1.2%
Electricity	6.1%	3.2%	-8.4%	5.9%	4.1%	3.9%	1.6%
Others	-0.4%	-0.1%	0.6%	-0.1%	-0.1%	-0.1%	0.1%

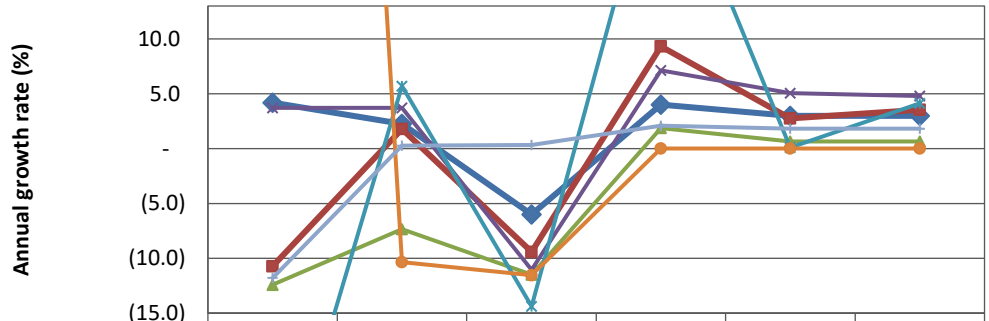
COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC= total final energy consumption.
Sources: Author; GDP from the Office of the National Economic and Social Development Council (2018.

3.2. Primary Energy Supply

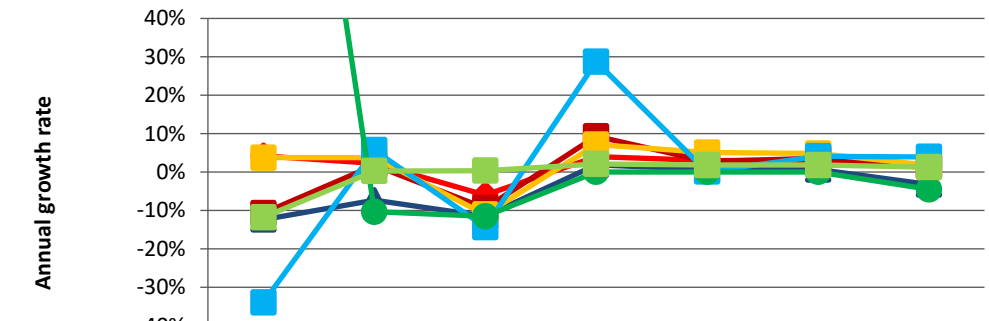
In the COVID-19 scenario, total primary energy supply (TPES) in 2020 declines steeply by 9.4% (92.2 Mtoe) (grows by 10.6% [112.6 Mtoe] in BAU). Natural gas decreases the most, by 14.4%

(17.2 Mtoe), followed by coal by 11.5% (10.7), hydro by 11.5% (0.9), and oil 11.0% (42.4), while other fuel types increase by 0.3% (21.1) (Figure 16.3). In BAU, primary energy supply of natural gas is 27.8 Mtoe, coal 11.7, hydro 0.9, oil 50.5, and 'others' 21.6. The average growth rates of TPES in 2018–2023 are 1.4% per year in the COVID-19 scenario and 5.0% in BAU.

Figure 16.3. Annual Growth Rate of Primary Energy Supply, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP Assumption	4.2	2.3	(6.0)	4.0	3.0	3.0
TPES	(10.7)	1.8	(9.4)	9.3	2.8	3.5
Coal	(12.4)	(7.4)	(11.5)	1.9	0.6	0.6
Oil	3.7	3.7	(11.0)	7.1	5.1	4.8
Natural gas	(33.9)	5.7	(14.4)	28.7	0.1	4.1
Hydro	182.9	(10.3)	(11.5)	-	-	-
Others	(11.8)	0.3	0.3	2.1	1.8	1.8



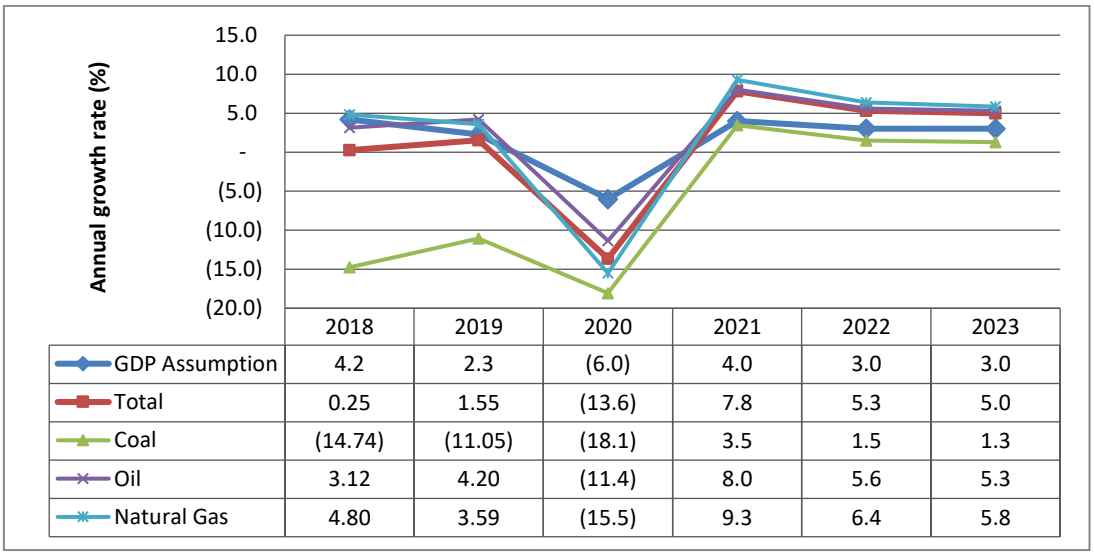
	2018	2019	2020	2021	2022	2023	2018-23
GDP Assumption	4.2%	2.3%	-6.0%	4.0%	3.0%	3.0%	1.2%
TPES	-10.7%	1.8%	-9.4%	9.3%	2.8%	3.5%	1.4%
Coal	-12.4%	-7.4%	-11.5%	1.9%	0.6%	0.6%	-3.3%
Oil	3.7%	3.7%	-11.0%	7.1%	5.1%	4.8%	1.7%
Natural gas	-33.9%	5.7%	-14.4%	28.7%	0.1%	4.1%	4.0%
Hydro	182.9%	-10.3%	-11.5%	0.0%	0.0%	0.0%	-4.5%
Others	-11.8%	0.3%	0.3%	2.1%	1.8%	1.8%	1.3%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES= total primary energy supply.
Sources: Author; GDP from the Office of the National Economic and Social Development Council (2018).

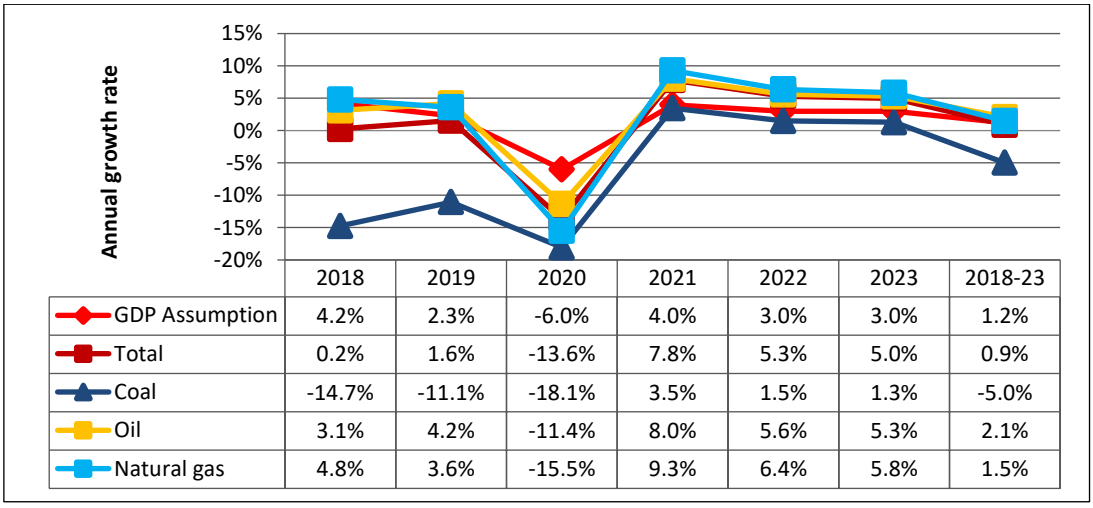
3.3. CO_2 Emissions

GDP outlook was revised to a significantly negative growth rate of 6.0%. In the COVID-19 scenario, GDP average growth rate increases by 1.2% per year in 2018–2023 (3.6% in BAU) and TPES grows on average by 1.4% per year. Greenhouse gas emissions grow on average by 0.9% per year in 2018–2023, from 205.1 million tonnes of CO_2 ($MtCO_2$) to 214.4 $MtCO_2$. CO_2 emissions from combustion of every fossil fuel type, coal, natural gas, and oil grow by a much lower rate on average than in BAU (Figure 16.4).

Figure 16.4. CO_2 Emissions, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023
GDP Assumption	4.2	2.3	(6.0)	4.0	3.0	3.0
Total	0.25	1.55	(13.6)	7.8	5.3	5.0
Coal	(14.74)	(11.05)	(18.1)	3.5	1.5	1.3
Oil	3.12	4.20	(11.4)	8.0	5.6	5.3
Natural Gas	4.80	3.59	(15.5)	9.3	6.4	5.8



	2018	2019	2020	2021	2022	2023	2018-23
GDP Assumption	4.2%	2.3%	-6.0%	4.0%	3.0%	3.0%	1.2%
Total	0.2%	1.6%	-13.6%	7.8%	5.3%	5.0%	0.9%
Coal	-14.7%	-11.1%	-18.1%	3.5%	1.5%	1.3%	-5.0%
Oil	3.1%	4.2%	-11.4%	8.0%	5.6%	5.3%	2.1%
Natural gas	4.8%	3.6%	-15.5%	9.3%	6.4%	5.8%	1.5%

COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Sources: Author; GDP from the Office of the National Economic and Social Development Council (2018.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

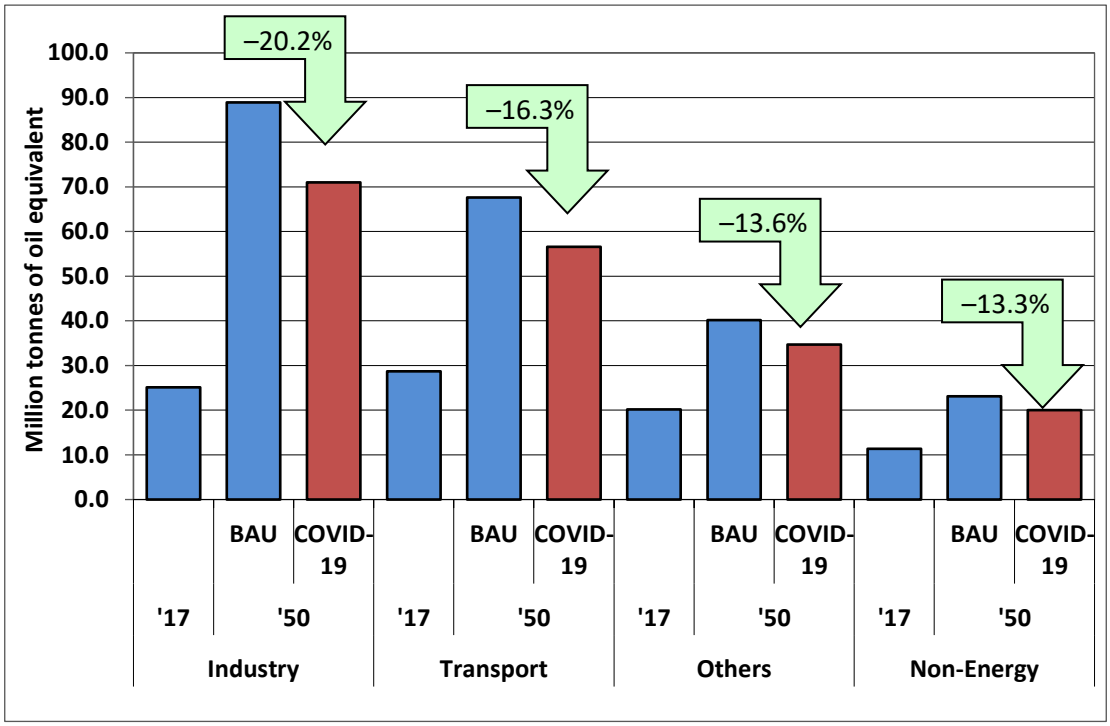
In the COVID-19 scenario, TFEC grows by 2.3% per year from 85.3 Mtoe in 2017 to 182.3 Mtoe in 2050, 17.1% lower than in BAU in 2050 (Table 16.2, Figure 16.5). Reduced energy consumption results from the decrease of energy consumption of industry by 20.2%, transportation by 16.3%, 'others' by 13.6%, and non-energy use by 13.3%.

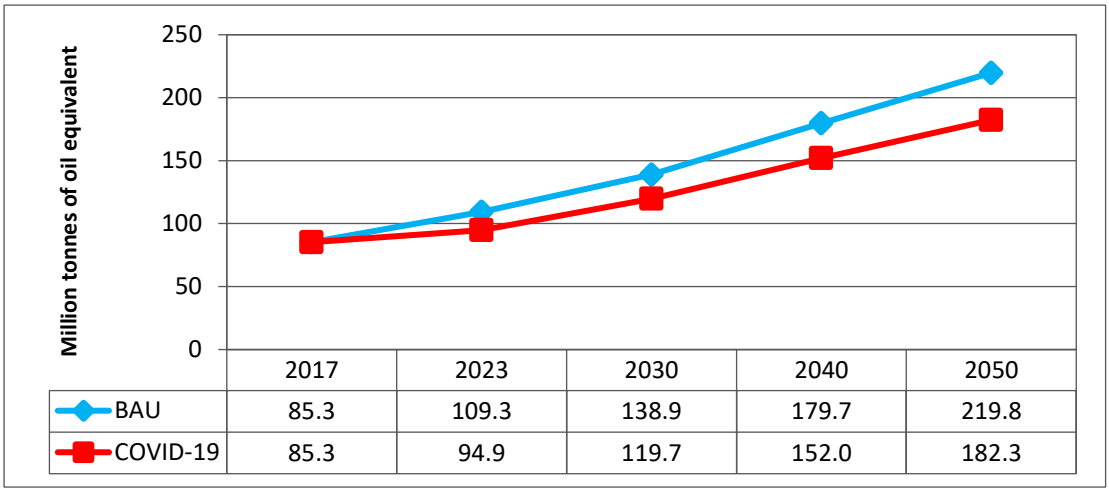
Table 16.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2020	2030	2040	2050	AAGR (2017–2050)
GDP (US$ billion, 2010)	BAU	424.2	526.7	682.5	974.9	1,388.6	3.7%
	COVID-19	424.2	468.8	576.5	763.6	996.7	2.6%
	COVID-19 vs. BAU	0.0%	–11.0%	–15.5%	–21.7%	–28.2%	
TFEC (Mtoe)	BAU	85.3	109.3	138.9	179.7	219.8	2.9%
	COVID-19-19	85.3	94.9	119.7	152.0	182.3	2.3%
	COVID-19 vs. BAU	0.0%	–13.2%	–13.8%	–15.4%	–17.1%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, GDP = gross domestic product, Mtoe = million tonnes of oil equivalent, TFEC = total final energy consumption.
Sources: Author; GDP from the Office of the National Economic and Social Development Council (2018.

Figure 16.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050





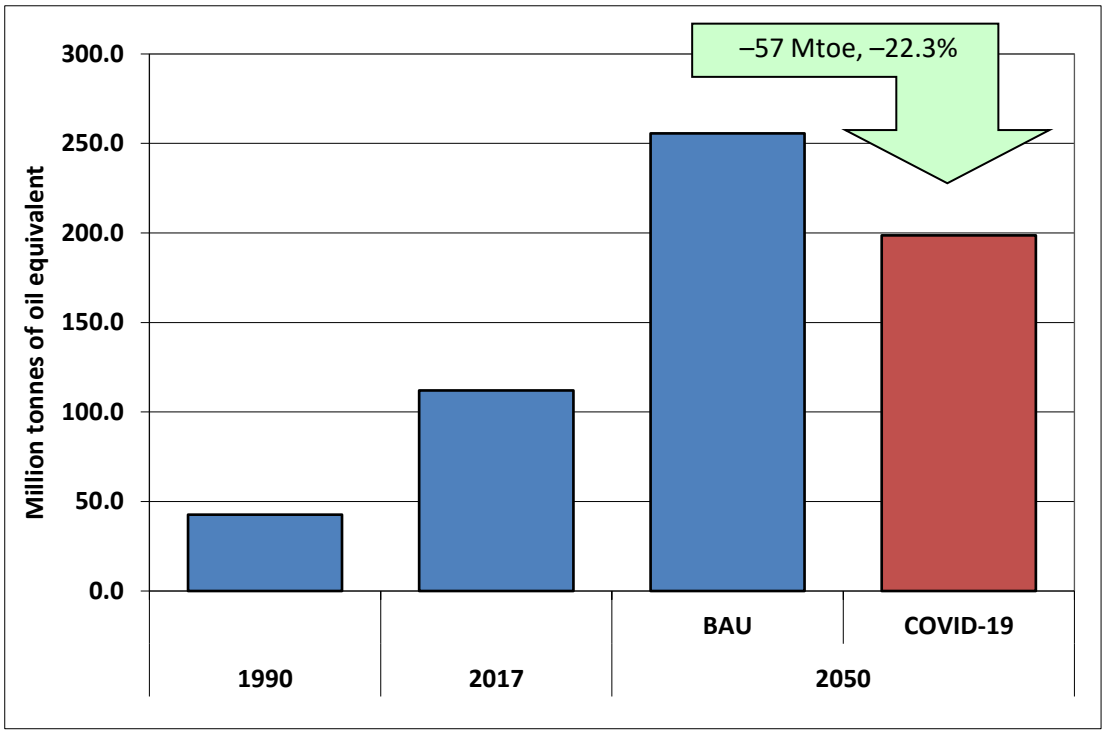
	2017	2023	2030	2040	2050
BAU	85.3	109.3	138.9	179.7	219.8
COVID-19	85.3	94.9	119.7	152.0	182.3

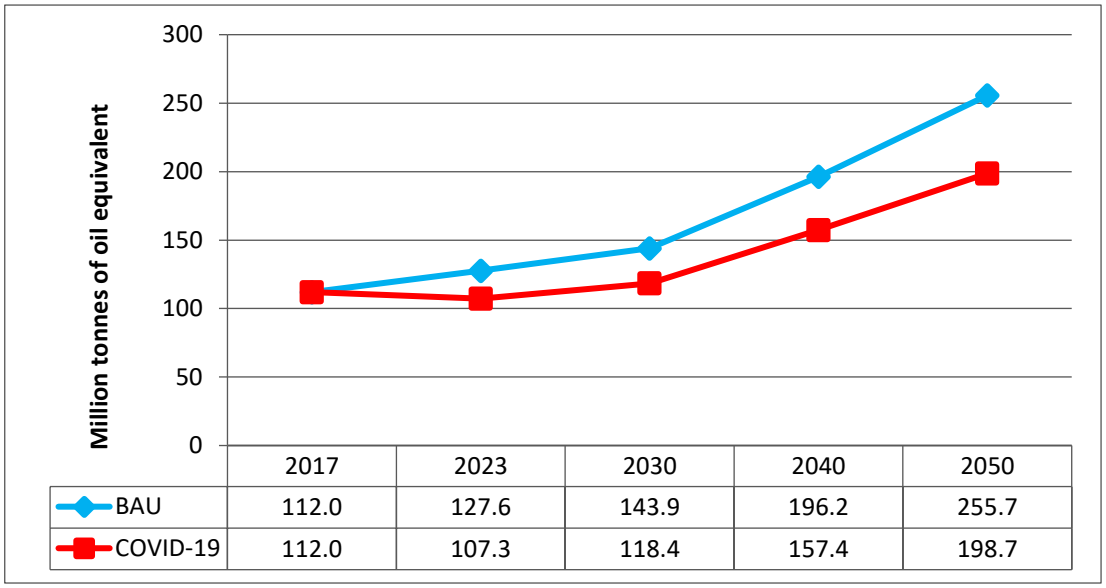
BAU = business as usual, COVID-19 = coronavirus disease.
Sources: Author.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases by 1.1% per year in 2017–2050 (2.5% in BAU) and is about 22.3% lower in BAU in 2050, a reduction of about 57.0 Mtoe. Coal increases by 0.3% per year in 2017–2050 (1.9% in BAU) and oil by 2.7% (3.3% in BAU). Natural gas increases by an annual average of 1.0% (2.2% in BAU), from 28.7 Mtoe in 2017 to 39.4 Mtoe in 2050 (Figure 16.6).

Figure 16.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 1990–2050





	2017	2023	2030	2040	2050
BAU	112.0	127.6	143.9	196.2	255.7
COVID-19	112.0	107.3	118.4	157.4	198.7

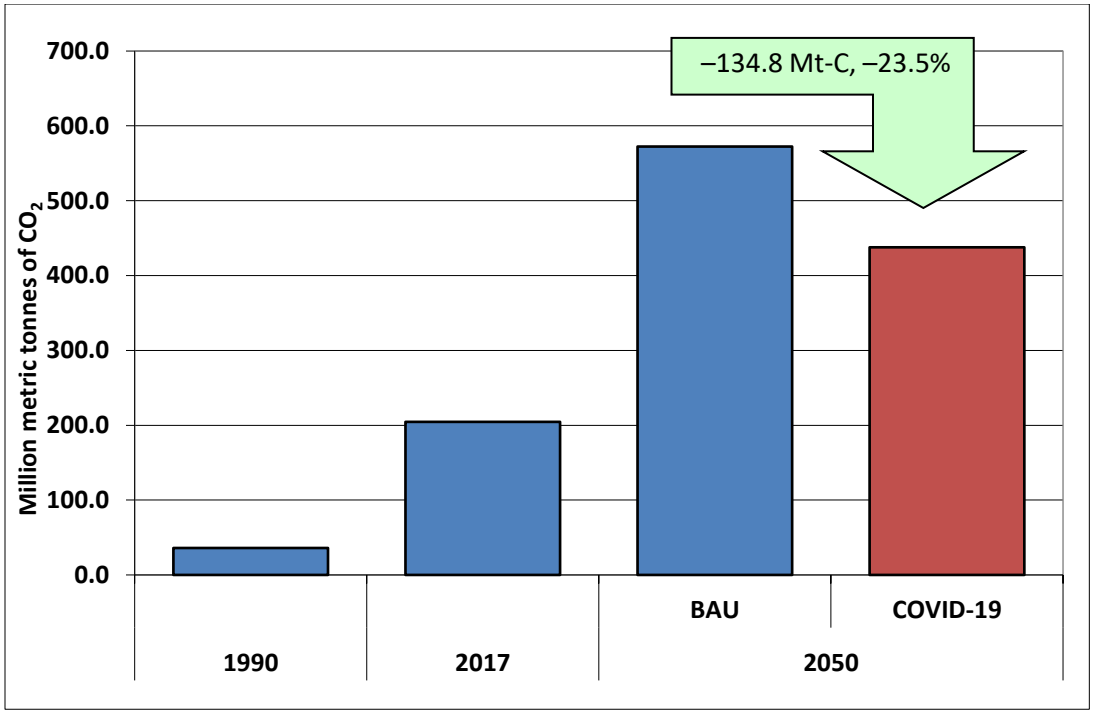
BAU = business as usual, COVID-19 = coronavirus disease.
Sources: Author.

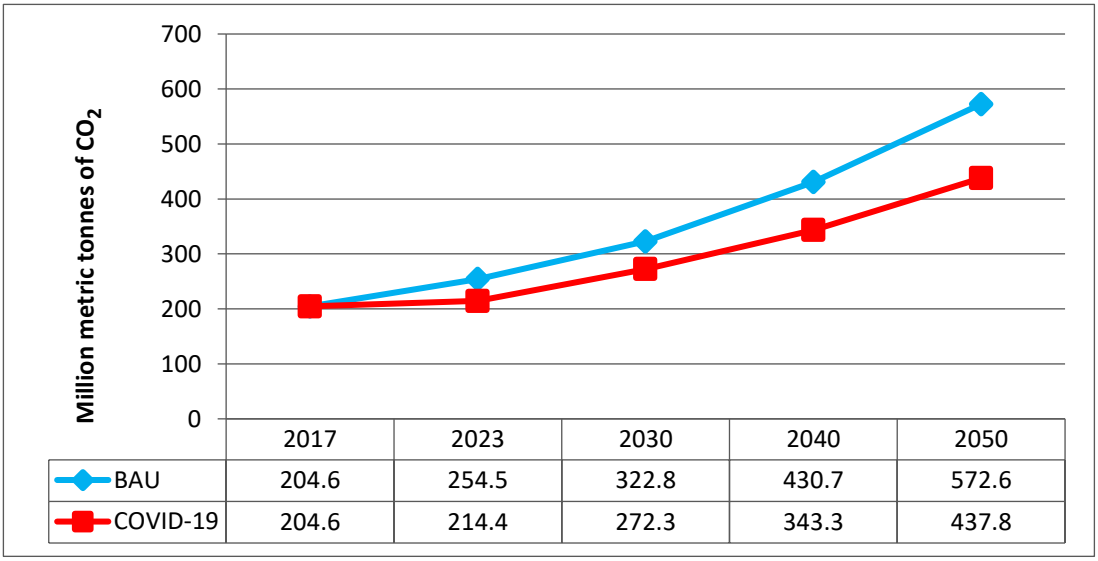
4.3. CO_2 Emissions

In BAU, CO_2 emissions from energy consumption increase by 3.2% per year on average from 204.6 $MtCO_2$ in 2017 to 572.6 $MtCO_2$in 2050. In the COVID-19 scenario, the average annual growth in CO_2 emissions in 2017–2050 increases by 2.3%, with an emission level of 437.8 $MtCO_2$ in 2050. The difference in CO_2 emissions between the BAU and COVID-19 scenarios is

134.8 million metric tonnes of CO_2 (Mt-C) or 23.5% (Figure 16.7).

Figure 16.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 1990–2050





	2017	2023	2030	2040	2050
BAU	204.6	254.5	322.8	430.7	572.6
COVID-19	204.6	214.4	272.3	343.3	437.8

BAU = business as usual, COVID-19 = coronavirus disease, Mt-C = million metric tonnes of CO_2.
Source: Author.

5. Implications and Policy Recommendations

The COVID-19 pandemic has reshaped not only Thailand's economy but also energy landscape, impacting the short- and long-term energy outlook, reducing CO_2 emissions from energy consumption. In 2020, the government attempted to restore consumption to compensate for the impact of working from home during the lockdown. For example, electricity was billed at the minimum rate for 3 months (March–May). The government ran a subsidised programme to support the natural gas for vehicles (NGV) price of THB3 per kilogram for public transport, including buses and taxis, for 3 months (April–June). Thailand strives for net-zero emissions in the near future and the negative impact of COVID-19 on energy is probably encouraging the government to achieve the target faster. Now may be right time to phase out fossil fuel subsidies and to accelerate more clean technologies and clean energy to contribute to carbon neutrality by 2060 as targeted by the government.

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Chapter 17
Viet Nam Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has had many negative socioeconomic impacts that have affected energy demand and supply in Viet Nam. Official energy statistics for 2020 have not yet been released, however, so this chapter uses the business-as-usual (BAU) scenario in Viet Nam Country Report, 2020[8] as a reference. This chapter examines how the pandemic reduced energy demand in 2020 and how it rebounds after 2020 in the COVID-19 scenario.

2. Macro Assumptions of the COVID-19 Scenario

The gross domestic product (GDP) growth rate in 2020 decreases to 1.6% in the COVID-19 scenario (6.8% in BAU) and rebounds to 6.7% in 2021, 7.4% in 2022, and 7.2% in 2023.

In 2023–2030, the growth rate is 6.5%per annum, slightly higher than in BAU, and 5.2% in 2030–2040 and 4.2% in 2040–2050, the same as in BAU (Table 17.1).

Table 17.1. Assumed Gross Domestic Product Annual Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 2018–2050

	2018	2019	2020	2021	2022	2023	2023–2030	2030–2040	2040–2050
COVID-19	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.5%	5.2%	4.2%
BAU	7.1%	7.0%	6.8%	6.5%	6.5%	6.5%	6.2%	5.2%	4.2%

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020).

[8] *Viet Nam Country Report in Energy Outlook and Energy Saving Potential in East Asia 2020, ERIA, pp.280-298.*

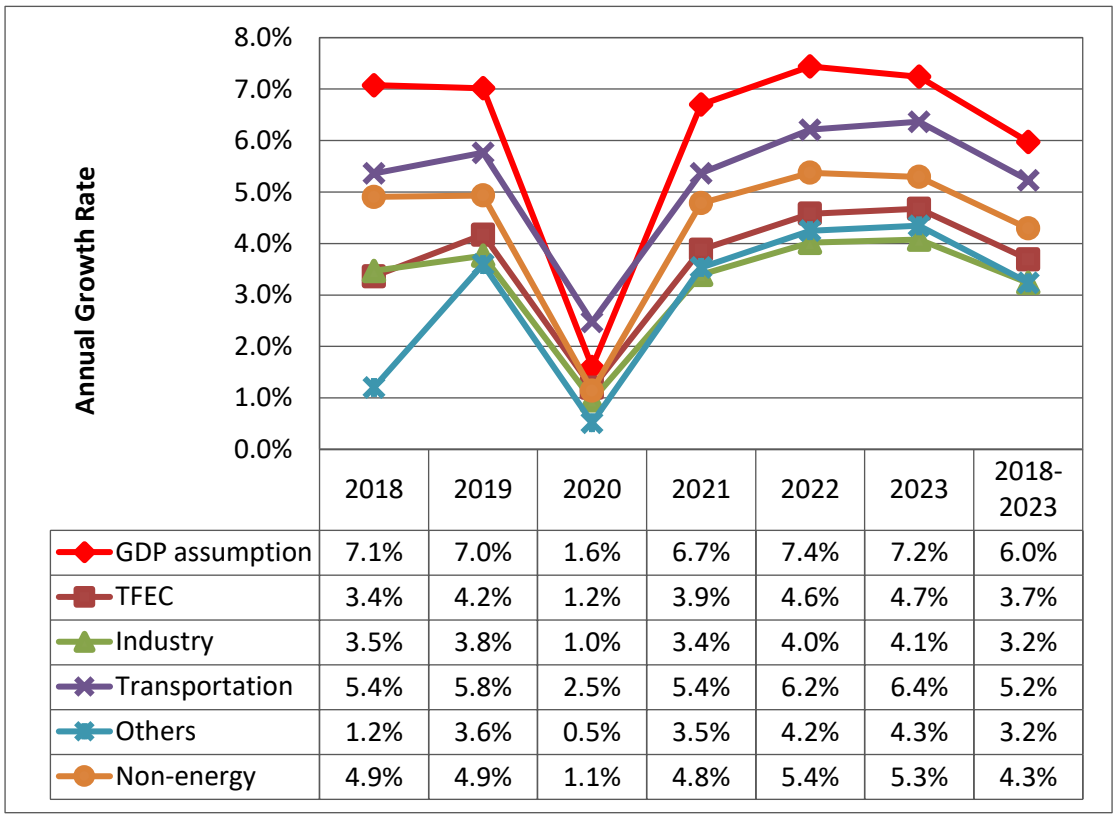
3. Short-term Impact (2018–2023)

3.1. Final Energy Consumption

In the COVID-19 scenario, which uses the revised BAU GDP (Table 17.1), total final energy consumption (TFEC) increases by an average of 3.7% per year in 2018–2023 (0.5% less than in BAU). The decrease is the result of the COVID-19 pandemic in 2020, which reduced TFEC growth rate to 1.2%in 2020 (3.1%less than in BAU).

Energy consumption growth decreased the most in transport, by 2.5% in 2020 (3.4% less than in BAU) and by 5.2% per year in 2018–2023 (0.7% less than in BAU). The reason for the steep fall is limited travel because more people worked from home. Industry's energy consumption grows by 1.0% in 2020 (4.0% in BAU) and 3.2% per year in 2018–2023 (3.7% in BAU). Energy consumption of 'others' (residential and commercial sectors) grows by 0.5% in 2020 (3.6% in BAU) and 3.2% per year in 2018–2023 (3.7% in BAU). Non-energy use increases by 4.3% in 2018–2023 (4.8% in BAU) (Figure 17.1).

Figure 17.1. Annual Growth Rate of Final Energy Consumption, by Sector, COVID-19 Scenario, 2018–2023



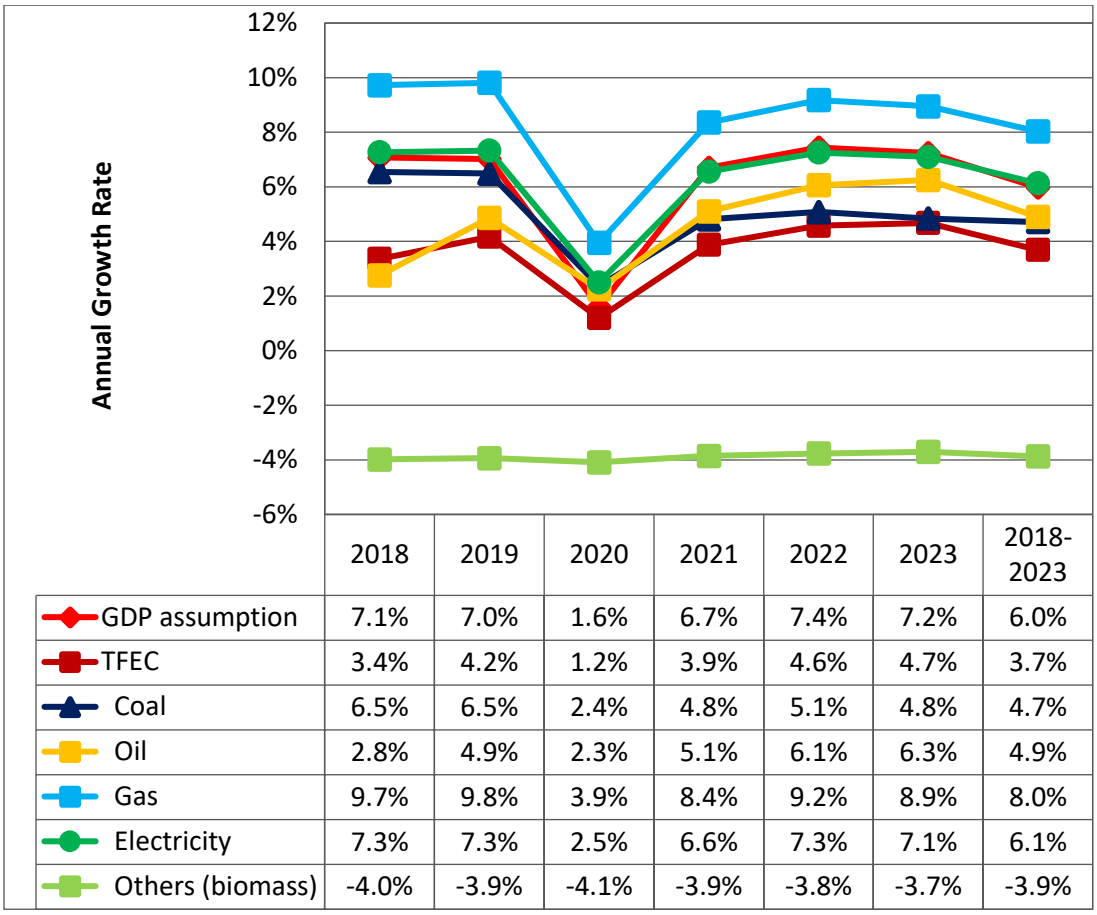
	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.0%
TFEC	3.4%	4.2%	1.2%	3.9%	4.6%	4.7%	3.7%
Industry	3.5%	3.8%	1.0%	3.4%	4.0%	4.1%	3.2%
Transportation	5.4%	5.8%	2.5%	5.4%	6.2%	6.4%	5.2%
Others	1.2%	3.6%	0.5%	3.5%	4.2%	4.3%	3.2%
Non-energy	4.9%	4.9%	1.1%	4.8%	5.4%	5.3%	4.3%

COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

In the COVID-19 scenario, the energy consumption growth of natural gas falls the most, by 3.9% in 2020 to 5.9 (9.8% in BAU) and by 0.8% to 8.0% per year in 2018–2023 (8.8% in BAU).

Natural gas consumption has been increasing but its share is still extremely small. Electricity consumption falls to 2.5% in 2020 (7.3% in BAU) and 6.1% per year in 2017–2023 (6.8% in BAU), oil to 2.3% in 2020 (5.6% in BAU) and 4.9% per year in 2018–2023 (5.5% in BAU), and coal to 2.4% in 2020 (5.7% in BAU) and 4.7% per year in 2018–2023 (5.1% in BAU). However, 'others' (mostly biomass) are hardly affected by the pandemic because of the continuous shift from biomass to conventional fuels such as oil and electricity (Figure 17.2).

Figure 17.2. Annual Growth Rate of Final Energy Consumption, by Fuel, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.0%
TFEC	3.4%	4.2%	1.2%	3.9%	4.6%	4.7%	3.7%
Coal	6.5%	6.5%	2.4%	4.8%	5.1%	4.8%	4.7%
Oil	2.8%	4.9%	2.3%	5.1%	6.1%	6.3%	4.9%
Gas	9.7%	9.8%	3.9%	8.4%	9.2%	8.9%	8.0%
Electricity	7.3%	7.3%	2.5%	6.6%	7.3%	7.1%	6.1%
Others (biomass)	-4.0%	-3.9%	-4.1%	-3.9%	-3.8%	-3.7%	-3.9%

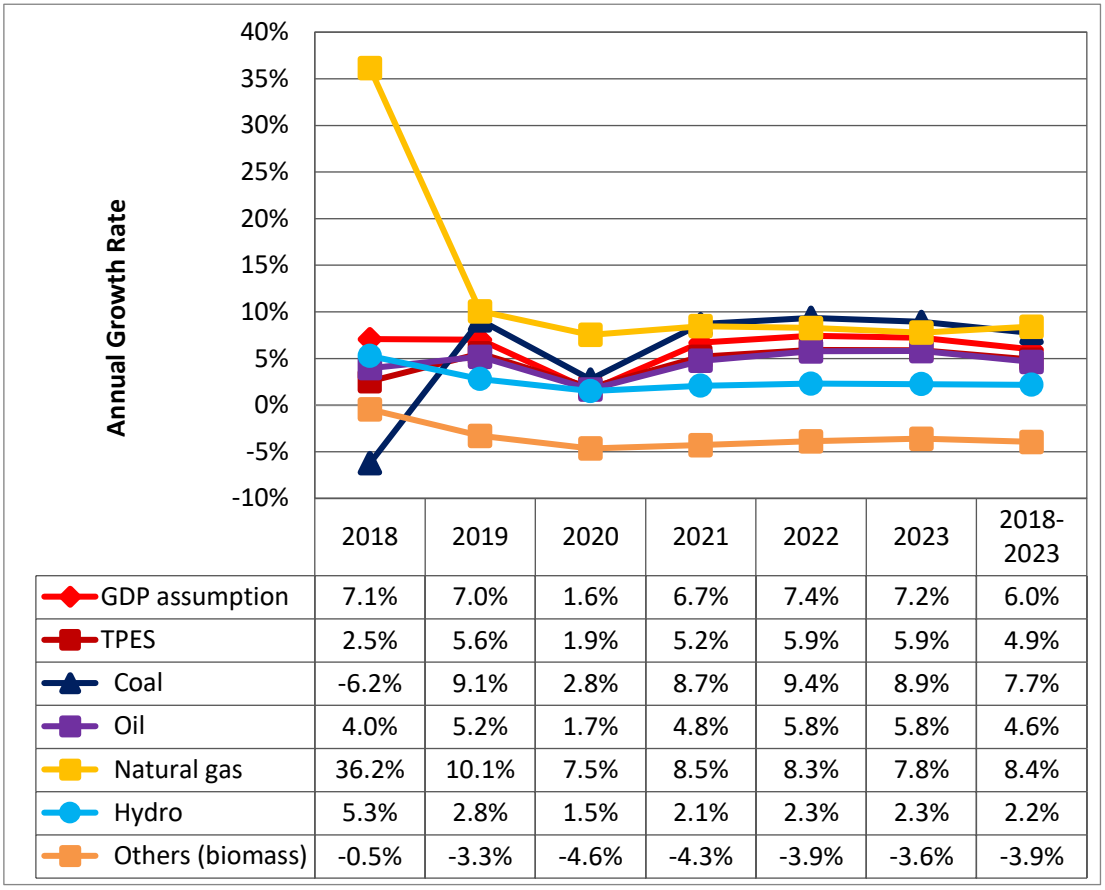
COVID-19 = coronavirus disease, GDP = gross domestic product, TFEC = total final energy consumption.
Source: Author.

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) slows to 3.8% in 2020 (5.7% in BAU) and to 4.9% per year in 2018–2023 (5.5% in BAU). The primary energy supply growth rate for coal falls the most, to 5.7% in 2020 (8.5% in BAU), rebounding to 7.7% per year in 2018–2023 (8.7% in BAU). The changes are caused by fluctuation of electricity (TFEC) after 2020 and fuel switching from coal (-6.2%) to gas (36.2%) in power generation in 2018. The primary energy supply growth rate for oil falls to 1.7% in 2020 (5.9% in BAU) and to 4.6% per

year in 2018–2023 (5.3% in BAU), and for natural gas to 7.5% in 2020 (9.4% in BAU) and to 8.4% per year in 2018–2023 (8.6% in BAU). 'Others' (mostly biomass) were hardly affected because of the continuous shift from biomass to other fuels (Figure 17.3).

Figure 17.3. Annual Growth Rate of Primary Energy Supply, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.0%
TPES	2.5%	5.6%	1.9%	5.2%	5.9%	5.9%	4.9%
Coal	-6.2%	9.1%	2.8%	8.7%	9.4%	8.9%	7.7%
Oil	4.0%	5.2%	1.7%	4.8%	5.8%	5.8%	4.6%
Natural gas	36.2%	10.1%	7.5%	8.5%	8.3%	7.8%	8.4%
Hydro	5.3%	2.8%	1.5%	2.1%	2.3%	2.3%	2.2%
Others (biomass)	-0.5%	-3.3%	-4.6%	-4.3%	-3.9%	-3.6%	-3.9%

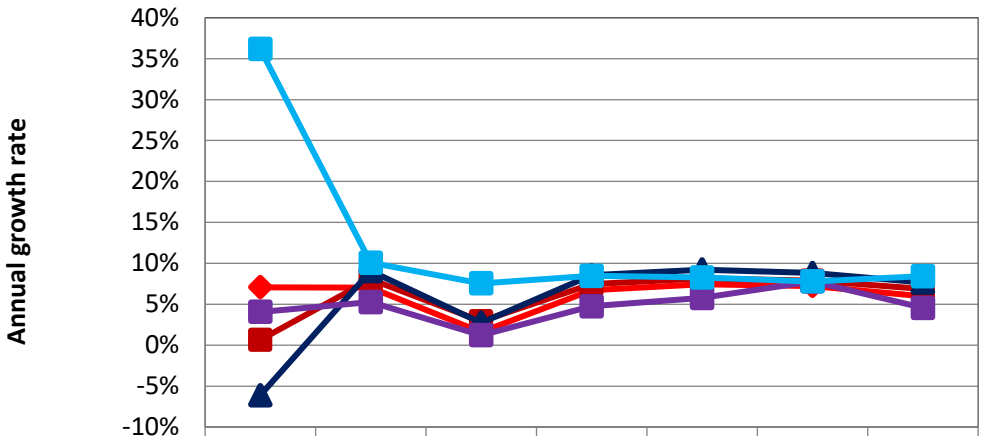
COVID-19 = coronavirus disease, GDP = gross domestic product, TPES = total primary energy supply.
Source: Author.

3.3. CO_2 Emissions

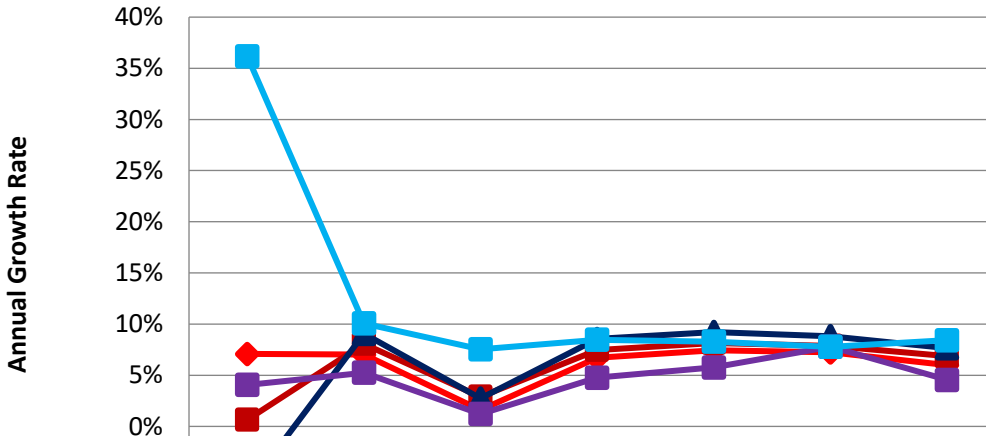
In the COVID-19 scenario, CO_2 emissions increase more slowly, by 2.9% to 4.8% in 2020 (7.7% in BAU) and by 0.7% to 6.9% per year in 2018–2023 (7.6% in BAU). The CO_2 emission growth rate decreases the most for coal, by 2.7% to 5.7% in 2020 (8.4% in BAU) and by 1.0% to 7.6% per year in 2018–2023 (8.6% in BAU), followed by oil to 1.2% in 2020 (5.4% in BAU) and to 4.5% per year in 2018–2023 (5.2% in BAU), and natural gas to 7.5% in 2020 (9.4% in BAU) and to 8.4% per year in 2018–2023 (8.6% in BAU).

The CO_2 emissions decreased mostly because of the pandemic (Figure 17.4).

Figure 17.4. CO_2 Emissions, by Source, COVID-19 Scenario, 2018–2023



	2018	2019	2020	2021	2022	2023	2018-23
GDP Assumption	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.0%
Total	0.7%	8.1%	2.9%	7.5%	8.2%	7.9%	6.9%
Coal	-6.1%	9.0%	2.7%	8.5%	9.2%	8.8%	7.6%
Oil	4.1%	5.3%	1.2%	4.8%	5.8%	7.8%	4.5%
Natural gas	36.2%	10.1%	7.5%	8.5%	8.3%	7.8%	8.4%



	2018	2019	2020	2021	2022	2023	2018-2023
GDP assumption	7.1%	7.0%	1.6%	6.7%	7.4%	7.2%	6.0%
Total	0.7%	8.1%	2.9%	7.5%	8.2%	7.9%	6.9%
Coal	-6.1%	9.0%	2.7%	8.5%	9.2%	8.8%	7.6%
Oil	4.1%	5.3%	1.2%	4.8%	5.8%	7.8%	4.5%
Natural gas	36.2%	10.1%	7.5%	8.5%	8.3%	7.8%	8.4%

COVID-19 = coronavirus disease, GDP = gross domestic product.
Source: Author.

4. Long-term Impact (2023–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases by an average of 3.7% per year in 2017–2050 (3.8% in BAU) because economic growth after the pandemic recovers by 5.3% (5.4% in BAU) (Table 17.2).

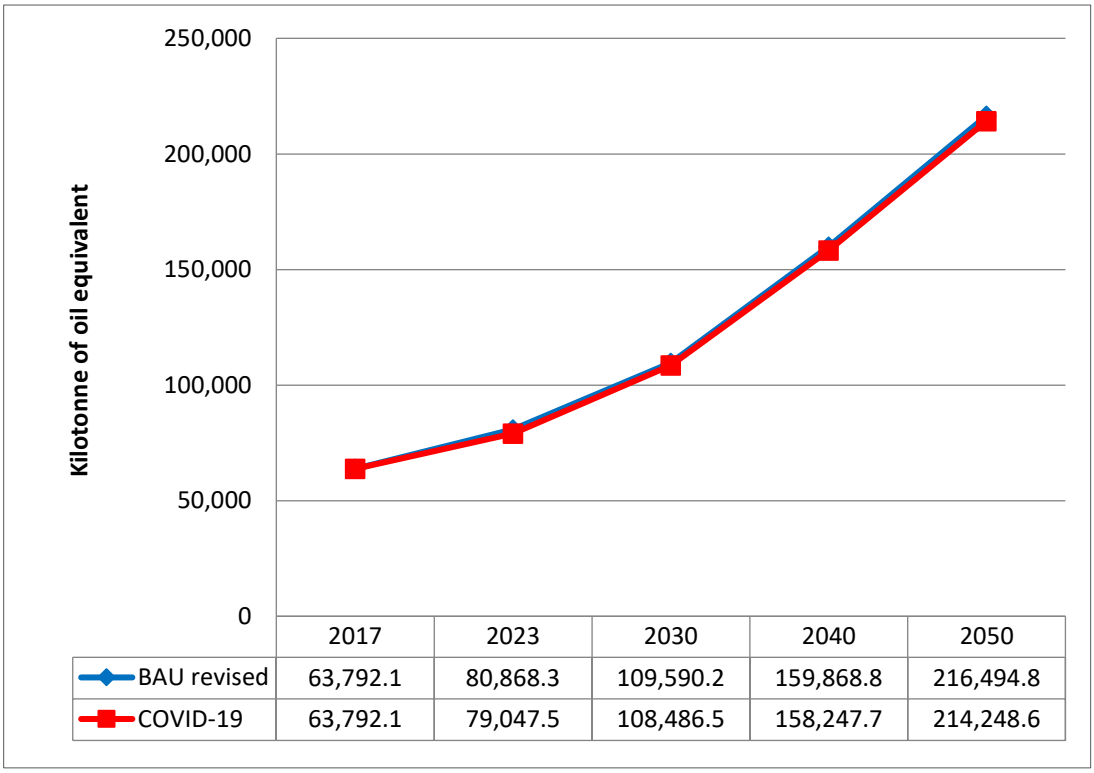
Table 17.2. Gross Domestic Product and Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2023	2030	2040	2050	AAGR (2017–2050)
GDP (VND trillion, 2010)	**BAU**	3,262.5	4,823.1	7,348.4	12,199.7	18,408.9	5.4%
	COVID-19	3,262.5	4,669.6	7,256.5	12,047.2	18,178.8	5.3%
	COVID-19 vs. BAU	0.0	–3.2%	–1.3%	–1.3%	–1.3%	
TFEC (Ktoe)	**BAU**	63,792.1	80,868.3	109,590.2	159,868.8	216,494.8	3.8%
	COVID-19	63,792.1	79,047.5	108,486.5	158,247.7	214,248.6	3.7%
	COVID-19 vs. BAU	0.0	–2.3%	–1.0%	–1.0%	–1.0%	

COVID-19 = coronavirus disease, GDP = gross domestic product, Ktoe = kilo tonne of oil equivalent, TFEC = total final energy consumption.
Source: Author.

TFEC in the COVID-19scenario cannot catch up with TFEC in BAU until 2050 because GDP in the COVID-19 scenario is lower than GDP in BAU. But TFEC in the COVID-19 scenario catches up with TFEC in BAU after 2030 because GDP rebounds in 2021–2030 (Figure 17.5).

Figure 17.5. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



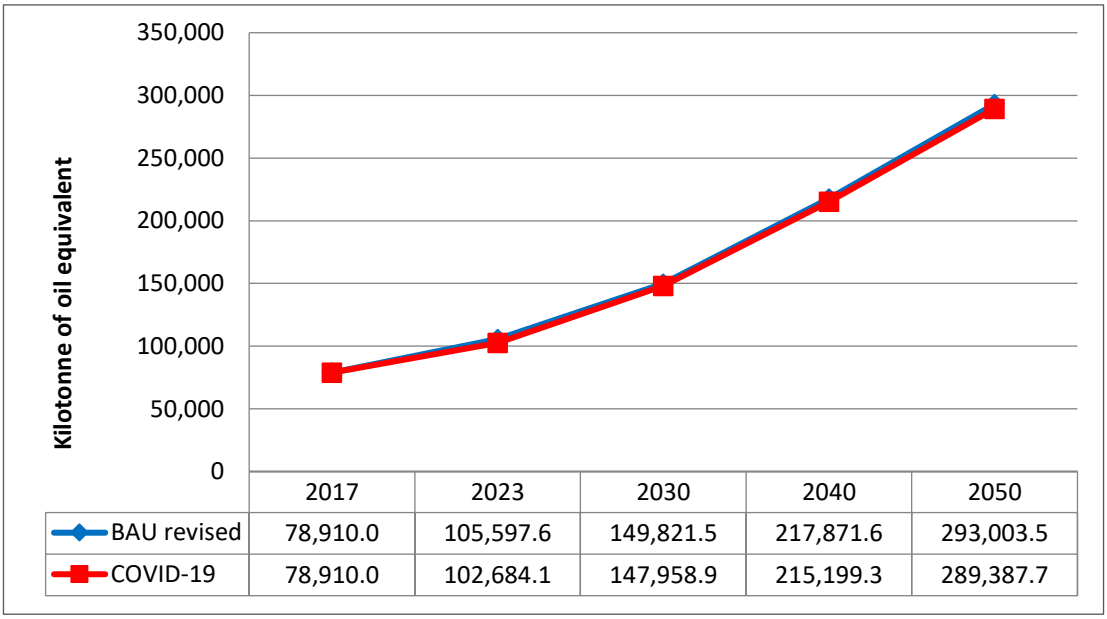
	2017	2023	2030	2040	2050
BAU revised	63,792.1	80,868.3	109,590.2	159,868.8	216,494.8
COVID-19	63,792.1	79,047.5	108,486.5	158,247.7	214,248.6

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases by an average of 4.0% per year in 2017–2050. Like TFEC, TPES in the COVID-19 scenario is the same as in BAU after 2030 because of strong GDP recovery in 2021–2030 (Figure 17.6).

Figure 17.6. Total Primary Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



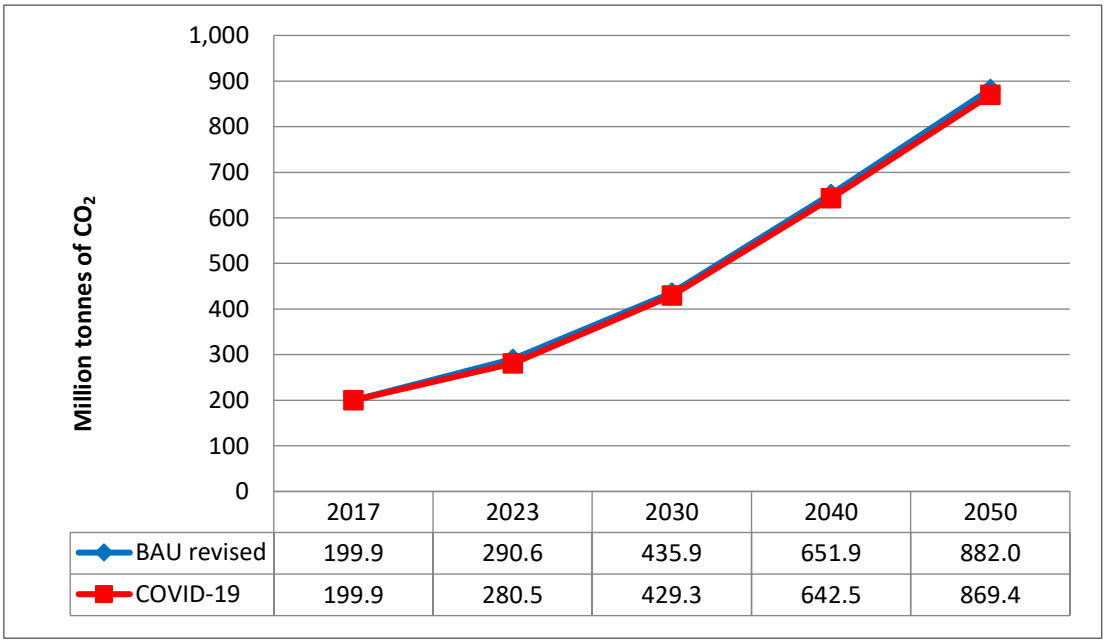
	2017	2023	2030	2040	2050
BAU revised	78,910.0	105,597.6	149,821.5	217,871.6	293,003.5
COVID-19	78,910.0	102,684.1	147,958.9	215,199.3	289,387.7

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

4.3. CO_2Emissions

In the COVID-19 scenario, greenhouse gas (GHG) emissions increase by 4.56% in 2017–2050 (4.6% in BAU) and are almost the same as in BAU after 2030 (Figure 17.7).

Figure 17.7. Total CO_2 Emissions, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050



	2017	2023	2030	2040	2050
BAU revised	199.9	290.6	435.9	651.9	882.0
COVID-19	199.9	280.5	429.3	642.5	869.4

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author.

5. Implications and Policy Recommendations

The COVID-19 pandemic has caused an unprecedented shock to Viet Nam's economy. Since the beginning of the pandemic, Viet Nam has shown resilience in its considerable efforts to enforce border closure; isolation, including social distancing; quarantines; and strengthening of health-care capacity. The government's cost-effective measures to combat the virus include strategic testing, contact tracing through apps, effective public communication campaigns, and limited national lockdowns. These timely and evidence-based responses have led to great success in combating the COVID-19 outbreak. Viet Nam's economy is one of few to have positive GDP growth in 2020. Based on the above results and discussions, the following implications and policy recommendations can be derived:

(i) As economic activities increase, so does energy demand. In 2020, GDP growth rate declines from the expected 6.8% (in BAU) to a preliminary 1.6%, affecting energy consumption in 2020 and after. The decline of GDP growth leads to a decline of energy consumption (1.2% of TFEC in 2020). The results, therefore, should be compared with actual energy consumption after official energy statistics are released.

(ii) In the long term, TFEC in the COVID-19 scenario does not catch up with that in BAU after 2020. The GDP growth rate assumption in the COVID-19 scenario in 2021–2030 is higher than in BAU, and energy consumption rebounds after 2020. However, because of the strong negative impact in 2020, TFEC in the COVID-19 scenario is slightly lower than in BAU in 2020–2050.But TFEC in the COVID-19 scenario is extremely close to that in BAU after 2030.

(iii) Although CO_2emission reduction from energy consumption in the COVID-19 scenario is significant (4.8%) compared with BAU, CO_2 emissions in 2020 are still higher than in 2018 (by 11%) and 2019 (by 3%) and projected to increase by an average of 6.9% in 2018–2023 and by 4.2% in 2023–2050. Continuous post–COVID-19 GHG reduction measures are needed. Viet Nam still needs to support measures such as energy efficiency and conservation on the demand side and highly efficient thermal power plants and deployment of renewable energy such as solar photovoltaic.

(iv) In the COVID-19 scenario, CO_2 emission growth rate is estimated to decrease to about 4.8% compared with BAU in 2020 mainly because of decreased fuel consumption, especially in transport, because of limited travel and work from home. If Viet Nam continues its digitalisation efforts after COVID-19, which will promote remote work, online business, and e-learning, Viet Nam could achieve long-term energy saving and GHG emission reduction along with stable economic growth.

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Chapter 18
United States Country Report

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1. Background

The coronavirus disease (COVID-19) pandemic has had a severe and pronounced effect on the United States (US). As of mid-May 2021, nearly 33,000,000 domestic cases had been reported, contributing to more than 583,000 deaths (Centers for Disease Control and Protection). In an attempt to reduce the human toll of the crisis and bring the outbreak under control, states, cities, and other communities have turned to lockdowns, social-distancing measures, and other restrictions on normal patterns of business, travel, and daily life. More recently, breakthroughs in the availability of vaccines, coupled with aggressive, nation-wide vaccination campaigns, have introduced new means for tackling the crisis, allowing for the easing of some, but not yet all, domestic restrictions.

Together, the above factors have all contributed to dramatically altering business-as-usual (BAU) expectations on a range of fronts. This chapter highlights how the COVID-19 scenario is already impacting near-term energy supply and demand outlooks and the extent to which these effects may ripple out to mid-century.

2. Macro Assumptions of the COVID-19 Scenario

The COVID-19 scenario assumes that while the economy shrank in 2020, evidence of an economic recovery is already apparent.[9] Gross domestic product (GDP) appears to have declined by 3.6% in 2020, compared with pre-pandemic expectations of 1.9% growth, but is now expected to grow by 3.1% in 2021. Amongst other factors, the US Bureau of Economic Analysis has cited the significance of the easing of earlier lockdowns and the reopening of various establishments, as well as the ripple effects of government stimulus packages, in supporting this recovery. Still, even with this rebounded growth, GDP is expected to reach only $18,131 billion in 2021 (4.1% less than the initial BAU projection of $18,930 billion).

The precise date of a full economic recovery remains highly variable because of ongoing uncertainty as to when the domestic outbreak might be considered irreversibly under control – including questions about potential variants – and thus permit a safe and sustainable return to unrestricted business activity and travel. GDP growth rates are expected to outpace BAU expectations in the near term. Yet, even with the new pace of growth, the COVID-19 scenario projects that GDP will reach only $19,798 billion, or 2.2% less than that anticipated in BAU,

[9] Unless otherwise cited, all data in this chapter can be attributed to The Institute of Energy Economics, Japan's economic modelling results for the US, which are included in full as an appendix to this publication.

as gains continue to be offset by the overall scale of losses in 2020.

By 2030, average annual growth rates (AAGR) in the COVID-19 scenario return to what is projected in BAU for the remainder of the outlook period. Still, the economic impacts of the pandemic may linger because of the sheer severity of the outbreak and its ripple effects on activities and life itself. In 2050, actual GDP reaches $33,170 billion, which, while suggesting notable economic growth in 2017–2050, is 2.25% less than pre-pandemic estimates (Table 18.1).

Table 18.1. Gross Domestic Product Growth Rates, Business-as-Usual vs. COVID-19 Scenarios, 1990–2050

(%)

	1990–2017	2020	2021	2022	2023	2021–2025	2025–2030	2031–2040	2010–2050
BAU	2.4	1.9	1.8	1.6	1.6	1.7	2.3	2.2	1.9
COVID-19	2.4	–3.6	3.1	2.9	2.3	2.2	2.3	2.2	1.9

BAU = business as usual, COVID-19 = coronavirus disease.
Source: Author, based on International Monetary Fund (2020).

3. Short-term Impact (2018–2023)

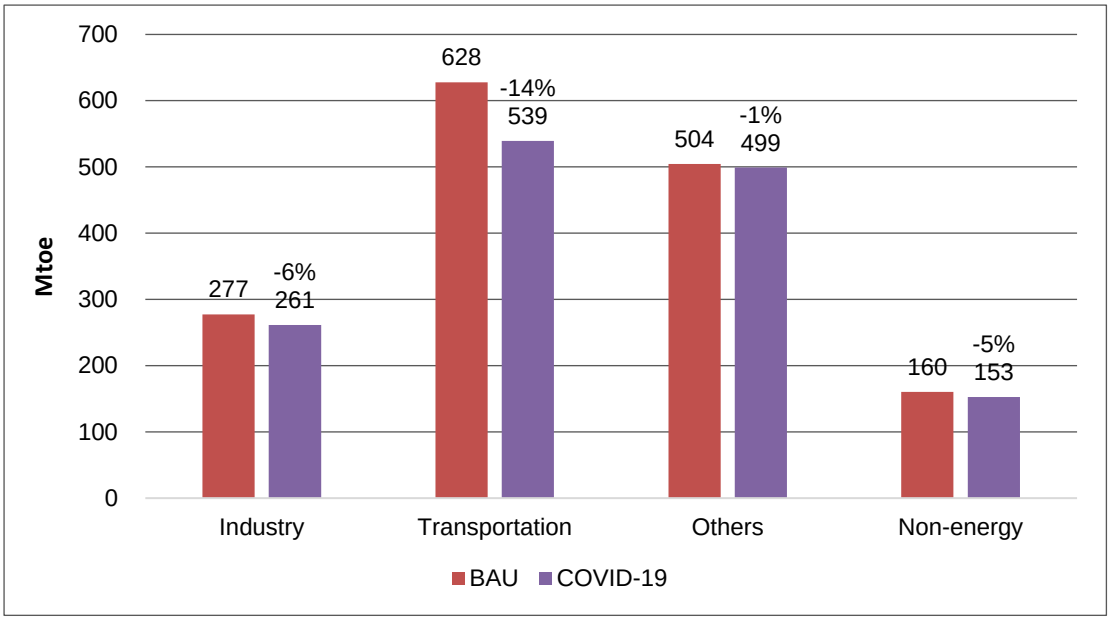
3.1. Final Energy Consumption

In the COVID-19 scenario, total final energy consumption (TFEC) shrinks by 6.9% in 2020 (grows by 0.6% in BAU). However, with the tentative economic recovery driving a return to prior consumption levels, TFEC grows by an average of 0.5% per year in 2018–2023, which approaches (but does not catch up with) expected slightly higher rates (0.7% in BAU).

The effects of the pandemic on energy consumption are felt differently across sectors. Transport energy consumption, for example, decreases the most in the COVID-19 scenario, by 14.1% in 2020 (flat growth in BAU). Still, growth is flat in 2018–2023 because the rapid shift to working from home and other disruptions to mobility altered expectations for 2020 in the COVID-19 scenario. Factors closely linked to emergency measures taken during the height of the crisis are assumed to be disproportionately temporary, allowing for the near-term recovery of suppressed demand.

Industrial energy consumption drops in 2020, declining by 4.3% (increasing by 1.4% in BAU). However, in contrast with transport, industry sees energy consumption growth rates that stay lower than anticipated in 2018–2023 given tentative economic recovery, with only 1.2% growth per year in the COVID-19 scenario (1.5% in BAU). ‘Others’ (residential and commercial sectors) decline by 0.9% in 2020 (0.2% in BAU), growing only 0.4% per year in 2018–2023 (0.6% in BAU). Non-energy use decreases by 1.9% to a modest 2.5% per year in 2018–2023 (2.7% in BAU) (Figure).

Figure 18.1. Total Final Energy Consumption, by Sector, Business-as-Usual vs. COVID-19 Scenarios, 2020



BAU = business as usual, COVID-19 = coronavirus disease, others = residential and commercial sectors. Mtoe = million tonnes of oil equivalent.
Source: Author.

Each of these trends has corresponding impacts on TFEC. In the COVID-19 scenario, the strongest decrease in energy consumption growth is, unsurprisingly, in oil, by 12.4% in 2020 (0.1.% in BAU); oil grows on average by 0.2% per year in 2018–2023 (0.5% in BAU). Coal, too, sees decreased consumption – by 6.5% in 2020 – wiping out expected growth in 2018–2023 and further accelerating anticipated declines. Heat declines by 4.3% and 'others' by 3.2% in 2020, reducing their 2018–2023 growth to virtually flat growth for heat and 0.4% per year for 'others'. Natural gas consumption remains relatively more resilient: although it decreases by 1.8% in 2020, it grows by 0.9% in 2018–2023, bringing it close to BAU expectations of 1.2% growth. Electricity sees a 1.1% decrease in 2020 (1.2% increase in BAU) and 1.2% growth per year in 2018–2023 (1.4% in BAU) (Figure 18).

3.2. Primary Energy Supply

In the COVID-19 scenario, total primary energy supply (TPES) declines by 134.30 million tonnes of oil equivalent (Mtoe) in 2020 or 6.1% (3.4% in BAU). Supply grows by only 17.55 Mtoe in 2018–2023, less than a third of that expected in BAU.

Primary energy supply growth decreases the most in oil, with –12.6% AAGR in 2020, although coal closely trails at –11%. Yet, while oil modestly rebounds by 0.2% in 2018–2023, coal's already anticipated decline accelerates, dropping from –3.4% growth in BAU to –4.4% in the COVID-19 scenario. Natural gas growth in 2020 slows dramatically in the COVID-19 scenario to 0.1% (3.4% in BAU), but edges slightly higher than modelled in BAU in 2018–2023 as production that was delayed or interrupted restarts alongside slowly recovering global

demand.

Most notable, however, is the marked divergence in how COVID-19 has impacted renewable energy supply projections more than other energy types. Wind, solar, and ocean energy not only grow dramatically in 2020 – at 10% – but collectively represent one of only two categories (the other being geothermal) to not see a decline in growth rates in the COVID-19 and BAU scenarios. Although wind and solar projects were also hit with challenges and delays that other supply sources faced, the International Energy Agency noted that declining costs and novel adaptions to pandemic circumstances helped them weather near-term disruptions, while developers raced to complete projects to meet several federal tax incentive deadlines. In the COVID-19 scenario, this resilience, coupled with downturns elsewhere, at least modestly shifts other near-term expectations for declining rates of growth, with these sources now growing 9.1% in 2018–2023 (8% in BAU).

3.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emissions fall from 4,759.1 metric tonnes of CO_2 (Mt-CO_2) to 4,345.0 Mt-CO_2 in 2019–2020, representing an 8.7% decrease (0.9% in BAU). Slightly lower overall final energy consumption also drives a slightly lower emission profile in 2018–2023, with a 0.5% decrease (0.1% in BAU).

The strongest decrease in CO_2 emissions in 2020 is in oil, by 283.5 Mt-CO2 or 14.1% (0.2% in BAU). A likely strong rebound in domestic demand for oil in 2021 may ultimately drive total oil-linked emissions slightly higher in 2018–2023 than in BAU, although both scenarios project essentially flat growth.

Although growth in natural gas–linked CO_2 emissions is flat in 2020, modest growth during the remainder of the outlook period pushes them to 2.1% growth in 2018–2023 (2.6% in BAU). A more notable shift appears in coal-linked emissions. After falling 10.9%, emissions continue to tumble, declining by 4% in 2018–2023 (3.3% in BAU).

The COVID-19 scenario suggests that while some of the CO_2 emission savings linked to the pandemic have been pronounced, the bulk of these effects have already been experienced. As energy demand recovers in the near term, these gains may be largely reversed by 2023.

4. Long-term Impact (2025–2050)

4.1. Final Energy Consumption

In the COVID-19 scenario, TFEC increases by an average of 0.1% per year in 2017–2050 (0.1% in BAU) (Table 18.2).

Table 18.2. Total Final Energy Consumption, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2025	2030	2040	2050	AAGR (2017–2050)
TFEC (Mtoe)	BAU	1,520.46	1,584.24	1,597.01	1,610.70	1,613.44	0.1%
	COVID-19	1,520.46	1,563.52	1,577.43	1,592.16	1,594.10	0.1%
	COVID-19 vs. BAU	0.0	–1.33%	–1.24%	–1.16%	–1.21%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = million tonnes of oil equivalent.
Source: Author.

TFEC in the COVID-19 scenario does not catch up to that in BAU up to 2050, although energy savings are relatively modest at 1.21%.

4.2. Primary Energy Supply

In the COVID-19 scenario, TPES increases at an average annual growth rate of 0.1% per year in 2017–2050 (0.1% in BAU). Like TFEC, TPES in 2050 is lower in the COVID-19 scenario than in BAU by roughly 2.75% (Table 18.3).

Table 18.3. Total Primary Energy Supply, Business-as-Usual vs. COVID-19 Scenarios, 2017–2050

		2017	2025	2030	2040	2050	AAGR (2017–2050)
TPES (Mtoe)	BAU	2,155.23	2,214.38	2,242.61	2,265.79	2,254.78	0.1%
	COVID-19	2,155.23	2,171.22	2,192.37	2,210.40	2,194.43	0.1%
	COVID-19 vs. BAU	0.0	–1.99%	–2.29%	–2.51%	–2.75%	

AAGR = average annual growth rate, BAU = business as usual, COVID-19 = coronavirus disease, Mtoe = million tonnes of oil equivalent, TPES = total primary energy supply.
Source: Author.

4.3. CO_2 Emissions

In the COVID-19 scenario, CO_2 emission AAGR decreases to 0.5% in 2017–2050 (0.4% in BAU). The result is that CO_2 emissions in the COVID-19 scenario are 4,010.1 Mt-CO_2 (4,191.7 Mt-CO_2 in BAU), representing a CO_2 emission reduction of 181.6 Mt-CO_2 in the COVID-19 scenario, savings of roughly 4.3% of BAU.

5. Implications and Policy Recommendations

(i) Given the severity of the COVID-19 outbreak, although the country's economic recovery was already underway as of 2021, some of the crisis' impacts appear likely to ripple out through mid-century, including in driving TPEC and TPES lower than in BAU.

(ii) The surprising resilience of renewable energy during the pandemic – particularly the growing role played by wind and solar in meeting requirements for power generation amidst declines elsewhere – represents a notable and potential watershed development. Nonetheless, oil and natural gas dominate energy mixes in both BAU and COVID-19 scenarios, with implications for larger policy and technology needs in the context of accelerating overall clean energy transition and CO_2 reduction.

(iii) Previous analyses by the Economic Research Institute for ASEAN and East Asia have suggested that, although the US has made substantial progress towards the goal of reducing its CO_2 emissions by 26%–28% from 2005 levels by 2025 (its original intended nationally determined contribution), fully realising the target likely requires more robust policy action. The COVID-19 scenario continues to affirm that finding, as 2020 emission declines related to the pandemic are expected to be largely wiped out by increases during 2021–2023, particularly as suppressed demand for oil and natural gas rebounds.

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