APEC ENERGY OVERVIEW 2023

Disclaimer

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Foreword

The ***APEC Energy Overview*** (the *Overview*) is an annual publication that highlights the current energy situation in each of the 21 APEC economies. It has been the pioneer publication for APERC that showcases the latest APEC energy data compiled by the Expert Group on Energy Data and Analysis (EGEDA) since its first publication in January 2001.

The Overview relies on EGEDA data to monitor progress toward meeting the two APEC energy goals, namely:

1. Energy intensity improvement of 45% by 2035 (relative to 2005)
2. Doubling the renewable energy share in the APEC energy mix by 2030 (relative to 2010)

By 2020, APEC-wide energy intensity had improved by 26%, leaving a 19% improvement needed to meet the 2035 goal. The recent 8th edition of the *APEC Energy Demand and Supply Outlook* forecasts that APEC will meet this goal in both the Reference and Carbon Neutrality scenarios of that report. Progress has also been made in doubling the share of modern renewables. Modern renewables in the energy demand mix have increased by 57% at the halfway point to the 2030 goal. Renewables in the energy supply mix have increased at a slightly slower pace, having increased by 53%, while the share of renewable generation has increased by 59%.

This edition of the Overview includes data to 2020, and so begins to shed light on the extent of the energy impact of the COVID-19 pandemic. One of the highlights of such a tumultuous year was that the growth of solar and wind remained strong posting the highest annual increases ever recorded. One of the highlights of such a tumultuous year was that the growth of solar and wind remained strong posting the highest annual increases ever recorded. Many other trends, issues, policies, initiatives, and notable developments are discussed in each of the economy chapters.

The basis of this report was the EGEDA data that each member economy submits on an annual basis. We thank EGEDA members for their continued support in providing us with these data. We also encourage APEC member economies and other stakeholders to make use of this publicly available resource to continue to develop, implement, refine, and analyse energy policy, alongside other energy related analyses.

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The ***APEC Energy Overview 2023*** could not have been accomplished without the contributions of many individuals and organisations in APEC. We would like to thank all those whose efforts made this publication possible.

We would also like to thank in particular those named below who contributed to the successful completion of this publication.

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Economy chapters

Commonly used abbreviations and terms

Abbreviation	Term
2017 USD PPP	2017 USD purchasing power parity
APEC	Asia Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
ASEAN	Association of South-east Asian Nations
B/D	barrels per day
Bcf	billion cubic feet
bcm	billion cubic metres
Btu	British thermal units
GW	gigawatt
GWh	gigawatt-hour
kL	kilolitre
km	kilometre
km/L	kilometres per litre
ktoe	kilotonne of oil equivalent
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
Mbbl/D	thousand barrels per day
ML	million litres (megalitre)
Mloe	Million litres of oil equivalent
MMbbl	million barrels
MMbbl/D	million barrels per day
MMBFOE	million barrels of fuel oil equivalent
MMBtu	million British thermal units
MMcf/D	million cubic feet per day
MMscf/D	million standard cubic feet per day
mpg	miles per gallon
Mt	million tonnes
Mtce	million tonnes of coal equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
PJ	petajoules
Tbbl/D	trillion barrels per day
tce	tonnes of coal equivalent
Tcf	trillion cubic feet
toe	tonnes of oil equivalent
tU	tonnes of uranium metal
TWh	terawatt-hours
W	watt
Wh	watt-hours

Currency codes

Code	Currency	Economy
AUD	Australian dollar	Australia
BND	Brunei dollar	Brunei Darussalam
CAD	Canadian dollar	Canada
CLP	Chilean peso	Chile
CNY	yuan renminbi	China
HKD	Hong Kong dollar	Hong Kong, China
IDR	rupiah	Indonesia
JPY	yen	Japan
KRW	won	Korea
MYR	Malaysian ringgit	Malaysia
MXN	Mexican peso	Mexico
NZD	New Zealand dollar	New Zealand
PGK	kina	Papua New Guinea
PEN	nuevo sol	Peru
PHP	Philippine peso	Philippines
RUB	Russian ruble	Russia
SGD	Singapore dollar	Singapore
TWD	New Taiwan dollar	Chinese Taipei
THB	baht	Thailand
USD	US dollar	United States
VND	dong	Viet Nam

Introduction

This year's APEC Energy Overview includes energy data to 2020, which begins to shed light definitively on the impact of COVID-19, one of the biggest global economic, health, and societal shocks of modern times.

In addition to energy supply, transformation, and final consumption data for the period 2000 to 2020, an up-to-date accounting of energy policies and notable energy developments to 2023 is provided in each of the APEC member economy chapters.

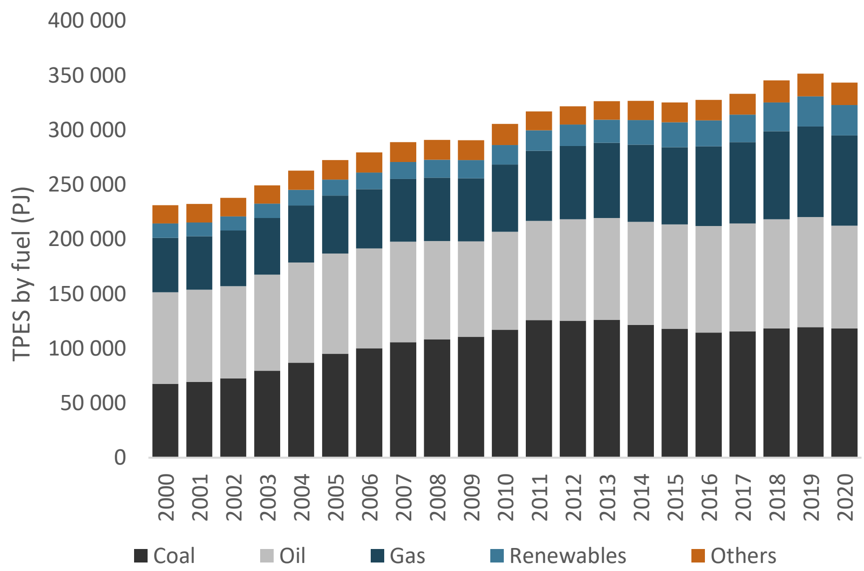
Energy supply and consumption

Total primary energy supply

Global economic output fell by 3.0% in 2020, though the resilience of multiple APEC economies to the initial health emergency meant that APEC economic output only fell by 1.7% (PPP constant 2017 USD). Nevertheless, the contraction in economic activity resulted in APEC energy supply falling by over 8 000 PJ (2.3% annual decline) to settle at just under 344 000 PJ (Figure 1). Oil supply fell by over 6 500 PJ, accounting for most of the decline.

Energy production (3.2% decline) fell further than supply, with that disparity meaning that energy stockpiles were relied upon in many economies to meet their energy requirements in 2020. Oil production fell furthest (5.1%), and natural gas production also declined (2.4%), which represented the first pullback in oil and gas production since the global financial crisis over a decade earlier.

Figure 1: APEC energy supply by fuel (PJ), 2000 to 2020

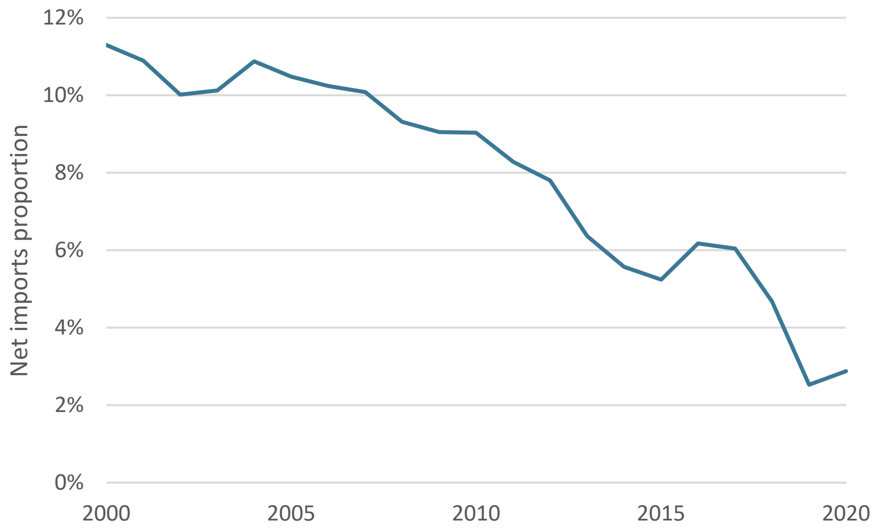


Source: EGEDA (2022)

APEC continues to be a net energy importer from the rest of the world, but the proportion of net imports to energy supply has been declining rapidly for over two decades (Figure 2). The notable halt to the decline in 2020 is mostly attributable to APEC southeast Asia energy exports falling by more than 70% in 2020. Most of the energy reliance on the rest of the world is tied to multiple APEC member economies importing oil from Middle East economies. But this reliance on the Middle East is being offset by the rise in energy production and exports from economies like Australia, Canada, Indonesia, Russia (until 2021), and the US.

Renewables were the only supply category to increase in 2020 (up 1.8%) though fossil fuels remain dominant, accounting for almost 86% of APEC energy supply.

Figure 2: APEC net energy imports as a proportion of supply, 2000 to 2020



Source: EGEDA (2022)

Total final consumption

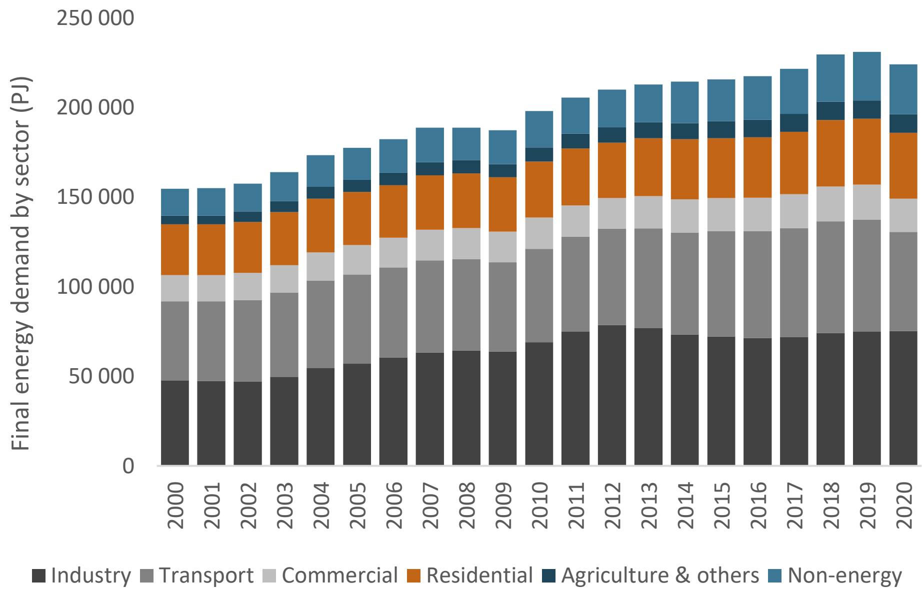
Total final consumption (which includes consumption of energy commodities by the non-energy sector) fell 3.0% to 224 000 PJ in 2020. Border closures, reduced mobility, and a slowdown in all economic activities were the main reasons for this decline.

The largest falls were in the transport (11.5% fall) and services (5.9% fall) sectors. Fuel consumption in all modes of transport declined, led by international aviation (down 47%) and domestic air transport (down 30%). The shift to work-from-home arrangements for many workers during the pandemic meant that residential energy consumption remained largely unchanged (Figure 3).

Non-energy use of energy commodities as feedstocks to petrochemicals, increased 2.8%, supported in part by increasing demand for personal protective equipment (PPE) and other medical and hygiene-related supplies.

Almost all APEC economies were severely impacted by the pandemic in 2020. The most notable exception was China, where energy demand increased 1.9% in 2020. A brief shutdown period and a prominent industry sector, which is less impacted by mobility constraints, partly explain why China continued to grow in economic and energy terms in 2020.

Figure 3: APEC final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

Mirroring supply, oil demand fell furthest in 2020 (down 10.1%). In contrast, coal consumption remained unchanged, mostly supported by

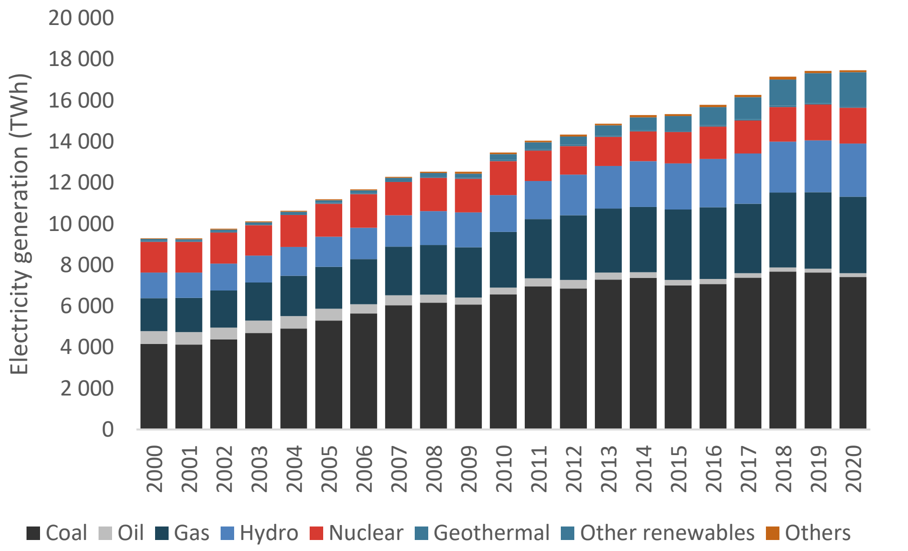
China's continued growth and resilience in the initial stages of the pandemic.

Transformation

Power sector

Power generation in APEC increased marginally (up 0.2%) to almost 17 500 TWh in 2020. The nature of the lockdowns meant that electricity demand remained robust due to increased home-based activity.

Figure 4: APEC electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

Even with the pandemic, the growth in other renewables generation (which includes solar and wind), increased 14.9% to almost 1 700 TWh in 2020 (Figure 4). Power generation from geothermal and hydro also grew by 3.5% and 3.0%, respectively. Renewables' share of total electricity generation rose from 23.1% in 2019 to 24.7% in 2020, with the almost 300 TWh increase being the largest ever observed.

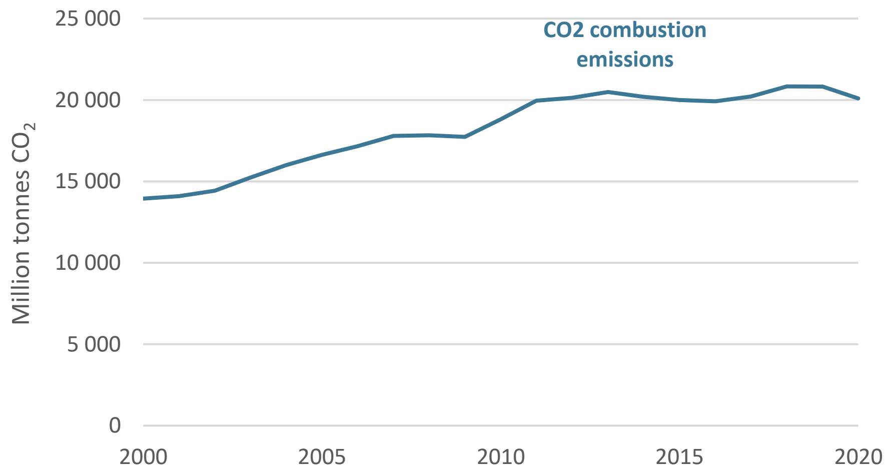
Thermal electricity generation fell 2.0% in 2020, meaning its share of electricity generation was below 65%, down from the most recent peak of 73% in 2011.

Energy transition

Emissions

The unusually large drop in fossil fuels consumption brought about by COVID-19 led to the largest year-on-year decline of carbon dioxide (CO_2) emissions from fuel combustion. CO_2 emissions in APEC fell 3.5% to just over 20 000 $MtCO_2$, a level last seen in 2012 (Figure 5).

Figure 5: APEC CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

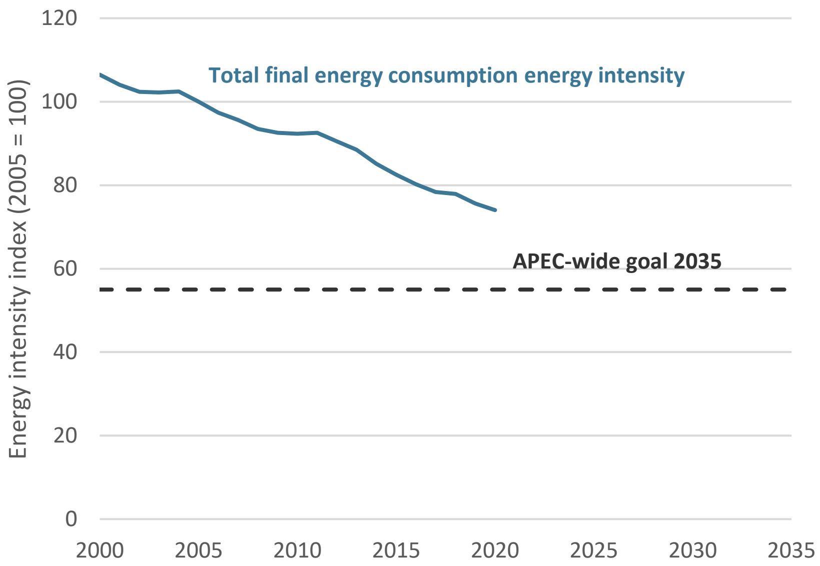
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective — to improve energy intensity and double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 6: APEC total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

As of 2020, APEC-wide final energy intensity has improved 26%, leaving an additional 19% improvement needed to meet the 2035 goal (Figure 6). APEC is on track to achieve this energy intensity improvement if current trends continue.

The observed improvement in energy supply intensity (not shown here) is very close to the observed improvement in energy demand intensity.

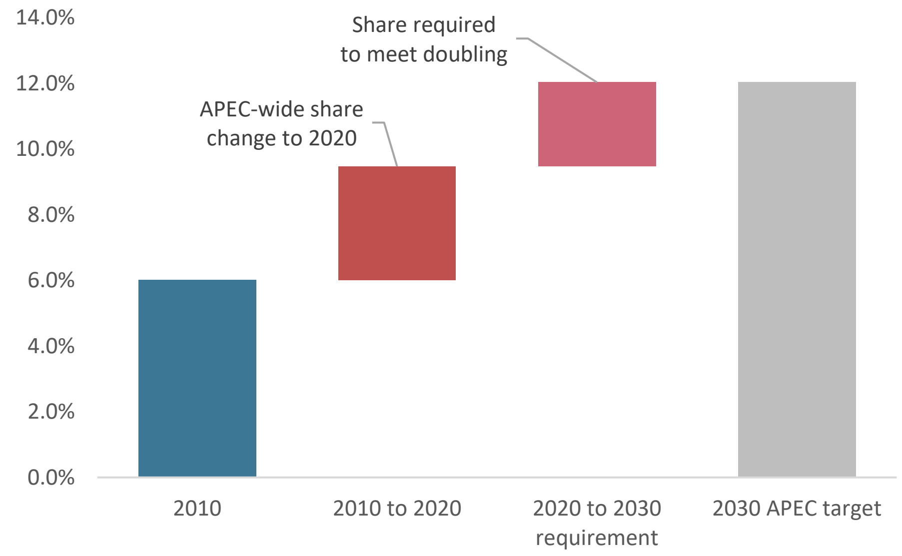
Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030.

Modern renewables do not include traditional biomass, which is typically relied on in emerging economies for household energy needs and is associated with negative health outcomes. Many APEC economies are enacting policies to reduce traditional biomass consumption, either through upgrading fuel stoves, or via facilitating switching to alternative fuels such as natural gas, liquefied petroleum gas (LPG), or electricity.

The modern renewables share of final consumption has increased from 6.0% in 2010 to almost 9.5% in 2020, which is a 57% improvement. This means that APEC is ahead of schedule to double its share of modern renewables by 2030 (Figure 7).

Figure 7: APEC modern renewable energy share in final energy consumption, 2010 through to 2030

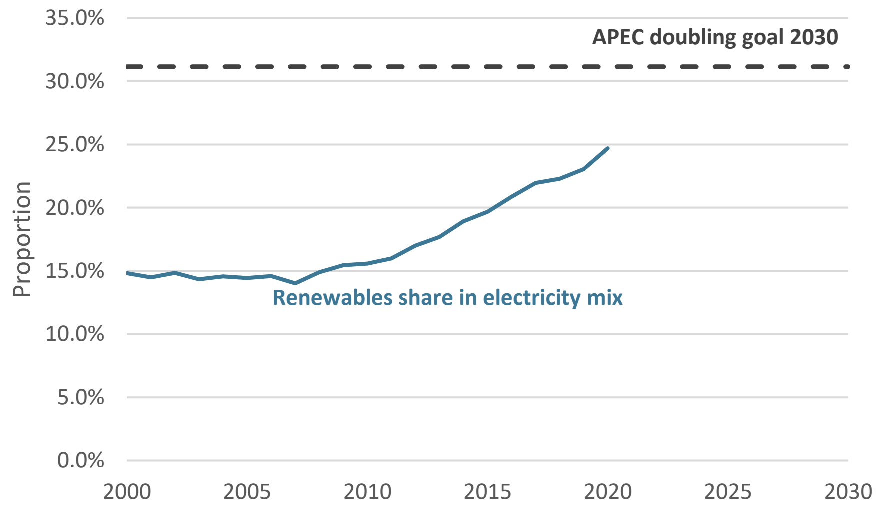


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Progress has also been made in doubling the share of renewables in the electricity mix by 2030 (relative to 2010). Renewable generation accounts for 24.7% of APEC electricity generation in 2020, up from 15.6% in 2010 (Figure 8).

Figure 8: APEC modern renewable energy share in the electricity mix, 2000 to 2020



Source: EGEDA (2022)

In terms of supply, modern renewables have increased from 4.8% in 2010 to 7.3% in 2020, which is an almost 53% increase at the halfway mark to the goal year of 2030.

Economy chapters

Australia

Introduction

Australia updated its nationally determined contribution (NDC) in June 2022, committing to reduce greenhouse gas emissions to 43% below 2005 levels by 2030. This is a significant expansion of the prior commitment of a 26 to 28% reduction for the same period. Australia also reaffirmed its late 2021 commitment to achieve net zero emissions by 2050. In September 2022, Australia legislated these new commitments.

These ambitious commitments were overshadowed by global energy market turmoil in 2022. Energy commodity prices had already been increasing through the latter half of 2021 as goods demand, and the energy required to deliver them, surged on the back of a COVID-19 recovery. With supply already tight, the Russia-Ukraine conflict exacerbated the situation and led to even higher energy prices for most of 2022.

The unprecedented high energy prices mean that Australian energy export earnings (predominantly thermal coal, metallurgical coal, and LNG) are at record levels.

LNG export earnings were over AUD 70 billion in 2021–22 (July to June), which is more than double the AUD 30 billion from the year prior, which accompanied the very low energy prices brought on by COVID-19. Export earnings are anticipated to climb to AUD 90 billion for 2022–23, with the volatile moves in earnings for the last three years largely due to price movements; volumes have been relatively consistent (Resources and Energy Quarterly, 2022).

Australia accounts for well over half of global metallurgical coal exports. Export earnings for this steel-making commodity are anticipated to reach over AUD 57 billion in 2022–23 for Australia, which is down from over AUD 67 billion the year before. The decline in earnings is because metallurgical coal prices have fallen back from the very high price spikes of more than USD 500 per tonne that occurred from March to June 2022 (REQ, 2022).

Thermal coal prices remain elevated, and as the second-largest global exporter, Australia is anticipated to derive AUD 75 billion in export earnings for 2022–23, up from AUD 46 billion in 2021–22 (REQ, 2022).

Table 1: Australia macroeconomic data and energy reserves

Key data [a, b]		**Energy reserves** [c, d]	
Area (million km^2)	7.7	Oil (billion barrels)	2.4
Population (million)	26	Gas (trillion cubic feet)	84
GDP (2017 USD billion PPP)	1 251	Coal (million tonnes)	150 227
GDP per capita (2017 USD PPP)	48 679	Uranium (kilotonnes U < USD 130/kgU)	1 184

Source: a ABS (2022); b World Bank (2022); c BP (2022); d UN (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Domestic energy consumers on the east coast of Australia have been subject to much higher electricity and natural gas prices in 2022, largely due to Australia's east coast gas market being linked to markets in Asia in 2015. Higher energy costs attributable to this linkage have been a prominent contributor to Australia's recent bout of domestic inflation. The Australian Government is attempting to shield east coast consumers from the ongoing global energy market turmoil by instituting a domestic wholesale natural gas price cap of AUD 12 per gigajoule for one year from December 2022. Thermal coal will also be capped at AUD 125 per tonne. Western Australia already enjoys some of the lowest natural gas prices in the world due to a policy of domestic reservation.

Energy supply and consumption

Total primary energy supply

Australia's energy supply—energy that is ultimately consumed domestically—has increased by an annual average of about 1% for the last two decades and reached almost 5 500 PJ in 2020.

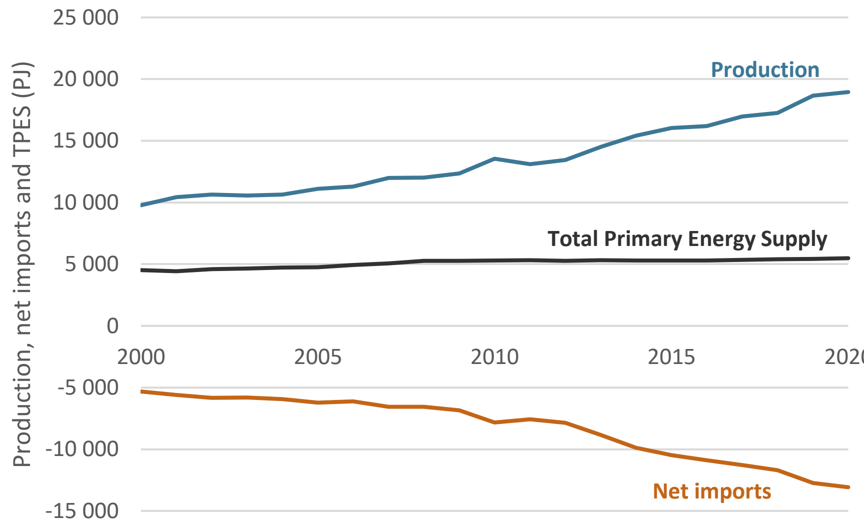
Steadily increasing energy supply has been outshone by rapidly increasing energy exports, and the production required to facilitate them. In 2000, Australia's net energy exports were roughly equivalent to the amount of energy consumed domestically. Whereas in 2020, energy exports were almost 2.5 times larger than energy supply.

Australia, China, PNG, and Viet Nam were the only four economies in APEC to post an increase in energy supply in 2020. For Australia, it was a 1.3% increase, contrasting with a 3.0% fall in final consumption, discussed later in the chapter.

On an energy content basis, Australia's combined metallurgical and thermal coal exports are 2.5 times larger than its LNG exports (BP, 2022).

Australia was the fourth-largest global producer of coal and the seventh-largest global producer of natural gas in 2021 (BP, 2022), with the ranking unchanged from 2020. Almost 90% of Australia's coal production is exported to meet demand from coal-fired power plants (thermal coal) and blast furnaces for steel production (metallurgical coal) that are in Asia. Metallurgical coal accounts for less than one-fifth of APEC coal consumption, though it accounts for almost half of Australia's coal exports.

Figure 1: Australia energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

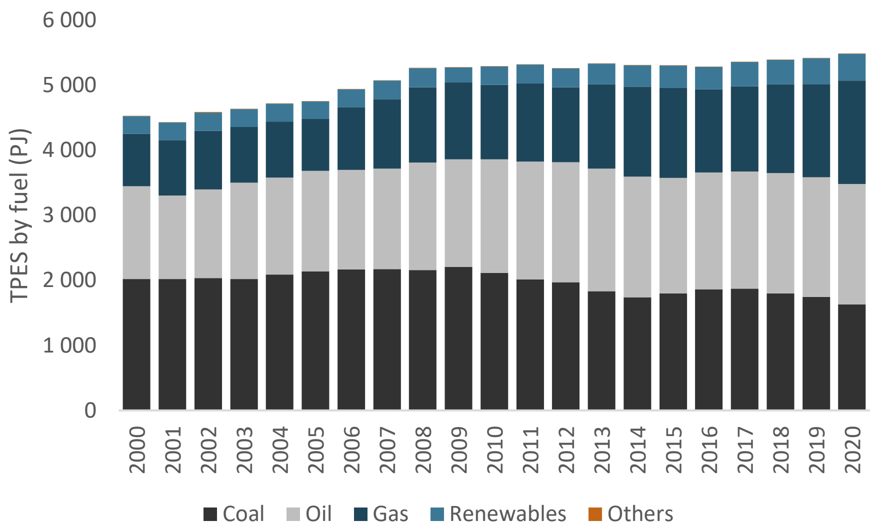
Australia shipped its first LNG cargo from the north-west shelf, Western Australia in 1989. The north-western regions of Australia continued to account for all of Australia's LNG exports until unconventional resources from the Surat and Bowen basins were developed in Queensland. The first east coast LNG cargo was shipped from

Gladstone, Queensland in 2015, and has since led Australia to rival Qatar as the largest global LNG exporter.

The strong growth in LNG exports combined with large quantities of thermal and metallurgical coal exports meant Australia posted a new high of more than 13 000 PJ of net energy exports in 2020 (Figure 1).

Australia's energy supply is the amount of energy consumed domestically and was tied more closely to economic growth prior to the global financial crisis in 2008. Since then, the accumulation of improvements in energy efficiency has been enough to offset increases in demand from a population that has increased by almost a fifth, and economic output that has grown by more than a quarter (Figure 2).

Figure 2: Australia energy supply by fuel (PJ), 2000 to 2020

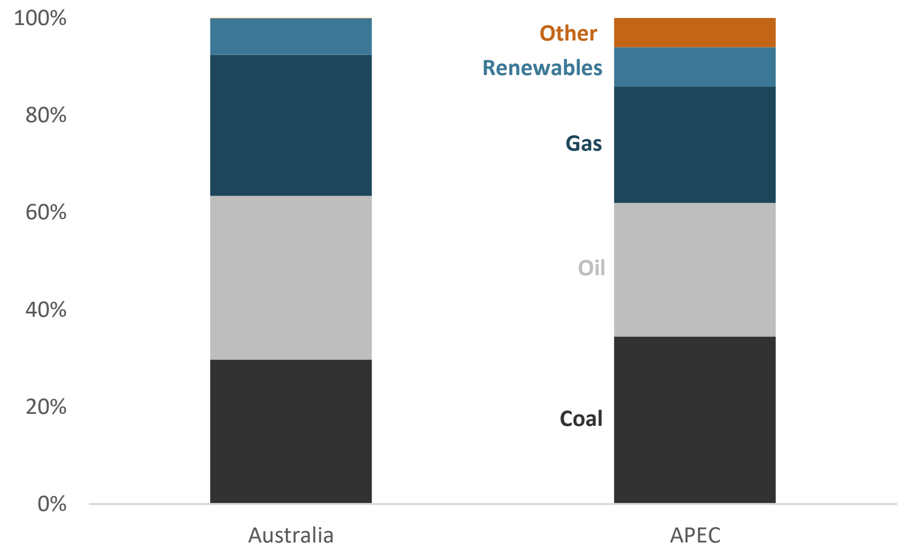


Source: EGEDA (2022)

Coal supply fell for the fourth year in a row, to less than 30% of Australia's supply mix in 2020. Oil (which includes refined products imports) increased by 0.6% in 2020 to remain the most prominent source of supply. Natural gas supply increased by almost 11% to a level that is only 40 PJ lower than coal. Natural gas consumption is falling in many end-use sectors, but it is playing an important role in the power sector, via gas-fired peaking turbines to help meet the challenge of variable renewable generation. There is also significant consumption of natural gas associated with the liquefaction process required for LNG exports.

Renewables supply increased by 5.2%, so that they now account for 7.6% of Australia's energy supply. Australia may have world-beating levels of solar PV, but other APEC economies have very significant hydro generation that contributes to APEC having a relatively higher share of renewables (8.2%) than Australia.

Figure 3: Energy supply mix – Australia and APEC, 2020



Source: EGEDA (2022)

When compared to APEC, oil is more prominent due to Australia's transport sector, and the refined fuel that is required to move people and freight between the population centres, mostly along the east coast.

Total final consumption

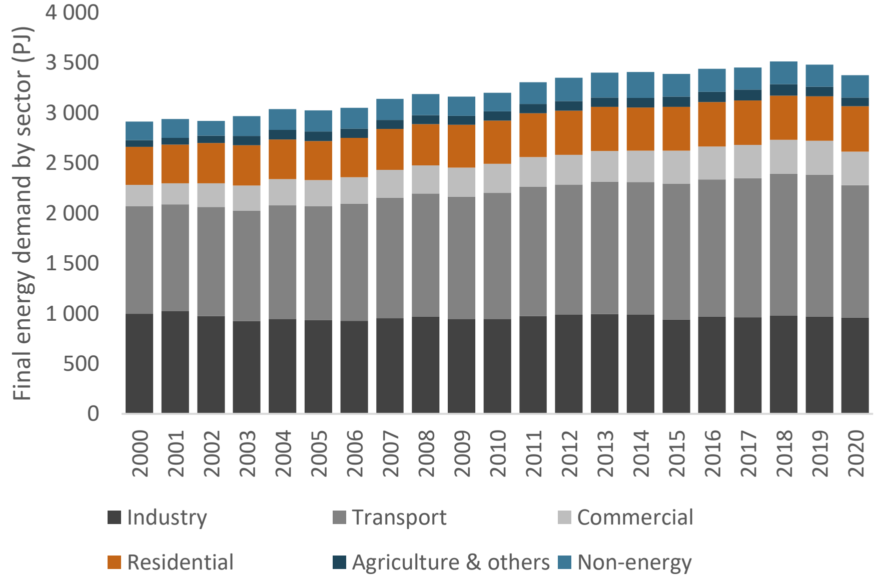
Australia's energy supply of 5 485 PJ in 2020 flows through to 3 377 PJ of end-use demand. This means that almost two-fifths is consumed in the transformation process, which includes own use and losses.

Total final consumption, which includes the consumption of energy commodities by the non-energy sector, fell by 3.0% in 2020, and is almost 4% lower than peak consumption in 2018. Commercial sector energy consumption fell by almost 2% due to COVID-19 activity restrictions, though this was more than offset by residential energy consumption increasing by more than 2.5%. The increase in residential energy consumption is partly explained by COVID-19 and the greater level of economic activity that occurred in households in 2020.

More than 90% of the annual fall in energy consumption was from a fall in transport activity and associated energy consumption, which fell 6.7% in 2020. Official lockdowns, lower levels of mobility, and negative net migration explain most of this fall. This fall was lower than for APEC, which posted an 11.4% decline in 2020. The much steeper decline in many other APEC economies meant that Australia's transport sector became almost 1.6 times larger, in a relative sense, than for APEC in 2020 (Figure 5).

Australia's industrial energy consumption has maintained a similar level for most of the last two decades (Figure 4). The commodity boom of the 2000s and 2010s led to increased minerals mining activity (the energy consumption is captured in the industry sector), but this was not enough to offset the impacts of a strong Australian dollar and the offshoring of many other industrial enterprises. The accelerating rollout of renewables and batteries will require large quantities of minerals such as lithium and rare earth elements, that Australia is well placed to supply. The Australian Government has developed a Critical Minerals Strategy (2023) which not only prioritises greater mining activity, but also seeks to expand downstream processing that could contribute to an industrial revival in the coming decades.

Figure 4: Australia final consumption by sector (PJ), 2000 to 2020

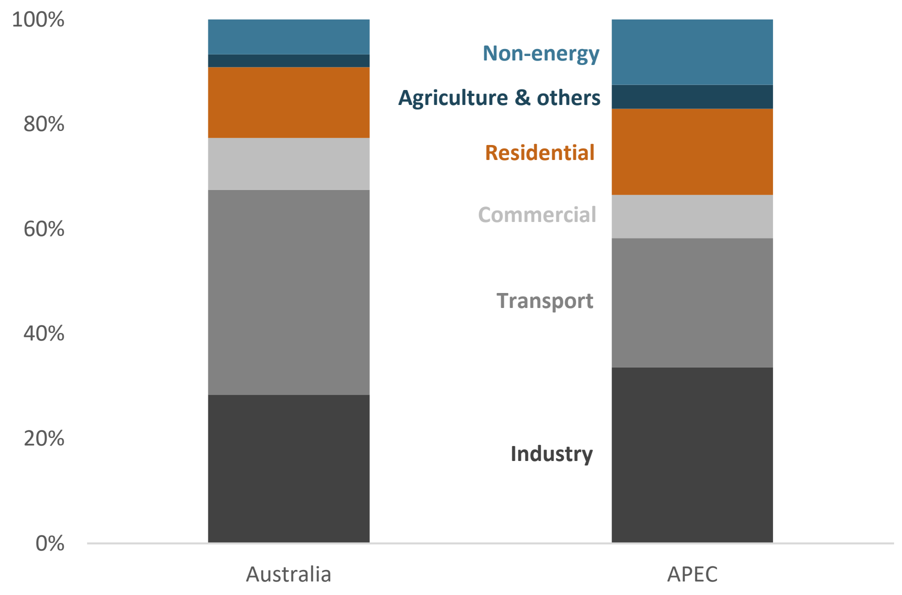


Source: EGEDA (2022)

While there are strong prospects for minerals mining, difficulty in securing reliable long-term gas supply at a competitive price will provide an incentive for the electrification of industrial processes. The rise of renewable powered industry, such as green steel, will be an opportunity for Australia to pursue due to its vast renewable potential.

But these prospects require significant infrastructure and technological development that are unlikely to be viable until at least the 2030s.

Figure 5: Final consumption by sector, Australia and APEC, 2020



Source: EGEDA (2022)

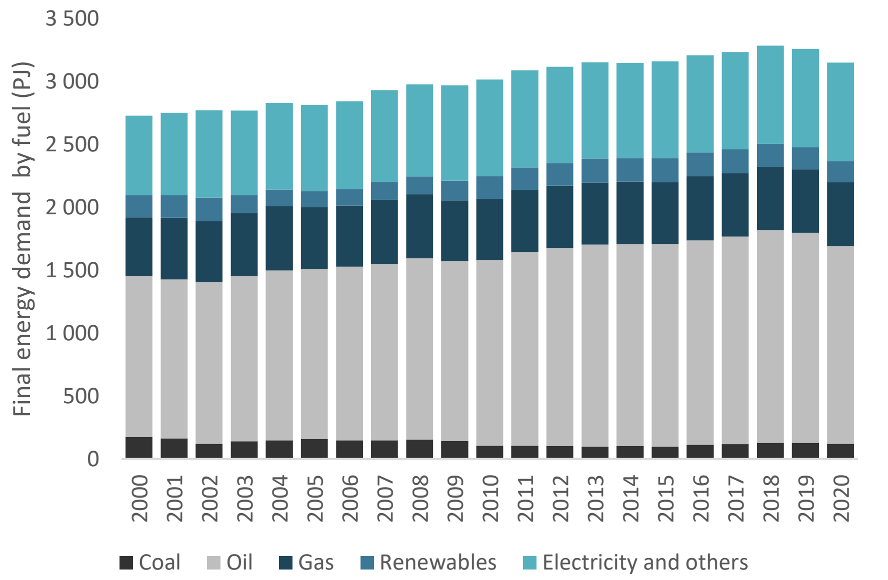
Final energy demand

Final energy demand excludes the consumption of energy products by the non-energy sector and is a subset of final consumption.

Transport energy consumption is still mostly tied to oil (refined products) in all APEC economies, Australia included. Refined products are also used in all other end-use sectors, such as diesel in minerals mining (industry), LPG in residential buildings, and diesel generators in commercial buildings. These use cases combine to mean that oil accounted for half of Australia's final energy demand in 2020, which represented an increase since 2000 (47%), but a decrease from 2019 (52%), due to COVID-19.

Wide scale electrification of end-use applications has yet to occur and so electricity has yet to rise in prominence, maintaining a share of roughly a quarter for most of the previous two decades. With the rise of electric vehicles, and a move to electrifying other sectors, electricity is anticipated to undergo significant growth in the next few decades. See the 8th edition of the *APEC Energy Demand and Supply Outlook* for an analysis and discussion of these trends.

Figure 6: Australia final energy demand by fuel (PJ), 2000 to 2020



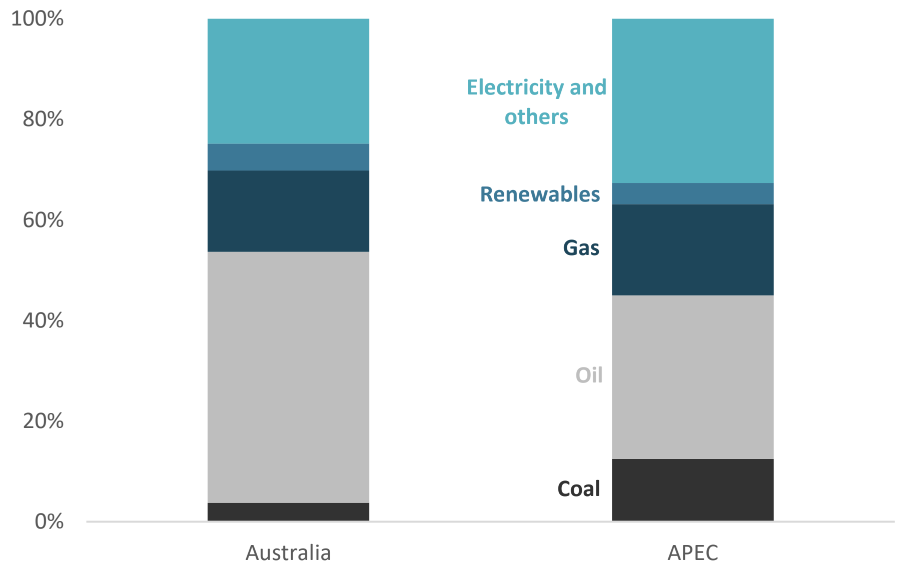
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products.

Australia's relatively small heavy industry sector means that coal consumption in applications such as steel-making, cement, and chemicals manufacturing is relatively low. The other end-use sectors use almost no coal in Australia.

Almost three-quarters of Australia's natural gas production was exported in 2020. A large portion of this production occurs in the north-west and is unavailable to domestic east coast consumers, due to limited domestic pipeline networks and no LNG import terminals. There are currently multiple proposals to build LNG import facilities at locations on the east and south coasts, but it is uncertain whether these plans will come to fruition.

Figure 7: Final energy demand fuel share, Australia and APEC, 2020



Source: EGEDA (2022)

Heating and cooking applications within the buildings sectors have been among the most prominent sources of natural gas demand. Multiple manufacturing applications have also relied on the consistent heating properties of natural gas and its ability to generate high heat. But higher prices and difficulty in securing long-term contracts on the east coast had been constraining natural gas demand in the lead up to COVID-19.

In 2020, natural gas consumption increased by 1.2%, which was partly due to lower global demand that freed up supply for domestic consumption. This small increase is likely to be a fluctuation away from the longer-term decline in domestic natural gas consumption. Australia's domestic consumption of gas is likely to stay lower than for the APEC region (Figure 7).

The small size of Australia's heavy industry sector provides a partial explanation for the relatively low consumption of coal by Australian end-use consumers. Australia's relatively low consumption of electricity also correlates with the high relative share of the transport sector, which is dependent on refined products (oil). With the rise of EVs, end-use electricity consumption is likely to grow faster in Australia than for other economies that have a less prominent transport sector.

Transformation

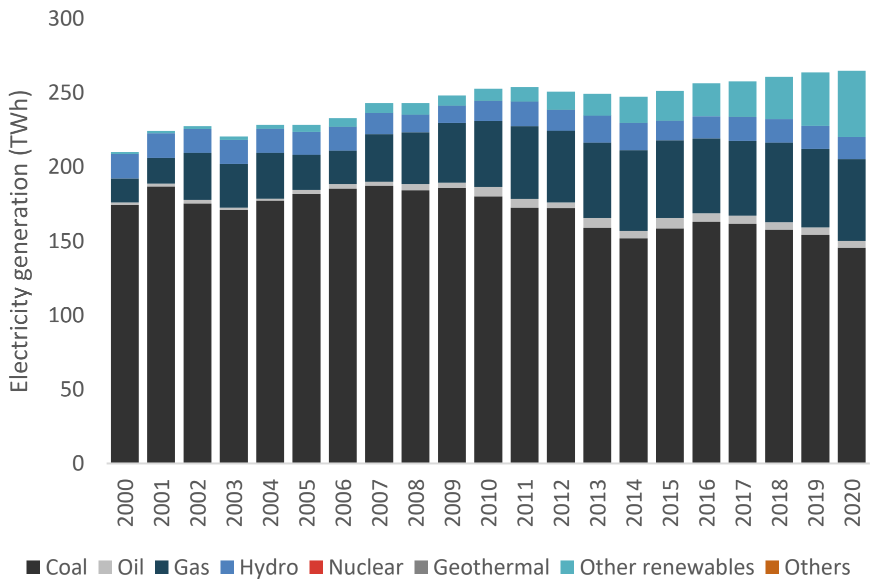
Power sector

Coal remains the dominant source of electricity generation for Australia. However, coal's share in the generation mix has fallen from well over 80% at its peak to 55% in 2020. The rapid rise in renewable generation, particularly solar PV, has negatively impacted the economics of coal-fired power, and with continued renewables deployment, coal is likely to be completely phased out by the 2030s, even without direct policy intervention.

In contrast, natural gas-fired generation has increased by almost a quarter since 2010 to account for 21% of generation in 2020. Part of this increased role is to provide power during evening peak demand to make up for the decline in rooftop solar PV generation.

The world-leading rise in solar rooftop PV is partially due to very favourable solar radiation conditions, and partially to do with policy support from state and federal governments. Almost one in three homes had a solar panel installed, as of June 2022. The complementary rise of utility scale solar and wind means that renewables increased their share of generation from 19.6% in 2019 to 22.5% in 2020 (Figure 8).

Figure 8: Australia electricity generation by fuel, 2000 to 2020

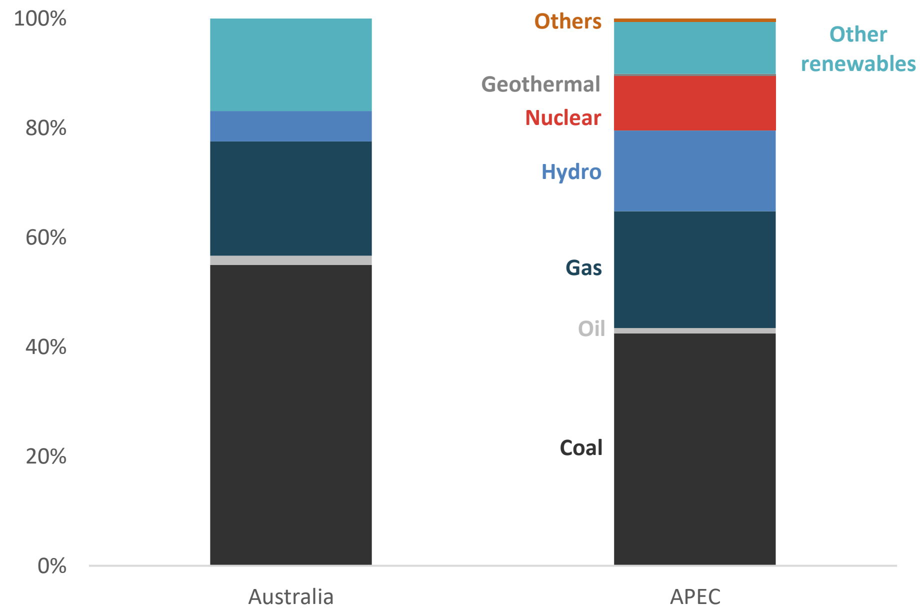


Source: EGEDA (2022)

The 'other renewables' generation category, which includes solar PV, increased by 24% in 2020. This amounted to over 8 700 GWh, which was large enough to almost offset the decline in coal-fired power generation. The relative share of the other renewables category for Australia is almost double the size for APEC.

Australia's hydro generation is under two-fifths of the relative share of hydro in the APEC generation mix. The Snowy Hydro 2.0 scheme will provide an additional two gigawatts of pumped hydro capacity, and is due for completion in 2027; thus, Australia's reliance on hydro is set to increase. However, hydro's share will never get to the levels that are seen in hydro-dominant APEC economies like Canada and New Zealand.

Figure 9: Electricity generation fuel share, Australia and APEC, 2019



Source: EGEDA (2022)

Refining

The Altona refinery in Victoria and Kwinana refinery in Western Australia wound down operations in 2021. These closures mean fuel security issues have shifted more to sources of refined products supplies instead of crude oil supplies. The federal government has announced support measures for the remaining two refineries in Geelong, Victoria and Lytton, Queensland to continue to meet some of Australia's demand for refined products until at least 2027.

Energy transition

Since a new federal government was elected in May 2022, commitments that support Australia's legislated net zero 2050 commitment have accelerated. A *National Net Zero Authority* has been established to ensure the opportunities are shared widely, including with workers and communities that are associated with emissions intensive sectors (Prime Minister of Australia, 2023).

At the end of 2022, Australian federal, and state and territory, energy ministers introduced the Commonwealth Capacity Investment Scheme (CIS). The scheme aims to develop a capacity market for clean dispatchable storage and generation to ensure reliability and security while delivering much lower emissions from Australia's electricity grid.

The first auction is expected to occur in 2023, with the intention that the scheme will become operational by the second half of 2023. Details are being finalised, but a key aspect is that the scheme will be limited to zero emissions dispatchable generation and storage technologies. This represents an evolution from the previous Energy Security Board capacity mechanism proposal, which considered fossil fuel technology.

New transmission infrastructure to deliver renewable energy and increased generation is being supported by low-cost finance (Rewiring the Nation, 2022). The locations of these new sources of power will be guided by renewable energy zone analysis by the Australian Energy Market Operator (AEMO), which includes Offshore Wind Zones analysis (AEMO, 2022).

Australia is supporting multiple hydrogen initiatives to capitalise on potential demand. Details of these hydrogen initiatives are available in the energy policy section later in the chapter.

The newly formed Department of Climate Change, Energy, the Environment and Water has also ensured that energy policy is more closely aligned with environmental considerations, to support energy transition objectives.

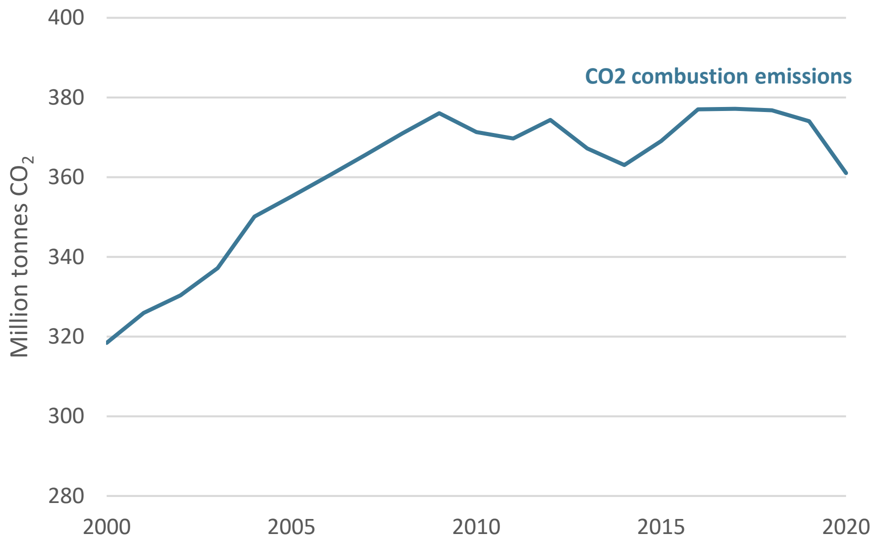
Emissions

The expert group on energy data and analysis (EGEDA) falls under the umbrella of APEC's Energy Working Group (EWG). In addition to energy data compiled by EGEDA, CO_2 emissions from combustion activities in the energy sector are recorded. These emissions are a subset of total greenhouse gas (GHG) emissions that are considered in the context of climate change, such as under the United Nations Framework Convention on Climate Change (UNFCCC).

For Australia, CO_2 combustion emissions have maintained a high plateau for most of the last decade, though they fell in 2020. This fall was partly due to a decline in economic activity that was brought on by the initial stages of the COVID-19 pandemic.

The EGEDA emissions data presented here only accounts for CO_2 from energy supply and consumption, calculated using default Intergovernmental Panel on Climate Change emission factors and energy contents. Due to these reasons, this data does not closely match Australia's emissions reported under UNFCCC guidelines.

Figure 10: Australia CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Even though Australia produces much more energy than it consumes, energy security has become an increasingly prominent issue in recent years. The Russia-Ukraine conflict almost immediately impacted Australian consumers of natural gas due to the tight market conditions that have been a feature of the east coast Australia natural gas market since LNG exports began in 2015. The difficulty in securing natural gas supply, and the much higher prices for that supply, mean that Australian consumers are in a similar predicament to many European consumers.

The much higher global price for coal and gas has also impacted Australia's electricity markets and is a prominent reason for the increased levels of inflation that Australia has experienced through 2022 and into 2023.

The unprecedented spikes in energy prices have sparked significant debate in Australia about energy policy settings. Two-thirds of the respondents of a survey of top economists (Economic Society of Australia, 2022) advocated intervention in response to these challenging market conditions. The proposed interventions include a cap on domestic prices, a tax on wartime profits that can then be used to finance subsidies, or domestic reservation.

In December 2022, the Australian Government implemented a wholesale price cap of AUD 12 per gigajoule for natural gas and AUD 125 per tonne of black coal for one year. The price cap will provide greater supply certainty, though at these levels, prices are still much higher than they have been historically.

Australia has been non-compliant with the International Energy Agency (IEA) 90 days of oil stock requirement since 2012. The federal government signed an agreement with the US in 2020 to lease a portion of the US Strategic Petroleum Reserve (SPR) as part of a commitment to return Australia to compliance by 2026. Economy owned oil held in the SPR was released to the market in response to the IEA's March collective action. A collective action is a coordinated release of oil that aims to stabilise the market and put downward pressure on prices.

The closure of two of the remaining four oil refineries in Australia in 2021 means that Australia is now more reliant on sources of refined products supply, and less reliant on sources of crude oil supply.

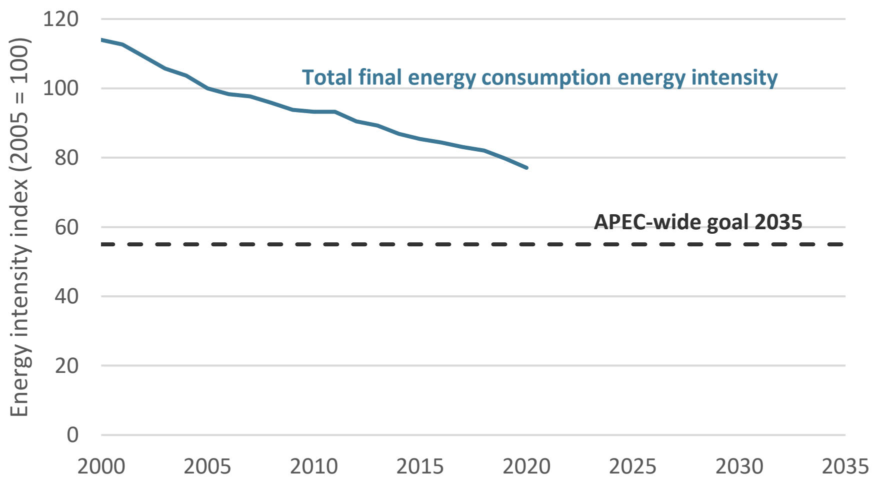
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective—to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target for reducing energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 11: Australia total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

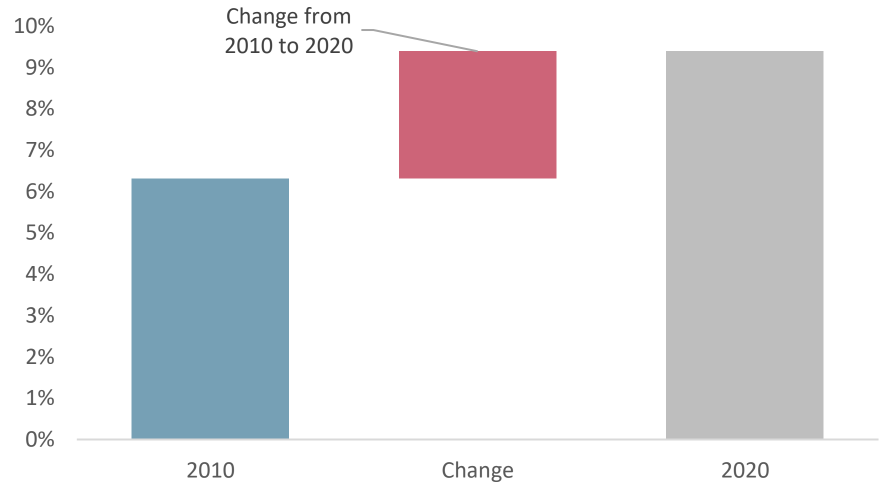
APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Australia's final energy demand energy intensity has been consistently improving at a rate of almost 2% per annum for the two decades to 2020 (Figure 11). This represents an almost 23% improvement since 2005. Energy supply intensity has improved by a similar magnitude.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There are no economy-level goals.

Figure 12: Australia modern renewable energy share, 2010 and 2020

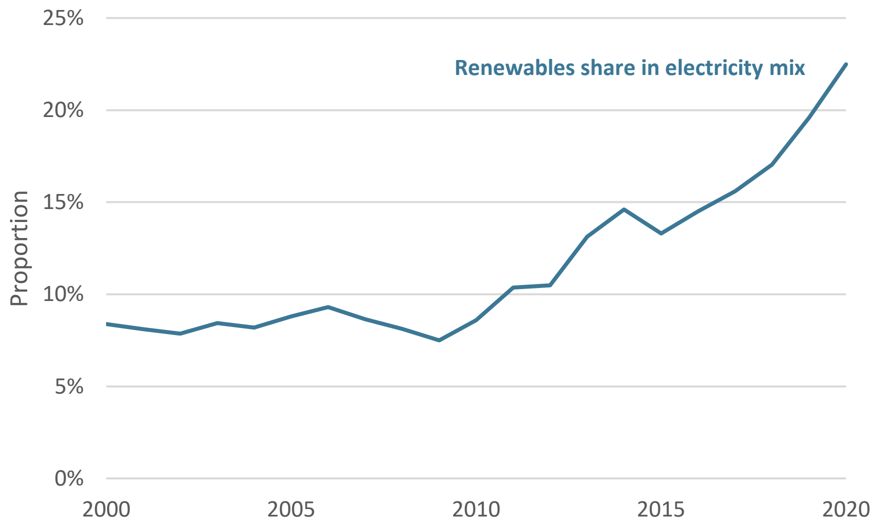


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

The share of modern renewables in Australia's final energy demand mix increased from 6.3% in 2010 to 9.4% in 2020, which was a 49% increase. In 2019, the share was much lower at 8.6%. Most of the large annual increase was due to the continued rapid rollout in renewables generation, which included household solar PV.

Figure 13: Australia renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Electricity generation from renewables increased to 22.5% in Australia in 2020, which was more than double the 2005 level of less than 9% (Figure 13). The large pull-back in 2015 coincided with the end of Australia's carbon price in 2014 and a collapse in renewables investment.

The short-lived carbon price, from 2012 to 2014, correlated with an increase in renewable generation but it is difficult to determine how large the impact was from the imposition of this short-lived price. The sustained rise of the late 2010s was largely due to the rise of rooftop solar, though utility scale solar and increased wind generation is accelerating and contributing more with each passing year.

In 2020, the annual increase in renewable generation was more than 15%, which was large considering that hydro generation fell by more than 5%. Solar and wind capacity continues to accelerate and is supporting increased climate ambitions such as Australia's updated NDC, released in 2022.

Energy policy

Energy policy	Details	Reference
Paris Agreement Nationally Determined Contribution	To reduce greenhouse gas emissions by 43% below 2005 levels by 2030. To achieve net zero emissions by 2050. These are enshrined in law in the *Climate Change Act 2022*.	Department of Climate Change, Energy, the Environment and Water
Energy price relief plan	The Commonwealth introduced a 12-month emergency gas price cap, at AUD 12 per gigajoule on new wholesale gas sales by east coast producers, though it is only for contracted gas and not for spot market gas. The New South Wales and Queensland governments have effectively set ceilings for the price of coal used for electricity generation to AUD 125 a tonne.	Prime Minister of Australia
Commonwealth Capacity Investment Scheme (CIS)	The scheme will provide a national framework to encourage new investment in clean dispatchable capacity to support reliability and reduce the risk of price shocks in Australia's rapidly changing energy market.	energy.gov.au
Powering Australia Plan	The Australian Government's Powering Australia plan is focused on creating jobs, cutting power bills and reducing emissions by boosting renewable energy.	Department of Climate Change, Energy, the Environment and Water
Critical Minerals Strategy 2023-2030	This updated strategy builds on the first Critical Minerals Strategy, published in 2019. It has a vision to put Australia at the centre of meeting the growing demand for critical minerals. It will underpin the economy's prosperity and security by improving access to reliable, secure and resilient supplies of critical minerals.	Department of Industry, Science and Resources
Safeguard mechanism	The safeguard complements the ACCU Scheme (previously ERF) by placing a legislated obligation on Australia's largest greenhouse gas emitters to keep net emissions below their emissions limit (or baseline). These baselines will decline on a trajectory consistent with achieving Australia's emission reduction targets of 43% below 2005 levels by 2030 and net zero by 2050. The targets were legislated into Australian law in 2022.	Clean Energy Regulator
ACCU Scheme (previously known as Emissions Reduction Fund)	This legislated scheme allows participants to earn Australian Carbon Credit Units (ACCUs) for every tonne of emissions reduced or sequestered through a project. These credits can be sold to the Australian Government or to other buyers in the market. The Independent Panel which released its completed review of ACCUs in December 2022 concluded the scheme arrangements are sound, while recommending some changes to strengthen the scheme. The Government is working with stakeholders to implement the recommendations from the Review.	Clean Energy Regulator

Australia’s National Hydrogen Strategy	Designed to establish Australia's hydrogen industry as a major global player by 2030.	Department of Climate Change, Energy, the Environment and Water
Rewiring the Nation	Rewiring the Nation is AUD 20 billion program to provide low-cost finance to upgrade, expand and modernise Australia’s electricity grid and drive down power prices.	Department of Climate Change, Energy, the Environment and Water
Growing Australia’s hydrogen industry (Multiple initiatives)	Various hydrogen projects, with the potential to help revitalise manufacturing, support regional economies, create jobs, investment, and trade opportunities, while helping Australia achieve its decarbonisation targets.	Department of Climate Change, Energy, the Environment and Water
The National Greenhouse and Energy Reporting scheme	A single national framework for mandatory reporting and dissemination of company information about greenhouse gas emissions, energy production, energy consumption and other information from the energy, waste and industrial processes sectors.	Clean Energy Regulator and DCCEEW
Bilateral energy and emissions reduction agreements	The federal government is developing bilateral energy and emissions reduction agreements with state and territory governments to improve energy reliability and affordability and support the transition of energy markets to lower-emissions technologies.	Department of Climate Change, Energy, the Environment and Water
Energy and Climate Change Ministerial Council (ECMC)	The ECMC is a forum for the Commonwealth, Australian states and territories, and New Zealand to work together on priority issues of national significance and key reforms in the energy and climate change sectors. ECMC is chaired by the Minister for Climate Change and Energy, the Hon Chris Bowen MP. This council replaced the former Energy National Cabinet Reform Committee in 2022.	Department of Climate Change, Energy, the Environment and Water
National Energy Customer Framework	Regulates the connection, supply, and sale of energy (electricity and gas) to grid-connected residential and small-business energy customers.	Department of Climate Change, Energy, the Environment and Water
Australia's fuel security package	Various measures to increase domestic storage and hold a sovereign refining capability that meets Australia's needs during an emergency.	Department of Climate Change, Energy, the Environment and Water
Energy emergency management forums	Participation in gas, liquid fuel, and electricity emergency management forums to ensure effective communication and collaboration between governments and industry in energy supply emergencies.	Department of Climate Change, Energy, the Environment and Water
Trusted Information Sharing Network	The Trusted Information Sharing Network for Critical Infrastructure Resilience Energy Sector Group is a forum for sharing information on security issues and practical measures to improve the resilience of energy infrastructure to all hazards.	Cyber and Infrastructure Security Centre

Energy supply policy	The Australian Government is ensuring supply security, reliability, and affordability via clean energy and electricity market reforms, delivering priority transmission projects and pumped hydro, and supporting the Tasmanian energy taskforce.	Department of Climate Change, Energy, the Environment and Water
Subsidies for residential (and commercial) storage and/or PV	State-based government programs providing incentives for solar PV installations.	Solar rebates in Australia
Large-scale Renewable Energy Target	The Large-scale Renewable Energy Target (LRET) incentivises the development of renewable energy power stations in Australia through a Renewable Energy Certificate Market for the creation and sale of certificates called large-scale generation certificates (LGCs).	Clean Energy Regulator
Small-scale Renewable Energy Scheme	Incentivises small-scale renewable energy systems through legislated demand for small-scale technology certificates (STCs). The STCs act as a discount offered to small energy consumers to install RE systems such as solar water heaters and solar PV.	Clean Energy Regulator
Snowy 2.0	Sponsoring and commissioning of a 2GW pumped hydro facility in 2027 by the federal government.	Snowy Hydro
Climate Active	Certification is awarded to Australian businesses that meet the requirements to achieve net zero carbon emissions.	Climate Active
Liddell Taskforce	Will advise government whether sufficient dispatchable capacity has been built to make up for the closure of the Liddell power plant in 2023.	Department of Climate Change, Energy, the Environment and Water
Retailer Reliability Obligation (RRO)	If gaps are forecast between energy demand and supply, the Australian Energy Market Operator will compel energy retailers to contract additional generation.	Department of Climate Change, Energy, the Environment and Water
Regional Australia Microgrid Pilots Program	An AUD 50 million six-year program that aims to improve the resilience and reliability of power supply for regional and remote communities. Administered by ARENA.	ARENA
GEMS program	The Greenhouse and Energy Minimum Standards Act 2012 (GEMS Act) provides for Greenhouse and Energy Minimum Standards for specific types of products before they can be supplied in Australia.	GEMS Determinations
Commercial Buildings Disclosure program	The Commercial Building Disclosure (CBD) Program requires energy efficiency information to be provided in most cases when commercial office space of 1000 square metres or more is offered for sale or lease.	Commercial Building Disclosure
National Electric Vehicle Strategy	The strategy paves the way for greater EV affordability, access to charging stations, and a massive reduction in emissions. Initiatives also focus on expanded EV availability and options for buyers.	energy.gov.au
Electric Vehicle policies	Australian states and territories have multiple targets for EV sales, EV rebates, support for EV charging infrastructure, and other such policies that aim to support electrification of transport.	Department of Climate Change, Energy, the Environment and Water

Notable energy developments

Notable development	Details	Reference
Climate change and energy transformation	The Australian Government announced a budget of AUD 24.9 billion in October 2022, which includes the Powering Australia Plan.	Energy Minister press release
Powering Australia Plan	- AUD 20 billion investment in transmission - AUD 102 million for community solar banks - AUD 224 million for installation of 400 community batteries - AUD 1.9 billion for powering the region's fund	Department of Climate Change, Energy, the Environment and Water
National Energy Performance Strategy	Framework to deliver the energy efficiency savings required to meet the government's 2030 and 2050 emissions reduction targets.	Department of Climate Change, Energy, the Environment and Water
National Energy Transformation Partnership	On 12 August 2022, federal, state and territory Energy Ministers agreed to establish a new National Energy Transformation Partnership. The partnership is a framework for national alignment and cooperative action by governments to support the smooth transformation of Australia's energy sector.	energy.gov.au
Gas Code of Conduct	The Australian Government has implemented a mandatory Gas Code of Conduct, as part of the Energy Price Relief Plan announced in December 2022, to ensure that east coast gas users can contract for gas at reasonable prices and on reasonable terms.	energy.gov.au
Hydrogen Headstart	The Australian Government will invest AUD 2.0 billion in the new Hydrogen Headstart program, providing revenue support for large-scale renewable hydrogen projects through competitive hydrogen production contracts. The Program will put Australia on course for up to a gigawatt of electrolyser capacity by 2030.	Department of Climate Change, Energy, the Environment and Water

Useful links

Australian Bureau of Statistics – https://www.abs.gov.au/

Australian Competition and Consumer Commission – https://www.accc.gov.au/

Australian Energy Market Commission – https://www.aemc.gov.au/

Australian Energy Market Operator – https://aemo.com.au/

Australian Energy Regulator – https://www.aer.gov.au/

Australian Renewable Energy Agency – https://arena.gov.au/

Clean Energy Finance Corporation – https://www.cefc.com.au/

Clean Energy Regulator – http://www.cleanenergyregulator.gov.au/

Department of Climate Change, Energy, the Environment and Water – https://www.dcceew.gov.au/

Department of Industry, Science and Resources – https://www.industry.gov.au/

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Brunei Darussalam

Introduction

Brunei Darussalam (BD) is a net energy exporter thanks to its abundance of two key energy commodities – oil and gas. The economy maintains its status as an energy exporter while its domestic demand rises to meet the requirements of industrial development to boost economic growth. Exports of such accounted for almost 60% of the government's total revenue in 2020 (MOFE, 2022). In 2020, most of the crude oil volumes were exported to several APEC member economies plus India and other non-APEC member economies, while LNG volumes were mainly shipped to Japan, Korea, Malaysia and others (MOFE, 2022).

Economic diversification is a main objective for achieving resilience in the economy's growth as part of Brunei Darussalam's Economic Blueprint. Focus is on the growth of non-oil and gas sectors namely downstream oil and gas, food, tourism, info-communications and technology, and services (MOFE, 2021).

In an effort to drive BD into a sustainable and low-carbon future, the Brunei National Climate Change Policy (BNCCP) was launched in 2020, outlining key strategies to reduce emissions across the energy sector in principle, in addition to strengthening the role of the forestry sector in carbon sequestration, as well as enhancing climate adaptation. The BNCCP serves as the basis of BD's updated Nationally Determined Contribution, in which the economy is committed to reducing its greenhouse gas (GHG) emissions by 20% in 2030, relative to its business-as-usual levels. To further enhance BD's climate ambitions, the economy is moving towards achieving net-zero emissions by 2050, as per its announcement at COP26.

Table 1: Brunei Darussalam's macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (km^2)	5 765	Oil (billion barrels)	1.1
Population (million)	0.44	Gas (trillion cubic feet)	7.9
GDP (2017 USD billion PPP)	27	Coal (million tonnes)	0
GDP per capita (2017 USD PPP)	62 201	Uranium (kilotonnes U < USD 130/kgU)	0

Source: a <reference> (2022); b World Bank (2022); c BP (2022); d UN (2022)

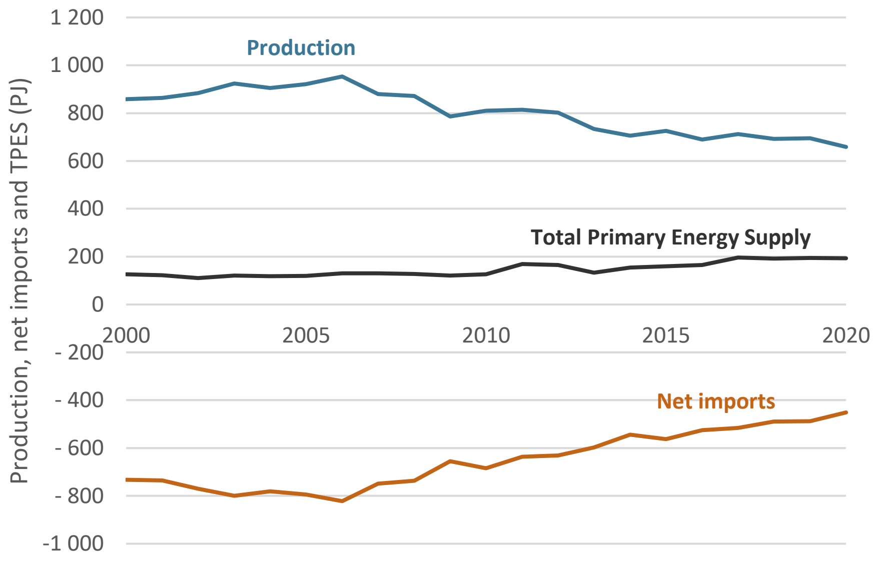
Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Energy supply and consumption

Total primary energy supply

Over the past two decades, BD's total primary energy supply has been increasing at a rate of above 2% per annum, reaching almost 194 PJ in 2020 – a slight decline from 195 PJ in 2019 (Figure 1). This decline is attributed mainly to the gas supply, which decreased significantly by more than 21%, as exported LNG volume in 2020 was higher than it was in 2019, albeit with a lower level of domestic gas production. Coal, sourced from Indonesia, increased by more than three-fold as the first phase of Hengyi Industries' refinery and petrochemical complex commenced its full operation, while oil grew by 16% on the back of increased non-transport-sector activities in 2020.

Figure 1: Brunei Darussalam's energy supply, production, and net imports (PJ), 2000 to 2020

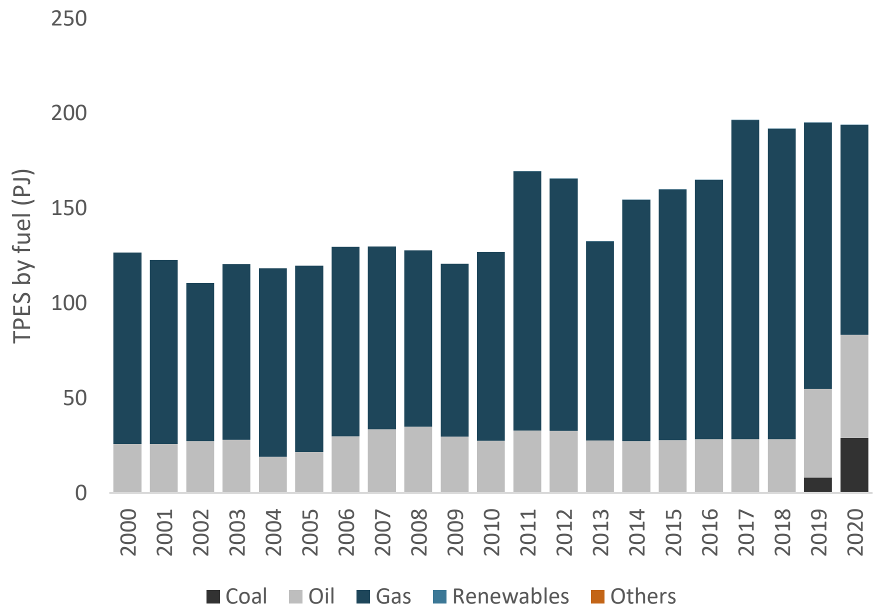


Source: EGEDA (2022)

BD's domestic upstream production increased between 2000 and 2006, where it peaked at 953 PJ. Since then, crude oil production has been on a downward trend while natural gas production has remained stable. The decline in upstream crude oil output was largely attributed to maturing oilfields and lack of new findings in shallow waters, although several maintenance and rejuvenation works on these fields have gradually increased the production in certain years. In 2020, crude oil production reached 244 PJ, down from 268 PJ in 2019 and from its peak output of 494 PJ in 2006.

Gas has been dominant for the past two decades, as shown in figure 2, feeding BD's power and non-energy sectors. However, its share in the energy supply mix declined to 57% in 2020 from 72% in the previous year, due to the prominence of coal in BD's energy supply mix. Coal provided 15% of BD's energy supply mix in 2020, equivalent to 29 PJ, which has been utilised solely to generate electricity and heat for the first phase of Hengyi Industries' refinery and petrochemical complex.

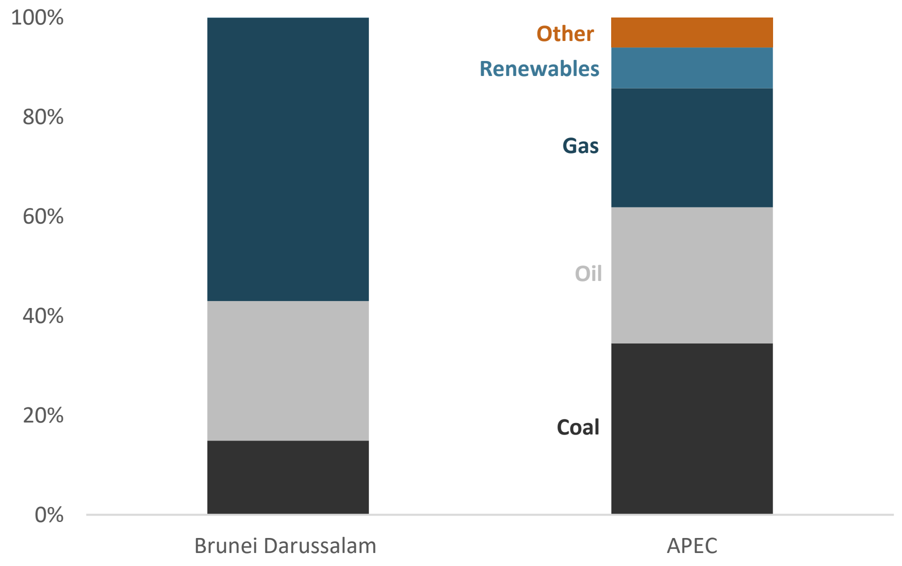
Figure 2: Brunei Darussalam's energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

When compared with the APEC region shown in figure 3, BD continued to be placed well above APEC in terms of gas share in 2020. BD and APEC's oil shares were nearly on a par with each other, while the coal share in BD was significantly below APEC's coal share. This figure illustrates that BD's fuel diversification is still in its infancy relative to the APEC region.

Figure 3: Energy supply mix – Brunei Darussalam and APEC, 2020



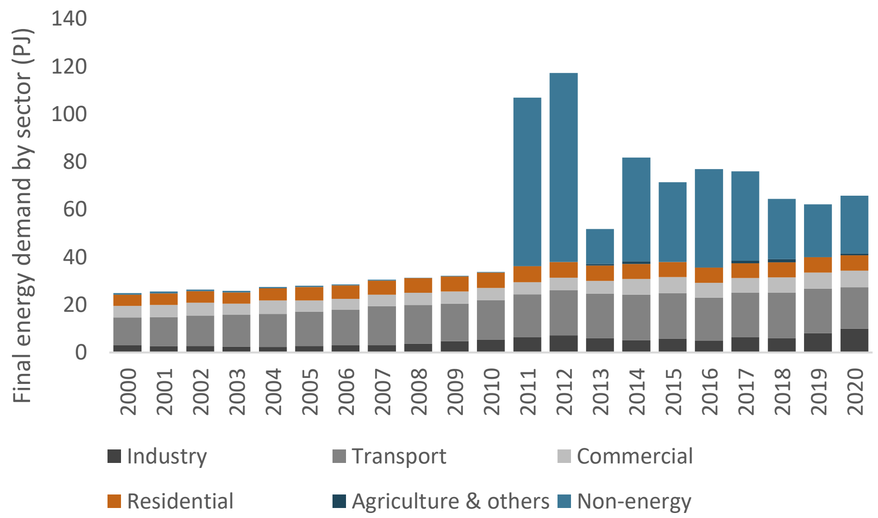
Source: EGEDA (2022)

Total final consumption

Over the last 20 years, final consumption in BD has been increasing at a rate of 5% per year as illustrated in figure 4, reaching close to 66 PJ in 2020. A significant contribution came from the non-energy and industry sectors, with annual increases of over 19% and 6%, respectively. The former's consumption, however, has been in decline since reaching its peak in 2012, due to a decrease in the production of domestic methanol, which is heavily impacted by technical issues affecting its plant reliability. Such production decline resulted in a reduction in the feedstock natural gas supply required to produce the chemical.

The non-energy and transport sectors remained the two largest end-use sectors, accounting for 37% and 26% of BD's total final consumption in 2020, respectively.

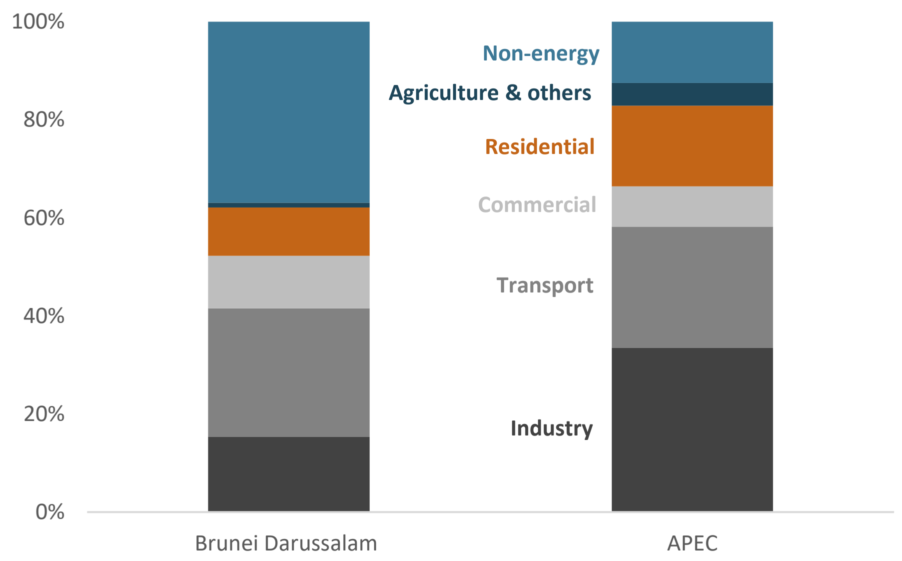
Figure 4: Brunei Darussalam final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

With respect to the APEC region, as shown in figure 5, BD's non-energy sector share was substantially higher than APEC's non-energy sector share, given the sizeable demand for natural gas as a feedstock rather than as a fuel within BD's sectoral consumption. On the other hand, given the low level of domestic energy demand in BD, its shares of industry, commercial, residential and agriculture sectors were well below those of APEC. BD's transport sector share, however, was slightly higher than APEC's share, owing to BD's high private vehicle ownership and limited public transport system.

Figure 5: Final consumption by sector, Brunei Darussalam and APEC, 2020



Source: EGEDA (2022)

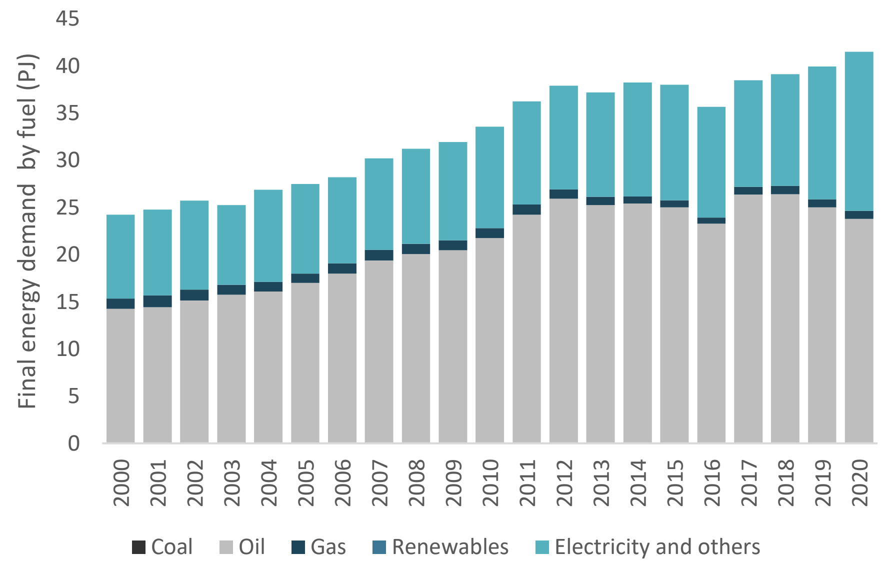
Final energy demand

Excluding the non-energy sector, BD's final energy demand reached almost 42 PJ in 2020, following an annual 3% growth over the past two decades, as shown in figure 6. Oil and electricity have consistently been the most dominant fuels, accounting for 57% and 41% of BD's final energy demand, respectively in 2020.

The transport sector is the primary recipient of oil (gasoline and diesel). Given the predominant use of gasoline-powered vehicles in BD, gasoline has been accounting for about 70% of the overall oil use in the transport sector, while the remaining 30% is from diesel. The industry sector is also a significant consumer of oil, in the form of diesel to support the operations of various industry subsectors.

The commercial sector accounted for most of the electricity consumed, followed by the industry and residential sectors.

Figure 6: Brunei Darussalam final energy demand by fuel (PJ), 2000 to 2020

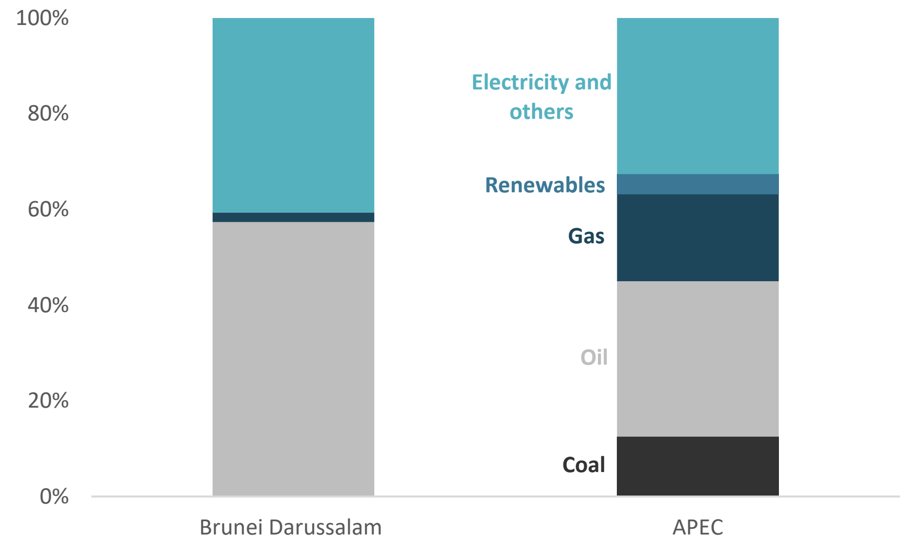


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

As illustrated in figure 7, BD's marginally higher share of electricity consumption with respect to APEC's share in 2020 was primarily attributed to the substantial electrification rate in BD, in addition to high electricity usage per capita. The economy's higher share of oil was due to the dominance of gasoline and diesel-powered vehicles, in addition to low fuel prices.

Figure 7: Final energy demand fuel share, Brunei Darussalam and APEC, 2020



Source: EGEDA (2022)

Transformation

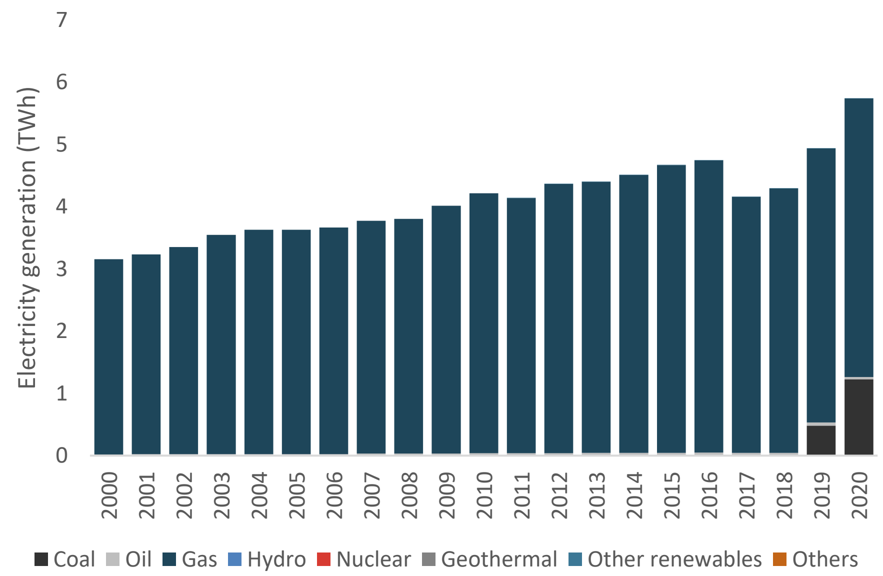
Power sector

Natural gas has been the principal source of electricity generation for BD since a gas turbine was first used in the Seria power station about five decades ago. Over the last 20 years, electricity generation from gas has been expanding at a rate of almost 2%, reaching almost 4 500 GWh in 2020, accounting for 78% of the total generation (Figure 8).

Generation from diesel, on the other hand, constituted only about 1% of the total, as electricity from diesel is only supplied to the small population in the Temburong district.

Electricity generation from coal more than doubled in 2020 from 2019 levels to reach over 1 TWh, driven by the full operation of the first phase of Hengyi Industries' refinery and petrochemical complex. Such generation accounted for 21% of BD's total electricity generation. The electricity generated from coal is exclusively for the refinery and petrochemical complex and is therefore not supplied to the public grid.

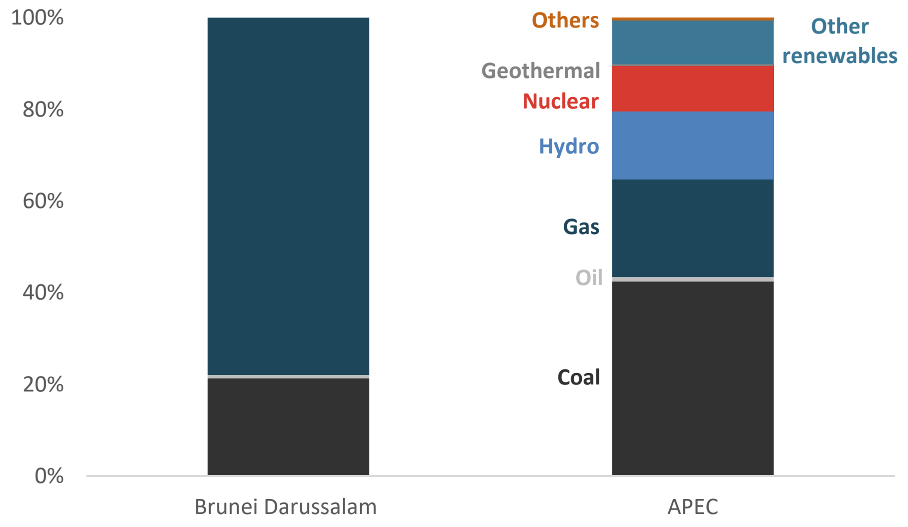
Figure 8: Brunei Darussalam's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

With respect to APEC's share in figure 9, fossil fuels clearly were dominant in BD's electricity generation in 2020, especially the gas-fired component. Conversely, the share of BD's electricity generation from coal was significantly lower than APEC's share, given that the coal utilisation in BD is only within the industry sector.

Figure 9: Electricity generation fuel share, Brunei Darussalam and APEC, 2020



Source: EGEDA (2022)

Refining

Most of the crude oil is now refined at Hengyi refinery and petrochemical complex (phase one). Prior to the establishment of the complex, refining activities were concentrated at the Brunei Shell Refinery complex, with a refining capacity of 10 000 barrels per day.

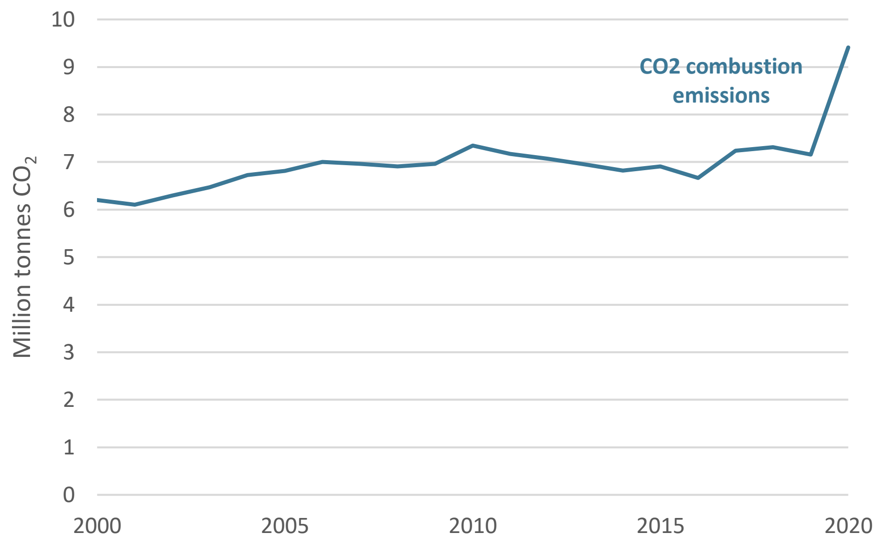
The Hengyi refinery and petrochemical complex (phase one) is capable of refining about 175 000 barrels of crude oil per day, which is almost 18 times higher than the capacity Brunei Shell refinery complex had. In 2020, over 1.1 million barrels of crude oil (380 PJ of energy equivalent) was refined, yielding 318 PJ of refined products comprising gasoline, diesel, jet fuels, kerosene and others.

Energy transition

Emissions

CO_2 emissions in BD have been increasing steadily over the past two decades. The sharp increase in 2020 relative to 2019 levels was due to the more than doubling of coal-fired electricity generation, which increased the emissions by over 30%.

Figure 10: Brunei Darussalam CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

The abundance of oil and gas resources in BD means that the economy fares very well in terms of its energy security. In 2020, BD energy self-sufficiency stood at 340%, well above the threshold of the self-sufficiency indicator.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

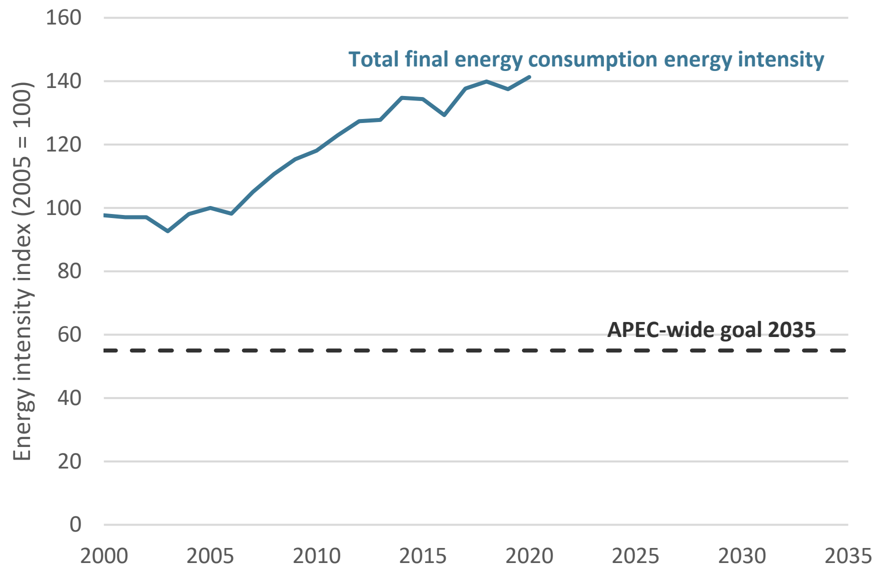
Energy Intensity Goal

In 2011, APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

As shown in figure 11, BD's energy intensity has seen an increasing trend since 2005, given that the rate of increase of total final energy consumption is greater than the increase rate of the economy's GDP.

Figure 11: Brunei Darussalam's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

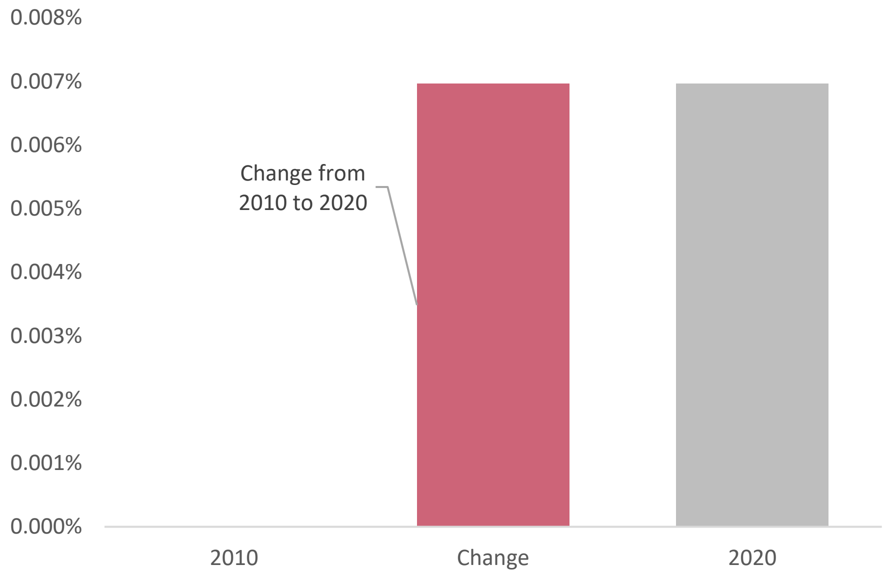


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: Brunei Darussalam's modern renewable energy share, 2010 and 2020

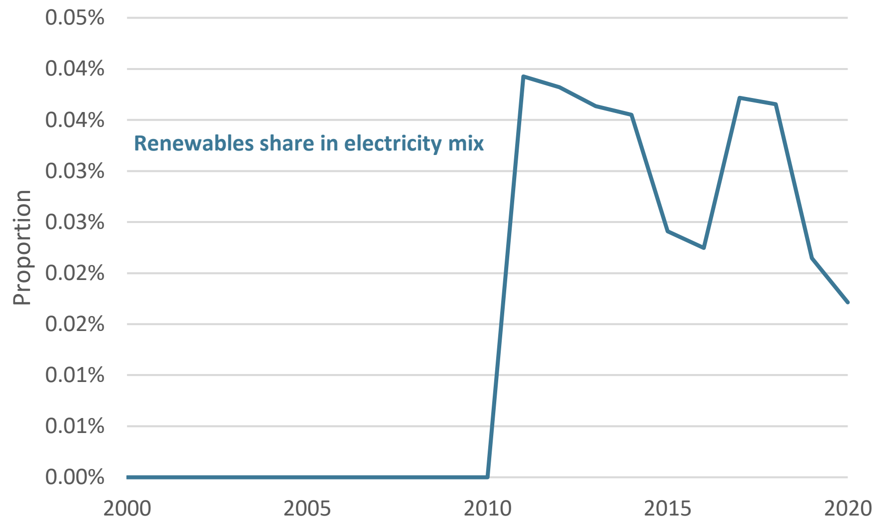


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Given the predominance of natural gas in BD's electricity generation mix, the share of modern renewables is still negligible (0.01% in 2020). To reduce the dependence on natural gas in the economy's power sector, BD is planning to expand its renewables share by aiming to install 200 MW of large-scale solar photovoltaic (PV) plants in 2025, and further increasing this to 300 MW in 2035.

Figure 13: Brunei Darussalam's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy Policy	Details	Reference
Nationally Determined Contributions	20% reduction of GHG emissions relative to Business-as-Usual levels by 2030.	UNFCCC (2020)
Brunei Darussalam National Climate Change Policy	The policy was established to pave the way for BD's low-carbon and climate-resilient pathways for a sustainable economy, through adoption of 10 key strategies: Industrial emissions; Forest cover; Electric vehicles; Renewable energy; Power management; Carbon pricing; Waste management; Climate resilience & adaptation; Carbon inventory; Awareness & education.	BCCS (2020)
Net-Zero Emissions	BD is moving towards net-zero emissions by 2050, announced at UNFCCC COP26 in Glasgow, Scotland, United Kingdom.	UNFCCC (2021)
Energy Efficiency (Standards and Labelling) Act, 2022	The Department of Energy at the Prime Minister's Office introduced the Order in 2021, in line with its energy efficiency and conservation initiatives. The Order would require manufacturers, suppliers, wholesalers and retailers in BD to import and sell appliances that meet the minimum energy performance standards.	Department of Energy, Prime Minister's Office (2022)

Notable energy developments

Energy development	Details	Reference
Renewable Energy	BSP has recently fulfilled the International Renewable Energy Certificate Standard (I-REC) to track attributes of solar energy production from its 3.3 MW solar PV plant.	Borneo Bulletin (2022)
Gas	BD is set to supply LNG to Japan Petroleum Exploration Co. (JAPEX) beginning in April 2023	Reuters (2023)
Electric Vehicles (EV)	Brunei Shell Marketing (BSM) launched the first retail EV charging station at IBA Petrol Station in Lambak in the Brunei-Muara district.	The Bruneian (2022)

Useful links

Brunei Shell Petroleum – https://www.bsp.com.bn/

Brunei LNG – https://www.bruneilng.com/

Department of Economic Planning and Statistics, Ministry of Finance and Economy – https://deps.mofe.gov.bn

Department of Energy, Prime Minister’s Office – https://www.energy.gov.bn/

Canada

Introduction

Canada continued to make progress on the climate front in 2022, releasing its 2030 Emissions Reduction Plan and both its methane reduction and critical mineral strategies, all of which lay out the measures needed for Canada to reduce its emissions and progress towards its enhanced nationally determined contribution (NDC) of reducing emissions by 40 to 45% below 2005 levels in 2030 en route to net-zero emissions in 2050 (ECCC, 2022a; ECCC, 2022b; NRCan, 2022a; UNFCCC, 2022).

However, these ambitions are likely overshadowed by the recent turmoil in energy markets, which has seen the global focus shifting away from long-term commitments and towards the short-term and immediate necessity of energy supply security. Canada is not immune to this. Global markets determine oil and oil products prices, and rising US LNG exports are increasingly connecting North America gas markets to global benchmarks. Thus, the energy crisis is increasing both the prices that Canadians pay for energy and the value that producers receive for their energy exports.

While high prices brought record revenue and cash flow to Canada's energy sector in 2022, reinvestment hit a record low of 30% as companies continued to privilege investor returns over investing in productive capacity (ARC, 2023). Still, oil production grew to record levels in 2022 and gas output is approaching its highest level in 20 years (CER, 2023a; CER, 2023b). The completion of several energy export pipelines and Canada's first large-sale LNG export terminal will give Canada the potential to play a larger role in providing oil and gas diversity for APEC and to satisfy a growing global demand for energy.

Nevertheless, with the last historical year of data in the charts and tables of this report being 2020, much of the discussion will centre around the impact of the COVID-19 pandemic on the Canadian energy system.

Table 1: Canada macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c,d]	
Area (million km^2)	10	Oil (billion barrels)	168
Population (million)	38	Gas (trillion cubic feet)	83
GDP (2017 USD billion PPP)	1 752	Coal (million tonnes)	6 582
GDP per capita (2017 USD PPP)	46 064	Uranium (kilotonnes U < USD 130/kgU)	490

Source: a DOS (2016); b World Bank (2022); c BP (2022); d NEA (2023)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Lower economic activity stemming from the pandemic reduced Canada's economic output by 5.2% to USD 1 752 billion (2017 USD purchasing power parity [PPP]) in 2020, and income by 6.3% to USD 46 064 (EGEDA, 2022).

Energy supply and consumption

Total primary energy supply

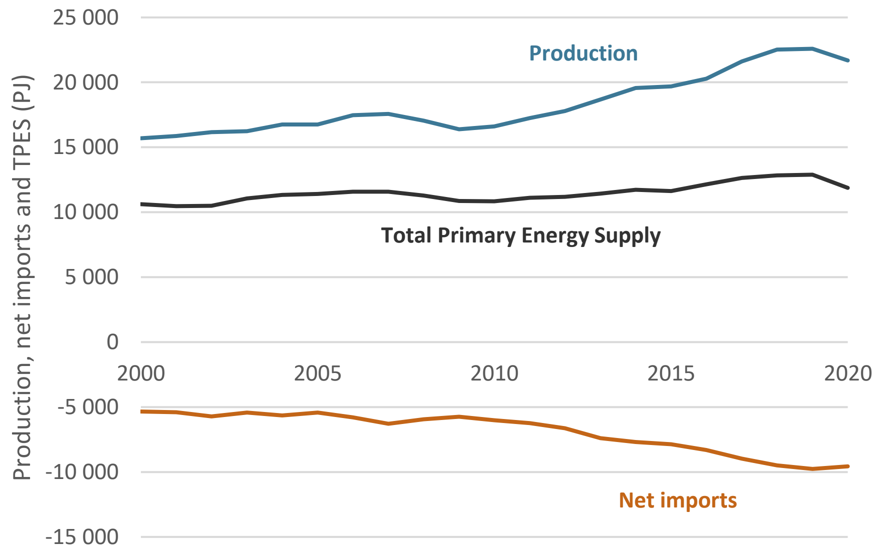
Canada is a self-sufficient and leading producer of energy, with much of its production driven by demand in global markets. Canada is a top-four producer of crude oil, gas, hydro and uranium, and a top-six exporter of crude oil, natural gas, uranium, and electricity. As such, the energy sector is an important contributor to Canada's economy, directly and indirectly accounting for a tenth of GDP (NRCan, 2022b).

With 90% of its energy exports landing in the US, Canada is trying to diversify its export market. The first phase of LNG Canada will become its first large-scale LNG export facility in 2026, and the Trans Mountain expansion will increase oil export capacity by 0.5 Mb/d in 2023 (LNG Canada, 2022; Trans Mountain, 2022). Both projects will provide a strategic source of energy supply for APEC members.

Although Canada's crude oil sources vary geographically, oil predominantly comes from Western Canada. Almost two-thirds of the total production comes from the oil sands, while onshore methods, through both conventional and unconventional techniques, make up a third, and offshore methods the remainder (CER, 2023a). Almost 99% of natural gas production occurs in Western Canada (CER, 2023b). While the output from conventional resources is declining, advances in hydraulic fracturing have enabled the development of tight gas resources in the Montney Formation and the Alberta Deep Basin. Production from these basins is expected to dominate future production growth and allow for significant LNG exports later this decade.

Energy production fell by 4.0% to 21 682 petajoules (PJ) in 2020, as collapsing oil prices led to curtailment in oil sands production during the onset of the pandemic (EGEDA, 2022). Coal-to-gas switching in the power sector and warmer weather also played a part in reducing coal and gas production. Fossil fuels continue to dominate production with a share of 85%. While the production impacts of COVID-19 were swift, Canada's oil production has proving resilient compared to other producers. By early 2021, production rebounded to pre-pandemic levels, and it is currently setting new highs, near 5.0 Mb/d (CER, 2023a).

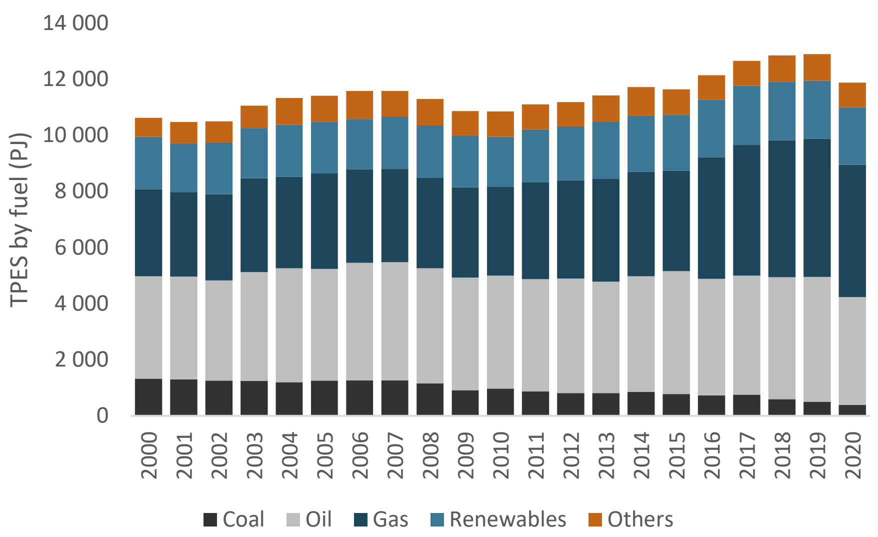
Figure 1: Canada energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

Net imports only fell 1.9%, as falling imports, mostly for crude oil and oil products, offset a declining export market. Lower imports stemmed from lower total primary energy supply (TPES) requirements, which fell 7.8% due to lower economic activity and personal movement during the onset of the coronavirus. Exports fell by around 5.6% (EGEDA, 2022).

Figure 2: Canada energy supply by fuel (PJ), 2000 to 2020

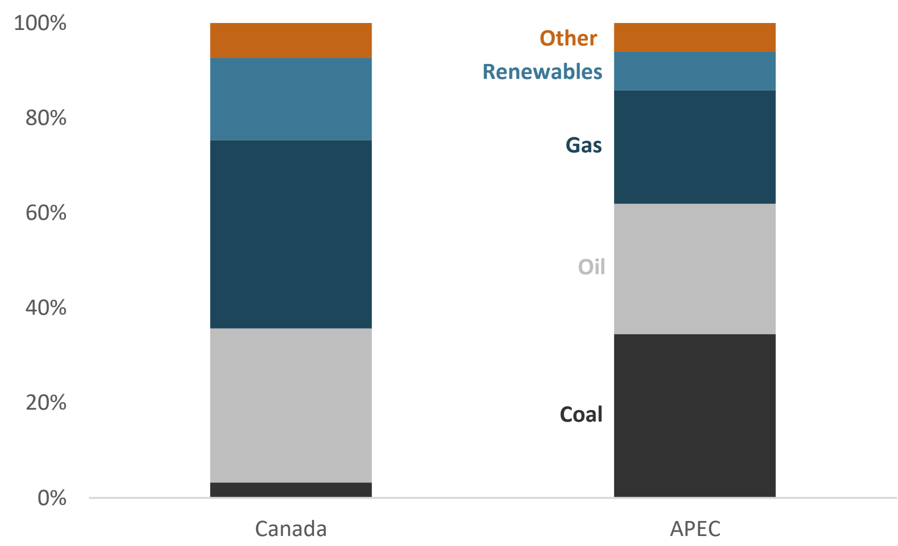


Source: EGEDA (2022)

Figures 2 and 3 illustrate how predominant fossil fuels continue to be in Canada's energy mix. However, Canada has significant renewable potential; while this is mostly in the form of hydroelectricity, it continues to realise more of its renewable potential with a higher deployment of solar and wind generating capacity across the economy.

Hydro is the most important source of renewable energy in Canada, supplying 59% of Canada's electricity in 2020 from an installed capacity of over 81 GW (CER, 2021a). Canada aims to leverage that hydro capacity and other emerging clean electricity sources to decarbonise its oil, natural gas, and LNG operations through electrification, driving down own-use emissions to align with its commitment to achieve net-zero emissions by 2050. Hydro is also a key fuel source for Canada's electricity exports, making up nearly three-quarters of the generation in the six provinces that export electricity to the US.

Figure 3: Energy supply mix, Canada and APEC, 2020

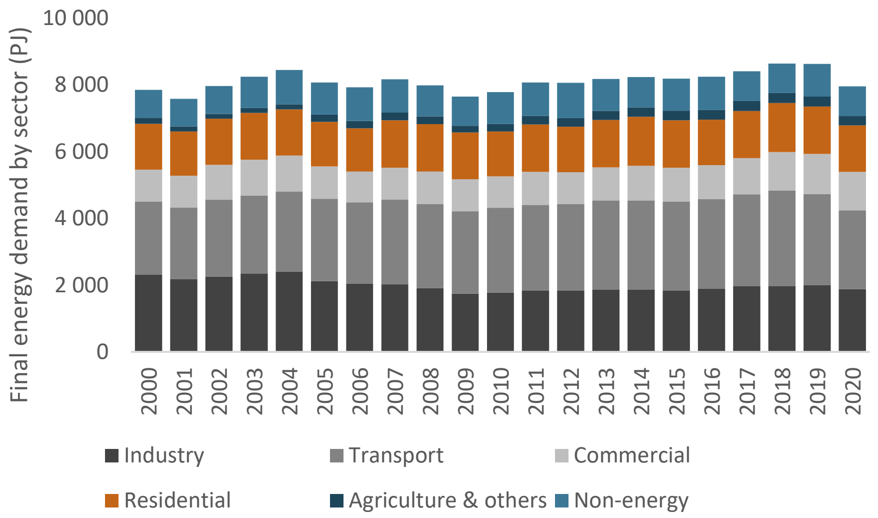


Source: EGEDA (2022)

Total final consumption

Global and domestic actions to reduce the spread of COVID-19 during its onset had a significant impact on Canada's economy and energy system. All sectors saw demand declines in 2020, with total final consumption falling 7.7% to 7 957 PJ, the lowest level since the Great Financial Crisis (EGEDA, 2022). The transport sector bore most (54%) of this decline, as government restrictions reduced the movement of people across Canada by over 13%. Lower industrial activity (from both the industry and non-energy sectors) made up a third of the demand decrease, while buildings and other sectors proved more resilient.

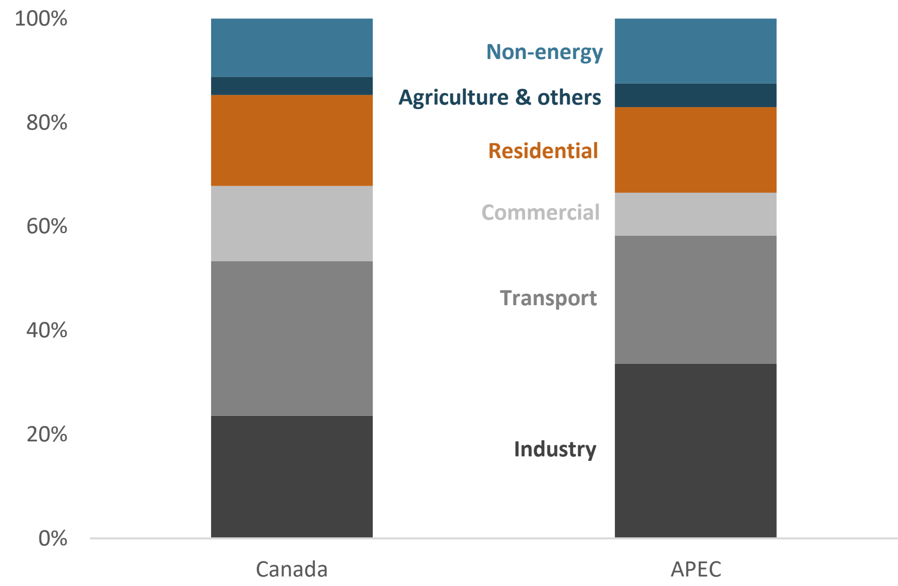
Figure 4: Canada final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

Despite the large drop, transport still accounted for the largest share of final energy consumption in 2020 (2 365 PJ, 30%), followed by the industrial sector (1 879 PJ, 24%) (EGEDA, 2022). Non-energy use made up 11% (892 PJ), and buildings along with agriculture and non-specified others made up the remainder (2 821 PJ, 35%).

Figure 5: Final consumption by sector, Canada and APEC, 2020

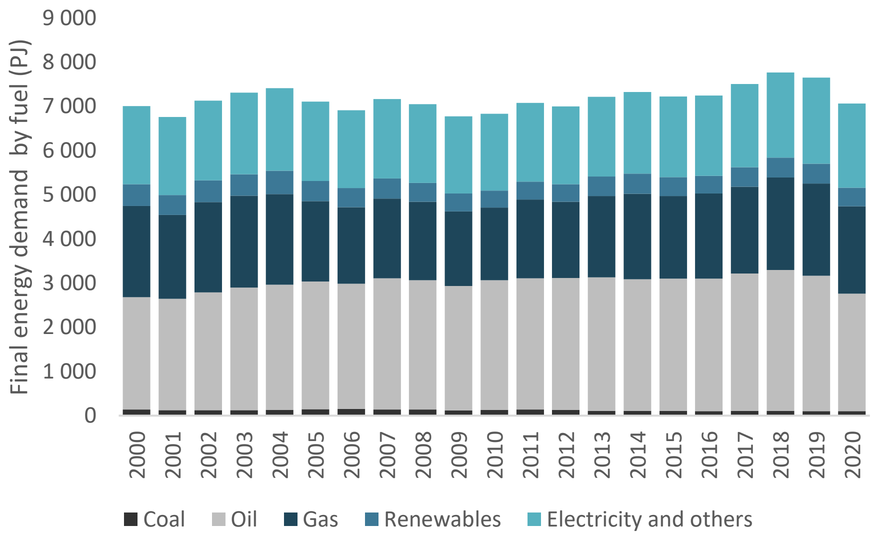


Source: EGEDA (2022)

Final energy demand

Canada's final energy demand paralleled total final consumption, falling 7.6% to 7 065 PJ in 2020. Lower oil demand contributed the most to this decrease, as government restrictions reduced miles travelled and in turn the use of oil products. Natural gas also fell significantly due to lower industrial output and reduced business activity. Electricity proved resilient, due in part to higher usage from residential consumers, who spent more time at home during the onset of the virus.

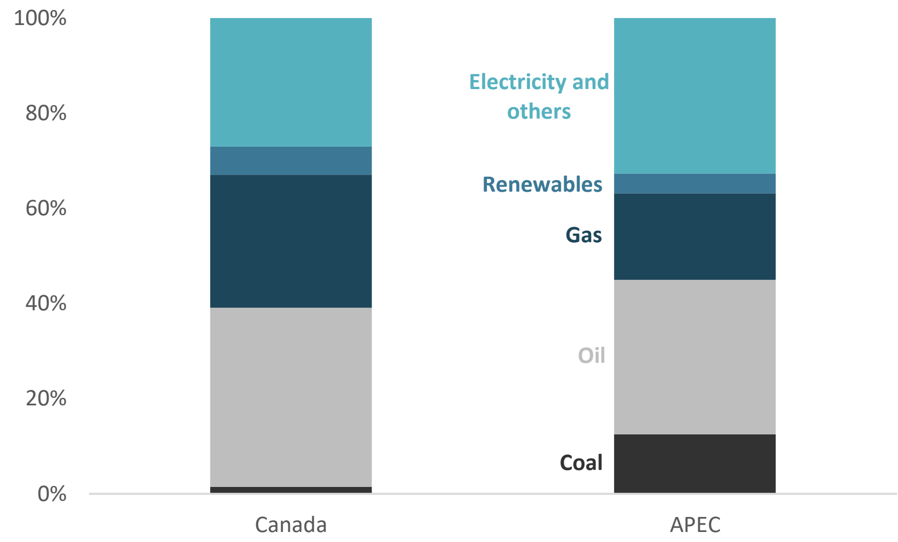
Figure 6: Canada final energy demand by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Figure 7: Final energy demand fuel share, Canada and APEC, 2020



Source: EGEDA (2022)

In 2020, fossil fuels accounted for two-thirds of final energy consumption[1], comprising oil (2 658 PJ, 38%), gas (1 977 PJ, 28%), and coal (105 PJ, 1.5%). The remainder was formed by the share of renewables (418 PJ, 5.9%) and electricity and others (1 907 PJ, 27%), of which the share of renewable electricity and others was 1 267 PJ. Although coal makes up less of Canada's fuel mix than the APEC region, Canada relies more on fossil fuels.

Transformation

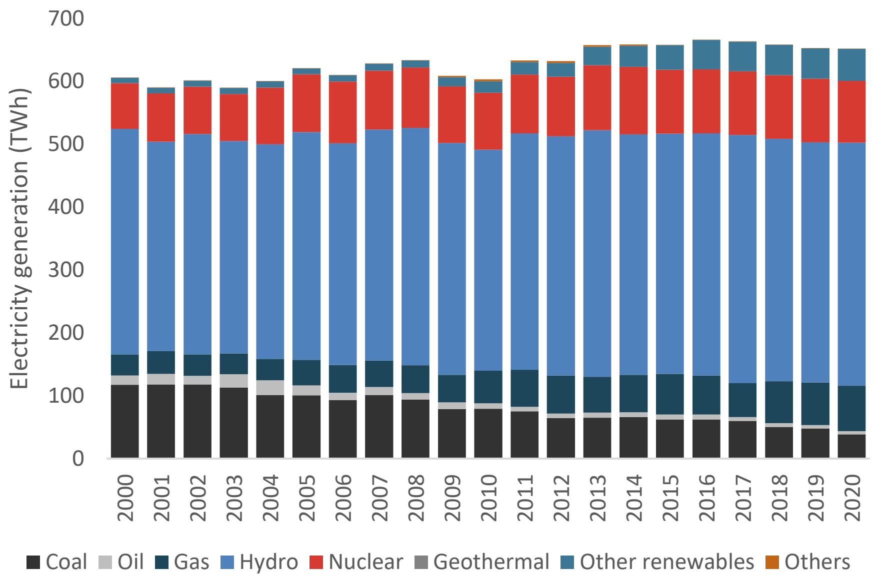
Power sector

Canada generated 652 terawatt-hours (TWh) of electricity in 2020, a slight decrease of 0.12% from the previous year. Renewables constituted the largest share of this generation (67%), with hydro as the major contributor (59%) and solar, wind, geothermal and tidal at 7.8% combined. The share of nuclear energy was 15%, which increases the combined share of non-emitting power generation to 82%. Fossil generation made up 18%, with natural gas-fired generation climbing to

[1] Note that the demands in the EGEDA energy balance differ than those in the Report on Energy Supply and Demand (RESD) energy balances due to differences in energy accounting frameworks (StatCan, 2022).

11% and coal falling to 5.9%. A combination of biomass (wood and spent pulping liquor) and other fossil fuels such as diesel, light fuel oil and heavy fuel oil accounted for the remaining 0.84% of generation.

Figure 8: Canada electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In 2016, the federal government announced its plan to phase out coal-fired electricity generation in Canada by 2030. Low natural gas prices and higher carbon prices began to accelerate this phase-out in 2018, prompting utilities to co-fire natural gas at existing coal units. Economics and investor pressure has since culminated in utilities announcing a complete coal phase-out in Alberta by 2023. The remaining coal-fired generators in Canada will be equipped with carbon capture and storage (CCS) or covered by an equivalency agreement to reduce power emissions.

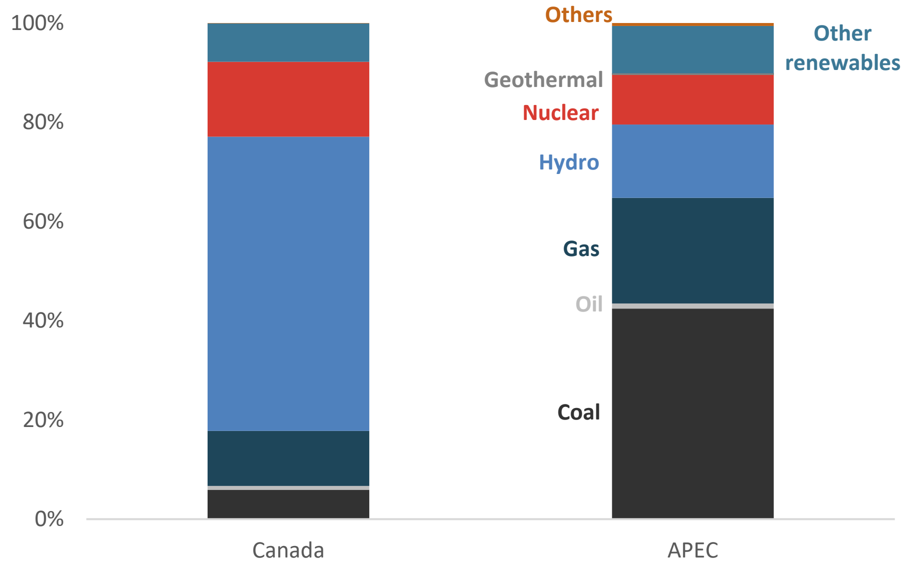
Ontario intends to continue with the refurbishment of 10 nuclear reactors, albeit on an altered, more cost-effective schedule. These refurbishments will add approximately 25–30 years to the operational life of each unit.

The emergence of clean energy credits (CECs) as a potential revenue stream could justify further investments in extending the life of Canada's nuclear reactors. The procurement of CECs from Ontario Power Generation (OPG) by Microsoft in 2022, and the subsequent extension and updated feasibility assessment of OPG's Pickering Nuclear Generation Station illustrate this (OPG, 2022; Ontario, 2022).

Canada's water resources enable significant parts of its economy to rely on clean electricity and provide clean electricity export options to several states in the US. The electricity networks of Canada and the US are highly integrated. In 2020, Canada exported 243 PJ of electricity to the US and imported 35 PJ (EGEDA, 2022). The bulk of Canada's electricity trade with the US occurs between Quebec, Ontario, Manitoba and British Columbia provinces and their neighbouring American states. While new international power lines could increase electricity trade between the two economies, opposition to the construction of new transmission lines, is challenging growth.

Canada's variable renewable capacity continues to grow. The installed capacity of major grid-connected solar hit 2.3 GW in 2021 and including off-grid and rooftop installations may put that close to 5 GW (CanREA, 2022; PV Magazine, 2022). Wind installations hit 14 GW, as Alberta, Saskatchewan, Ontario, and British Columbia continued to lead the way in installations (CanREA, 2022). Policy support stemming from the Clean Electricity Regulation, a 2035 target of 100% net-zero power and higher carbon prices will likely drive renewable deployment higher this decade.

Figure 9: Electricity generation fuel share, Canada and APEC, 2020



Source: EGEDA (2022)

Refining

While refinery capacity hit an all-time high in 2020, collapsing demand for oil products prompted the idling, closure, and eventual conversion of Newfoundland & Labrador's Come by Chance refinery into a producer of renewable diesel and sustainable aviation fuel (BP, 2022).

Energy transition

Canada released its 2030 Emissions Reduction Plan in 2030, which details the reductions that Canada expects its sectors to contribute en route to achieving its goal of reducing emissions to 40 to 45% below 2005 levels by 2030 (ECCC, 2022a). In the prospective path provided in the document's backgrounder, Canada expects the oil and gas sector to make the largest reduction (29%), with power (17%), transport (15%) and buildings (14%) making significant contributions.

Canada will implement a declining cap on oil and gas emissions to encourage the deployment of lower-emitting technology that enables producers to continue output and provide the world with low-carbon energy. This will be complemented by Canada's Methane Strategy, which will reduce upstream methane emissions by at least 30% below 2020 levels this decade (and 75% below 2012 levels).

Canada will continue to increase the non-emitting share of its power system, by enabling fuel-switching and the construction of newbuild renewable capacity en route to a net-zero power system in 2035. To promote more renewable adoption, Canada is striving to develop a Pan-Canadian Grid Council and supporting grid modernisation projects.

Canada is investing in zero emission vehicle (ZEV) charging and refuelling infrastructure and incentives to make it easier and more affordable to own and operate ZEVs. Canada will introduce sales mandates that ensure that ZEVs constitute 20% of light-duty vehicles (LDVs) sales by 2026, 60% by 2030 and 100% by 2035. For medium- and heavy-duty vehicles (MHDVs), the government is targeting 35% of sales by 2030 and, for those applications wherein it is feasible, a 100% target by 2040.

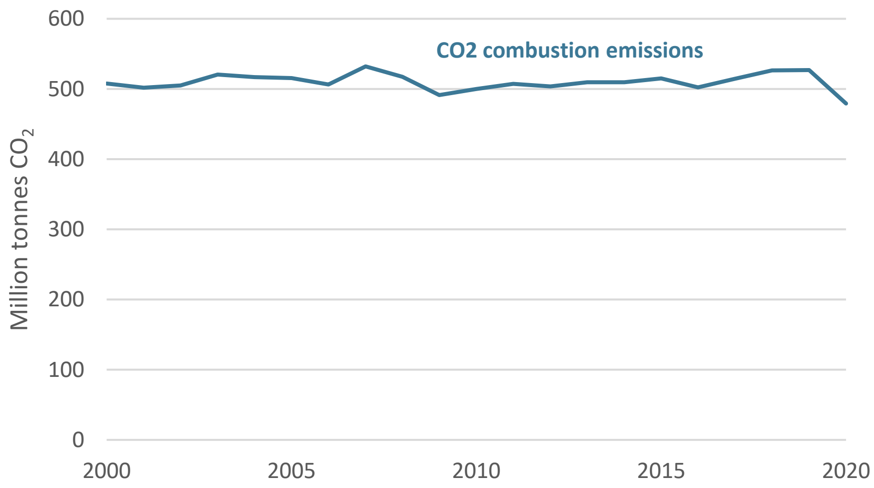
To support buildings reductions, Canada will enable a mass retrofit of the building stock and develop net-zero ready building standards to reduce the emissions of newbuilds. Several supporting initiatives, like the Canada Greener Homes Loan program, will provide funds to enable renovations, such as the installation of heat pumps and insulation, which will reduce energy usage and in turn heating costs for home dwellers.

Emissions

The expert group on energy data and analysis (EGEDA) falls under the umbrella of APEC's Energy Working Group (EWG). In addition to energy data compiled by EGEDA, CO_2 emissions from combustion activities in the energy sector are recorded. These emissions are a subset of total greenhouse gas (GHG) emissions that are considered in the context of climate change, such as under the United Nations Framework Convention on Climate Change (UNFCCC).

Canada's CO_2 combustion emissions have maintained a plateau near record highs over the past 20 years, but lower activity during the onset of COVID-19 led to a 9.0% drop in 2020. While the pandemic recovery will cause emissions to rebound in the short-term, Canada's climate policies should provide downward pressure on emissions this decade.

Figure 10: Canada CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Because Canada is a net-energy exporter, it generally considers itself as a driver of energy security solutions, not a victim of energy security disruptions. However, higher energy prices are challenging the affordability of energy for Canadians. Provinces across the economy are providing relief via tax cuts, subsidies, and retail price caps on the end-user prices for oil products, natural gas and electricity. Furthermore, Canadian power system operators are working to address the challenges that integrating high amounts of variable renewables could pose for the reliability and affordability of their electricity systems (AESO, 2022).

Power system operators are beginning to include reliability assessments in their plans to target a net-zero electricity system by 2035.

Several infrastructure developments to connect Canadian oil and natural gas to global markets are inching towards completion. The 14 million tonnes per annum (Mtpa) first phase of the LNG Canada project is 80% complete, the construction of its Coastal Gaslink feeder pipeline continues, and production is expected to begin in 2026 (LNG Canada, 2022). The Trans Mountain pipeline is aiming for completion in 2023. Upon completion, both projects will provide a strategic source of energy supply for APEC members for the coming decades.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy Intensity Goal

In 2011, APEC member economies agreed to increase their target for reducing energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

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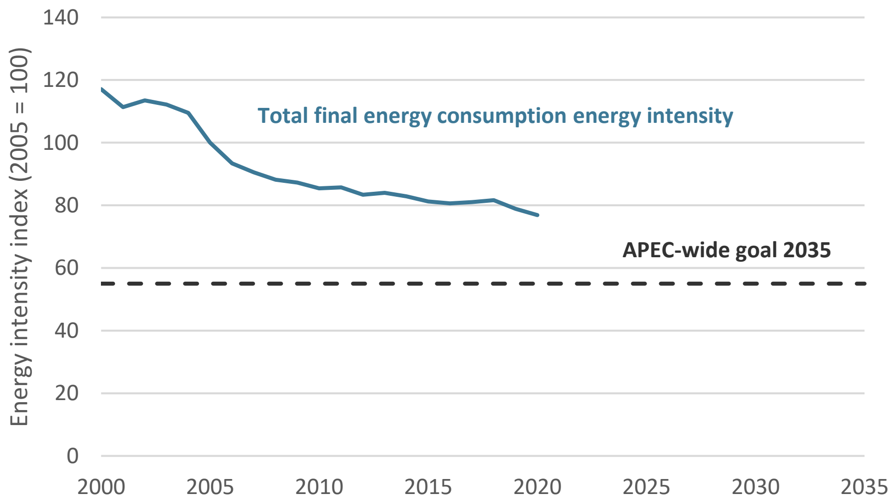

Source: EGEDA (2022)

Canada's energy efficiency policies, commitment to reducing GHG emissions, and other targeted regulations have historically reduced energy intensity. Figure 11 illustrates this, showing a 23% reduction in energy intensity since 2005.

After plateauing for several years, energy intensity fell for two consecutive years in 2019 and 2020. The implementation of economy-wide carbon prices and the adoption of energy-efficient technologies and climate policies (see below) could prompt accelerated efficiency improvements en route to achieving the aspiration target by 2035.

Doubling of Renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

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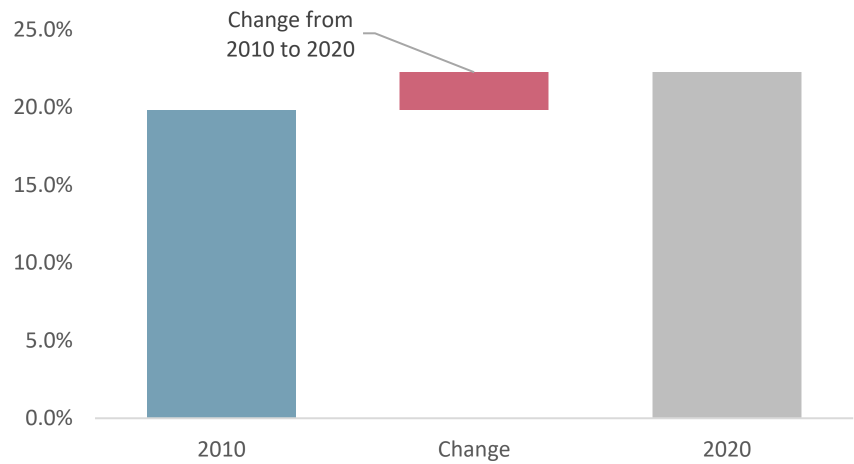
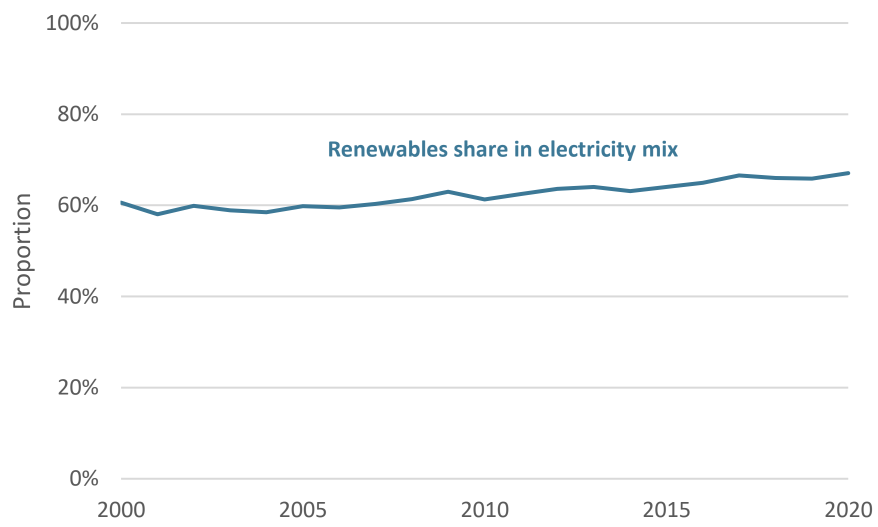


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Canada is hard-pressed to double its share to 40%, particularly with its high share of renewable electricity share of two-thirds (Figure 13). However, Canada can still contribute to APEC achieving its aspirational goals. Several of Canada's climate policy announcements, including the Clean Fuel Standard, Clean Electricity Regulation, a 100% net-zero power system target by 2035 and higher carbon prices, will continue to increase the share of renewables in the Canadian and APEC fuel mix. Canada's renewables share in the electricity mix hit a new high of 67% in 2020 on the back of rising hydro output and record generation from wind and solar assets.

Figure 13: Canada renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

This table is not an exhaustive list of energy and climate policies in Canada. However, it is a list of policies that are expected to have a substantial impact on Canada's energy system going forward. For the complete list of key federal energy and climate measures, please refer to the following:

- The Pan-Canadian Framework on Clean Growth and Climate Change (ECCC, 2016): This was Canada's first-ever economy-wide climate plan that was developed with its provinces and territories and in consultation with Indigenous peoples. It is an important first step for Canada to achieve its Paris Agreement target. It is structured to cut pollution in a more practical and affordable way than any climate plan in Canadian history.
- Canada's Strengthen Climate Plan: A Healthy Environment and a Healthy Economy (ECCC, 2020): Includes over 60 new and strengthened federal measures and an initial CAD 15 billion in investments, to make life more affordable for Canadians, make communities more liveable and, at every turn, focus on creating jobs, growing the middle class, and supporting workers in a stronger and cleaner economy.
- 2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy (ECCC, 2022a): A comprehensive roadmap that reflects levels of ambition to guide emissions reduction efforts in each sector. Progress under the plan will be reviewed in progress reports produced in 2023, 2025, and 2027. Additional targets and plans will be developed for 2035 through to 2050.
- Budget 2023 (Department of Finance, 2023): Announces a new federal toolkit for investing in the clean economy: a set of clear and predictable investment tax credits, low-cost strategic financing, and targeted investments and programming, where necessary, to respond to the unique needs of sectors or projects of economic significance.

Note: All monetary amounts in the tables below are provided in Canadian dollars.

Energy policy	Details	Reference
Canadian Net-Zero Emissions Accountability Act	Legislates emissions reductions accountability to address climate change, by setting legal requirements on the Government of Canada to plan, report, and course correct on the path to net-zero emissions by 2050.	Justice Canada
Canada's Enhanced NDC Under the Paris Agreement	In 2021, Canada updated its Nationally Determined Contribution under the Paris Agreement to 40 to 45% below 2005 levels by 2030.	UNFCCC

Pan-Canadian Approach to Pricing Carbon Pollution	Sets a 'federal benchmark' establishing minimum economy standards of stringency for carbon pricing systems in Canada, while also providing provinces and territories the flexibility to implement systems tailored to their jurisdiction. Price increases from CAD 50 per tonne in 2022 by CAD 15 per year, reaching CAD 170per tonne in 2030. In Budget 2023, the Government of Canada announced it will consult on the development of a broad-based approach to carbon contracts for difference that aims to make carbon pricing even more predictable.	Environment and Climate Change Canada
Output-based Pricing System (OBPS) for large emitters in industry and power sectors	Put a price on carbon pollution that creates an incentive for large emitters to reduce emissions per unit of output, while continuing to mitigate competitiveness impacts and carbon leakage risks on carbon-intensive, trade exposed industries.	Environment and Climate Change Canada
Federal Greenhouse Gas Offset System	Encourages businesses, municipalities, Indigenous communities, foresters and farmers to undertake innovative projects that reduce greenhouse gas (GHG) emissions compared to business-as-usual practices.	Environment and Climate Change Canada
Canada Greener Homes Initiative	Provides grants of up to CAD 5 000 and loans of up to CAD 40 000 to help homeowners undertake home retrofits, and up to CAD 600 toward the costs of pre- and post-retrofit EnerGuide evaluations. Also provides an additional CAD 5 000 for help households with median income or less who are currently heating their homes with oil make the transition to a better, more efficient option.	Natural Resources Canada
Low Carbon Economy Fund	Fund to empower communities to take climate action. Targets municipalities, businesses, not-for-profits, and Indigenous communities. Up to CAD 250 million will help homeowners transition from home heating oil to more affordable and greener home heating sources, like electric heat pumps.	Environment and Climate Change Canada
Green Municipal Fund	Invest CAD 1.6 billion to increase energy efficiency in residential, commercial, and multi-unit buildings.	Green Municipal Fund
CMHC Eco Plus	A partial insurance premium refund of up to 25% for eligible home investments that improve energy efficiency.	Canadian Mortgage Housing Corporation
Energy Efficiency Regulations	Establishes energy efficiency standards for a wide range of energy-using products, with the objective of eliminating the least energy-efficient products from the Canadian market.	Justice Canada
NRCC National Energy Code of Canada for Buildings 2017	2017 NRRC Building Codes sets out minimum technical requirements for the energy efficient design and construction of new buildings.	National Research Council Canada
Renewable Fuels Regulations	Refineries and importers to have an average of 5% renewable fuel content in gasoline and 2% in diesel fuel and heating distillate oil based on volume.	Justice Canada

Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)	Introduce operating and maintenance standards for the upstream oil and gas industry to support Canada's goals of reducing methane emissions by 40 - 45% below 2012 levels by 2025 and 75% by 2030; supports the Global Methane pledge to reduce methane emissions to 30% below 2020 levels by 2030.	Justice Canada
Oil and gas emissions cap	In addition to methane reduction, the Government of Canada is consulting on an oil and gas sector emissions cap to maximize opportunities to invest in decarbonizing the sector while accounting for evolving energy security considerations. The cap will focus on emissions and will not be a cap on oil and gas production.	Environment and Climate Change Canada
LDV, LDT emission Standards: 2017 - 2025	LDVs: 5% annual reduction in CO_2-e per mile for passenger cars from 2017 to 2025. LDTs: 3.5% per year 2017-2021, 5% 2022 to 2025.	Canada Gazette
Heavy-duty vehicle regulations: 2021 - 2027	GHG reductions in Model Year (MY) 2027 versus MY 2017 resulting from the standards include: tractor trucks: 15%-27%; vocational vehicles: 10% - 24%; HD trucks, vans: 16%; commercial trailers: 5% to 9%.	Canada Gazette
Clean Fuel Regulations	Requires liquid fossil fuel (gasoline and diesel) suppliers to gradually reduce the carbon intensity from the fuels they produce and sell for use in Canada over time, leading to a decrease of approximately 15% (below 2016 levels) by 2030.	Justice Canada
Clean Fuels Fund	CAD 1.5 billion to encourage investment in the production of clean fuels, including clean hydrogen and biofuels.	Natural Resources Canada
ZEV purchase and lease incentives	Capped purchase and lease subsidy on eligible ZEVs; up to CAD 5 000 for light-duty ZEVs and CAD 200 000 medium- and heavy-duty ZEVs.	Transport Canada
Zero-Emission Vehicle Infrastructure Program	CAD 680 million to increase the availability of localized charging and hydrogen refuelling opportunities where Canadians live, work, and play.	Natural Resources Canada
Smart Renewables and Electrification Pathways Program	CAD 1.6 billion to advance renewable electricity generation and smart grid projects. Budget 2023 announced a recapitalization of the program to support critical regional priorities and Indigenous-led projects and add transmission projects to the program's eligibility.	Natural Resources Canada
Clean Energy for Rural and Remote Communities Program	CAD 520 million to support renewable energy and capacity building projects and related energy efficiency measures in Indigenous, rural and remote communities.	Natural Resources Canada
Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations	Phases-out coal-fired electricity in Canada by 2030, with exceptions for coal power equipped with CCS units.	Justice Canada
Regulations Limiting Carbon Dioxide Emissions from Natural Gas-fired Generation of Electricity	Prohibits the operation of facilities exceeding the standards: 420 tCO_2e/GWh for natural gas boilers; declining standard for coal-to-gas conversions; 550 tCO_2e/GWh if facility under 150 MW.	Justice Canada

Regional Energy and Resource Tables	Through the Regional Tables, the Government of Canada is seeking to establish joint partnerships with each province and territory, as well as formal collaboration with Indigenous partners, to identify and accelerate opportunities to transform Canada's traditional resource industries and advance emerging ones.	Natural Resources Canada
Sustainable Jobs Plan	The Plan aims to support Canadians and their communities in realizing the net-zero economy of the future by equipping Canadians and their communities with skills and training they need to continue to thrive. It also supports the growth of new industries and sectors in which Canadians can find meaningful work.	Natural Resources Canada

Notable energy developments

	Details	Reference
Clean Electricity Regulations (CER)	The Government of Canada is currently developing the CER that will help drive progress towards a net-zero electricity grid by 2035.	Environment and Climate Change Canada
Clean Electricity Investment Tax Credit	In Budget 2023, the Government of Canada announced its intention to introduce a 15 per cent refundable tax credit for eligible investments in non-emitting electricity generation systems, abated natural gas electricity-fired electricity generation, stationary electricity storage systems, and equipment for the transmission of electricity between provinces and territories.	Department of Finance
Sales targets for zero emission vehicles (ZEVs)	The Government of Canada has committed to light-duty ZEV sales targets (20% by 2026, 60% by 2030, 100% by 2035) and medium- and heavy-duty ZEV sales targets (45% by 2030 and 100% by 2040)	Environment and Climate Change Canada
Hydrogen Strategy for Canada	Vision and roadmap for hydrogen development in Canada.	Natural Resources Canada
SMR Action Plan	Canada's plan for the development, demonstration and deployment of SMRs for multiple applications at home and abroad.	SMR Action Plan
The Canada Green Buildings Strategy	The Government of Canada is in the process of finalizing the Canada Green Buildings Strategy, which will set out measures to achieve net zero by 2050 in the buildings sector. Actions will focus on reducing GHG emissions, creating more climate-resilient buildings, increasing skilled jobs, and increasing investment.	Natural Resources Canada
Greening Government Strategy	Sets a target to reduce greenhouse gas emissions from federal operations by 40% by 2025 and by at least 90% below 2005 levels by 2050.	Treasury Board of Canada Secretariat

LNG Canada 70% complete	The first 14 Mtpa facility scheduled to be commissioned in 2026; a possible final investment decision (FID) on a second phase would increase this to 28 Mtpa.	LNG Canada
Court rules referendum against the NECEC transmission project unconstitutional; upholds lease	If built, the New England Clean Energy Connect (NECEC) transmission project will transport electricity from Quebec to New England through Maine via a 1 200 MW link.	NECEC
Thermal coal export ban	Announced an intention to ban thermal coal exports from Canada by 2030; includes re-exports.	Environment and Climate Change Canada
The Canadian Critical Minerals Strategy	Aims to increase the supply of responsibly sourced critical minerals and support the development of domestic and global value chains for the green and digital economy.	Natural Resources Canada
Canada's Methane Strategy	Provides a pathway to further reduce methane emissions from across the economy.	Environment and Climate Change Canada
Carbon Management Strategy	The Government of Canada is leading the development of a Carbon Management Strategy, which will enable the Canadian carbon management industry to realize its GHG reduction and commercial potential.	Natural Resources Canada

Useful links

Atomic Energy of Canada Ltd – www.aecl.ca

Canada Gazette – http://www.gazette.gc.ca/

Canada-Nova Scotia Offshore Petroleum Board – http://www.cnsopb.ns.ca/

Canadian Centre for Energy Information – https://energy-information.canada.ca/en

Canadian Energy Regulator – https://www.cer-rec.gc.ca/index-eng.html

Canadian Nuclear Laboratories – www.cnl.ca

Canadian Nuclear Safety Association – http://nuclearsafety.gc.ca

Canada Newfoundland and Labrador Offshore Petroleum Board – http://www.cnlopb.ca/

Environment and Climate Change Canada – www.ec.gc.ca

Natural Resources Canada – www.nrcan-rncan.gc.ca

Statistics Canada – www.statcan.ca

Transport Canada – www.tc.gc.ca

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Chile

Introduction

With one of the world's fastest vaccination rates, which helped it to normalise its economic activities, Chile's economy is recovering from the pandemic effects. After a gross domestic (GDP) growth of 12% in 2021, the Chilean economy was expected to grow 2.4% in 2022.

In August 2022 Chile launched the *Agenda de Energía* 2022-2026, the energy roadmap of the new government. This document presents eight core themes: equitable access to quality energy, a clean energy mix, secure and resilient energy development, a fair energy transition and sustainable infrastructure, energy decentralisation, citizen empowering and energy democratisation, innovation and inclusive economic growth, and modernisation of public management.

In May 2022, Chile approved the first update to the National Energy Policy 2050. This update increased the goal of renewable energy in electricity generation to 80% by 2030 and 100% by 2050, aimed to achieve 100% access to electricity by 2030, established goals for hydrogen and electromobility, and mentioned the potential role of Chile as a green hydrogen and derivates exporter by 2030.

In June 2022, the Framework Law on Climate Change, Law 21.455, was published. The objective of this Law is to achieve and maintain neutrality in greenhouse gas emissions by 2050 to help the adaptation to climate change, reduce vulnerability, increase resilience, and fulfil international commitments.

In November 2022, Law 21.499, which regulates the production and trade of solid biofuels, was published. This law declares fuelwood, pellets, briquettes, charcoal, and agricultural waste to be fuels and establishes requirements and standards for commercialisation. This law is intended to improve air quality and protect the health and safety of people who live in areas where these fuels are used.

In April 2023 the Ministry of Energy launched the Initial Agenda for a Second Time of the Energy Transition, with the aim of taking actions for an accelerated decarbonization of the electricity sector. The agenda considers the deployment of the first 10 measures in four areas of action: storage promotion; mitigation of risks to suppliers; operational flexibility; and political, regulatory actions and urgent works.

Table 1: Chile's macroeconomic data and energy reserves

Key data [a]		**Energy reserves** [b, c]	
Area (million km^2)	0.8	Oil (billion barrels)	000
Population (million)	20	Gas (trillion cubic feet)	000
GDP (2017 USD billion PPP)	496	Coal (million tonnes)	000
GDP per capita (2017 USD PPP)	25 400	Uranium (kilotonnes U < USD 130/kgU)	0 000

Source: a World Bank (2022); b BP (2022); c Nuclear Energy Agency and International Atomic Energy Agency (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Despite the lack of fossil fuel resources, Chile has an enormous potential for renewable energy (Chile has 2.3 TW of renewable energy reserve from the 30 GW installed by 2023) that is trying to develop in accordance with its energy policy. In that direction, the Chilean National Energy Commission awarded 777 GWh/year of renewable energy to supply electricity to the economy's electricity system, starting in 2027.

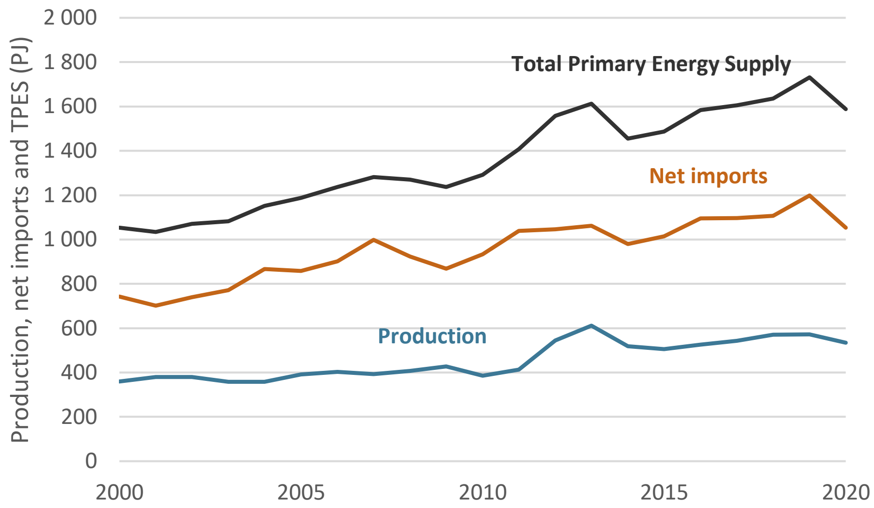
Additionally, several green hydrogen projects have been announced. One is a mobile hydrogen pilot plant in Antofagasta that will estimate the real potential of green hydrogen production from solar energy under real working conditions. Another announced project is the injection of hydrogen into a natural gas system that supplies 1800 households in la Serena and Coquimbo. During the first phase, a mixture of 1 to 5% of hydrogen in the natural gas supply is considered. The share of hydrogen is expected to reach 20% in further phases.

Energy supply and consumption

Energy supply

Chile was affected by the COVID-19 pandemic in 2020. Chile implemented several measures such as a curfew during the night-time, building occupancy capacity reduction in public areas, and social distancing among others, all of which impacted energy consumption in the economy.

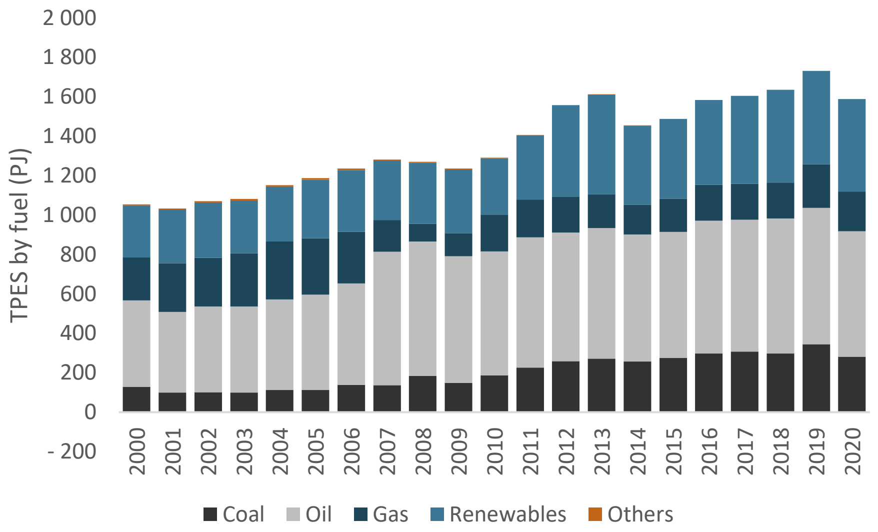
Figure 1: Chile's energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

In 2020, total primary energy production was reduced 8.2% from the 2019 level, a fall from 1 730 PJ to 1 590 PJ. This reduction was mainly due to imports falling from 1 200 PJ to 1 050 PJ, or a reduction of 12%. Domestic energy production also decreased 6.5%, a fall from 572 PJ to 535 PJ.

Figure 2: Chile's energy supply by fuel (PJ), 2000 to 2020

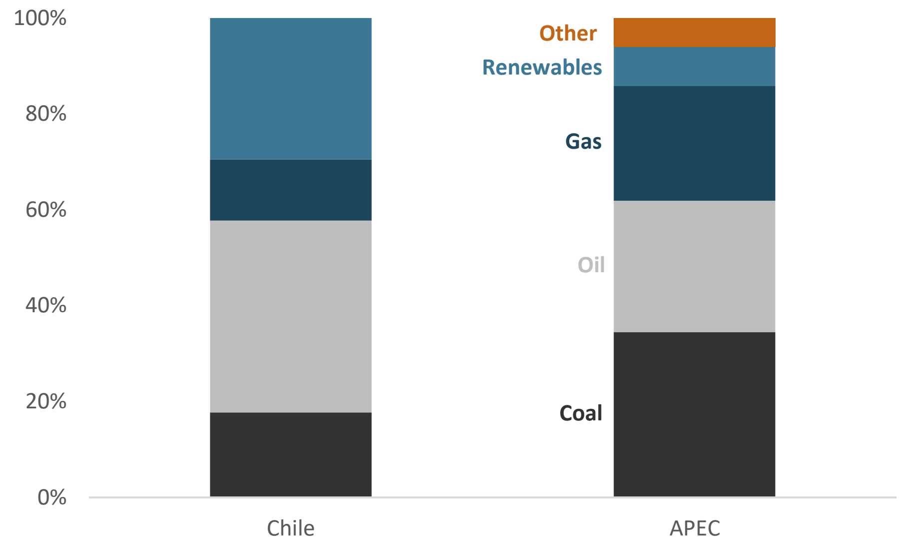


Source: EGEDA (2022)

The supply of all fuels was reduced in 2020. The supply of oil and oil products was reduced by 8.1%, going from 692 PJ in 2019 to 636 PJ in 2020. This was the effect of transport restrictions due to the pandemic. The natural gas supply was reduced by 8.4%, going from 220 PJ to 202 PJ, and the coal supply was reduced by 18%, going from 345 PJ to 282 PJ. These fuels are mainly imported; therefore, their behaviour explains the drop in net imports observed in 2020.

On the other hand, the renewable energy supply was slightly reduced, by 1.1%. Most of this renewable energy was biomass and renewable energy used in electricity generation, and the fall was due to a decrease in demand because of COVID-19 restrictions.

Figure 3: Energy supply mix – Chile and APEC, 2020



Source: EGEDA (2022)

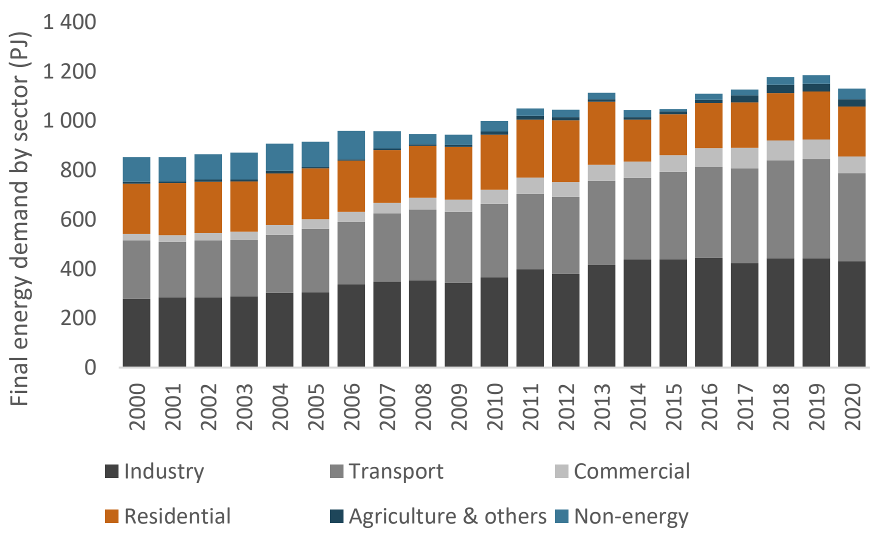
The Chilean energy supply mix shows a greater dependency on oil and oil products than APEC does, the oil and oil products share being 40%. In contrast, renewables supply 30% of the energy in Chile, almost three times the share of renewables in the APEC energy supply mix, which is 8.2%.

Total final consumption

The residential sector was the only sector that grew during 2020. Quarantine and telework from home were implemented as transport was reduced to restrict the spread of COVID-19. Consequently, part of the energy demand that was previously consumed by the commerce and public sectors was transferred to the residential sector. Residential energy consumption increased 4.0%, going from 194 PJ in 2019 to 201 PJ in 2020.

Industry, the largest energy consumer, reduced its demand by 2.5%, going from 442 PJ in 2019 to 431 PJ in 2020. Transport, the second largest energy consumer, reported a decrease of energy consumption of 11%, falling from 403 PJ in 2019 to 357 PJ in 2020. Commercial energy consumption was reduced 14%, going from 79 PJ in 2019 to 68 PJ in 2020. Activities such as hotel and tourist services, and entertainment, which were severely restricted during 2020, are included in this sector. Other sectors that consumed energy, such as agriculture, fisheries and others also saw their energy consumption reduced in 2020, falling by around 4.8%.

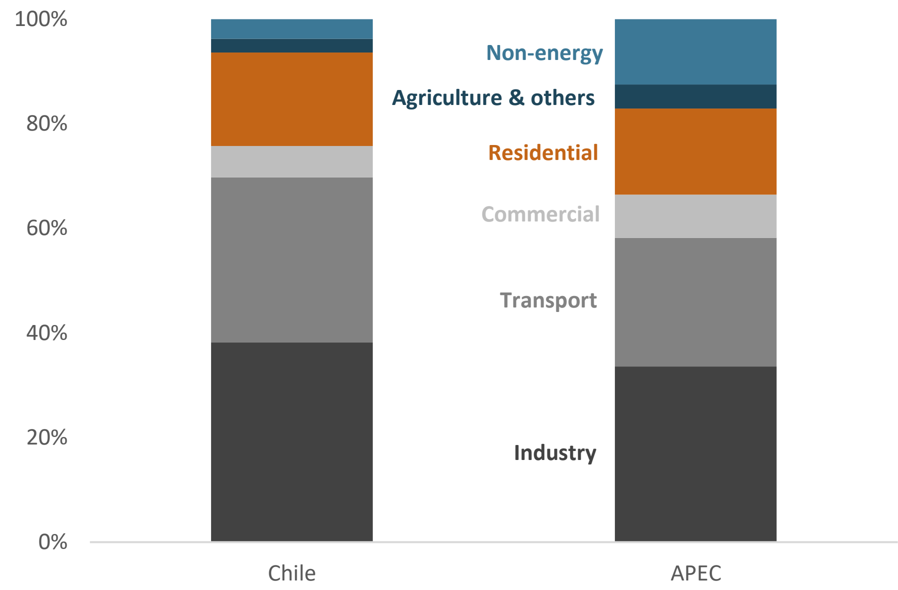
Figure 4: Chile's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

It is notable that, in comparison to APEC, Chile's final energy fuel consumption by sector shows a greater share of transport: 40% in Chile versus 25% for APEC. Another important difference is the share of non-energy uses, which includes the use of mainly oil and oil products as raw materials for non-energy products such as lubricants. In Chile, non-energy use represents 3.7% of final consumption while in APEC it represents 13%.

Figure 5: Final consumption by sector, Chile and APEC, 2020

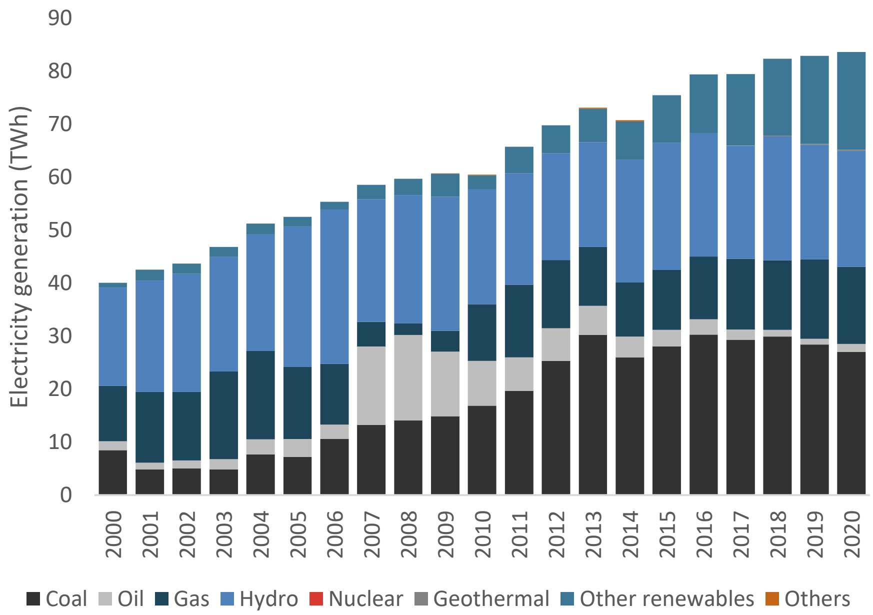


Source: EGEDA (2022)

Final energy demand

Electricity demand slightly grew in 2020: 0.6% in 2020, a growth of 1 PJ from the 267 PJ reported in 2019. This growth rate was well below the 3.1% average rate for the decade and was impacted by the restrictions imposed on activities. Demand for renewable energy fell 3.18%, going from 166 PJ to 160 PJ. On the other hand, demand for other fuels was reduced. Coal demand was reduced 37%, going from 10 PJ to 6 PJ; demand for oil and oil products fell 7.9%, going from 640 PJ to 589 PJ; and for natural gas the fall was 5.5%, going from 67 PJ to 64 PJ.

Figure 6: Chile's final energy demand by fuel (PJ), 2000 to 2020



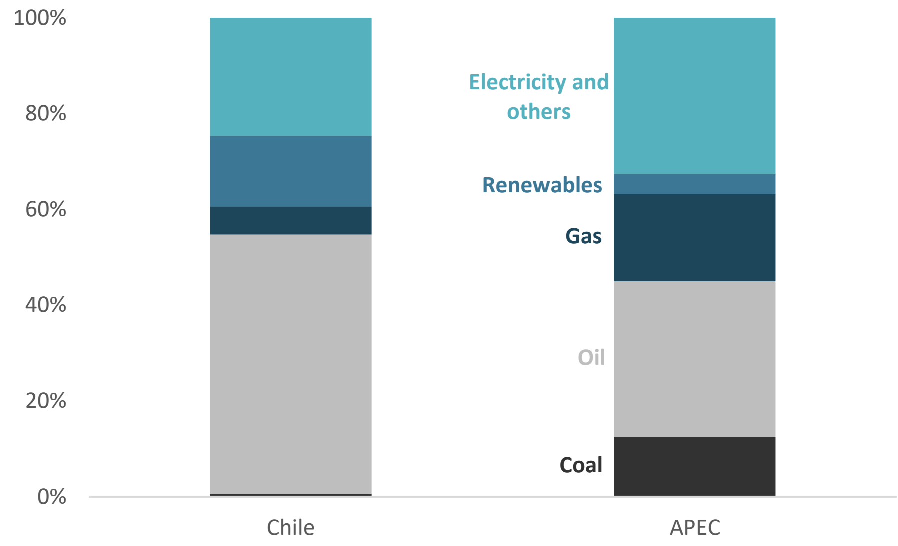
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Chile's final energy demand fuel share did not change drastically if compared with 2019; more than half of the final energy demand in Chile, 56%, is satisfied by oil and oil products. Coal satisfied 0.9 % of final energy demand; renewables, 15%; and natural gas, 5.9%.

Additionally, electricity represented 25% of the final energy demand, slightly below the 33% of final energy demand observed in APEC.

Figure 7: Final energy demand fuel share, Chile and APEC, 2020



Source: EGEDA (2022)

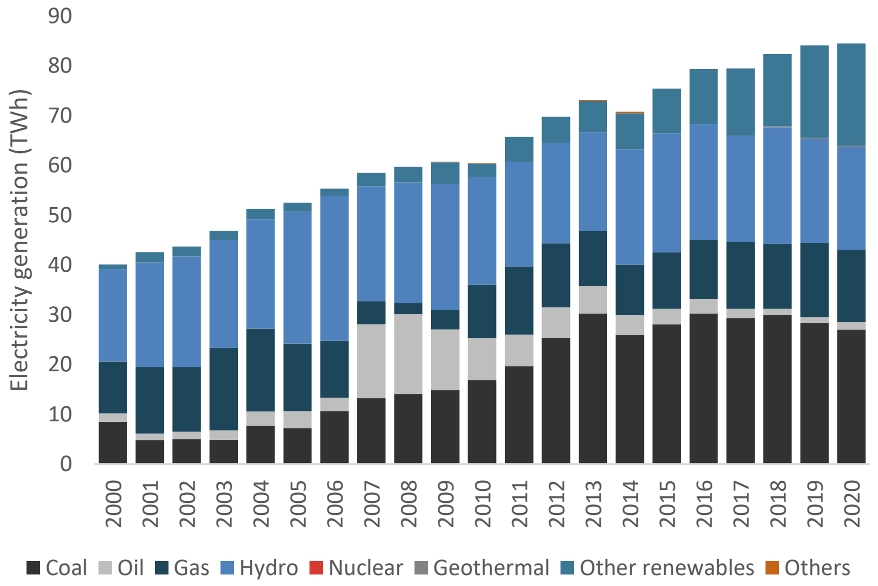
Despite the higher share of renewables if compared with APEC, Chile's final energy demand mix shows that carbon-emitting fossil fuels are the main source of energy. Natural gas, sometimes considered a cleaner fossil fuel, has a larger share in APEC's final energy demand mix, at 18%. Chile has natural gas reserves in the Southern Magallanes region, but they are not enough to significantly affect the expansion of natural gas in the economy. For that reason, Chile relies on imports to secure its natural gas supply, representing a challenge to the aim of increasing the natural gas share.

Transformation

Power sector

Chile has an ambitious goal of achieving 70% of renewable energy in the electricity fuel mix by 2030.This goal will drastically change the electricity in 2020 mix as coal represents 32% of electricity generation, and gas, 18%.

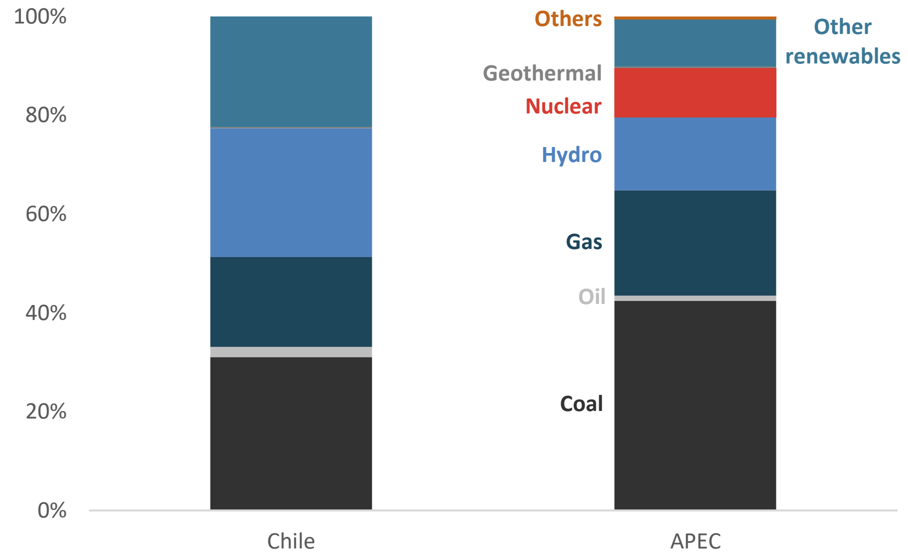
Figure 8: Chile's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

The coal share has increased since 2005 as a response to restrictions on natural gas imports, mainly from Argentina, that happened during the 2000s. However, Chile announced the phase out of all coal-fired power plants by 2040, although it has expressed the intention of bringing the date forward to 2030 or earlier if the development of the electric grid allows it. The ceasing of operations of the Tocopilla U12, Tocopilla U13 and Tarapacá in 2019, Bocamina 1 and Ventanas 1 in 2020, the Bocamina II,Tocopilla U14 and U15 coal-fired power plants in 2022 shows advancements in that direction. Currently, around 1.2 GW of coal capacity have been retired, and there are still approximately 4.4 GW to be retired or converted. Therefore, a Decarbonization Plan is being developed during 2023, which will define the roadmap for decarbonization, in such way as to establish technological alternatives that will have an accelerated impact on the progressive reduction of greenhouse gas emissions and thus meet the climate and environmental commitments, and in particular the economy's carbon budget between 2020 and 2030.

Figure 9: Electricity generation fuel share, Chile and APEC, 2020



Source: EGEDA (2022)

In 2020, electricity generation grew only 0.9%, going from 82.9 TWh in 2019 to 83.6 TWh in 2020. This level of generation estimates the activity of electricity autoproducers. A reduction was mainly observed in thermal power plants, with coal-fired power plants reducing production by 4.9%, going from 28.4 TWh in 2019 to 27.0 TWh in 2020, and gas-fired production decreased 2.8%, a drop from the 15.0 TWh level observed in 2019. In contrast, hydro power plants remained stable at around 21.7 TWh, while other renewable energy sources such as solar, wind and biomass, not including geothermal, grew from 16.6 TWh in 2019 to 18.4 TWh in 2020.

The combined share of hydro and other renewables represented 49% of the Chilean electricity generation fuel share in 2020, where 22% represented just the share of geothermal, biomass, wind, and solar energy. In that regard, Chile's electricity generation has a lower carbon intensity than APEC does because in APEC, all renewables represent 25% of electricity generation.

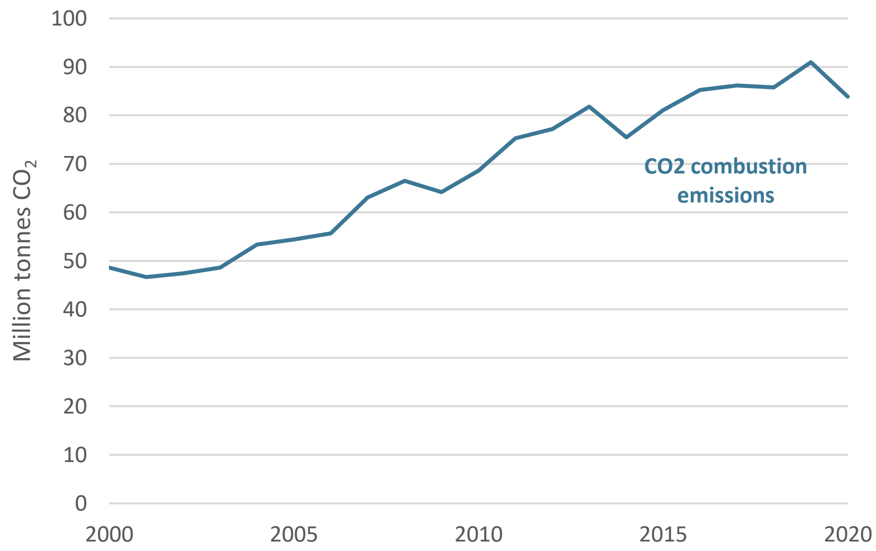
Energy transition

In addition to the policies mentioned above, Chile approved Law 21.505 to promote electricity storage and electromobility in late 2022.This law will expand renewables in the electricity mix by promoting storage technologies, providing greater security to the grid, and facilitating the process of decarbonisation. The law also promotes electric mobility through economic incentives.

Emissions

Due to the observed decrease of energy demand and the increase of the share of renewable energy, emissions dropped 8% in 2020. However, a rebound in the economy might increase emissions in later years, although this growth might be curbed by the effect of the policies mentioned above.

Figure 10: Chile's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

To contribute to energy security, Chile and Argentina signed an agreement on energy collaboration that includes Argentina supplying 300 000 m3/day of gas to Chile from June 2022 to September 2023. It is expected that this supply might increase to 4 000 000 m3/day in the future.

In mid-2022, Chile suffered a shortage of wood pellets, which are used for heating in southern regions in August. This was due to an increase in pellet demand and a contraction of production by the wood industry.

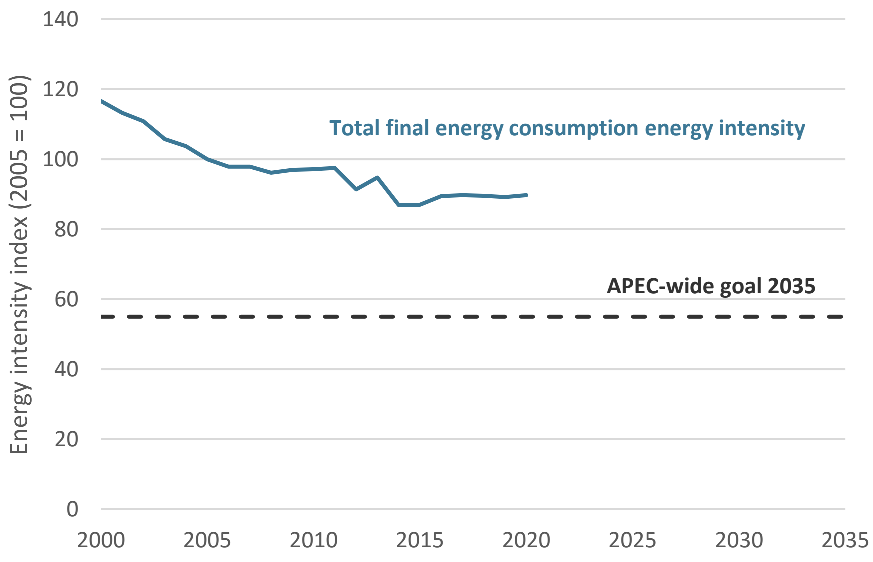
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective: to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 11: Chile's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

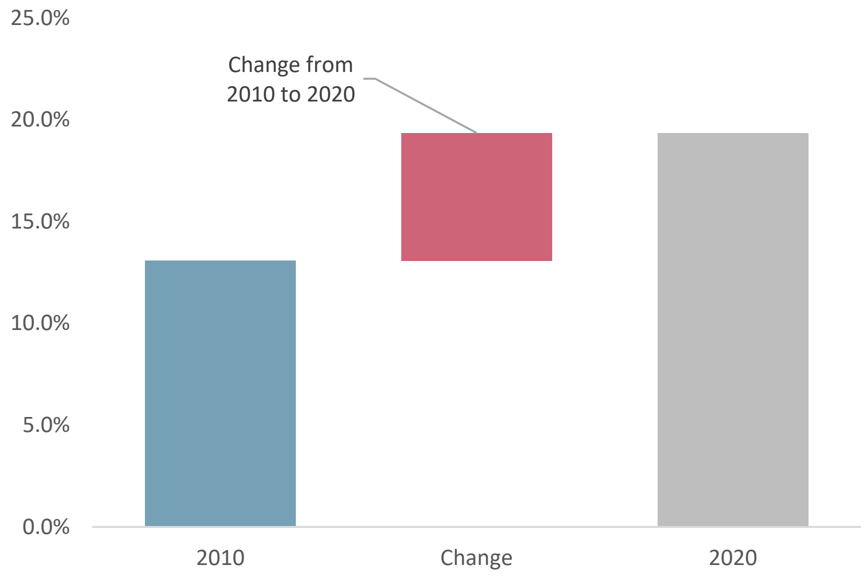
APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Chilean energy intensity increased 1% in 2020, maintaining energy intensity at around 90% of the 2005 level. This stabilisation of the level of energy intensity has been observed since 2016 and might reveal the effect of some challenges that Chile faces in increasing energy efficiency because most of its final energy consumption is in industry and transport, where fossil fuels are consumed for thermal purposes. Implementation of energy efficiency, fuel substitution, and innovation can be challenging as economic factors play a major role in the decision-making on implementing actions that affect energy consumption in those sectors.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: Chile’s modern renewable energy share, 2010 and 2020

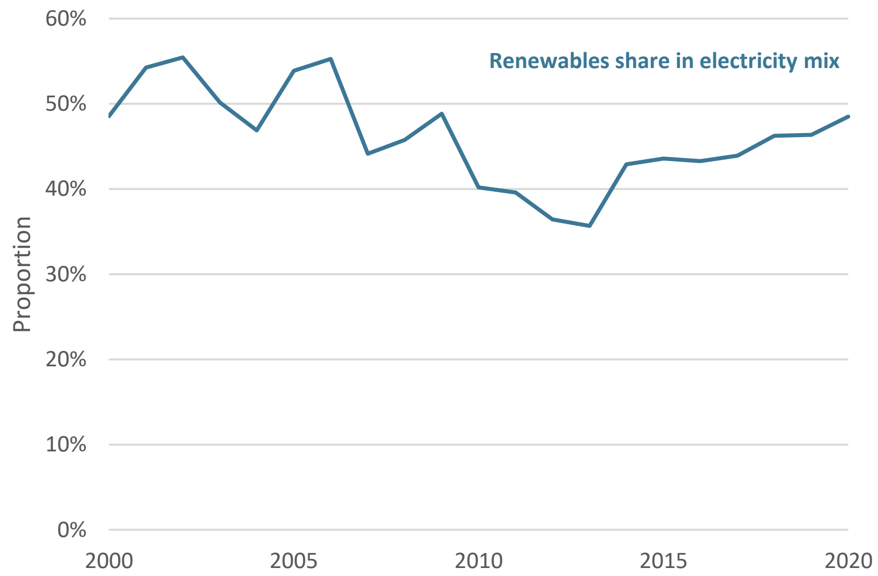


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Chile has increased its share of modern renewables, which went from 13.1% in 2010 to 19.4% in 2020. This is the third highest modern renewable energy share registered in APEC, after New Zealand and Canada. Given Chile’s aspiration to become an important hub of green hydrogen production, this share might increase during this decade.

Figure 13: Chile’s renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Chile showed growth in its renewable generation share in 2020, moving from 46.4% in 2019 to 48.5%. This increase is due to new solar and wind projects.The goals established in the updated National Energy Policy 2050 suggest that Chile will see a rapid increase in its renewable generation share.

Energy policy

Energy policy	Details	Reference
Framework Law on Climate Change	In June 2022, the Chilean government published the Law 21455 The21.455, the Framework Law on Climate Change, that establishes the goal of reaching carbon neutrality by 2050.	Ministry of Environment
Coal-fired power plant shutdown	A total of 3.63 GW of coal-fired power plants will shut down before 2025, which is equivalent to 65% of the total coal electricity capacity. Operation of coal power plants will cease by 2040 at the latest.	Ministry of Energy
National electromobility strategy	This strategy outlines actions to be taken in the short and medium terms to meet the government's goal of having 40% of the private vehicle and 100% of the public transport fleets powered by electricity by 2040. By the end of 2050, 58% of privately-owned vehicles will be powered by electricity.	Ministry of Energy
Long-term national energy planning (2018-2022)	In 2018, this plan was approved by the Ministry of Energy. The main objectives of this work are to present scenarios to estimate the future energy demand, to be used as input information for the electric transmission planning and to function as a tool that helps policy makers develop energy policies. The last report that updated the background information for the Long-Term National Energy Planning was released in 2020 and the new Long-Term National Energy Planning (2023-2027) is under development.	Ministry of Energy
Energy Agenda 2022-2026	Chile launched this energy roadmap of the new government. This document emphasises equitable access to quality energy and the development of a clean, secure, and resilient energy system.	Ministry of Energy
Updated economy energy policy 2050	This update increased the goal of renewable energy in electricity generation to 80% by 2030 and zero energy aimed to achieve 100% zero-emission energy by 2050. 100% access to electricity by 2030, established goals for hydrogen and electromobility, and mentioned the role of Chile as a green hydrogen and derivates exporter by 2030.	Ministry of Energy
Law 21.499 that regulates production and trade of solid fuels	This law declares fuelwood, pellets, briquettes, charcoal, and agricultural waste as fuels and establishes requirements and standards for commercialisation. This law is intended to improve air quality and protect the health and safety of people who live in areas where these fuels are used.	Ministry of Energy
Law 21.505 to promote electricity storage and electromobility	This law will expand renewables in the electricity mix by promoting storage technologies, provide greater security to the grid, and help the process of decarbonisation. The law also promotes electric mobility through economic incentives.	Ministry of Energy
Initial Agenda for a Second Time of the Energy Transition	In April 2023 the Ministry of Energy launched the Initial Agenda for a Second Time of the Energy Transition, with the aim of taking actions for an accelerated decarbonization of the electricity sector	Ministry of Energy

Notable energy developments

Energy development	Details	Reference
NDC Update, Emission budget	A new absolute emission target of a maximum emission level of 95 $MtCO_2$ (excluding land use, land-use change, and forestry) in 2030 has been announced. A greenhouses gases (GHG) emission budget of 1 100 $MtCO_2$ between 2020 and 2030, and GHG emissions peaking in 2025. The new target is 26% lower than the 2016 NDC agreement.	Ministry of Environment
Energy Efficiency Law	The law 21.305 outlines a long-term energy efficiency plan, to be updated every five years. The new law regulates the management of energy by large consumers and delivers information to home buyers regarding housing energy requirements.	Ministry of Energy
Hydrogen Strategy for Chile	The design and implementation of a development policy for hydrogen would allow the displacement of fossil fuels on a large scale in the power generation, transport, and industry sectors.	Ministry of Energy
Chile and Argentina signed an energy collaboration agreement	Argentina agreed to supply 300 000 m3/day of gas to Chile from June 2022 to September 2023. It is expected that this supply might increase to 4 000 000 m3/day in the future.	Ministry de Energy
The ceasing of operations of coal-fired power plants	Tocopilla U12, Tocopilla U13 and Tarapacá in 2019, Bocamina 1 and Ventanas 1 in 2020, Bocamina II, Tocopilla U14 and Tocopilla U15 in 2022 were retired in accordance with the Chilean aspiration to phase out coal by 2040.	Engie, Enel Chile
Southern regions suffered a wood pellet shortage during August.	Chile suffered a shortage of wood pellets that are used for heating in southern regions during August. This was due to an increase in pellet demand and a contraction of production by the wood industry.	La Tercera
Green hydrogen projects	One announced project is a mobile hydrogen pilot plant in Antofagasta that will estimate the real potential of green hydrogen production from solar energy under real working conditions. Another project is the injection of hydrogen into a natural gas system that supplies 1800 households in la Serena and Coquimbo.	Ministry of Energy
Clean energy traceability platform	RENOVA (National Renewable Energy Registry) Platform is an initiative that involves the traceability of renewable energies considering the fulfillment of contracts with the respective customers, through 4.0 technology tools (blockchain), incorporated into an open platform, public and transparent access, located on the website of the system operator (CEN).	CEN - RENOVA
Reduction of information asymmetry in the energy sector	- Energía Abierta: information and reporting platform for the Chilean energy sector, with the use of blockchain certification and focused on citizens.	CNE - EnergiaAbierta

- Bencina en línea: geo-referenced fuel price information platform, which includes different formats for the use of citizens.	CNE - Bencinaenlinea

Useful links

Government Institutions

Chilean National Energy Commission (CNE) – www.cne.cl

Renewable Energy National Register(RENOVA) - https://www.coordinador.cl/renova/

Energía Abierta Beta - www.energiaabierta.cl

Fuel Prices in Refuelling Stations Information System - http://www.bencinaenlinea.cl/web2/

Chilean Energy Sustainability Agency (ASE) – www.agenciaSE.org

National Electric Coordinator – www.coordinador.cl

Government of Chile – www.gobiernodechile.cl

Ministry of Economy, Development and Reconstruction – www.economia.cl

Ministry of Energy – www.energia.gob.cl

Ministry of the Environment – www.mma.gob.cl

Nuclear Energy Chilean Commission (CCHEN) – www.cchen.cl

National Institute of Statistics (INE) – www.ine.cl

National Oil Company (ENAP) – www.enap.cl Superintendence of Electricity and Fuel (SEC) – www.sec.cl

Energy Associations

Chilean Association of Power Generators – www.generadoras.cl

Chilean Association for Renewable Energies and Storage ACERA AG – www.acera.cl

Chilean Association of Electric Companies – www.electricas.cl

Chilean Association of Solar Energy – www.acesol.cl

Chilean Association for Small and Mid-hydro Power Plants (APEMEC) – www.apemec.cl

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China

Introduction

China's President Xi Jinping announced in September 2020 that China aims to have carbon dioxide emission peak before 2030 and achieve carbon neutrality before 2060. Since this announcement additional details were issued in 2021 by the Central Committee of Communist Party of China (CPC) and the Council. In 2022, the 20th CPC National Congress was successfully convened and continued its commitment to proceed with Carbon Peaking and Carbon Neutrality. The National Energy Administration (NEA), local governments, and economy-owned energy enterprises in areas ranging from electricity, the power grid, coal, oil, and gas, published their own roadmaps to decarbonise.

China is relatively rich in energy resources, particularly coal. According to the BP statistics published in 2022, China's proven coal reserves were over 143 billion tonnes, proven oil reserves were 3.5 billion tonnes, and proven natural gas reserves were 8.4 trillion cubic metres (TCM) (BP, 2022). In addition, China has 400 gigawatts (GW) of economic hydropower potential, more than any other economy (IRENA, 2014).

In 2022, according to the update of NEA, China's coal production achieved 4.5 billion tonnes, 8% more than the previous year. After several years of striving, the crude oil annual production returned to 200 million tonnes, and gas annual production climbed to 218 billion cubic metres, 6.4% more than the previous year, thereby maintaining a stable growth rate of around 10 billion cubic metres annually for five consecutive years. The first round of large-scale wind power (97 GW) in the Gobi Desert and desertification areas was launched, followed by the second and third rounds. All newly installed wind and solar power capacities would produce more than 120 GW. In 2022 renewable electricity generation accounted for 32% of China's electricity consumption.

Table 1: China's macroeconomic data and energy reserves in 2020

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	9.6	Oil (billion tones)	3.5
Population (million)	1 411	Gas (trillion cubic metres)	8.4
GDP (2017 USD billion PPP)	22 996	Coal (billion tonnes)	143
GDP per capita (2017 USD PPP)	16 297	Uranium (kilotonnes U < USD 130/kgU)	119

Source: a UN (2022); b World Bank (2022); c BP (2022); d UN (2022)

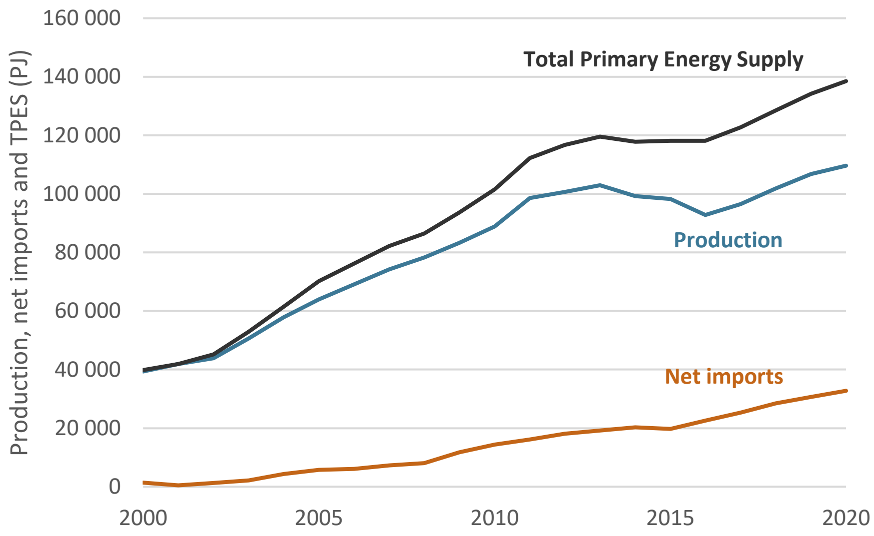
Energy supply and consumption

After a long period of development, and despite the COVID-19 pandemic, China has maintained steady GDP growth and has become the world's largest energy producer and consumer, forming an energy supply system through the comprehensive development of coal, electricity, oil, natural gas, and renewable energy.

Total primary energy supply

In 2020, China's total primary energy supply increased by 3.2%, reaching 138 509 PJ. Energy production increased by 2.7%, while net imports increased by 7.0%, emphasising China's dependency on international markets for energy. The net imports share of energy supply grew from 23% in 2019 to 24% in 2020 (Figure 1).

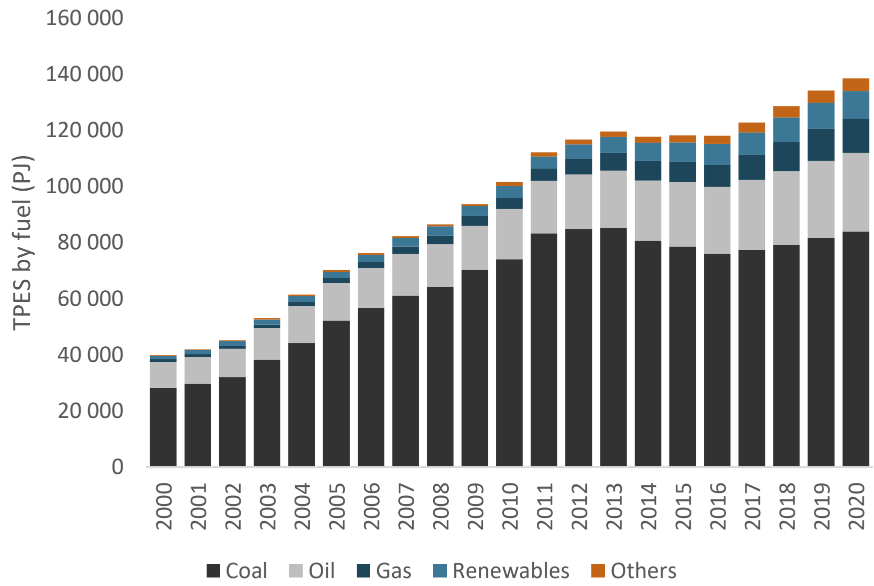
Figure 1: China's energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

From the macro view, coals share has maintained a similar share of energy supply in 2020 at 61%, whereas oil's share has fallen by more than one percentage point to 20%. In contrast, the share of gas and renewables has increased from 8.5% and 6.9% to 8.8% and 7.2%. The structure of the energy mix is moving away from the most carbon intensive fossil fuels on the way to decarbonisation (Figure 2).

Figure 2: China's energy supply by fuel (PJ), 2000 to 2020



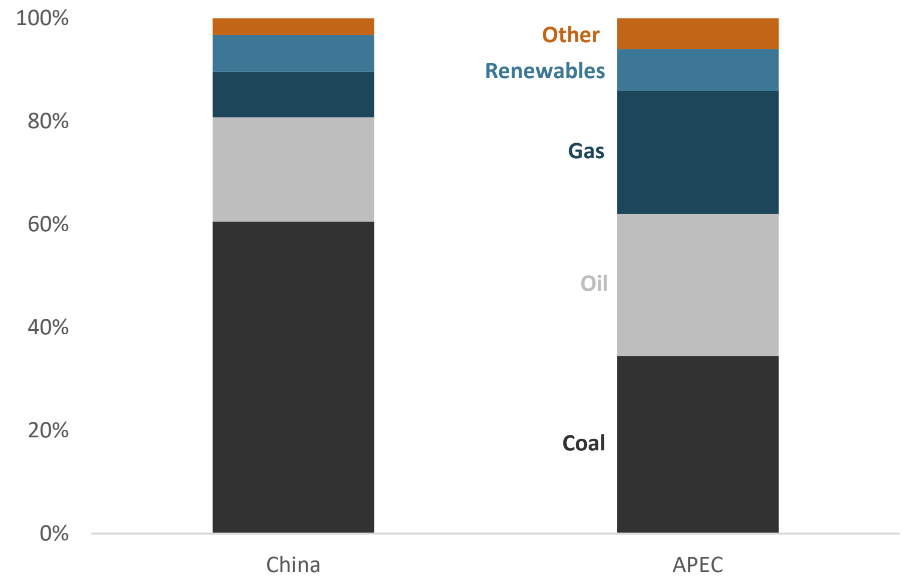
Source: EGEDA (2022)

Since 2000, the total consumption has experienced three different stages. 2000-2011 was the high-speed stage, in which the average annual consumption growth rate remained at around 10%. 2012-2016, was the plateau stage, where the average annual was around 1%. Simultaneously, in 2012 China entered a "New Era" by shifting its policy to "high-quality development", focusing more on environmental protection and commitment to building a community with a shared future for mankind. 2017-recent has been the low-speed stage, where the total consumption grew at a low rate of around 4% (Figure 1, 2).

China's large coal reserves, coal's favourable situation, and more uncertainties about the oil and gas supply chain mean that the share of coal in China's energy supply is much higher than that of APEC.

However, this share has declined as gas and renewables begin to account for a more substantial share. China's rapid development of renewable energy in recent years has meant that China's share of renewables was comparable to the APEC region in 2020 (Figure 3).

Figure 3: Energy supply mix – China and APEC, 2020



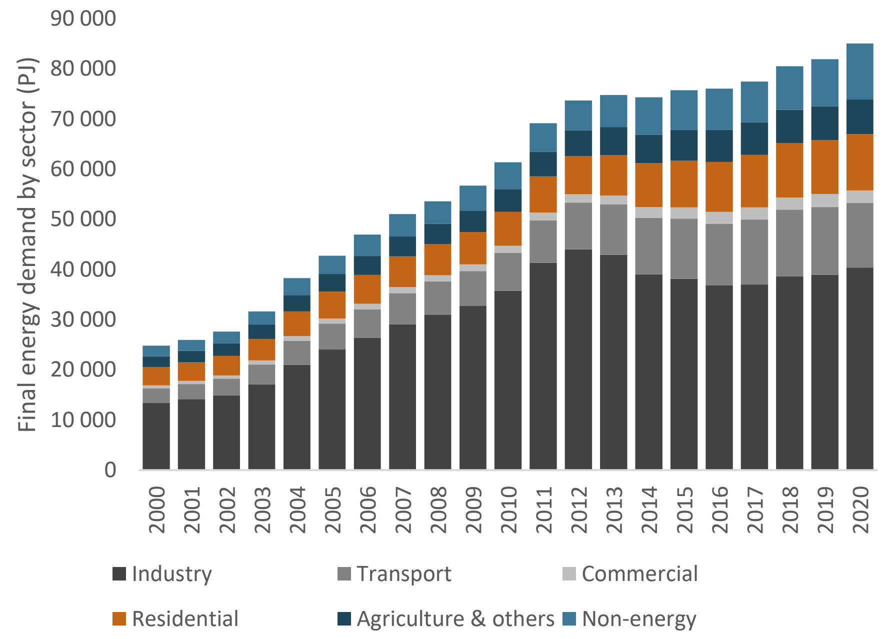
Source: EGEDA (2022)

Total final consumption

Total final consumption is a representation of end-use energy, including non-energy consumption. China's final consumption increased by 3.8% in 2020 and the industry accounted for 48% of the total, followed by transport (15%) and residential (13%). China's industrial sector is the largest in the world and currently produces large volumes of steel, cement, aluminium, and many manufactured products. Industrial energy consumption increased more than twice from 2000 to 2012, though it was relatively stable until 2020, reflecting the switch to a more services-intensive economy.

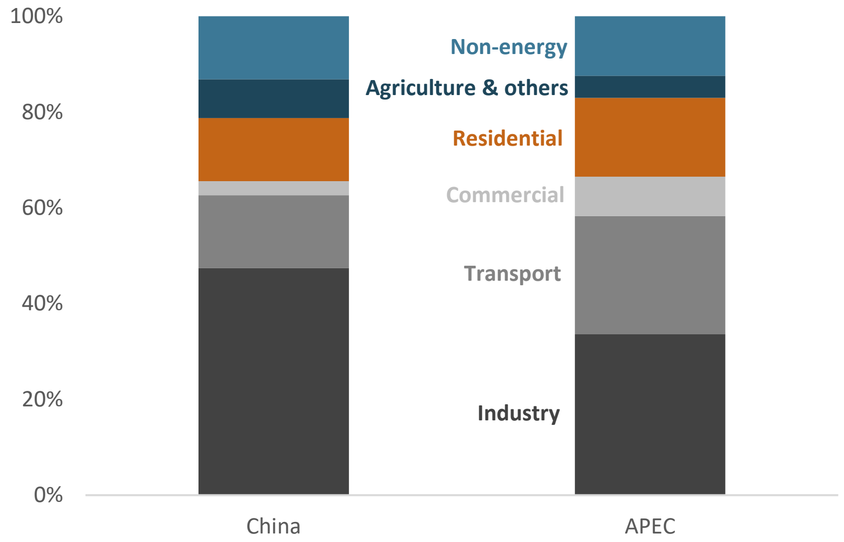
China's transport sector has the second-largest share and kept growing from 2000 to 2019, but in 2020 it experienced its first annual fall of -4.8%, which was probably caused by the COVID-19 pandemic-related traffic control. The consumption of the residential sector continuously grew, partially elevated by the implementation of the "Clean Winter Heating Plan in Northern China (2017 - 2021)", which helped tens of millions of families convert from small coal or biomass stove heating to gas or electricity heating.

Figure 4: China's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

Figure 5: Final consumption by sector, China and APEC, 2020



Source: EGEDA (2022)

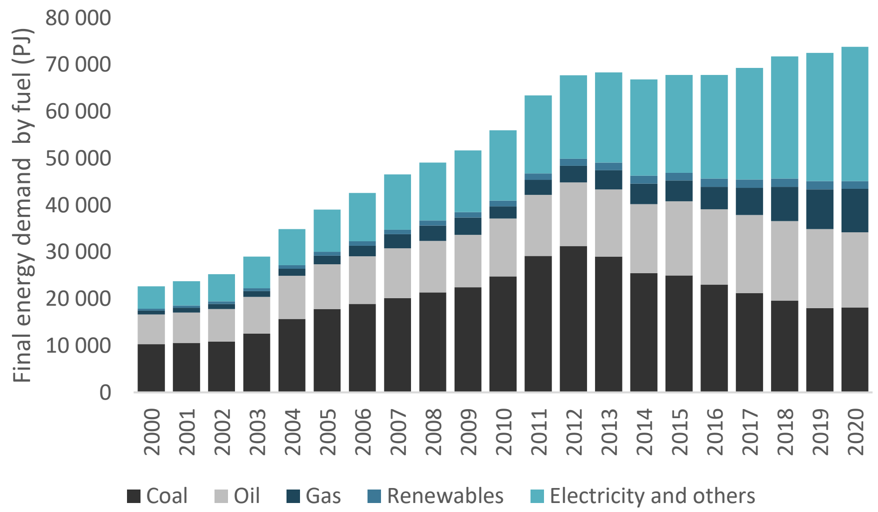
China's industrial energy consumption accounts for 18% of the final consumption for the entire APEC region. A continued transition to a more service-based economy will be important for China to reduce the industry's final energy consumption. However, it is important to recognise that China remains an important source of industrial products for almost all global economies. A large decline in China's industrial sector may necessitate an increase in industrial activity in other economies.

Final energy demand

From 2000 to 2020, the fuel composition of the final energy demand changed significantly. The most prominent change is that of coal, which increased from just above 10 000 PJ in 2000 to a peak of about 31 284 PJ in 2012. After 2012, coal consumption declined by more than 40% until 2020, and its share in final energy demand was 25% in 2020, down from 46% when it peaked in 2012. In contrast, the share of electricity and others, and gas had increased by 2020, reaching 39% and 13%, while the share of renewables remained almost stable at 2.3%.

According to the updated Nationally Determined Commitment (NDC) submitted in October 2021 and the 14th Five-Year Plan (FYP), China will strictly limit the increase in coal consumption and phase coal consumption in the future decades. The 14th FYP set the targets for 2025: the share of non-fossil fuels in final energy consumption will increase to 20%, CO_2 emissions intensity will decrease by 18%, domestic oil production will keep at 200 million tonnes and natural gas will produce more than 230 billion cubic metres.

Figure 6: China's final energy demand by fuel (PJ), 2000 to 2020

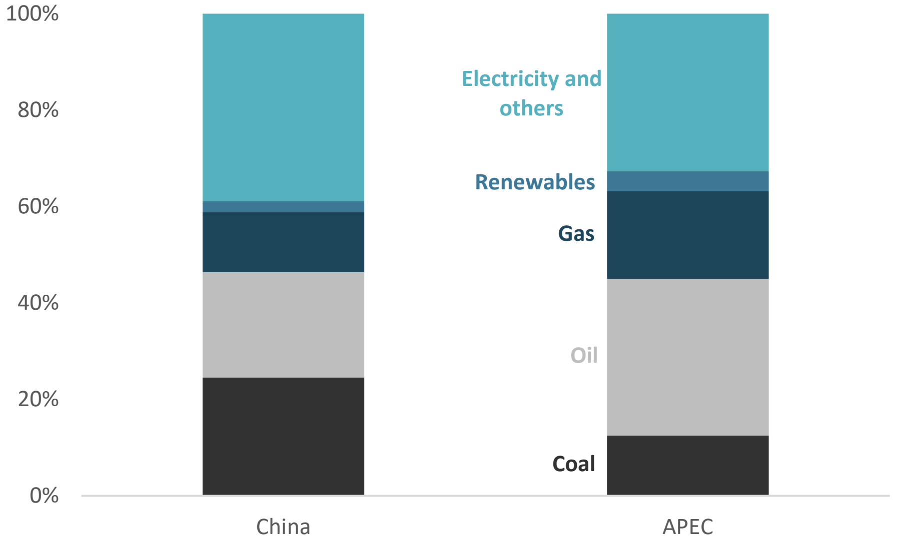


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Although demand for coal and its share has decreased from the record high in 2012, China's share of coal in 2020 (25%) was still relatively high (Figure 7). For the entire APEC region, coal's share of final energy consumption was 13%.

Figure 7: Final energy consumption fuel share, China and APEC, 2020



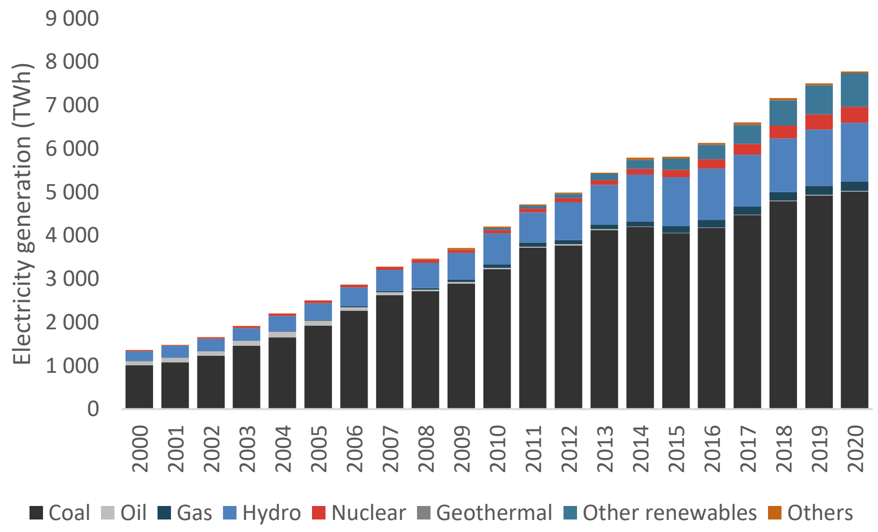
Source: EGEDA (2022)

Transformation

Power sector

Power generation has been an important component fuelling China's economic growth and has increased more than five-fold since 2000. China's power sector remains heavily reliant on coal, with 64% of China's electricity generated from coal-fired power plants in 2020. However, this share represents a decline from 75% in 2000 (EGEDA, 2022). From 2000, the proportion of non-fossil energy in electricity increased from 16% to 27%. Within that increase, nuclear generation is now 20 times greater (Figure 8).

Figure 8: China's electricity generation by fuel, 2000 to 2020

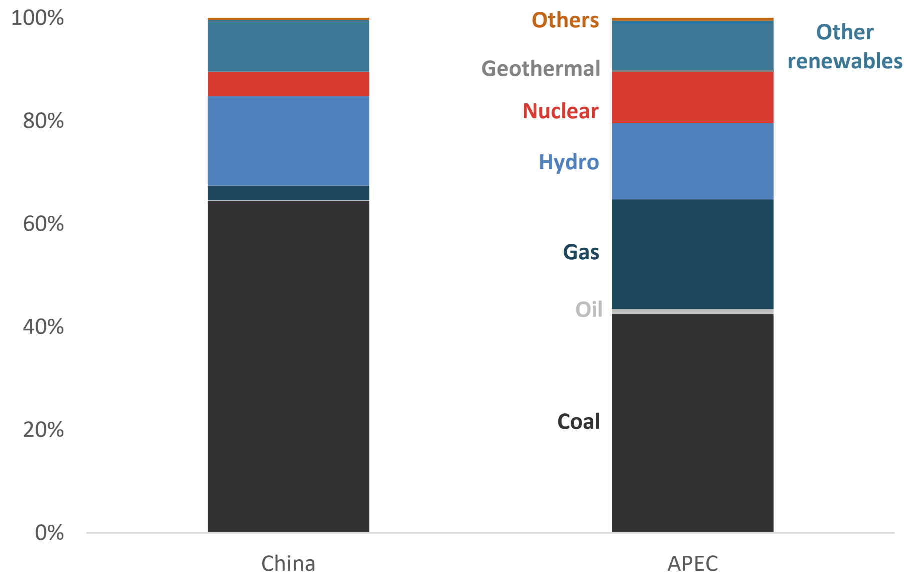


Source: EGEDA (2022)

China is stringently curbing coal-powered projects and has committed to no longer pursuing new coal-fired power projects abroad. At the same time, China has committed to establishing a new-type power system characterised by a high share of renewable energy. The construction of large-scale wind power in the Gobi Desert and desertification areas has been initiated and accelerated. Hydropower and pumped storage power stations will also be developed, depending on regional feasibility.

As for nuclear power, it will be advanced in an orderly and safe manner.

Figure 9: Electricity generation fuel share, China and APEC, 2020



Source: EGEDA (2022)

Secure supply combined with favourable prices has meant that the proportion of coal-fired power in China is higher than that of APEC, while that of gas generation is less than APEC (Figure 9).

In 2020, China's power generation reached 7 779 TWh. Thermal power and hydropower reached 5 245 TWh and 1 355 TWh, respectively (EGEDA, 2022), each ranking as first in the world. Nuclear power generation reached 366 TWh, ranking second behind US. (EGEDA, 2022; BP, 2022).

Energy transition

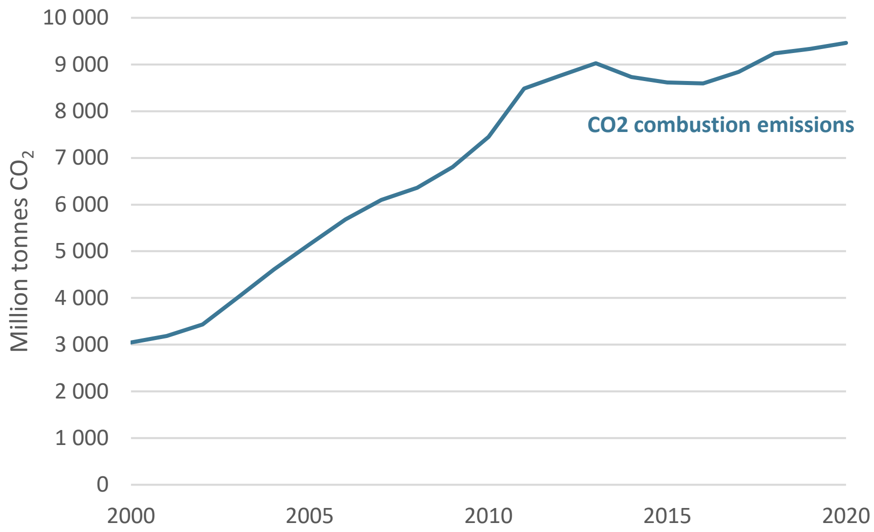
Emissions

For the past decade, China has continued to expand its supply-side structural reform and to reverse the extensive development model that relies heavily on resource consumption at the cost of high pollution and emissions. Therefore, China's GDP growth remains relatively high with relatively low CO_2 emissions.

While protecting industrial and supply chains, China has taken measures to curb industries that over-exploit resources and cause environmental damage, such as steel, cement, and electrolytic aluminium. During the 13th Five-year Plan period (2016-2020), China removed more than 150 million tonnes of excess steel production capacity and 300 million tonnes of excess cement production capacity. Substandard steel products have been eliminated and almost all outdated production capacity in industries such as electrolytic aluminium and cement manufacturing has been removed.

To optimise the structure of transportation, China has accelerated the construction of special railway lines, promoted the shift of freight transport from road to railways and waterways, and encouraged intermodal transport. In 2021, the railway and waterway freight volume accounted for 25% of the total in China, an increase of 3.9% over 2012. At the same time, China has vigorously promoted the use of new-energy vehicles in public transport, taxi services, environmental sanitation, logistics, distribution, civil aviation, airports, and Party and government institutions. By the end of 2021, the number of China's registered new-energy vehicles had reached 7.8 million, accounting for about half of the global figure (China's Economy Council Information Office).

Figure 10: China CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

APEC energy goals

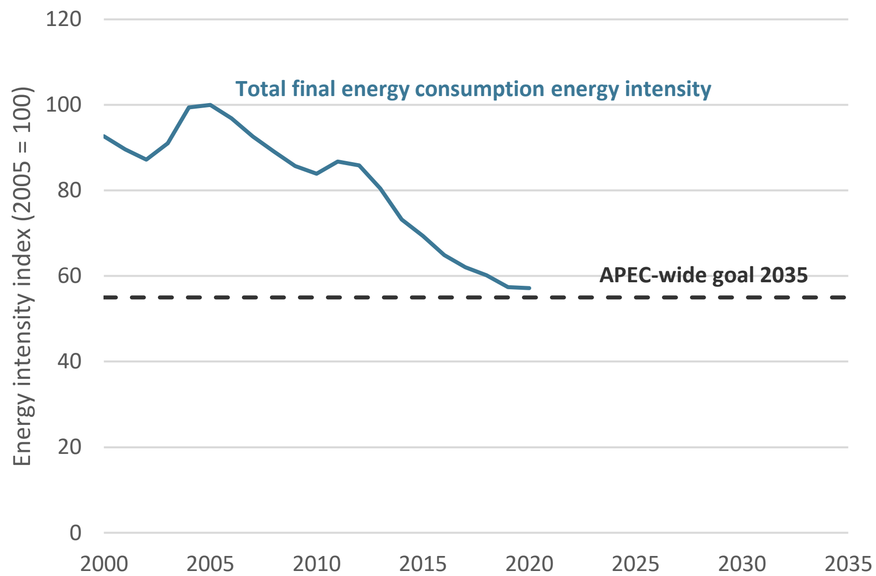
There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

Energy intensity in the APEC region has been continuously improving. China is contributing to APEC's aspirational goal of a 45% energy intensity reduction from the 2005 level by 2035. Since 2012, the growth rate of China's energy consumption has slowed significantly, and the 'dual control' of energy intensity and total energy consumption has been included in China's 13th FYP and 14th FYP. In the 14th FYP period, China aims to lower the energy consumption per unit of GDP by 13.5%.

In 2020, China's total final energy consumption (excluding non-energy sources) energy intensity declined by 43% relative to 2005 (Figure 11).

Figure 11: China's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

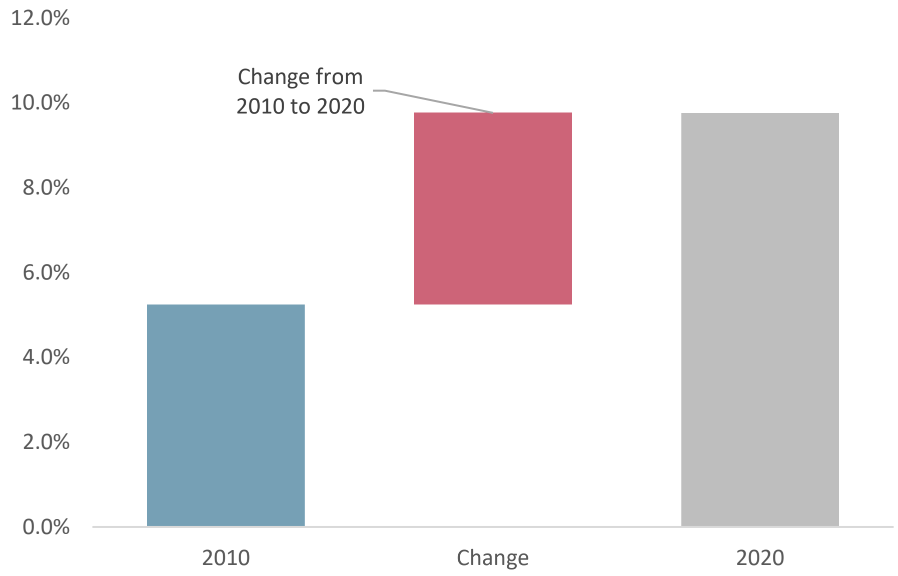


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix between 2010 and 2030. Modern renewables do not include traditional biomass, and the share is relative to final energy consumption.

Figure 12: China’s modern renewable energy share, 2010 and 2020



Source: EGEDA (2022)

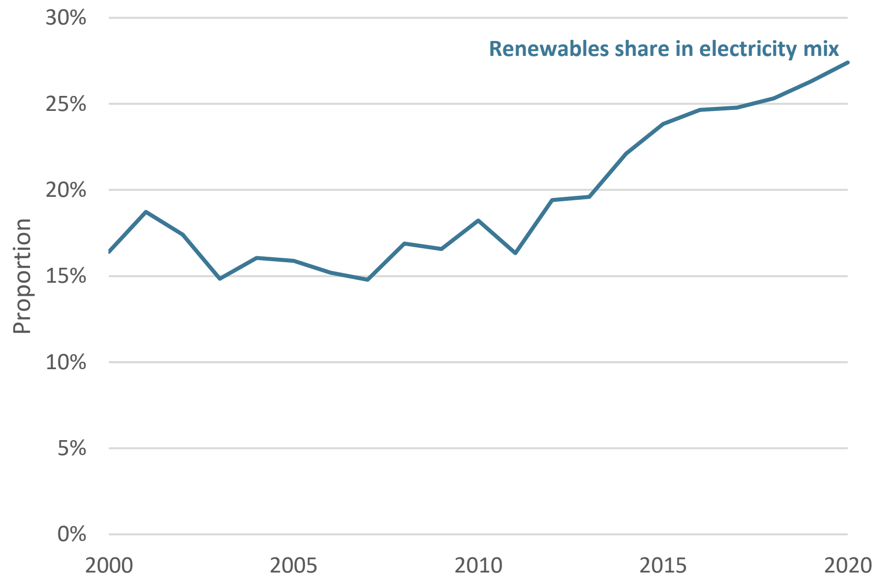
Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

There is no economy-level goal for individual member economies; however, it is possible to calculate the relative improvement of individual economies to get a better sense of whether the goal will be achieved.

Since the implementation of the Renewable Energy Law in 2006, China has entered a period of rapid development of renewable energy. The modern renewables’ share of final energy consumption in 2010 was 5.2%. In 2020, this proportional share was 9.8%, which represents a 4.6% increase (Figure 12).

The renewables share in China’s electricity mix increased from 16% in 2000 to 27% in 2020 (Figure 13). The increase was mainly driven by wind and solar. The capacity of wind and solar is expected to exceed the NDC goals, with China’s total installed capacity of wind and solar power expected to grow to over 1 200 GW by 2030 (UNFCCC, 2021).

Figure 13: China’s renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Opinions on the Complete, Accurate and Comprehensive Implementation of the New Development Concept to Do a Good Job of Carbon Neutralisation	The opinion is important for the systematic planning and overall deployment for the important work of carbon neutralisation	The Economy Council of the People's Republic of China
Action Plan for Carbon Dioxide Peaking Before 2030	Outline measures for gradually slowing the emission of carbon, transitioning to renewable energy, and reducing waste. Offers an overview of China's overall plan for reaching both the 2030 and the 2060 goals	Policy link
14th Five-Year Plan for a Modern Energy System	Clarifies the key tasks for the development of China's energy sector from 2021 to 2025	NEA of China
14th Five-Year Plan on Renewable Energy Development (2021–2025)	Clarifies the key tasks for the development of China's renewable energy sector from 2021 to 2025	NDRC
Comprehensive Work Plan for Energy Conservation and Emission Reduction in the 14th Five-Year Plan	Improves and implements the dual control system for energy consumption intensity and total volume and total discharge of major pollutants; organises the implementation of key projects for energy conservation and emissions reduction	Government link

Notable energy developments

Energy development	Details	Reference
China's Green Development in the New Era	Presents a full picture of China's ideas, actions, and achievements in green development in the new era, and shares with the world its experience in this regard	China's Economy Council Information Office
National Electric Power Industry Statistics in 2022	The installed capacity of wind power is about 370 million KW, an increase of 11% year-on-year; the installed capacity of solar power is about 390 million KW, an increase of 28% year-on-year	NEA of China
Top Ten Landmark Achievements of National Oil and Gas Exploration and Development in 2022	Top Ten Landmark Achievements of National Oil and Gas Exploration and Development in 2022 appraised by the National Energy Administration	NEA of China
Energy Development Achievements in the Past 10 years in the New Era	Energy Development Achievements in the Past 10 years in the New Era released by the National Energy Administration	NEA of China

Useful links

National Development and Reform Commission- https://www.ndrc.gov.cn/

National Energy Administration– http://www.nea.gov.cn/

National Bureau of Statistics of China – http://www.stats.gov.cn/english/

References

National Energy Administration, Press Conference, 13 Feb 2023. http://www.nea.gov.cn/2023-02/13/c_1310697026.htm

EGEDA (Expert Group on Energy Data Analysis, APEC Energy Working Group) (2021), *APEC Energy Database.* https://www.egeda.ewg.apec.org/egeda/database_info/index.html

Hong Kong, China

Introduction

Hong Kong, China (HKC) announced its goal to achieve carbon neutrality before 2050 during the release of the Climate Action Plan 2050 (CAP2050) in October 2021. The CAP2050 comprises long-term decarbonising targets and action plans, covering energy supply and demand aspects and including the roadmap towards carbon neutrality. The CAP2050 is one of the major environmental policy plans. It sets a carbon neutrality target following the issue of the Climate Action Plan 2030+ (CAP2030+) released in 2017 after China acceded to the Paris Agreement in 2016. The CAP 2050 brings together the overall strategies, plans, targets and actions for HKC to achieve carbon neutrality before 2050.

Other than CAP2030+, various policies have been released by HKC, explicitly detailing the targets and action plans for three key areas, namely electricity generation, transport, and waste, aimed at reducing CO_2 emissions while simultaneously sustaining the use and source of energy. The implementation horizon of these policies is between 2012 and 2035.

In 2022, HKC focused on implementing the action plans through four key strategies to track towards achieving its carbon-neutral goal. In accomplishing net-zero electricity generation, the structural shift from coal to gas for the past few years has reflected the energy transition. Four units of a coal-fired power plant at Castle Peak A Power Station will be closed in the next few years, while a new unit of a gas-fired power plant with a capacity of 600 MW at Black Point Power Station will begin operations by the end of 2023.

Despite the hilly terrain in HKC, efforts to increase the renewables share in electricity generation have continued by exploring the development of renewable energy. An offshore wind farm project, with a total capacity of 150 MW, is expected to be operational by 2027. The under-construction waste-to-energy facility at Shek Kwu Chau (I•PARK1), with a treatment capacity of 3 000 tonnes of municipal solid waste, is targeted for commissioning in 2025 and will subsequently increase the contribution of renewables to electricity generation.

Table 1: Hong Kong, China's macroeconomic data and energy reserves

Key data [a]		Energy reserves	
Area (km^2)	1110	Oil (billion barrels)	-
Population (million)	7.5	Gas (trillion cubic feet)	-
GDP (2017 USD billion PPP)	418	Coal (million tonnes)	-
GDP per capita (2017 USD PPP)	55 918	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a World Bank (2022); Government HKC (2022)

HKC is also in the process of adding three household appliances, namely gas cookers, gas instantaneous water heaters, and light-emitting diode lamps, to the Mandatory Energy Efficiency Labelling Scheme as part of the measures to reduce residential buildings' electricity consumption by 20% to 30% from the 2015 level by 2050. For commercial buildings, Kai Tak Development (KTD) has adopted a district cooling system as its energy-efficient air-conditioning system, which consumes 20% to 35% less electricity than standard air-conditioning systems. KTD's district cooling system began its operations in 2013, and the final phase is expected to come into effect in December 2025.

Electrification of vehicles has become the key initiative to reach zero vehicular emissions and zero carbon emissions in the transport sector before 2050. In the next three years, HKC will provide an additional 7 000 parking spaces with electric vehicle chargers in government buildings and will collaborate with franchised bus companies and other stakeholders for commencing trials of hydrogen fuel cell electric buses and heavy vehicles. At the same time, HKC has set a target of introducing about 700 electric buses and 3 000 electric taxis by the end of 2027.

Energy supply and consumption

Total primary energy supply

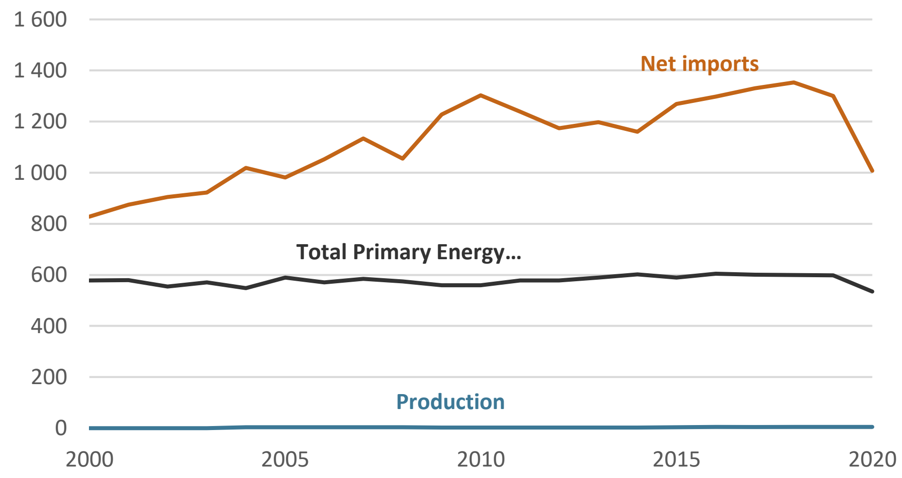
HKC has been relying almost entirely on imported fuels to meet its energy demands, either in the form of oil and coal products or transformed into secondary energy for final consumption, such as electricity and gas. Energy supply from renewables has been produced domestically through small-scale wind power projects, waste-to-energy projects and government-funded and non-funded solar photovoltaic (PV) projects.

HKC's total primary energy supply had remained stable at about 600 PJ since 2000 before it dropped to 535 petajoules (PJ) in 2020, declining 11% or 64 PJ from the previous year (Figure 1). HKC was among 14 economies in the APEC region that experienced a drop in supply due to lower energy demand during the COVID-19 lockdown in 2020.

Renewable source as part of the total primary energy production, has remained stable at about 5 PJ since 2016. Apart from low energy demand across end-use sectors except for the residential sector, the 23% significant drop in net imports in 2020 was also partially due to the gradual reduction of coal consumption in electricity generation.

In 2020, 46% of oil products in HKC was imported from China, as well as 100% of LPG and gas. 73% of coal products was imported from Indonesia.

Figure 1: Hong Kong, China’s energy supply, production, and net imports (PJ), 2000 to 2020

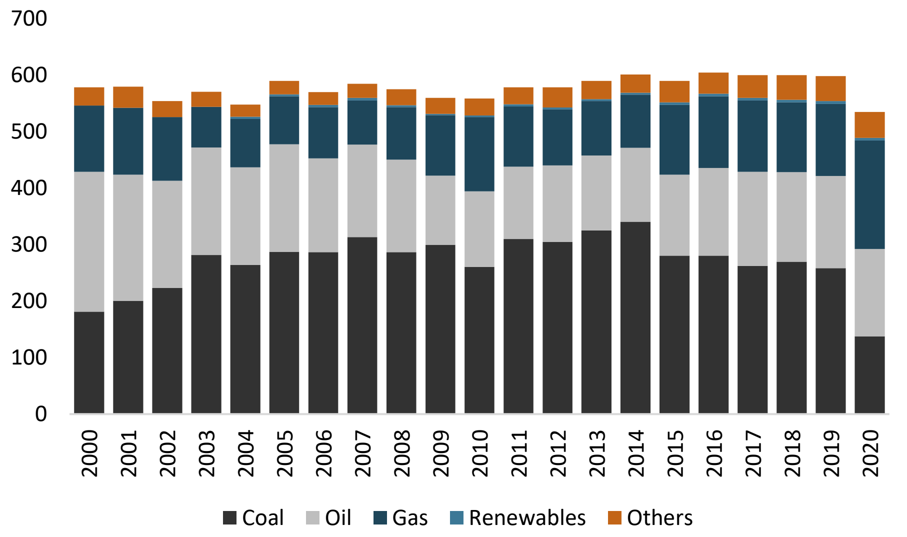


Source: EGEDA (2022)

Fossil fuels have dominated HKC's total primary energy supply for the past two decades, with changes in structure over the period (Figure 2). Coal's share rose from 31% in 2000 to 57% at the peak in 2014, and gradually declining to 26% in 2020. In meanwhile, gas's share increased from 16% in 2014 to 36% in 2020 to replace coal in electricity generation. Oil's share showed a similar trend as gas, but at a slower rate, from 22% to 29% over the same period.

Renewables and others grew from 5.6% in 2000 to 9.4% in 2020, as the geographical constraint limited the large-scale renewable sources in HKC.

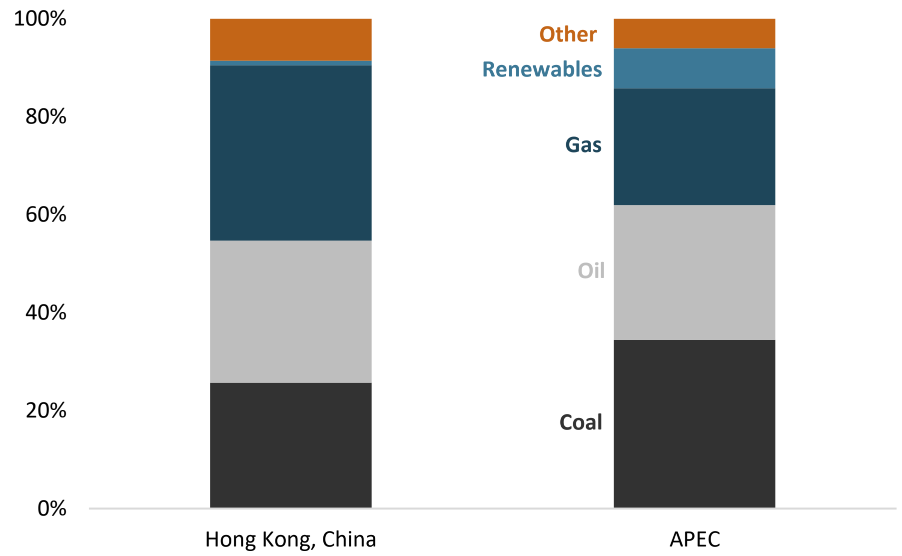
Figure 2: Hong Kong, China's energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

HKC's total primary energy supply structure showed a reliance on fossil fuels about 5% higher than the entire APEC region in 2020, partly because of a larger share of gas (Figure 3). The coal share was 8.8% lower, while the oil share was almost the same. The share of renewables was significantly lower than the APEC region.

Figure 3: Energy supply mix – Hong Kong, China and APEC, 2020



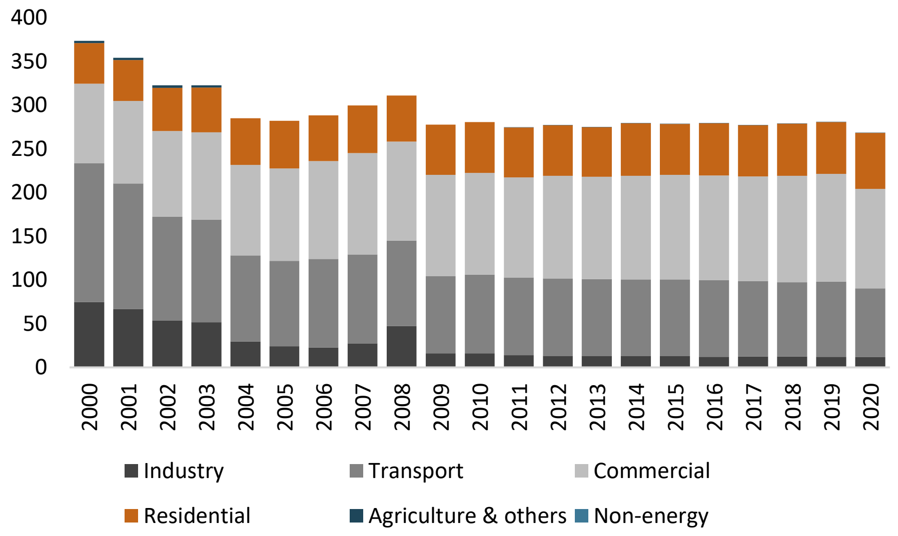
Source: EGEDA (2022)

Total final consumption

HKC's total final consumption declined by about a quarter from 374 PJ in 2000 to 282 PJ in 2005, driven by falling demand from the industry sector due to the relocation of labour-intensive manufacturing industry to China or other economies (Figure 4). Economic growth in HKC had led to a steady growth of final consumption before it was impacted by the financial crisis in 2008. Since then, the final consumption in HKC has stabilised at an average of 277 PJ.

The commercial and transport sectors were the main end-use sectors for the past 20 years, accounting for 42% and 29% of all end-use energy consumption in 2020. The commercial sector has experienced steady energy growth since 2000, while the transport sector has slowly declined in energy consumption. In 2004, the former surpassed the latter for the first time, became the largest consumption sector, and has been rising gradually since then. Limited economic activities due to the COVID-19 lockdown in 2020 caused a drop in energy consumption across sectors, except for the residential sector.

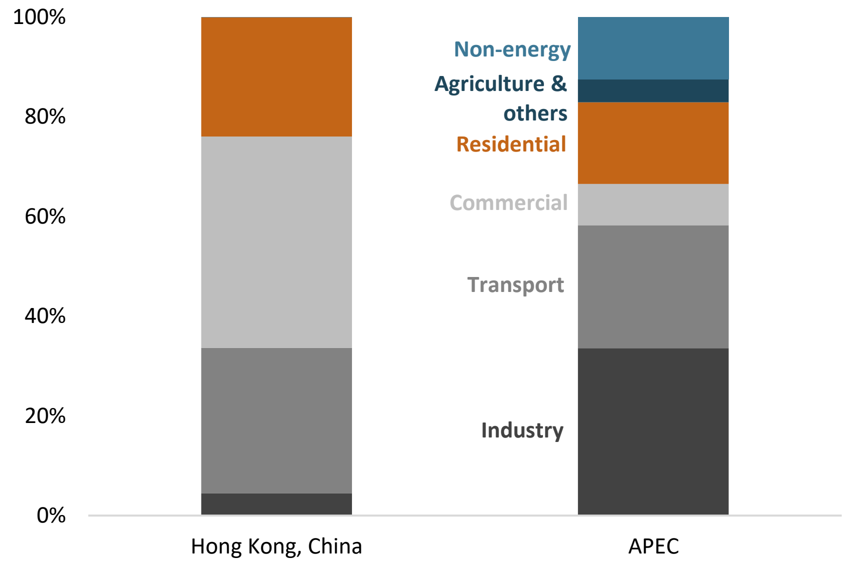
Figure 4: Hong Kong, China's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

HKC's commercial sector energy consumption share was five times larger than the APEC region in 2020 (Figure 5), as services activities have contributed the largest share of economic output since the early 2000s. The transport sector's share was slightly higher than the APEC region, while industry and agriculture and other sectors' shares were much smaller.

Figure 5: Final consumption by sector, Hong Kong, China and APEC, 2020



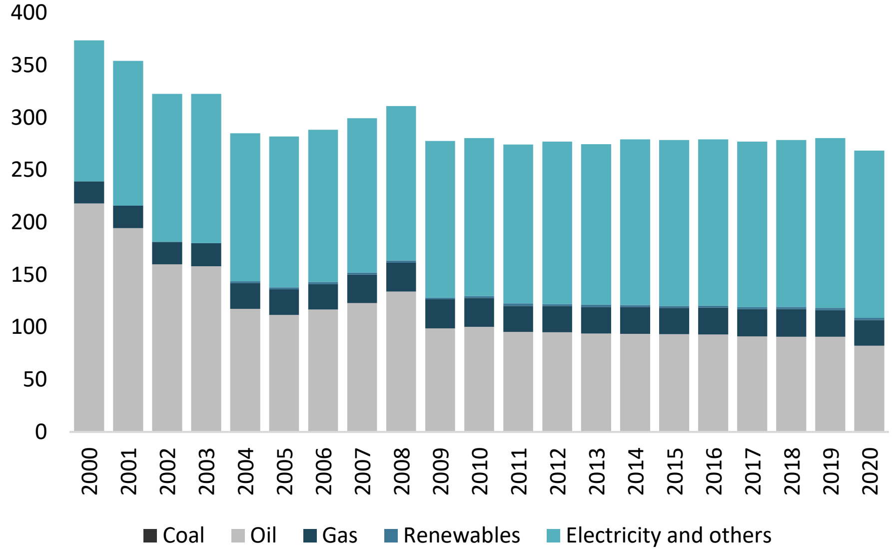
Source: EGEDA (2022)

Final energy demand

HKC's final energy demand was stable at around 280 PJ from 2010 to 2019 before declining by 4.3% to 268 PJ (Figure 6). The final energy demand has been dominated by the electricity and others category since 2004. The share of electricity and others rose from 50% in 2004 to 60% in 2020. The electricity and others' share increased by 1.7% in 2020 compared to the previous year, as most people in HKC worked from home during the COVID-19 lockdown.

Demand for oil, gas, renewables, and electricity and others dropped in 2020, reflecting limited mobility and slow economic activities due to the COVID-19 lockdown.

Figure 6: Hong Kong, China's final energy demand by fuel (PJ), 2000 to 2020

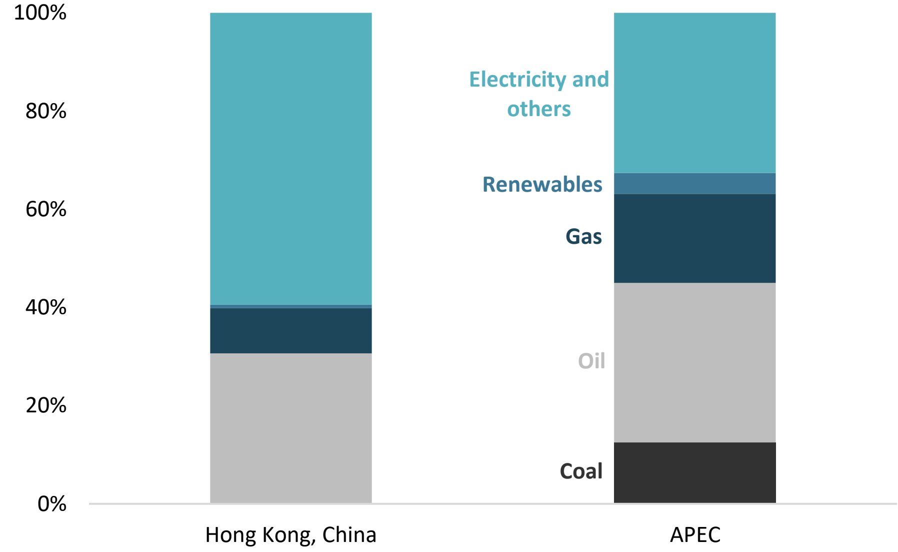


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

As a services-based economy, HKC's electricity and others' share was almost double compared to the APEC region in 2020 (Figure 7), with the energy mostly consumed by the commercial and residential sectors. The shares of oil, gas and renewables were smaller than in the APEC region, while end-users in HKC did not consume coal in 2020.

Figure 7: Final energy demand fuel share, Hong Kong, China and APEC, 2020



Source: EGEDA (2022)

Transformation

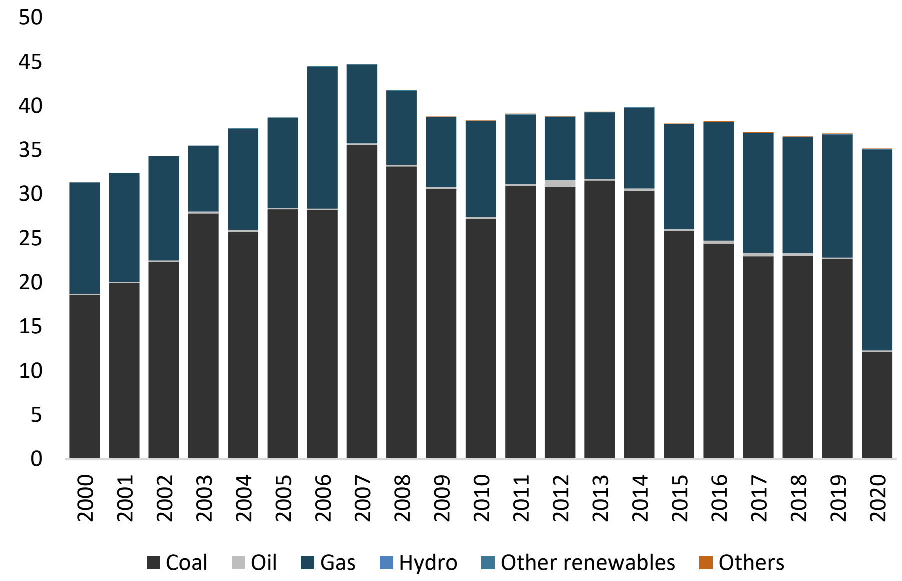
Power sector

In the total primary energy supply, HKC's electricity generation relies heavily on fossil fuels, specifically coal and gas. However, the structure has gradually changed between both fuels for the past ten years, following the HKC decarbonisation plan in the power sector. On top of its commitment to the Paris Agreement, HKC released the Climate Action Plan 2030+ (CAP 2030+) in 2017, which comprises a target and mitigations to reduce carbon emissions by 2030. One of the mitigations in CAP 2030+ is to phase down coal consumption gradually in electricity generation.

As a result of decarbonisation commitment, the coal share in electricity generation declined by more than half, from 80% in 2013 to 35% in 2020 (Figure 8), while the share of electricity generation from gas increased from 19% in 2013 to 66% in 2020. It reflects the shift from coal to gas in HKC's power sector. All other fuels aside from coal and gas accounted for less than 1% of the fuel mix in 2020. Other renewables and others increased by about 51% in a year, increasing from 0.11 TWh in 2019 to 0.17 TWh in 2020. About one quarter of other renewables and others was generated from solar photovoltaics in 2020.

HKC will gradually reduce the use of coal in electricity generation and finally cease coal use by 2035, as stated in Hong Kong, China's Climate Action Plan 2050. Gas will be the primary fuel to replace coal, supported by other renewables. Other renewables' share will be increased to 7.5% to 10% of the fuel mix in electricity generation by 2035 and further increasing to 15% by 2050.

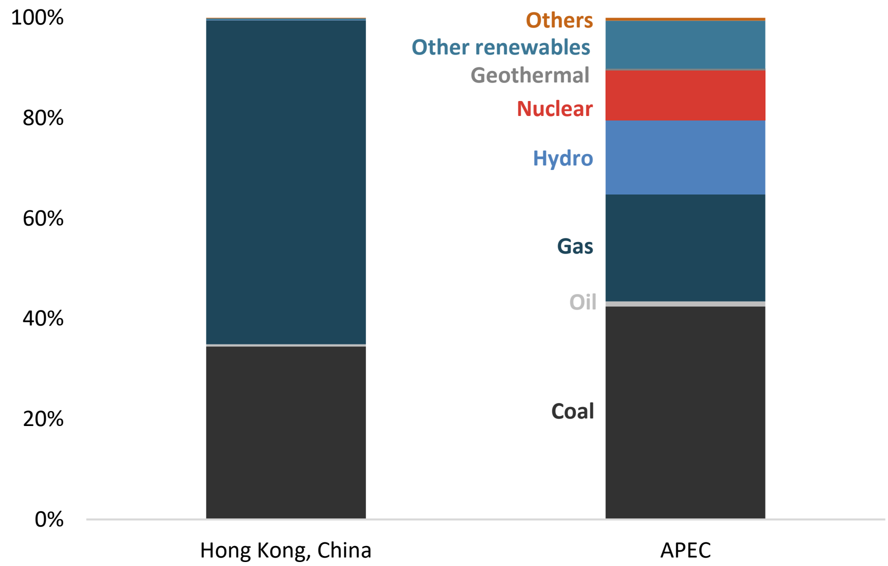
Figure 8: Hong Kong, China's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

HKC relies heavily on imported fossil fuels to generate electricity and meet demands. Most of the imported coal and gas in 2020 was transformed into electricity for final consumption. The dominance of both fuels in the power sector is apparent compared to the APEC region's generation mix in 2020 (Figure 9).

Figure 9: Electricity generation fuel share, Hong Kong, China and APEC, 2020



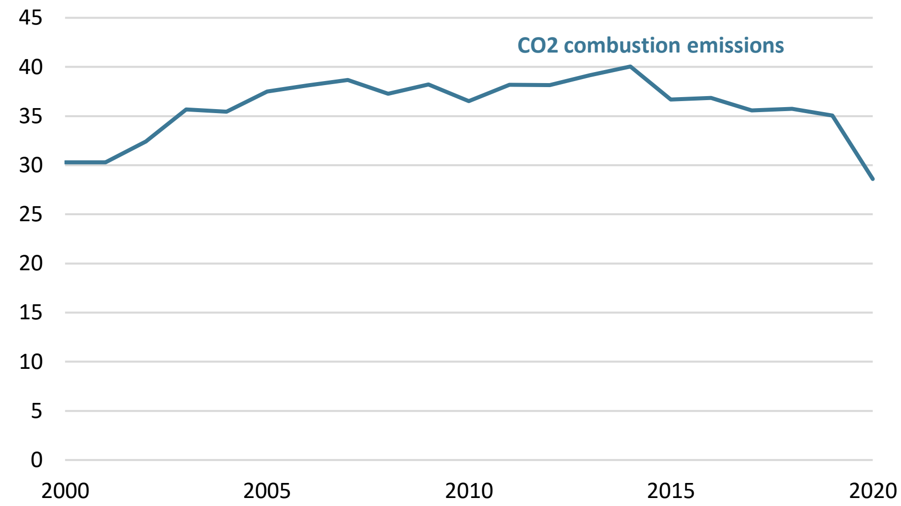
Source: EGEDA (2022)

Energy transition

Emissions

HKC CO_2 emissions increased by about a third between 2000 to 2014, peaking at 40 million tonnes in 2014. Since then, CO_2 emissions declining to 29 million tonnes in 2020 which is even less than in 2000. Various decarbonisation measures from both the supply and demand sides have supported the reduction of CO_2 emissions in HKC, including promoting electric vehicles and energy-saving measures, introducing innovative waste-to-energy and waste-to-resources facilities, and reducing coal use in electricity generation.

Figure 10: Hong Kong, China's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

HKC will start diversifying its gas sources by importing liquefied natural gas (LNG) through the operation of its first offshore LNG receiving terminal in mid-2023. Besides fuel source diversification purposes, the offshore LNG receiving terminal, with a maximum regasification capacity of 800 million standard cubic feet per day, is expected to meet the growing gas demand mainly from the power sector. The first floating storage and regasification unit (FSRU) vessel arrived in HKC on 13 April 2023, and prepares got final commissioning to go into service.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

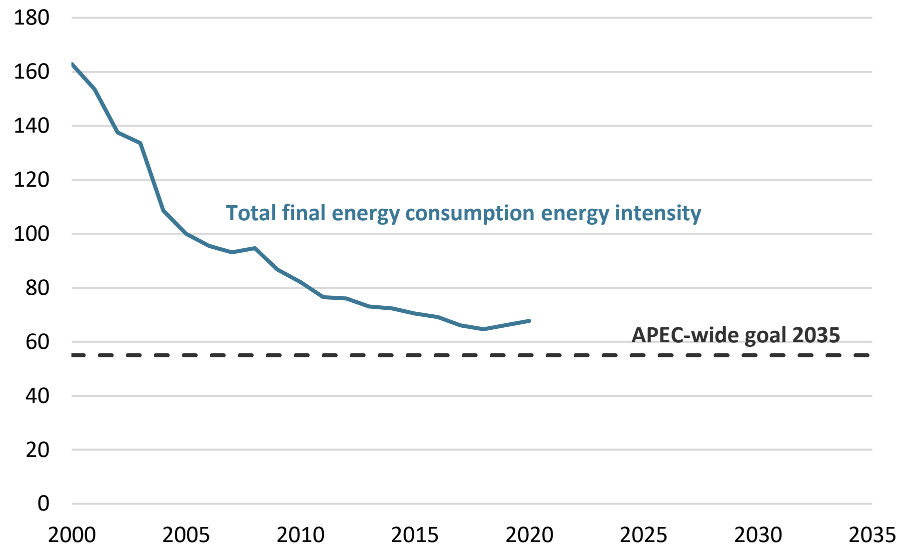
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

HKC has set its own energy intensity target to reduce its energy intensity by 40% in 2025, relative to a 2005 baseline, as stated in the Energy-Saving Plan for Hong Kong's Built Environment 2015-2025+. HKC's final energy consumption intensity declined by 32% from 2005 to 2020, about 2.6% annually reduction. The energy intensity reduction in HKC has also contributed to the positive progress towards achieving APEC's energy intensity goal.

Figure 11: Hong Kong, China's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



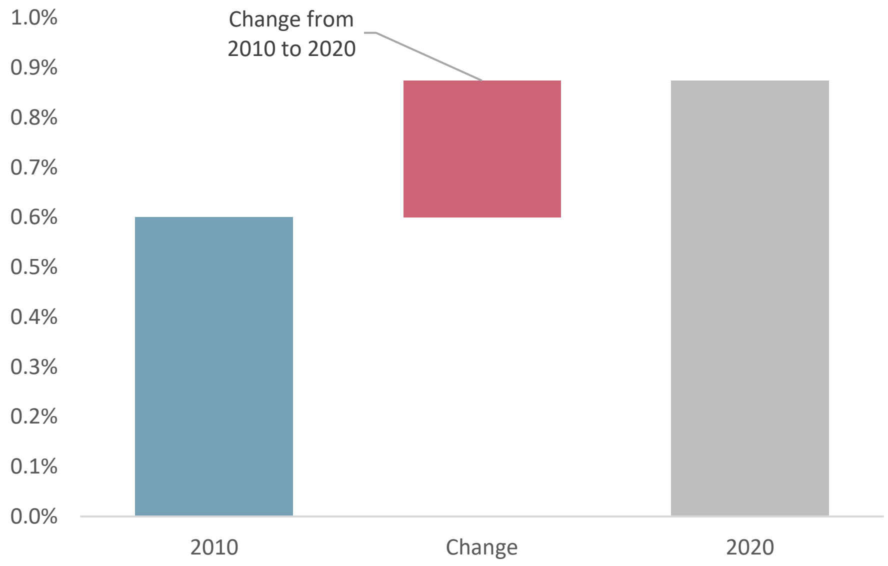
Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

HKC's share of modern renewables in final energy consumption reached 0.9% in 2020, increasing by about 50% in 10 years (Figure 12). The renewables share in electricity generation is relatively low. Having said that, there was a rising from 0.11% to 0.35% over the same period (Figure 13).

Figure 12: Hong Kong, China's modern renewable energy share, 2010 and 2020

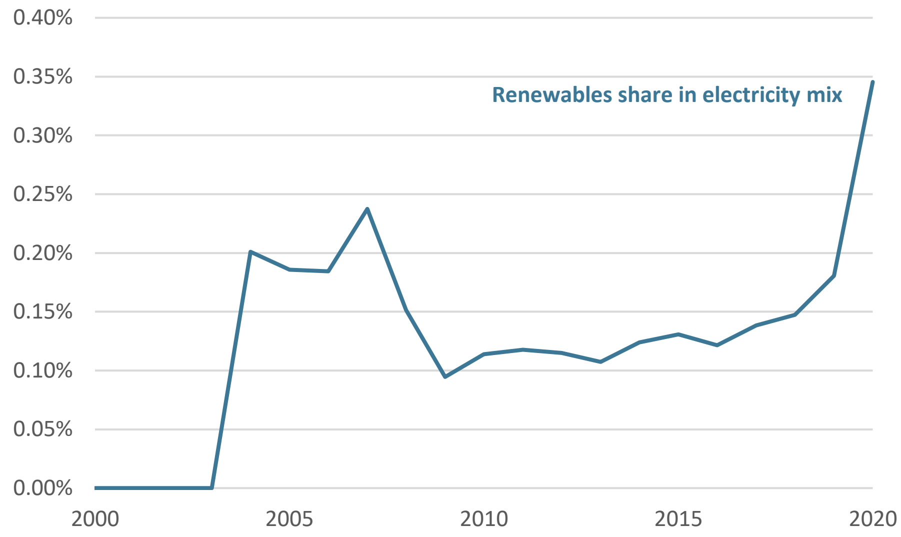


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

HKC committed to increasing the share of renewables in the fuel mix for electricity generation to 7.5% to 10% by 2035 and 15% by 2050 through developing more advanced waste-to-energy facilities and offshore wind farms and introducing a Feed-in Tariff (FiT) Scheme to encourage the community to develop distributed renewables, specifically solar energy.

Figure 13: Hong Kong, China's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Green Tech Fund (GTF)	HKD 400 million has been allocated for setting up the GTF to provide better and more focused funding support for environmental protection	GTF
Energy Efficiency Initiatives	Mandatory Energy Efficiency Labelling Scheme (MEELS), Voluntary Energy Efficiency Labelling Scheme (VEELS), Building Energy Efficiency Ordinance (BEEO), District Cooling System (DCS), Retro-Commissioning	MEELS, VEELS, BEEO, DCS, RCx
Renewable Energy Initiatives	Feed-in Tariff and Renewable Energy Certificate, Installing renewable energy system in various government schools and welfare non-government organisations, Waste-to-energy infrastructures	GOVHK, HKRENet
Scheme of Control Agreements (SCAs)	Promotes the development of quality service by power companies and improves energy efficiency and energy conservation	Environment and Ecology Bureau
A memorandum of understanding between the National Energy Administration (NEA) and HKC	China provides HKC with a stable supply of natural gas and nuclear electricity	Environment and Ecology Bureau
Energy-Saving Plan for Hong Kong's Built Environment 2015-2025+	Comprises an energy-saving policy and strategies to achieve energy intensity reduction by 40% from the 2005 level by 2025	Environment and Ecology Bureau
Climate Action Plan 2030+ report	Plans and measures across sectors to reduce carbon intensity by 65% to 70% from the 2005 level by 2030, equivalent to a 26% to 36% absolute reduction and a reduction to 3.3–3.8 tonnes on a per capita basis.	CLIMATEREADY
Climate Action Plan 2050	Comprehensive plans and measures across sectors to achieve carbon neutrality before 2050	Environment and Ecology Bureau
HKC Roadmap on Popularisation of Electrical Vehicles	Measures related to electric vehicles to achieve zero vehicular emissions before 2050	Environment and Ecology Bureau

Clean Air Plan for HKC 2035	Comprehensive policies, measures and long-term decarbonisation strategies to improve the air quality	Environment and Ecology Bureau
Building a Liveable City	Striving towards carbon neutrality before 2050	Policy Address 2021

Notable energy developments

Energy development	Details	Reference
Green Tech Fund (GTF)	GTF Assessment Committee approved 22 projects from 288 applications received during the first and second rounds of the GTF application with a total grant of around HKD 100 million. The third round of GTF applications will be closed on 14 March 2023.	Green Tech Fund
Tax Incentives Scheme for Environment-friendly Commercial Vehicles	HKC released a Qualifying Standard for Environment-friendly Commercial Vehicles, which will take effect from 1 April 2023 to 31 March 2024.	Environmental Protection Department
LNG Receiving Terminal	The first HKC LNG receiving terminal is expected to commence its operation in 2023. The floating storage and regasification unit (FSRU) vessel has a storage capacity of 263 000 cubic metres, a regasification capacity of 800 million standard cubic feet per day.	CLP HKE
Offshore Wind Farm	The proposed offshore wind farm is four kilometres from Lamma Power Station. It will comprise about 13 to 19 wind turbines with a total capacity of about 150 MW and is targeted for commissioning in 2027.	HK Electric

Useful links

The HKC Government – www.gov.hk/en

Electrical and Mechanical Services Department – www.emsd.gov.hk

Environment and Ecology Bureau - https://www.eeb.gov.hk

Environmental Protection Department – www.epd.gov.hk

Council for Sustainable Development – https://www.eeb.gov.hk/en/susdev/council/pastreports.htm Climate Ready – www.climateready.gov.hk

Information on Renewable Energy (RE) Technologies - https://re.emsd.gov.hk/

Low Carbon Living Calculator – https://www.carboncalculator.gov.hk

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Indonesia

Introduction

Indonesia is the world's largest archipelagic economy, located to the southeast of mainland Southeast Asia, between the Pacific Ocean and the Indian Ocean. The economy's total land area (25% of its territory) is approximately 1.9 million km^2, and the population was around 273 million in 2021 (BPS, 2022b).

Indonesia had a gross domestic product (GDP) of US dollar (USD) 3 130 billion and a GDP per capita of USD 11 445 in 2020 (2017 USD purchasing power parity [PPP]), recording an annual decrease of 2.1% and 3.1% since 2019, respectively (World Bank, 2021), primarily due to the COVID-19 pandemic. Indonesia's economy rebounded in 2021, with a modest growth of 3.7% (Coordinating Ministry for Economic Affairs [MOE], 2022). In 2022, Indonesia's economy grew at the rate of 5.7% (quarter three y-on-y) (BPS, 2022a), and it is projected to grow by 5.3% in 2023 (MOE, 2022a).

Indonesia is a net energy exporter, with coal as the main energy export commodity. In 2021, coal exports reached 435 million tonnes, with the export destinations including China, India, Japan, and Korea (MEMR, 2021a).

Indonesia updated its nationally determined contribution (NDC) in September 2022. In this new enhanced NDC, Indonesia increased its commitment to the emission reduction target in 2030 compared to the 2010 level from 29% in the First NDC and the Updated NDC to 31.89% unconditionally and from 41% in the Updated NDC to 43.20% conditionally. This enhanced NDC and the Long-Term Low Carbon and Climate Resilience Strategy (LTS-LCCR) 2050 contained Indonesia's vision to achieve net-zero emissions by 2060 or sooner (UNFCCC, 2022).

In 2022, Indonesia and the International Partners Group (IPG) launched the Just Energy Transition Partnership to accelerate Indonesia's transition towards cleaner energy in the future. The aim of this long-term partnership is to mobilise an initial USD 20 billion in public and private financing over three to five years for Indonesia's energy transition and to achieve the climate energy target (EU, 2022).

Table 1: Indonesia macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	1.9	Oil (billion barrels)	2.4
Population (2021 million)	273	Gas (trillion cubic feet)	44
GDP (2017 USD billion PPP)	3 130	Coal (million tonnes)	34 869
GDP per capita (2017 USD PPP)	11 445	Uranium (tonnes U < USD 130/kgU)	5 300

Source: a ABS (2022); b World Bank (2022); c BP (2022); d OECD (2020)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Indonesia has substantial and diverse energy resources of oil, natural gas, coal and renewables. In 2020, the proven oil proven reserves were 2.4 billion barrels, and the proven natural gas reserves amounted to over 44 trillion cubic feet (tcf). In the same year, Indonesia's coal reserve was estimated at almost 35 billion tonnes (Table 1), with more than 60% of the reserve in Kalimantan, and the rest mainly in Sumatra (MEMR, 2021b).

In 2015, renewable energy potential included 29.5 gigawatts (GW) of geothermal, 75 GW of hydropower, 208 GW of solar, 33 GW of bioenergy, 61 GW of wind power and 17.9 GW of ocean energy (National Energy Plan, 2017).

Energy supply and consumption

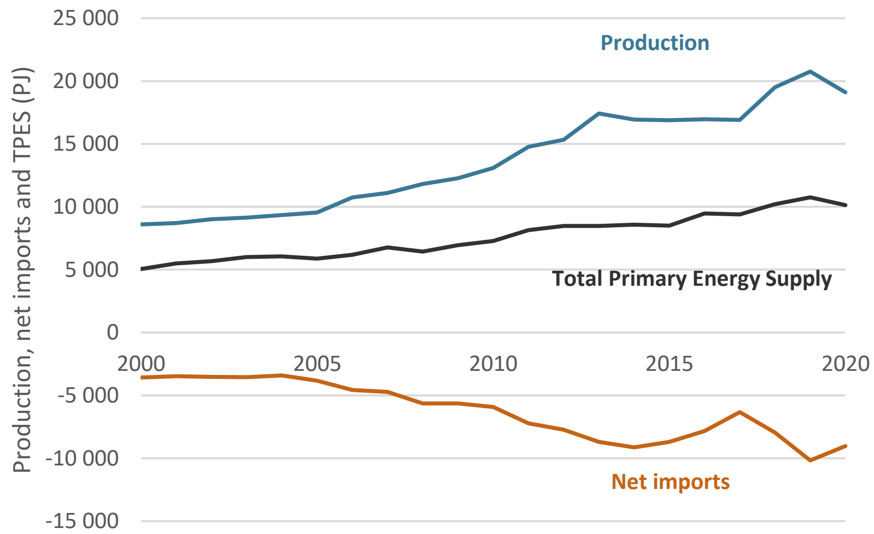
Total primary energy supply

In 2020, Indonesia's total primary energy supply (TPES), production and net imports declined. Compared to previous year, TPES declined by 5.7% to reach 10 139 petajoules (PJ), whereas annual energy production declined more steeply by 7.9% and reached 19 115 PJ (Figure 1; Expert Group on Energy Data Analysis [(EGEDA, 2022). Indonesia is still a net energy exporter, though the net export declined in 2020. Indonesia is a net exporter of energy, with thermal coal and natural gas are being the most two predominant export commodities (MEMR, 2021a).

Indonesia is one of the world's biggest thermal coal exporters. In 2020, coal production was 8.5% lower than in 2019 due to decreasing coal demand caused by the COVID-19 pandemic. Nonetheless, in 2021, coal production and export rebounded to almost the same level as it was in 2019, with production amounting to 613 million tonnes and exports reaching 435 million tonnes (MEMR, 2021a).

Indonesia's natural gas production is decreasing. In the past decade, gas production has shown a declining trend; it fell from 2.9 million MMSCF in 2011 to 2.1 million MMSCF in 2021 (MEMR, 2021a). Nevertheless, gas was still Indonesia's second-largest energy export in 2020, amounting to 184 000 MMSCF exported via pipeline and 507 000 thousand MMBTU via LNG (MEMR, 2021a). Indonesia's second-largest energy export in 2019 was gas, with 252 000 MMSCF exported via pipeline and 513 000 MMSCF exported via LNG (MEMR, 2021b).

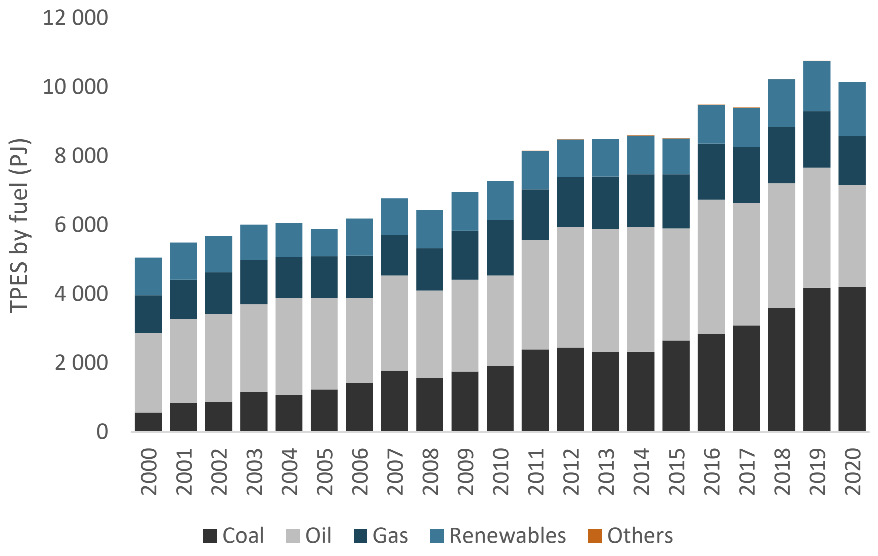
Figure 1: Indonesia energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

Indonesia's energy mix is still heavily reliant on fossil fuels, especially coal and oil (Figure 2). In 2020, Indonesia's TPES decreased by about 6% from the previous year to become around 10 139 PJ, with the biggest drop in TPES being from oil, which decreased by 15% compared to the previous year. This high decrease in oil supply is partly explained by a significant drop in oil demand from the transport sector due to the COVID-19 pandemic.

Figure 2: Indonesia energy supply by fuel (PJ), 2000 to 2020



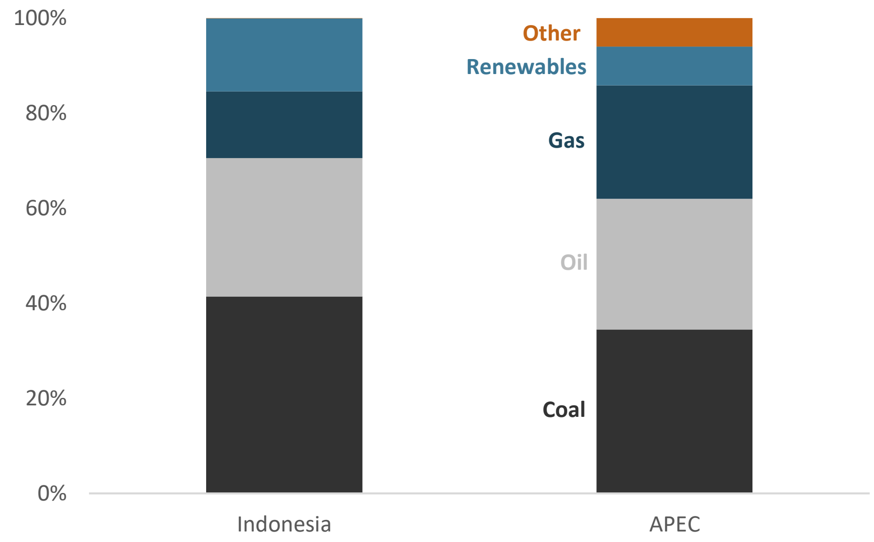
Source: EGEDA (2022)

Natural gas supply also declined in 2020 by about 13% compared to the previous year, amounting to about 1 417 PJ, which is the lowest level of gas supply in TPES in the past decade (EGEDA, 2022).

Coal supply slightly increased in 2020 and it is still the dominant fuel in TPES (41%). Coal in Indonesia is mainly used for power generation, and in 2020, from 131 million tonnes of domestic coal consumption, around 105 million tonnes (80%) were consumed by the power sector (MEMR, 2021a).

On the other hand, the renewable energy supply showed a significant increase of about 7% in 2020, with the result that its share in TPES increased from 14% in the previous year to 15% in 2020.

Figure 3: Energy supply mix – Indonesia and APEC, 2020



Source: EGEDA (2022)

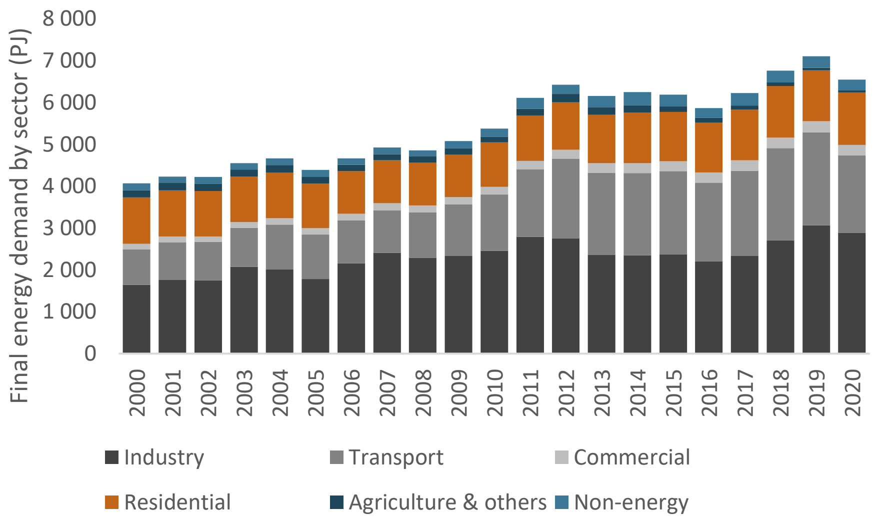
As of 2020, fossil fuels accounted for more than 80% of Indonesia's energy supply and that of the APEC region at large (Figure 3). In Indonesia, coal accounted for a slightly higher share of the fuel mix than in APEC. The amount of oil was proportionally larger in Indonesia at 29%, compared with 27% in the APEC region. High demand from the transport sector drove up the proportion of oil to 29%. Renewable energy in Indonesia (15%) was almost double that of APEC (8%), while, gas was recorded at 14% in Indonesia as opposed to 24% in APEC.

Total final consumption

Indonesia's final energy demand decreased by almost 8% in 2020 compared to 2019 (Figure 4). Total final consumption was 6 542 PJ in 2020. The transport sector's energy consumption decreased by more than 16% in 2020, falling by more than 360 PJ, which was the biggest drop compared to other sectors in 2020. The official lockdown and lower levels of mobility due to the COVID-19 pandemic explain most of this fall.

The final energy demand for industry also fell, though as not deeply as in the transport sector, decreasing by 6% in 2020 compared to the year before to the level of 2 879 PJ. Nevertheless, with this drop in 2020, industry still has consistently been the largest energy consuming sector for multiple decades.

Figure 4: Indonesia final consumption by sector (PJ), 2000 to 2020

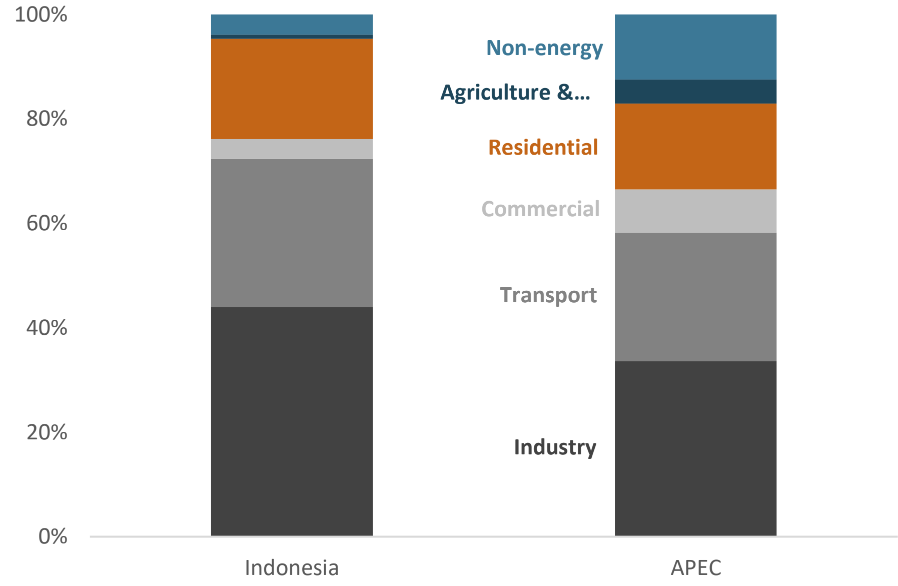


Source: EGEDA (2022)

In 2020, the commercial, agricultural, and other sectors consumed around 300 PJ, representing also significant percentage decrease compared to the year before, though Figure 4 shows that these sectors only accounted for a small proportion of all end-use consumption.

In contrast, the residential sector's final energy demand increased by around 3.5% in 2020. Travel limitations and an increasing trend of working from home during the COVID-19 pandemic boosted the final energy demand in the residential sector.

Figure 5: Final consumption by sector, Indonesia and APEC, 2020



Source: EGEDA (2022)

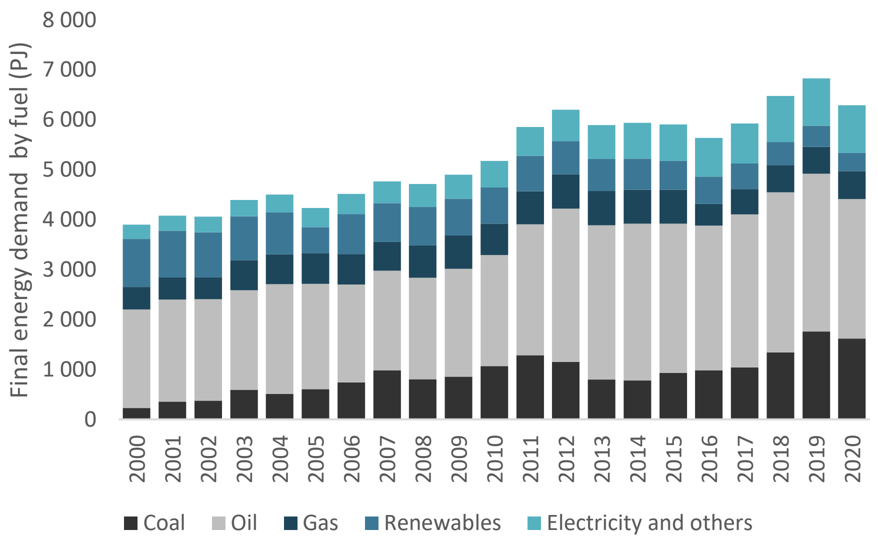
The transport, industry and residential sectors accounted for the largest proportion of final energy demand in Indonesia and the APEC region in 2020 (Figure 5). Industry energy consumption was the most prominent, followed by transport and residential, in both Indonesia and APEC.

The industry share was around 44% of total consumption in Indonesia, while in APEC the share was around 33%. The transport sector's share for Indonesia (28%) was a little higher than APEC (24%) in 2020. It was the same story for the residential sector's final energy demand, where the figure for Indonesia was 19% while in APEC it was 16%. The significant difference was that the non-energy share in APEC was significantly high compared to Indonesia in 2020.

Final energy demand

Over the past several decades, oil has represented the bulk of Indonesia's final energy consumption mainly consumed in the transport sector, though its share in final energy demand has been falling since 2018. In 2020, the oil demand dropped by around 12% compared to the previous year as the transport demand decreased significantly and as a result the oil demand share became 44% in 2020 (Figure 6).

Figure 6: Indonesia final energy demand by fuel (PJ), 2000 to 2020



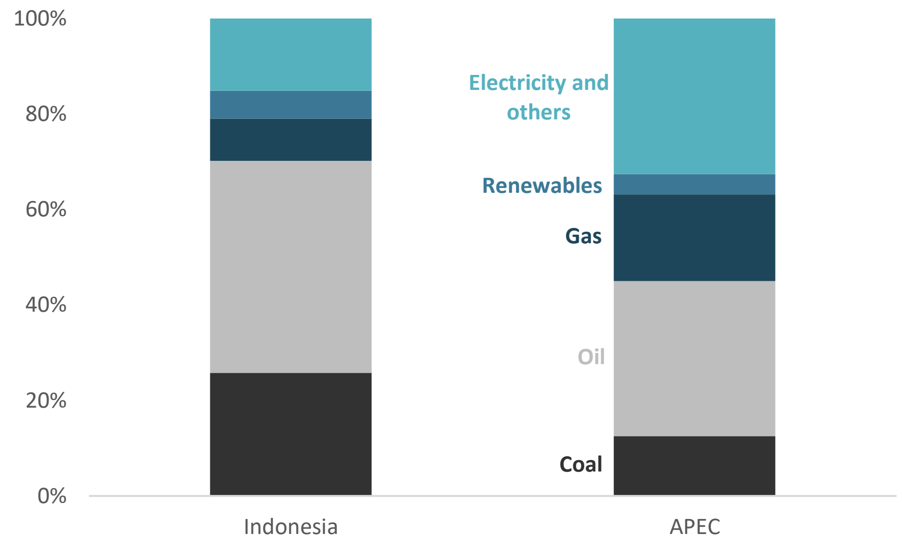
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products.

Coal in final energy demand (FED) is mainly consumed in the industry sector applications. As the industry's activities were slowing down due to the COVID-19 pandemic, the coal demand in FED declined by 8% in 2020. Renewable consumption in FED also fell in 2020, reducing its share of the final energy demand to 5.8%.

Natural gas consumption increased, accounting for about 554 PJ in 2020, with its share increasing only marginally to 8.8% of Indonesia's final energy demand. Electricity and other sectors' demand also slightly increased in 2020, increasing slightly their share to 15% (EGEDA, 2022).

Figure 7: Final energy demand fuel share, Indonesia and APEC, 2020



Source: EGEDA (2022)

Indonesia's final energy demand is dominated by oil (44%) and coal (26%) with both together representing a 70% share in 2020 (Figure 7). In contrast, oil and coal in APEC's energy share represented about

45%. Electricity and others in APEC had a significantly high share of about 33%, while in Indonesia it was just 15%.

Nevertheless, as can be seen in Figure 7, the renewables share was slightly higher in Indonesia than in APEC in 2020; around 6% for Indonesia and about 4% in APEC generally.

Transformation

Power sector

In 2020, 290 terawatt-hours (TWh) of electricity was generated, a slight decline of about 1.1% compared to 2019. Indonesia's power sector has been increasingly reliant on coal (Figure 8), with coal's share in electricity generation increasing from 37% in 2000 to 62% in 2020 (EGEDA, 2022).

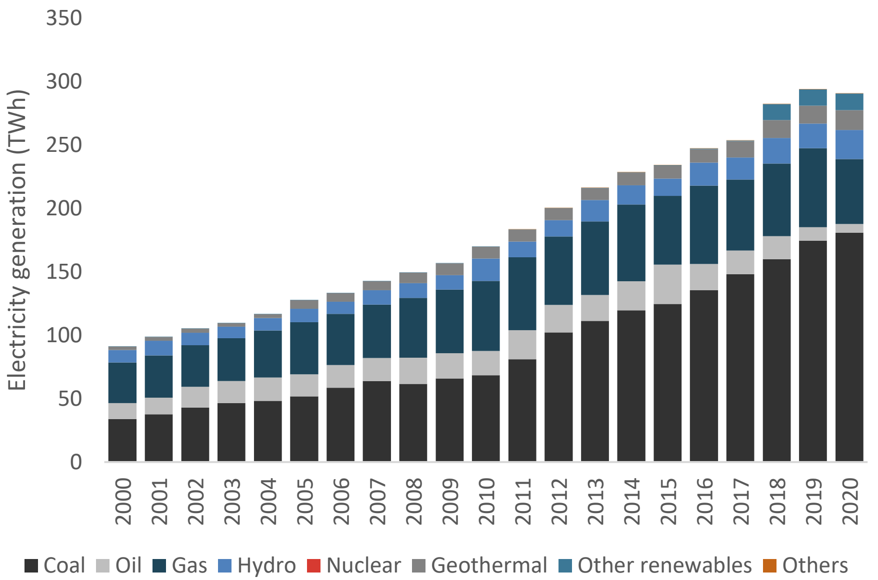
Indonesia's installed electricity generation capacity in 2020 was about 73 GW, which comprised both on- and off-grid generation (MEMR, 2021a). This capacity increased by 3.1 GW compared to total capacity in the previous year, dominated by coal capacity additions of about 1.9 GW (MEMR, 2021a), and this explained the increasing coal generation in 2020, while the total electricity generation was slightly decreased in 2020 (Figure 8).

Coal supply for power generation is mainly produced domestically. In 2020, even though the coal production decreased, the domestic coal for power generation increased, amounting to 105 million tonnes (MEMR, 2021a).

Electricity generation from gas decreased significantly by 18% in 2020, resulting in a fall of the gas share in electricity generation from 21% in 2019 to 18% in 2020 (EGEDA, 2022).

However, renewable energy generation from hydro, geothermal and other sources is relatively small in its share, but increased significantly by around 11%, with the greatest increase from hydro power (EGEDA, 2022). The new addition of hydro power generation capacity of around 144 MW (MEMR, 2021a) partly explained the increased overall generation.

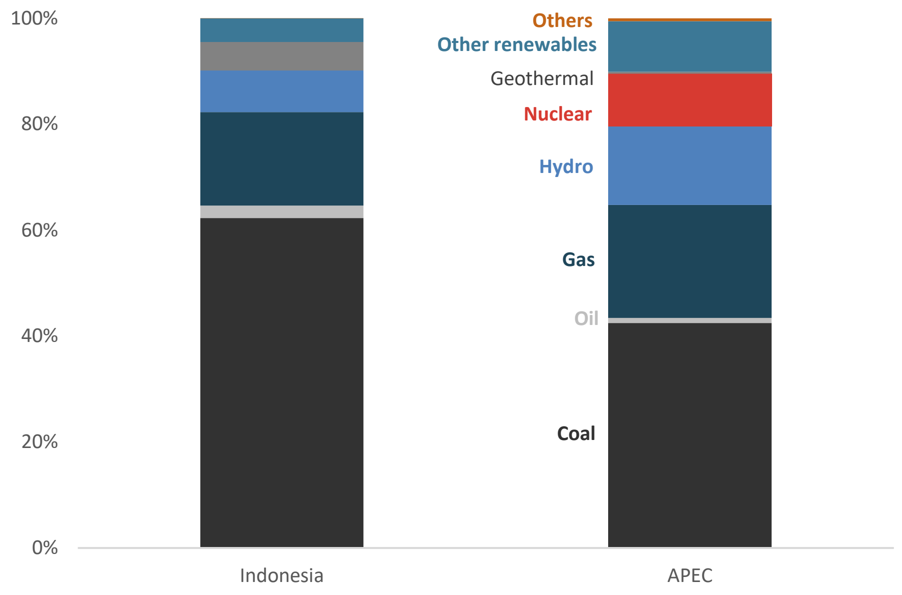
Figure 8: Indonesia electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In contrast to the generation mix for APEC in 2020, coal dominates Indonesia's power sector (Figure 9). Indonesia produced 62% of its electricity from coal, compared with 42% in APEC. There were almost the same percentages of gas in Indonesia and APEC, at 18% and 21% respectively. A proportionately lower amount of hydropower is generated in Indonesia than in APEC (8% as opposed to 15%). Geothermal generation in Indonesia accounted for 5% of its total energy generation, which was large in comparison to other APEC economies' negligible shares. Other renewables' generation in Indonesia is expected to grow due to abundant renewable potential and increasingly cost-competitive technologies.

Figure 9: Electricity generation fuel share, Indonesia and APEC, 2020



Source: EGEDA (2022)

Refining

In 2021, they were eight operating oil refineries in Indonesia, with a total refinery capacity of 1 151 MBSD (million barrels of steam per day), with the biggest refinery capacity is located in Cilacap (MEMR, 2021a). The crude oil input for the refineries comes both from domestic sources and imports. Imported crude oil fulfilled around one-third of refinery demand in 2021 (MEMR, 2021a).

The currently operating refineries produced in total around 255 048 thousand BOE (barrels of oil equivalent) in 2021, which satisfied around 60% of the fuel final energy consumption in 2021 (MEMR, 2021a).

Energy transition

In 2021, Indonesia announced its net-zero intentions by issuing its Long-Term Strategy on Low Carbon and Climate Resilient Development (LTS-LCCR) 2050 documents, containing its intentions for achieving towards net-zero emissions by 2060. In 2022, Indonesia updated its nationally determined contribution (NDC). In this new enhanced NDC, Indonesia increased its commitment to the emission reduction target of 2030. In the energy sector, MEMR and IEA launched Indonesia's Net Zero Emission (NZE) roadmap in September 2022 (MEMR, 2022a).

The roadmap identifies several mitigation actions to achieve Indonesia's NZE target, which include massive development of renewables with a focus on solar, hydro, and geothermal, the gradual phase down of coal power plants, improving transmission connectivity and CCS/CCUS, conversion to electric vehicles, improving energy efficiency and the use and development of nuclear, hydrogen, and ammonia in the energy sector (MEMR, 2022a).

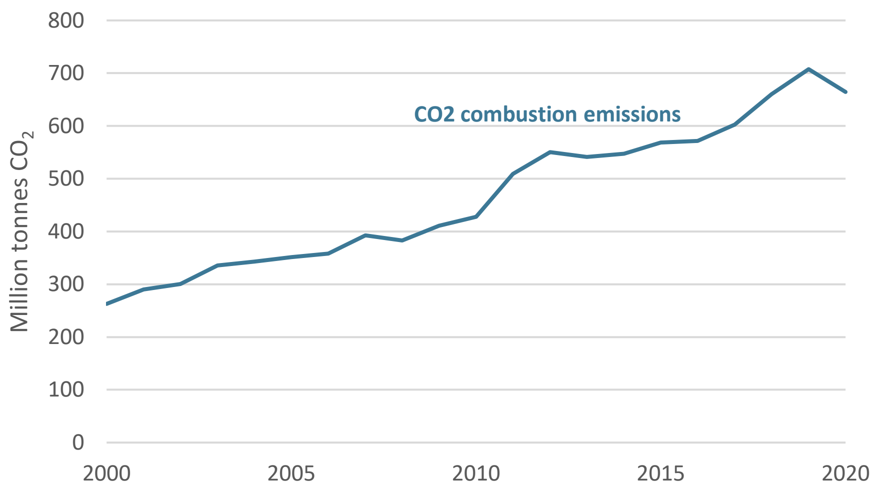
The Just Energy Transition Partnership (JETP) is expected to be able to accelerate the energy transition in Indonesia. The JETP is also aiming for a more ambitious energy transition target in Indonesia, which includes a peaking date for power sector emissions by 2030 and accelerated coal plant retirement (Embassy, 2022).

Emissions

Based on the recorded CO_2 emissions from combustion activities in the energy sector, Indonesia's CO_2 combustion emissions have maintained an increasing trend for the past two decades (Figure 10).

On average, the CO_2 combustion emissions increased by 4.7% CAGR from 2000, though we can see that in 2020 the emissions decreased by about 6% compared to 2019.

Figure 10: Indonesia CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Coal, oil and gas have dominated Indonesia's energy supply. In 2020, the three fossil fuels represented an 85% share of TPES with coal having the biggest share of 41% (EGEDA, 2022). Most of the fossil fuel supply is produced domestically in Indonesia, as currently Indonesia is a net energy exporter, securing the availability of energy for the economy especially from coal and gas. However, for oil (crude oil and oil products), Indonesia has shifted from being a net oil exporter to being an importer (EGEDA, 2022), exposing further the Indonesia's oil supply security to the global market fluctuation. Nevertheless, Indonesia's self-sufficiency rate (energy production/TPES) was still considerably high at 189% in 2020 (EGEDA, 2022).

To maintain affordability of the energy demand, Indonesia has regulated the energy price for domestic consumption. In 2022, the economy still continued the domestic market obligation policy for coal, which imposed the coal miners to allocate 25% of their coal production for domestic consumption and capped the coal price at 70 USD/ton for electricity and 90 USD/ton for the industry. The same is true for gas, since Indonesia has set fixed prices for gas used for electricity and specific type of industries from 2021 to 2024 (MEMR, 2022b).

APEC energy goals

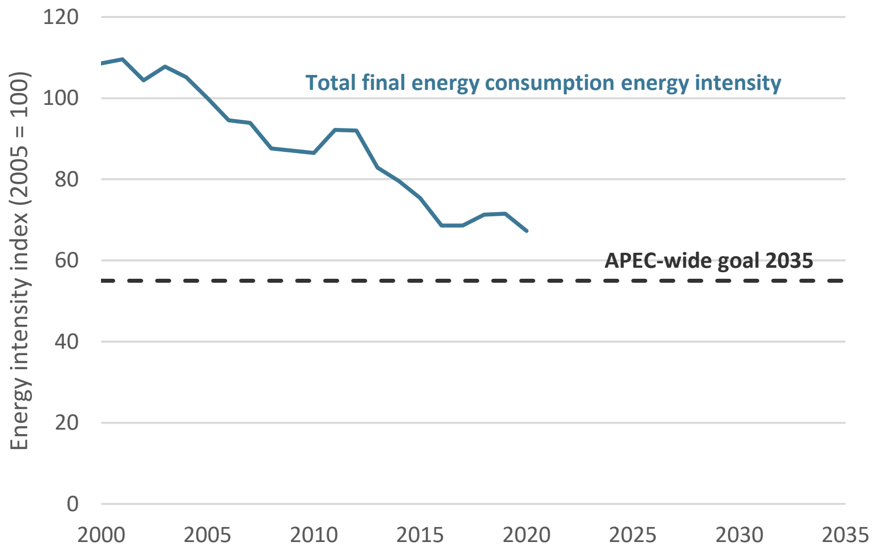
There are two energy-related objectives that APEC member economies have agreed to meet collectively: improving energy intensity and increasing the share of renewables in their energy mix.

Energy intensity goal

In 2011, APEC member economies agreed to increase their ambitions to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline. APEC is on track to meet this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track individual APEC economies' progress in relation to the overarching proportional improvement.

In 2020, Indonesia's total final energy consumption intensity (not including non-energy) improved by around 33% relative to 2005. This has contributed to APEC's overall commitment to improve energy intensity by 45% by 2035, as shown in Figure 11.

Figure 11: Indonesia total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



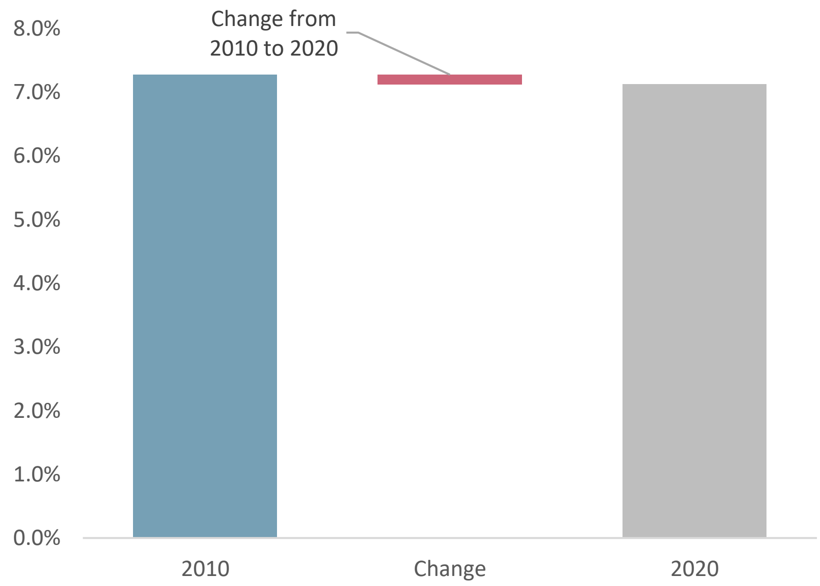
Source: EGEDA (2022)

Doubling of Renewables

The second energy goal involves doubling modern renewables' share in the APEC energy mix for 2010–2030. Modern renewables do not include traditional biomass, and the share is relative to final energy consumption (excluding non-energy consumption).

There is no economy-level goal for individual member economies. However, it is possible to calculate the relative improvement of individual economies to understand how they can contribute towards the doubling goal.

Figure 12: Indonesia modern renewable energy share, 2010 and 2020

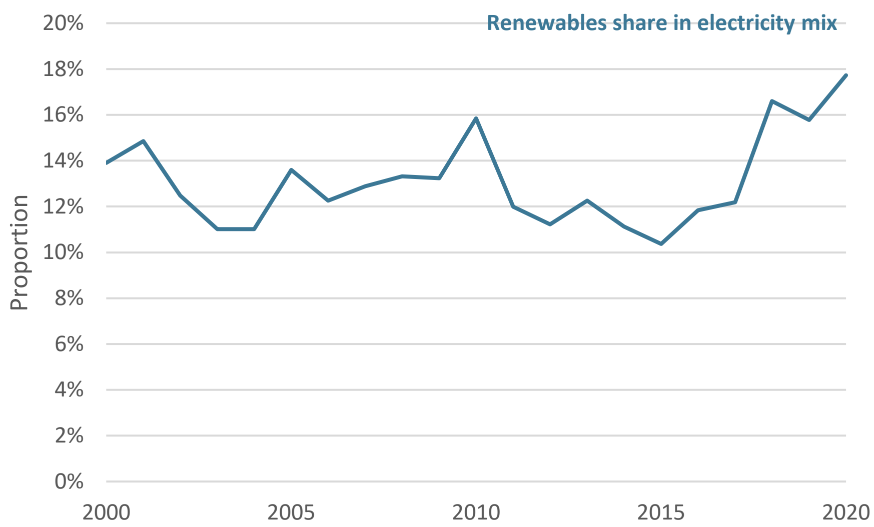


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Indonesia's share of modern renewables in its final energy consumption in 2010 was 7.3%. In 2020, that proportional share was 7.1% (Figure 12). In the past decade, use of fossil fuels, especially coal and oil, has increased in Indonesia to meet the fast-growing energy demand (EGEDA, 2022). The modern renewable shares in the 2020s have actually been bigger than in 2019. The decreasing fossil fuel demand, especially from oil in final energy consumption and increasing renewables in electricity generation contributed to the increase. Indonesia's policy towards achieving net-zero emissions by 2060 or sooner will probably increase the share of renewables in the economy.

Figure 13: Indonesia renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Based on the EGEDA data, the share of electricity generation from renewables in Indonesia increased to 18% (Figure 13), which was a significant increase from previous year of around 16% (EGEDA, 2022).

Hydro and geothermal were still the two dominant forms of renewable electricity generation in 2020 (MEMR, 2021a). With Indonesia's intention to achieve net-zero emissions, combined with its extensive deployment of renewable power generation, Indonesia is likely to increase its renewable share of power generation.

Energy policy

Energy policy	Details	Reference
General Plan of National Energy	Indonesia has renewable energy targets in the energy mix of 23% in 2025 and 31% in 2050.	Ministry of Energy and Mineral Resources
General Plan of National Electricity	Electricity generation targets are 23% renewables, 22% natural gas, 55% coal, 0.4% oil by 2025. For 2038, targets are 28% renewables, 25% natural gas, 47% coal, 0.1% oil.	Ministry of Energy and Mineral Resources
Enhanced Nationally Determined Contribution of Indonesia	Reduction target of 31.89% and conditional reduction target up to 43.2% of the business as usual scenario by 2030, with reduction targets for the energy sector 12.5% and conditionally 15.5%.	UNFCC
Coal gasification Program	Indonesia is prioritising coal gasification as a key energy security program. The first pilot program is delivery of the coal-to-dimethyl ether project in Sumatera. The constructed plant can produce 1.4 tons of Dimethyl Ether (DME) per year from 2027.	Ministry of Energy and Mineral Resources
One million barrels of oil production	Program to increase domestic oil production through investment in new oilfields and the use of enhanced oil recovery. Through this approach, oil production is expected to increase from 705 000 bpd currently to 1 million barrels per day and gas production to 12 BSCFD by 2030.	Ministry of Energy and Mineral Resources
The Refinery Development Master Plan	The refinery development master plan improves Indonesian energy security by mandating domestic processing of oil products. This is targeted to increase to 1.3 million bpd by 2025.	Pertamina
Green Refinery Project	The oil company produces 100% diesel from palm oil after converting the existing Cilacap refinery, producing 6 000 bpd from 2021.	Pertamina
New Simplified Gross Split production share contract	Indonesian plant to introduce new production share contract, simplified gross split, for oil and gas development in Indonesia.	Directorate General of Oil and Gas
Gas pricing policy for industry	The gas price for the industrial sector will be reduced to or close to USD 6/MMBTU for 2020-2024	Ministry of Energy and Mineral Resources
Gas pricing policy for electricity generation	The gas price for electricity generation will be reduced to or close to USD 6/MMBTU for 2020-2024	Ministry of Energy and Mineral Resources
Fuel conversion to LPG for small fishery boats	Indonesia continues its program to convert oil fuel to LPG for small fishery boats as an effort to reduce emissions.	Directorate General of Oil and Gas
City gas expansion program	Increases the share of gas supply to buildings, mostly residential buildings. City gas network expansion increases from up to 662.431 by 2021.	Directorate General of Oil and Gas
Biodiesel blending rate program increased from 30% to 35%	Mandatory biodiesel blending program starting from a 10% blend rate in 2016 to a 20% rate in 2019 and to a 30% rate in 2020, and a 35% rate from February 2023 onward.	Ministry of Energy and Mineral Resources

Energy policy	Details	Reference
Coal Domestic Market Obligation	Implementation of the Coal Domestic Market Obligation rate at 25% of each coal mining company's production, with a selling price of USD 70 per ton for power production in 2022	Ministry of Energy and Mineral Resources
Electric Vehicle (EV) Development Program	Target for light duty EVs to reach 2 million units and electric motorcycles to reach 13 million units by 2030.	Directorate General New and Renewable Energy and Energy Conservation
The 2-wheeler Internal Combustion Engine (ICE) motorcycle conversion program	Currently, 121 million units of ICE two-wheeler motorcycles are in operation in Indonesia. To accelerate the electrification in the transport sector, Indonesia plans to launch an ICE to EV conversion program for two-wheeler motorcycles.	Ministry of Energy and Mineral Resources
Mandatory Energy Efficiency	Mandatory efficiency standards for home appliances (LED, lighting, air circulating and air conditioning)	Ministry of Energy and Mineral Resources
Energy Efficiency Improvement Program	The Indonesian government put forward a target to improve energy efficiency by 17% of energy saving in 2025 and by 39% in 2050 against business as usual energy consumption.	Ministry of Energy and Mineral Resources
Indonesia NZE Roadmap	Indonesia with cooperation with IEA launched its NZE roadmap for the energy sector of 2060.	Ministry of Energy and Mineral Resources
Accelerating renewable energy development	Indonesia has issued a new presidential regulation to accelerate the development of renewable energy and phase out its coal power generation plants.	Ministry of Energy and Mineral Resources
Indonesia aims to increase mineral-added value by developing downstream industries	Indonesia aims to increase mineral-added value by developing downstream industries (not only providing/exporting raw materials) and the battery industry to support electrification, especially in the transport sector (EV)	Ministry of Energy and Mineral Resources

Notable energy developments

Energy development	Details	Reference
Abadi LNG Project	Indonesia may form a consortium to take over Shell after Shell (35%) pulled out from the Masela Block (Abadi LNG Project). In this project, INPEX controls 65% and hopes to make a final investment in Masela in the latter half of this decade.	REUTERS

Energy development	Details	Reference
Pertamina begins the year 2023 with discovery of thousands of barrels of oil reserves.	Pertamina managed to find potential oil deposits and produce thousands of barrels of new oil reserves in the Rokan Working Area. There are four mainstay wells that are currently in focus because they have sizeable oil reserves, namely in the Minas, Petani, Benar, and Bekasap fields which produce between 1 000 and 1 400 barrels per day	Pertamina
Bio-CNG from palm plantation	Indonesia started to produce Bio-CNG from palm plantations. For the first phase, 25 installations started to be constructed to produce 387 000 M3 Bio-CNG.	Ministry of Energy and Mineral Resources
Extension of Operation 2055 : BP LNG Tangguh Terminal	The operation contract of LNG Tangguh Terminal operated by BP is extended from 2035 to 2055 with an expected new investment of USD 4.6 billion.	Ministry of Energy and Mineral Resources
Coal-to-Dimethyl Ether (DME) Conversion Program	The Coal-to-DME conversion program is a strategy to reduce LPG imports relied on by the buildings sector. DME production is expected to be 1.4 million tons per year in 2027, with a total investment value of around USD 2.1 billion	Ministry of Energy and Mineral Resources
Just Energy Transition Partnership Commitment with Indonesia	The EU and the IPG launched JETP with Indonesia. This long partnership aims to mobilise initial USD 20 billion over a three- to five-year period to achieve future ambitious climate and energy targets.	European Commission
Asia Zero Emission Community (AZEC)	Japan and Indonesia initiated the AZEC. With this initiative, Indonesia is prioritised to receive USD 500 million in funding to implement the energy transition.	Ministry of Energy and Mineral Resources
CCGT 275 MW in Sumatera	CCGT Riau, with a total capacity of 275 MW, started its operation in 2022.	Directorate General of Electricity

Useful links

BPH Migas, Downstream Oil and Gas Regulatory Agency – www.bphmigas.go.id or www.silvia.esdm.go.id

Directorate General of Electricity – www.djk.esdm.go.id

Ministry of Energy and Mineral Resources (KESDM) – www.esdm.go.id

Ministry of Transportation – www.dephub.go.id

Ministry of Industry – www.kemenperin.go.id

National Energy Council – www.den.go.id

PT Pertamina – www.pertamina.com

PT Pertamina Gas – www.pertagas.pertamina.com

PT PGN (Persero) – www.pgn.co.id

PT PLN (Persero) – www.pln.co.id

SKKMIGAS, Special Task Force for Upstream Oil and Gas – www.skkmigas-esdm.go.id

Statistics Indonesia (BPS) – www.bps.go.id

UNDP Indonesia – www.id.undp.org

World Bank – www.worldbank.org

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Japan

Introduction

Japan, located in northeast Asia, comprises several thousand islands, the largest ones being Honshu, Hokkaido, Kyushu and Shikoku. Most of its land area is mountainous and thickly forested. It has the third-largest economy in the world after fellow APEC economies, the United States and China. In 2020, Japan's real gross domestic product (GDP) was approximately USD 5 040 billion (2017 USD purchasing power parity [PPP]) (World Bank, 2022). The population of 126 million people enjoyed a per capita income of almost USD 40 000, which accounted for a -4.2% decrease in 2020 compared to 2019. The COVID-19 infection spread resulted in the suppression of human flows and a decline in production activities, affecting per capita income.

Japan's energy resources are modest, which means that it imports nearly all its fossil fuels to sustain its economic activities. Its proven reserves include approximately 44 million barrels of oil, 738 billion cubic feet (bcf) of natural gas and 350 million tonnes (Mt) of coal.

Every several years, the Japanese government formulates its Strategic Energy Plan to show the direction of Japan's energy policy. The Sixth Strategic Energy Plan, released in 2021, was formulated with two key themes: (1) making appropriate energy policies that will ensure carbon neutrality by 2050 and reduce greenhouse gas (GHG) emissions, and (2) presenting initiatives to ensure a stable energy supply and reduce energy costs in order to ensure safety and meet Japan's energy demands while acting against climate change (Ministry of Economy, Trade and Industry [METI], 2021).

The Act on Rationalizing Energy Use amendment was passed in the Plenary Session of the House of Councillors and enacted on 13 May 2022. The most remarkable revision of the act is expanding the Act on the Rationalization of Energy Use (e.g., improving energy consumption per unit) to include non-fossil energy. The Act on Rationalizing Energy Use amendment will become effective from April 2023.

Table 1: Japan's macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d, e]	
Area (million km^2) [a]	378	Oil (million barrels) [c]	44
Population (million) [b]	126	Gas (billion cubic feet) [c]	738
GDP (2017 USD billion PPP) [b]	5 040	Coal (million tonnes) [d]	350
GDP per capita (2017 USD PPP) [b]	39 940	Uranium (kilotonnes U < USD 130/kgU) [e]	6.6

Source: [a] GIS (2022); [b] World Bank (2022); [c] Conglin Xu and Laura Bell (2021); [d] BP (2022); [e] OECD (2020)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

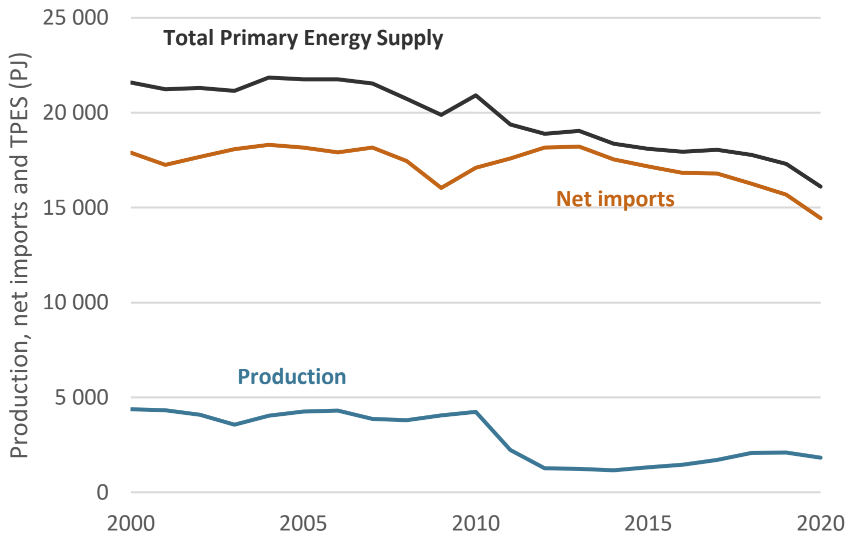
Energy supply and consumption

Total primary energy supply

Japan's total primary energy supply was 16 110 petajoules (PJ) in 2020, which represents an annual decrease of 6.9% (EGEDA [Expert Group on Energy Data Analysis], 2022) (Figure 1). After the Great East Japan

Earthquake, the role of fossil fuels became more important than that of nuclear power. Since 2013, thanks to the introduction of renewable energy and the restarting of nuclear power plants, the percentage of oil in the total primary energy supply has been decreasing for eight years (METI, 2022).

Figure 1: Japan's energy supply, production, and net imports (PJ), 2000 to 2020

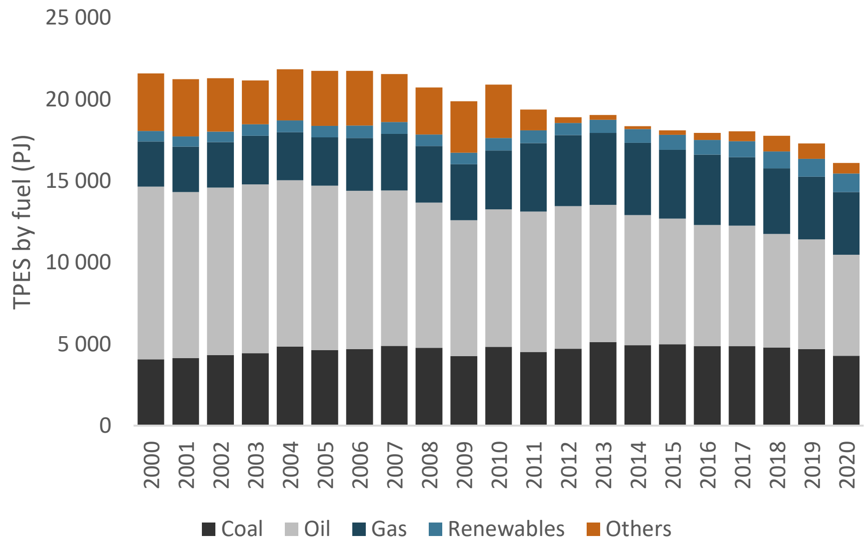


Source: EGEDA (2022)

In 2020, oil contributed the most (38%) to Japan's energy supply, followed by coal (27%) and natural gas (24%). Japan's energy supply is highly dependent on imports. The net energy imports comprised 90% of the total primary energy supply (EGEDA, 2022).

Japan was the sixth-largest oil consumer in the world following the United States, China, India, Saudi Arabia and Russian Federation and the fourth among APEC economies in 2021 (BP, 2022). In fact, almost all of Japan's oil requirements are met through imports. Dependency on Middle Eastern oil declined in the early and mid-2010s due to oil imports from Russia via the expansion of the Eastern Siberia Pacific Ocean pipelines. However, more recently, oil imports from Russia and other Asian regions have decreased, causing Japan's dependency on the Middle East bounce to back to 92% in FY 2020 (METI, 2022).

Figure 2: Japan's energy supply by fuel (PJ), 2000 to 2020



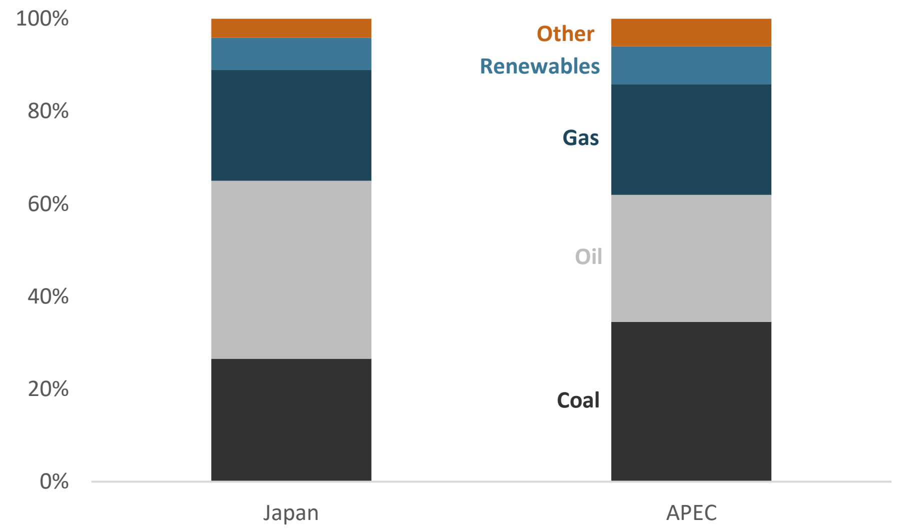
Source: EGEDA (2022)

Saudi Arabia, the United Arab Emirates and Kuwait were the three largest suppliers of oil to Japan in FY 2020 (METI, 2022). In 2020, the primary oil supply was 6 190 PJ, a decrease of 7.9% from the previous year (EGEDA, 2022) (Figure 2). In 2020, the primary coal supply was 4 270 PJ, a decrease of 8.8% from the previous year (EGEDA, 2022).

Almost all of Japan's coal was imported, making it one of the world's largest coal importers. Power generation, steel production and the cement industries are the main users of coal. Japan's main steam (or thermal) coal suppliers are Australia (68%), Russia (15%) and Indonesia (12%), as of FY 2020. The top suppliers for coking coal are Australia (50%), Indonesia (21%) and the United States (10%) (METI, 2022).

Like coal and oil, natural gas resources are scarce in Japan. In FY 2020, its domestic production stood at 2.3 billion cubic metres (bcm) and was mainly located in Niigata, Chiba and Hokkaido Prefectures (METI, 2022).

Figure 3: Energy supply mix – Japan and APEC, 2020



Source: EGEDA (2022)

In FY 2020, liquefied natural gas (LNG) imports met almost all of Japan's domestic demands. These imports were from Australia (37%), Malaysia (14%), Qatar (12%) and Russia (8.4%). The LNG imports to Japan accounted for 21% of the total global LNG trade in 2020.

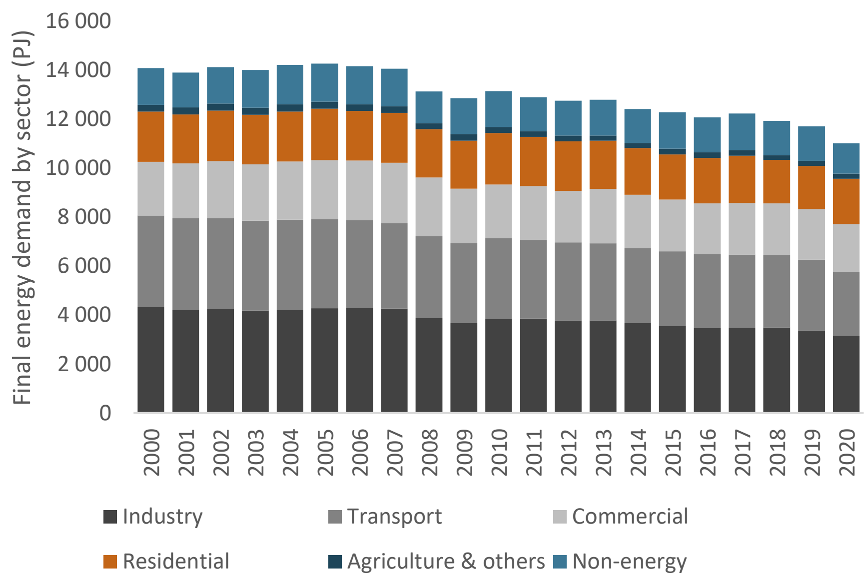
Electricity generation and city gas are the main use cases for natural gas in Japan (METI, 2022).

The primary natural gas supply was 3 860 PJ in 2020, an increase of 0.2% from the previous year. Japan has a larger share of oil (+11%) and a smaller share of coal (-8%), and there was almost no change for gas and renewables when compared to the entire APEC region (EGEDA, 2022) (Figure 3).

Total final consumption

Japan's final energy consumption (excluding non-energy uses) decreased by 5.1% to 9 770 PJ in 2020 from the previous year. Including non-energy would place the final consumption at just over 11 000 PJ.

Figure 4: Japan's final consumption by sector (PJ), 2000 to 2020



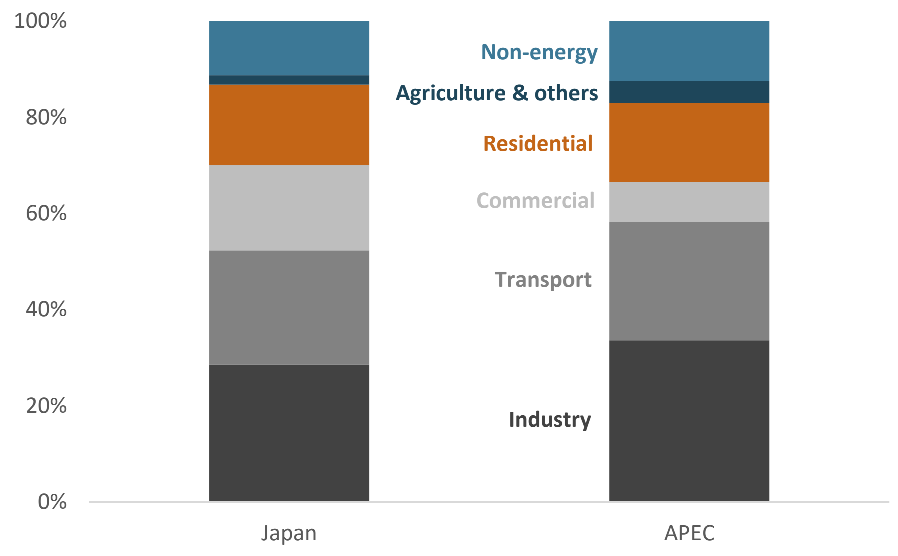
Source: EGEDA (2022)

Japan's consumption has been declining after peaking in 2005. The non-energy uses amounted to an additional 1 240 PJ of final consumption with a decrease of 12% in 2020 from 2019. In FY 2020, restrictions on the movement of people domestically and internationally due to the spreading of COVID-19 drastically affected economic activities. Owing to this, Japan's final consumption fell by more than 650 PJ from FY 2019 to FY 2020 (EGEDA, 2022) (Figure 4).

In 2020, the industry sector accounted for 29% of Japan's final consumption, followed by the transport sector (24%), the commercial sector (18%) and the residential sector (17%). The percentage of final consumption in the commercial sector of Japan is more than twice compared to that of APEC as a whole (8%) (EGEDA, 2022) (Figure 5).

In terms of final energy consumption by sector, a comparison between FY 2019 and FY 2020 shows that the manufacturing industry, which accounts for 70% of the industrial sector, experienced a decrease of approximately 10%. The transportation sector dropped by roughly 10%, while the residential sector conversely experienced an increase of about 5% during the period. The changes in final energy consumption in these two sectors are thought to be because demand for transport and other services fell due to the public's voluntary restraints on travel. Following the declaration of a state of emergency, the spread of teleworking and online classes led to people spending more time at home, which in turn resulted in more domestic energy use (METI, 2022).

Figure 5: Final consumption by sector, Japan and APEC, 2020

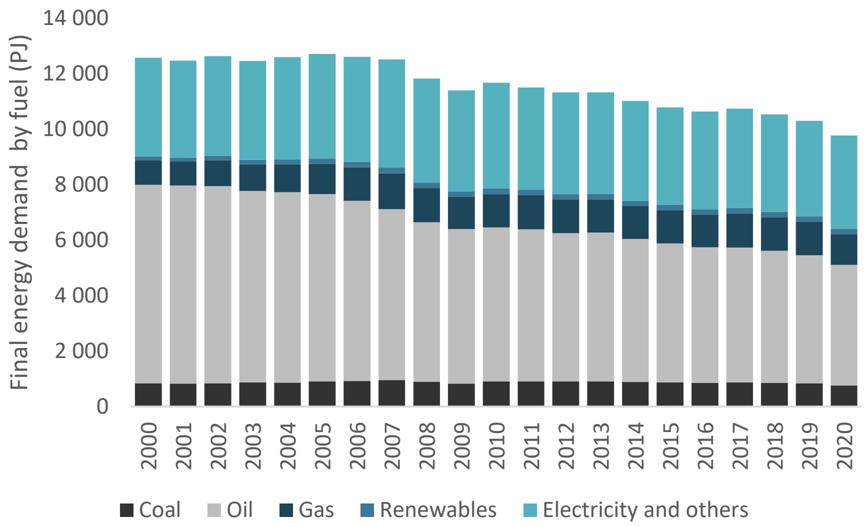


Source: EGEDA (2022)

Final energy demand

Regarding Japan's final energy demand, in 2020, oil constituted the largest share at 45%, electricity and others accounted for 35%, gas constituted 11%, and coal constituted 7.7%. The renewables share in this was still low at 1.9%. Compared with the entire APEC region, Japan had a large share of oil (+12%), electricity and others (+2%), and a smaller share of coal (–5%), gas (–7%) and renewables (–2%) (EGEDA, 2022) (Figure 7).

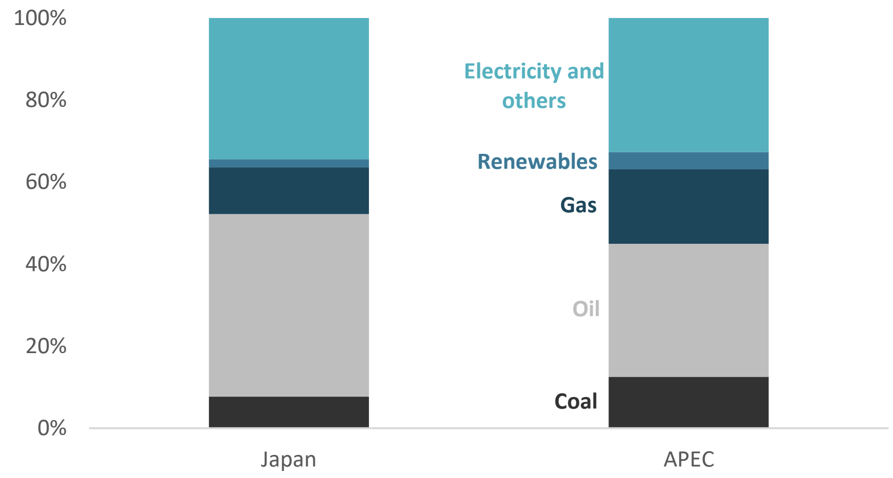
Figure 6: Japan's final energy demand by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

Note: Final energy demand excludes the non-energy sector

Figure 7: Final energy demand fuel share, Japan and APEC, 2020



Source: EGEDA (2022)

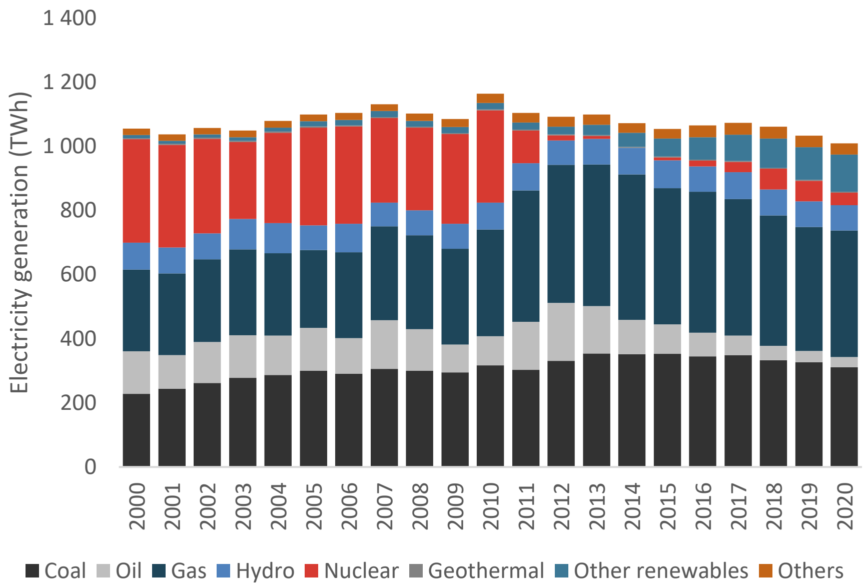
Note: Final energy demand excludes the non-energy sector

Transformation

Power sector

Japan had 265 gigawatts (GW) of installed generating capacity by electricity utilities as of November 2022 (METI, 2023a). It generated 1 009 terawatt-hours (TWh) of electricity in 2020. Fossil fuels – coal, oil and gas – constituted 73% of the generated electricity. Renewables, including hydro, solar, wind and geothermal, accounted for 20% of the generation. The remaining share was accounted for by nuclear energy (3.8%) (EGEDA, 2022) (Figure 8).

Figure 8: Japan's electricity generation by fuel, 2000 to 2020



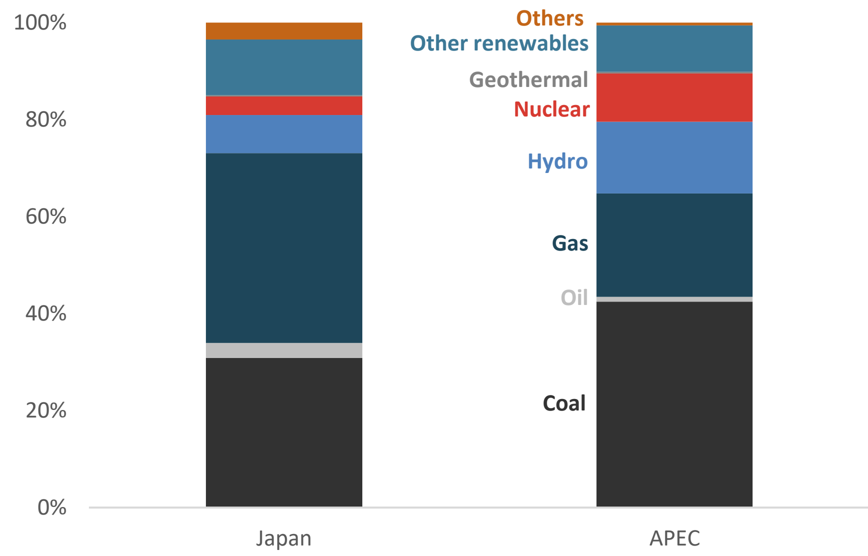
Source: EGEDA (2022)

Compared with the entire APEC region, Japan has a larger percentage of fossil fuels (+8%), significantly more gas (+18%), and a smaller share of hydro (–7%) (EGEDA, 2022) (Figure 9).

In 2021, the Mihama Units three nuclear power plants resumed operations (METI, 2022). It is worth noting that many of the reactors have not been operating since the Fukushima Daiichi nuclear power plant accident in 2011. As of December 2022, 10 commercial reactors had begun operating again (METI, 2023b).

Since 1995, the Japanese electricity market has been undergoing a process of liberalisation to ensure fair competition and transparency. Liberalisation diminishes monopoly power by facilitating competition in the electricity market, where practical. Japan's partial liberalisation enabled businesses other than electricity companies to sell electricity. Independent power producers were introduced in 1995, and a system of power producers and suppliers (PPSs) and partial retail competition (for purchases over 2 000 kW) was established in 2000. The scope of the retail competition was expanded to include contracts larger than 500 kW in 2004 and larger than 50 kW in 2005 (METI, 2011).

Figure 9: Electricity generation fuel share, Japan and APEC, 2020



Source: EGEDA (2022)

As a result of the earthquake and nuclear power accident in March 2011, due to limitations in the capacity of the east-west frequency conversion facilities and inter-regional interconnection lines, it was not possible to sufficiently operate the wide-area grid and supply electricity. Afterwards, Japan's electricity sector faced mounting pressure to deregulate even more to create a more competitive and transparent system. Finally, in 2016, the retail electricity market was fully liberalised. As of December 2021, the sales share of PPS reached around 22% (METI, 2022).

Energy transition

Securing a stable energy supply is vital for Japan, which has few natural energy resources. But in securing this energy supply, emissions considerations are becoming increasingly important.

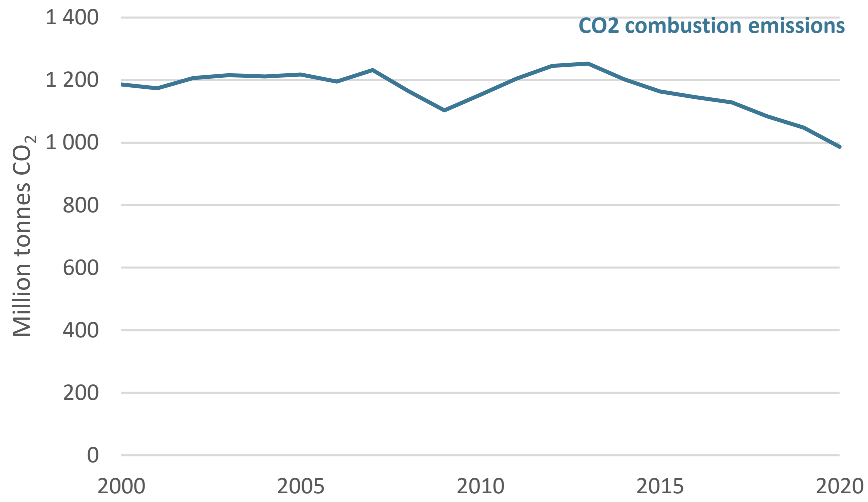
Emissions

In Japan, achieving carbon neutrality by 2050 has been made a fundamental principle in law. In addition, the government set an ambitious target of a 46% reduction in greenhouse gas emissions by 2030 compared to 2013, with a further challenge to reach the 50% reduction, which it submitted to the United Nations Framework Convention on Climate Change（UNFCCC) as the 'NDC of Japan'. (MoE, 2022)

Japan's CO_2 combustion emissions have reduced remarkably in the last few years. The total CO_2 combustion emissions were reduced by 21% in 2013 from 2020 (EGEDA, 2022) (Figure 10).

In addition, in developing economies where energy consumption is expected to increase significantly, it is essential to improve their energy efficiency to reduce the increasing CO_2 emissions associated with fossil energy use. Therefore, developed economies, including Japan, are expected to support that. (METI, 2022)

Figure 10: Japan's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Japan is strengthening its energy security by building cooperative systems with other economies and accelerating the introduction of renewable energy that can be produced domestically. At the same time, Japan continues operating nuclear power plants and developing thermal power plants that have the potential for low emissions by using ammonia co-combustion in the boiler, and other techniques. Moreover, carbon capture and utilisation (CCU) and carbon capture, utilisation and storage (CCUS) projects have been implemented to ensure energy security alongside achieving carbon neutrality (METI, 2022).

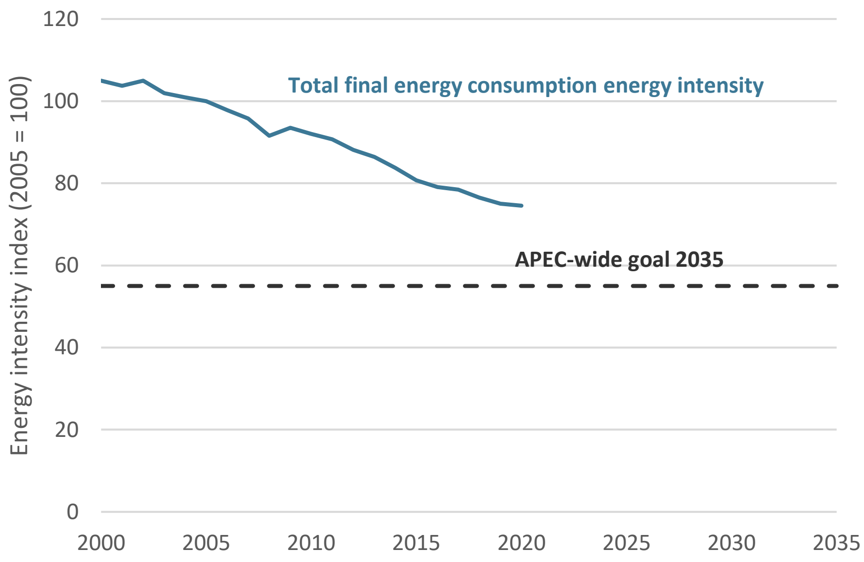
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 11: Japan’s total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

While energy intensity in Japan has improved remarkably in the last few decades, the total final energy consumption (excluding non-energy uses) intensity improved by 0.5% from 2019 to 2020 (EGEDA, 2022).

The Energy Conservation Law, established in 1979 after the oil crisis, is the basis of all energy conservation policies in Japan. It requires energy efficiency improvements for the industrial, building (commercial and residential) and transport sectors (METI, 2019). Due to this, Japan achieved a 26% improvement in energy intensity from 2005 to 2020 (EGEDA, 2022) (Figure 11).

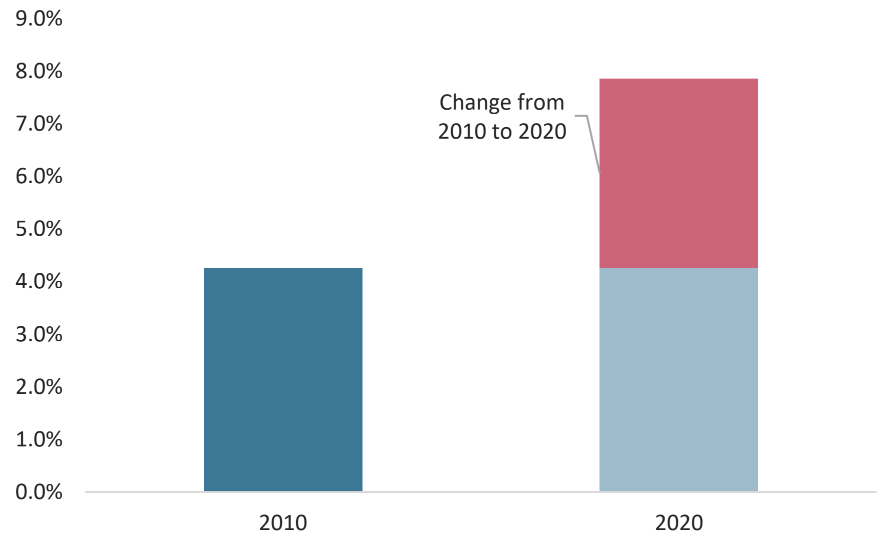
Doubling of Renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix from 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by respective economies will contribute to the doubling goal.

There has been a massive improvement in the renewable energy share of final energy consumption for the last decade in Japan. Japan's renewable energy share of final energy consumption was 7.9% in 2020, which means it improved by 84% from 2010 to 2020 (EGEDA, 2022) (Figure 12).

This improvement was caused by the introduction of the feed-in tariff; a system under which the government committed to purchase electricity generated from renewable energy sources for a certain period at a specific price from utility companies in July 2012. Consequently, the introduction of renewable energy expanded rapidly, with the amount of renewable energy introduced approximately four times higher than before the project started (METI, 2022).

Figure 12: Japan’s modern renewable energy share, 2010 and 2020



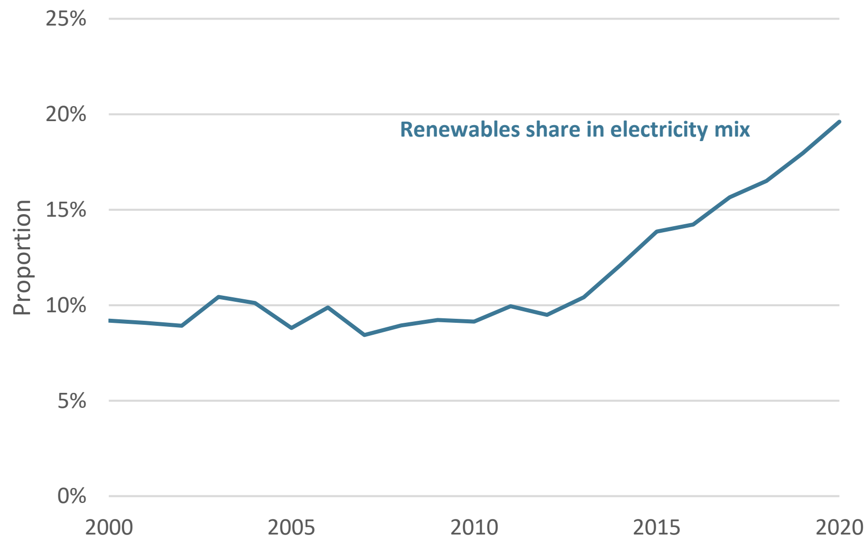
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Japan's renewable generation share in the electricity mix increased from 9% to 20% between 2000 and 2020. This means the renewable share in the electricity mix has increased by 2.1 times within 20 years (EGEDA, 2022) (Figure 13).

Although the cost of renewable generation in Japan has been steadily declining, it is still high compared with international standards. To achieve a renewable energy target of about 36-38% of the electricity mix in FY 2030, it will be necessary to reduce the generation cost of renewable energy (METI, 2022).

Figure 13: Japan’s renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Japan's Nationally Determined Contribution (NDC)	In 2021, at the Leaders' Meeting on the Climate, the Economic Leader declared a new target of a 46% GHG emission reduction by FY 2030, compared to FY 2013.	MOE
The Plan for Global Warming Countermeasures	This provides measures that businesses, citizens, and multiple levels of governments should implement to achieve the target of a 46% reduction in GHG emissions by FY 2050.	METI
The Long-Term Strategy under the Paris Agreement	The strategy is formulated by the Government of Japan as a long-term low GHG emission development strategy in accordance with the provisions of the Paris Agreement.	United Nations Climate Change
Task Force on Climate-related Financial Disclosures (TFCD) Guidance	METI released the TCFD Guidance in 2018. The guidance has since been revised and 'Green Investment Guidance 2.0' was released by a private sector-led initiative.	TCFD Consortium
Plan for Global Warming Countermeasures of the Ministry of Agriculture, Forestry and Fisheries	This includes various measures to reduce and absorb GHG and to adapt to climate change. This was revised in October 2021 to ensure carbon neutrality by 2050.	MAFF
Climate Change Adaptation Plan of the Ministry of Agriculture, Forestry and Fisheries	This prompts leading production fields to disseminate adaptive techniques to avoid or lessen influences of high temperature (caused by climate change) and introduce breeds with high-temperature tolerance. It was revised in October 2021.	MAFF
J-Credit Scheme	The government certifies carbon dioxide (CO_2) reduction or absorption volumes as credit. Credit creators can sell their credits, while buyers use purchased credits for various purposes such as Corporate Social Responsibility and carbon offset.	METI
The Biomass Town Plan	Japanese local governments and private corporations have established biomass towns using agricultural residues, livestock waste, forestry residues, food waste and sewage sludge, which are converted into electricity, heat, ethanol, etc.	MAFF

Act on the Rational Use of Energy	This secures the effective utilisation of fuel resources in accordance with economic and social conditions related to energy in and outside Japan by taking the necessary measures for the rationalisation of energy use.	METI (Only in Japanese) Translation
FIT Law and its revision	This creates a new authorisation system, a revised method of setting purchase prices, a change of the purchaser of renewable energy (from the retail electric power company to the power transmission and distribution company) and a revision of the arrangements for reducing surcharges on electricity rates.	METI
Introduction of Feed-in Premium (FIP)	Introduction of FIP started from April 2022.	METI
Electricity System Reform	This aims to expand nationwide coordination of transmission operators, achieve full liberalisation of electricity retail business and generation, and secure the neutrality of the power transmission and distribution sectors.	METI
Baseload Market	This ensures equal access to cheap power supplies for new power retail companies as part of reforms to foster competition in the market.	METI
Establishing Resilient and Sustainable Electricity Supply Systems	This aims to secure sustainable electricity supply systems by implementing various measures, including requiring electricity transmission/distribution businesses to formulate action plans on their collaboration in disaster responses, establishing a new scheme for supporting businesses in introducing renewable energy, and adding new functions to those provided by the Japan Oil, Gas and Metals National Corporation (JOGMEC).	METI
JOGMEC's Financial Assistance to Japanese Companies	This encompasses multiple projects with equity capital and liability guarantees.	JOGMEC
Japan Bank for International Cooperation (JBIC) Support	This provides export loans, overseas investment loans, import loans, united loans, equity participation and guarantees.	JBIC
Roadmap for Carbon Recycling Technologies	Taking into account the concept of carbon recycling technology, CO_2 is considered as a source of carbon. In this regard, CO_2 will be recycled into concrete through mineralisation, into chemicals through artificial photosynthesis and into fuels through methanation to reduce CO_2 emissions into the atmosphere.	METI
Local Governments' Initiatives to achieve Net-zero Carbon Emissions by 2050	In Japan, as of March 2022, 679 local governments, including those of Tokyo, Kyoto and Yokohama, have announced their commitment to achieve net-zero carbon emissions by 2050.	MOE

Joint Statement on Japan–United States Strategic Energy Partnership	Both economies agreed to establish a free and competitive energy market, strengthen partnerships between private corporations, and work on the integration of the energy market in this region.	METI
Basic Plan for the Promotion of Biomass Utilisation	Promoting utilisation of biomass as energy or products to contribute to resolving the issues Japan faces, such as the revitalisation of rural areas, the prevention of global warming and the formulation of a recycling-oriented society.	MAFF
A New Strategic Roadmap for Hydrogen and Fuel Cells	Under this roadmap, a revised version of the Strategic Roadmap for Hydrogen and Fuel Cells was released, which included new goals and specific explanations of the efforts to be made.	METI
LNG Producer–Consumer Conference 2022	Since 2012, the LNG Producer–Consumer Conference has been held every year in Japan by METI as a platform for exchanging ideas and enhancing cooperation among producers, consumers and all the key stakeholders of the LNG market.	LNG Producer–Consumer Conference
Fourth Hydrogen Energy Ministerial Meeting	Delegates from 29 economies, regions, international organisations (among them 18 leaders) and company representatives delivered messages and shared information about their efforts, challenges and policy directions to help further the cause of using hydrogen globally in the future.	METI

Notable energy developments

Energy development	Details	Reference
Amendment to the Act on Rationalising Energy Use	On 13 May 2022, the amendment to the Act on Rationalising Energy Use was passed in the Plenary Session of the House of Councillors and enacted. The revisions and additions of the amended Act are as follows. ・Expands the Act on the Rationalisation of Energy Use (e.g., improving energy consumption per unit) to include non-fossil energy. ・Calls on large-scale energy consumers to report their non-fossil fuel usage and submit their plan to transition from fossil to non-fossil energy.	METI

	・Describes high volume energy users' obligation to report their demand response efforts and electricity utilities to prepare electricity fee programs. And promote demand response-ready appliances. These will become effective from April 2023.	
Amendment to the Energy Consumption Performance of Buildings Act	・There was an improvement to include the requirement that all housing and small-scale buildings should meet energy efficiency standards by FY 2025.	MLIT
Tokyo GX (Green Transformation) Week	・This was held from 26 September to 7 October 2022, and aimed to shift economic, social and industrial structures that have depended on fossil fuels to structures driven by clean energy.	METI

Useful links

Agency for Natural Resources and Energy – https://www.enecho.meti.go.jp/en/

Ministry of Economy, Trade and Industry – https://www.meti.go.jp/english/index.html

Ministry of the Environment – http://www.env.go.jp/en/index.html

Institute of Energy Economics, Japan – https://eneken.ieej.or.jp/

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Conglin Xu and Laura Bell (2021), '2021 worldwide oil and gas reserves down, oil production up modestly', *Oil & Gas Journal*, Vol. 119, Issue 12, Dec 2021.

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GIS (Geospatial Information Authority of Japan) (2022), *The Survey of Land Area,* https://www.gsi.go.jp/KOKUJYOHO/MENCHO/backnumber/GSI-menseki20221001.pdf

METI (Ministry of Economy, Trade and Industry)

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—(2019), *Overview of the Energy Conservation Law*, https://www.enecho.meti.go.jp/category/saving_and_new/saving/summary/pdf/20181227_001_gaiyo.pdf

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MoE (Ministry of the Environment) (2022), *White Paper on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2022*, https://www.env.go.jp/policy/hakusyo/r04/pdf.html

OECD (The Organisation for Economic Co-operation and Development) (2020), *Uranium 2020: Resources, Production and Demand*, https://www.oecd-nea.org/jcms/pl_52718/uranium-2020-resources-production-and-demand

World Bank (2022), *Open Data*, https://data.worldbank.org

Republic of Korea

Introduction

The Republic of Korea (Korea) is in Northeast Asia, situated between China and Japan. It has an area of 100 413 square kilometres (km^2) and had a population of 52 million as of 2020. Korea's population density is very high, with an average of more than 516 people per km^2. Around 20% of the population lives in Seoul, Korea's largest city and capital, and its population density reaches 15 839 people per km^2. The economy's geography consists of hills and mountains with wide coastal plains in the west and the south. The climate is relatively moderate, with four distinct seasons. Air conditioning is necessary during the tropical hot summers, and heating is required during the bitterly cold winters.

Over the past few decades, Korea has become one of Asia's fastest growing and most dynamic economies. Gross domestic product (GDP) reached USD 2 195 billion (2017 USD purchasing power parity [PPP]) in 2020. GDP per capita (2017 USD PPP) in 2020 was USD 42 336, approximately three times higher than in 1990.

Korea's major industries include semiconductors, shipbuilding, cars, petrochemicals, digital electronics, steel, and machinery parts and materials. Manufacturing accounted for about 28% of GDP in 2021, and economic activity has been driven by an export-oriented manufacturing sector. For example, Korea's EV (Electrical Vehicle) battery manufacturing industry is expanding its capability with emerging new mobilities.

Before and since a new government was launched following the presidential election in May 2022, the Korean government has faced global energy supply instability with the Ukraine crisis and post-COVID conditions. As it becomes more important to balance carbon neutrality and energy security, the new government continues to monitor the direction of changes in the global energy supply chain in order to derive an applicable and reasonable energy mix, releasing the new energy policy goals and directions in July 2022.

This consideration is partly due to the fact that Korea has few domestic energy resources. It has no oil resources except for a small amount of condensate, only 359 million tonnes of recoverable coal reserves and 0.3 trillion cubic feet of natural gas. To sustain its high level of economic growth, Korea imports large quantities of energy products.

Table 1: Korea's macroeconomic data and energy reserves

Key data [a, b, c]		Energy reserves [d]	
Area (km^2)	100 413	Oil (billion barrels)	-
Population (million)	52	Gas (trillion cubic feet)	0.3
GDP (2017 USD billion PPP)	2 915	Coal (million tonnes)	359
GDP per capita (2017 USD PPP)	42 336	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a KOSIS (2022); b EGEDA (2022); c World Bank (2022); d EIA (2021)

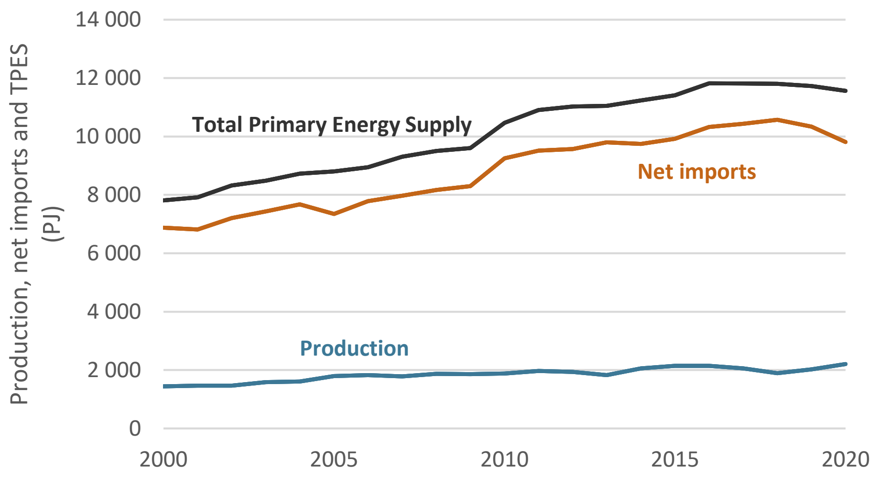
Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Energy supply and consumption

Total primary energy supply

Korea's total primary energy supply (TPES) almost tripled between 1990 and 2020, from 3 890 PJ to 11 560 PJ. From 1990 to 2000, energy supply increased at an average annual growth rate of 7.3%, exceeding the economic growth rate of 7.1% for the same period. After 2000, TPES increased by around 50%, from 7 811 PJ to 11 560 PJ. However, in the recent three-year trend from 2017 to 2019, there was a slight decrease of 0.8% (Figure 1). In 2020, there was a 1.4% decrease in energy supply came from coal and oil with the COVID-19 pandemic, compared to 2019 (EGEDA, 2022).

Figure 1: Korea's energy supply, production, and net imports (PJ), 2000 to 2020

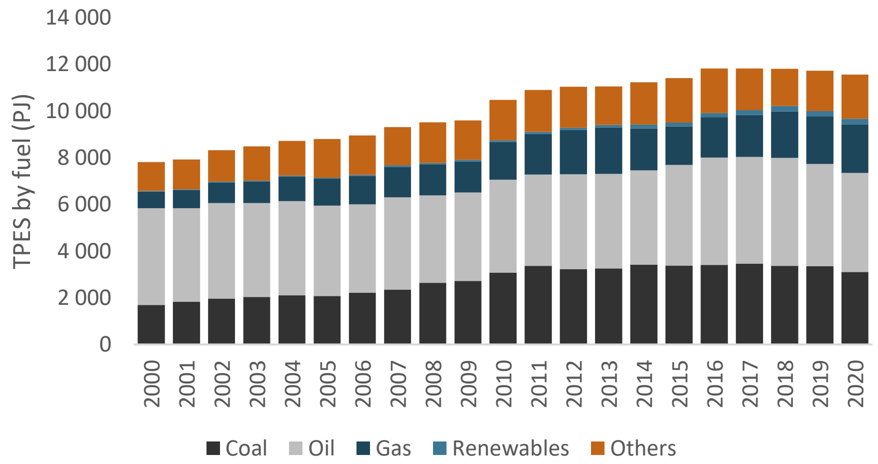


Source: EGEDA (2022)

Since Korea has limited domestic energy resources, a significant portion of Korea's TPES is imported. Korea imported approximately 89% of its TPES in 2018. In the same year, it was the world's fourth-largest importer of crude oil, the fifth-largest importer of natural gas and the fourth-largest importer of coal (IEA, 2020).

Korea's TPES fuel mix focused on a stable energy supply from 2000 to 2020, though it did not undergo a drastic change in terms of the fuel share (Figure 2). Renewables showed the fastest growth rate from 34 PJ in 2000 to 246 PJ in 2020, having gradually increased by a small relative amount from 0.4% to 2.1% for the same period. Natural gas also expanded from 9% in 2000 to 18% in 2020. Natural gas has continuously expanded its volume from 1 809 PJ in 2017 to 2 072 PJ in 2020. Whereas renewables and natural gas have increased, coal peaked in 2017 and oil peaked in 2018 with a decreasing trend until 2020 (EGEDA, 2022).

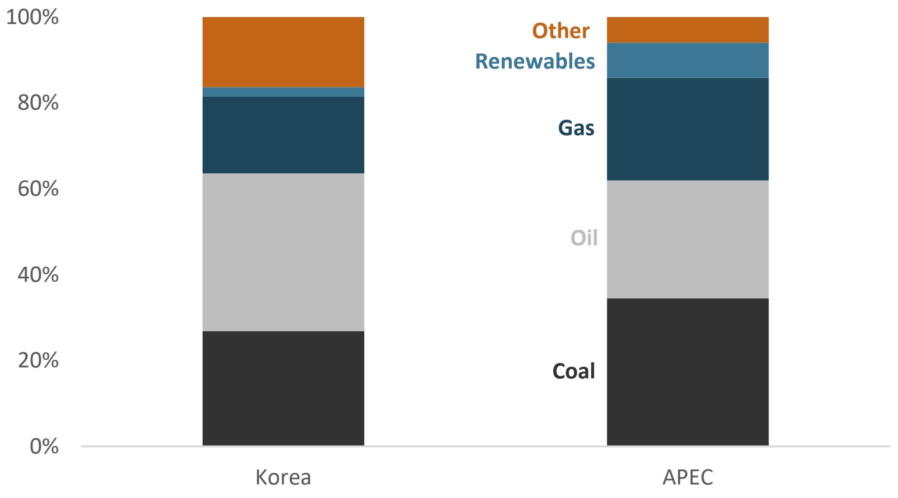
Figure 2: Korea's energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

As of 2020, the share of coal, oil and gas in Korea accounted for more than 80%, similar to that of APEC (Figure 3). However, Korea's TPES fuel mix had some differences in the share of energy sources compared to that of the entire APEC region. Specifically, oil supply was proportionally higher, whereas the other categories were lower. Korea's oil share of TPES was 37%. Coal and gas followed at 27% and 18% respectively, lower than the figures for APEC. Meanwhile, the portion of renewables in APEC was four times that of Korea. The share of renewable energy supply in APEC is 8.2%, whereas the share of renewables in Korea is 2.1%.

Figure 3: Energy supply mix – Korea and APEC, 2020



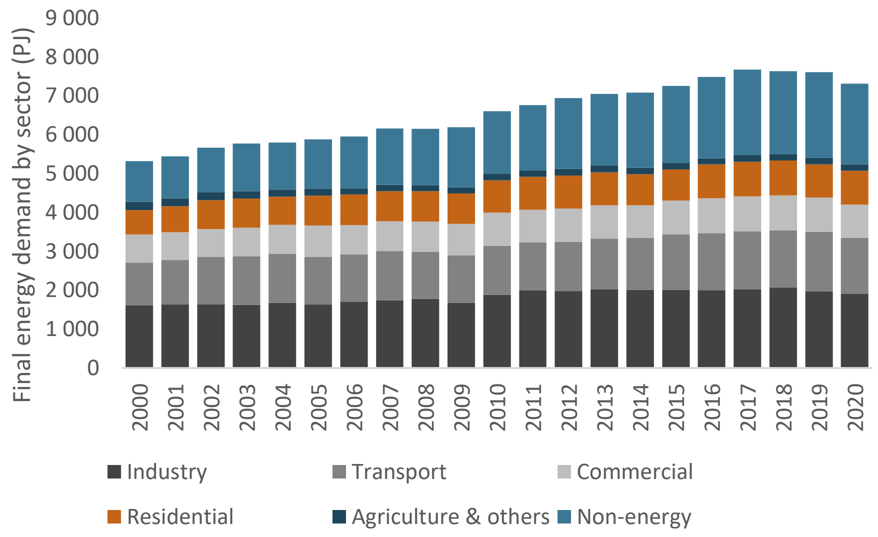
Source: EGEDA (2022)

Total final consumption

Total final consumption is a representation of end-use energy, including non-energy uses of energy products. Korea's total final consumption (including non-energy) in 2020 was 7 313 PJ, which was a 3.9% decrease from the previous year. The decrease in energy consumption was significant compared to the 0.5% decrease in 2018 compared to 2017 and the 0.3% decrease in 2019 compared to 2018. 2020 was the first year the COVID-19 pandemic affected and thus it is estimated that there was a reduction in energy consumption as a result.

The non-energy and industrial sectors, respectively, accounted for the largest shares of Korea's final consumption at 28% and 26%, while the transport sector accounted for 20%. The remainder (26%) was associated with the other sectors (combined commercial, residential and agriculture sectors). Consumption in the agriculture sector has generally weakened since the late 1990s and recorded 163 PJ in 2020, down slightly from 164 PJ in 2019. Except for residential, consumption in all the other sectors declined in 2020 compared to the previous year.

Figure 4: Korea's final consumption by sector (PJ), 2000 to 2020

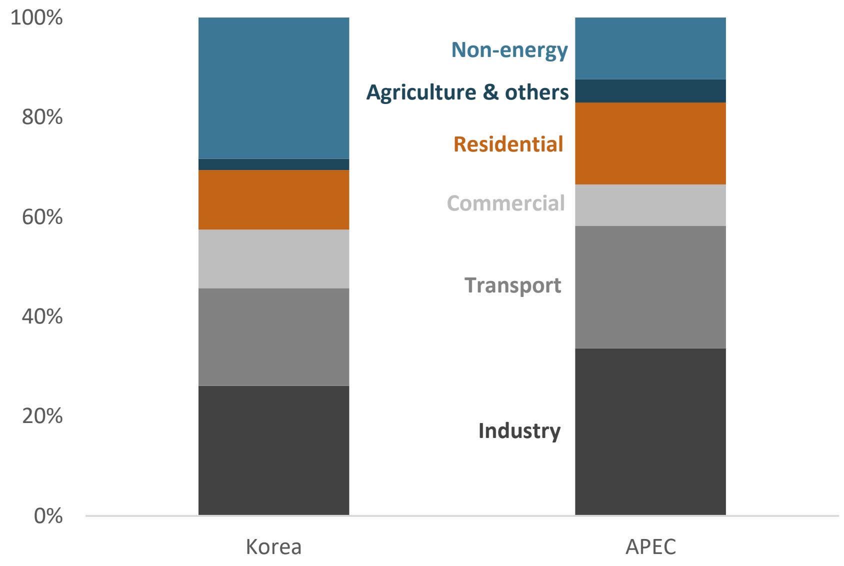


Source: EGEDA (2022)

Relative to APEC, Korea's industry and transport sectors constitute a lower portion of final consumption, whereas the non-energy sector accounts for more use (Figure 5). APEC's final consumption share in the industry and transport sectors was 34% and 25% respectively in 2020, whereas Korea's respective consumption accounted for 26% and 20% in the same year.

Non-energy generally refers to energy products that are used as raw materials and not consumed as fuel or transformed. These are generally oil products used in the chemical and petrochemical subsector to make plastics or lubricants. In 2020, Korea's non-energy sector accounted for 28% of final consumption, more than doubling its relative share in APEC at 13%.

Figure 5: Final consumption by sector, Korea and APEC, 2020

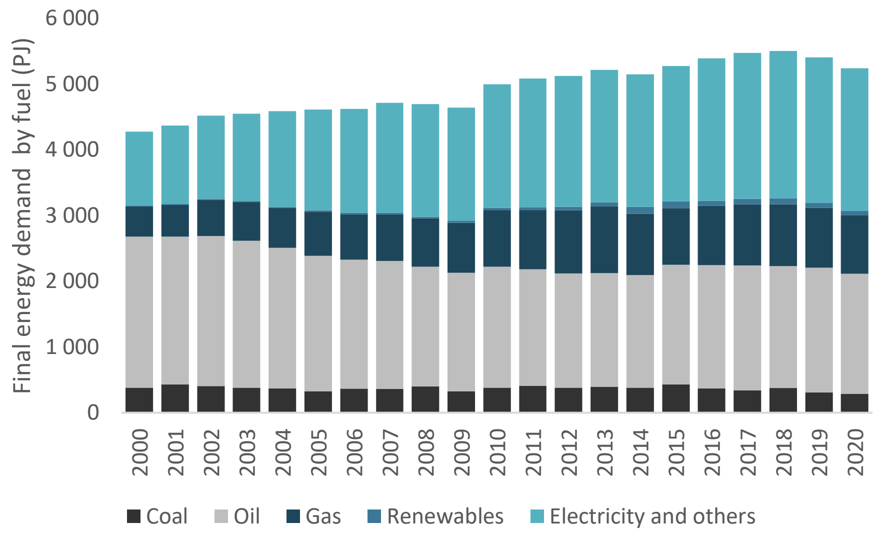


Source: EGEDA (2022)

Final energy demand

Korea's final energy demand had an increasing trend from 2009 to 2017. However, with 2018 as the peak year, final energy demand showed a declining trend through 2020 (Figure 6). The decline was even greater in 2020 due to the unexpected COVID-19 pandemic. When examined by fuel from 2000 to 2020, the share of coal and oil demand in 2020 compared to that of the 2000 data revealed that the proportion in the total share declined. Specifically, the proportion of the two fuels accounted for 40% in 2020, compared to 63% in 2000. On the other hand, between 2000 and 2020, there was an overall upward trend in terms of the proportion of other sectors like gas, renewables, electricity and others in the total share of the year.

Figure 6: Korea's final energy demand by fuel (PJ), 2000 to 2020

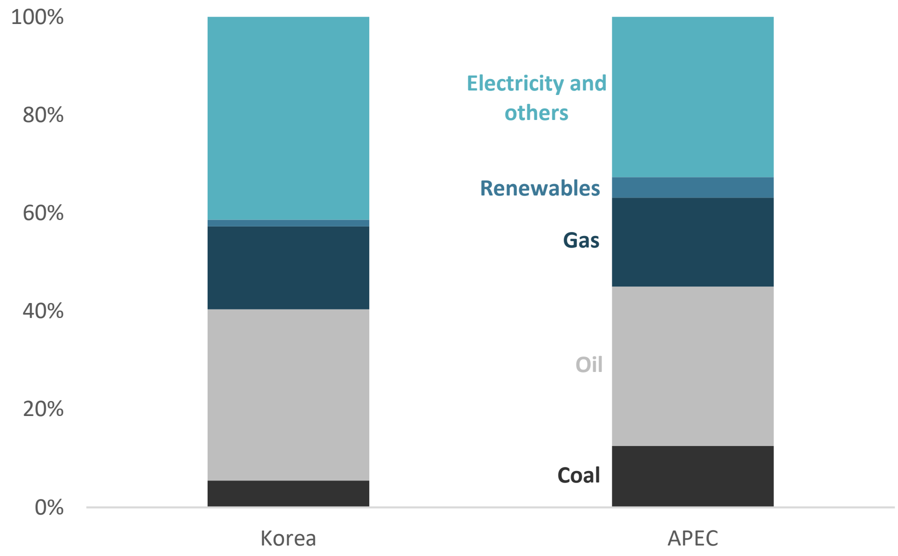


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Relative to APEC, Korea's electricity demand is relatively large. Korea's electricity and others share of final energy demand is 41%, while APEC's share is 33% (Figure 7). Korea's economic growth has significantly increased electricity demand over the past few decades. Power-based appliances have also continuously increased, contributing to electricity's higher share in the final energy demand. The 10th Basic Plan for Long-term Electricity Demand and Supply (2022–36), finalised by the Ministry of Trade, Industry and Energy (MOTIE), projects that electricity consumption will grow by 1.5% per year from 2022 to 2036. Meanwhile, as of 2020, the proportion of coal in Korea is lower than that of APEC.

Figure 7: Final energy demand fuel share, Korea and APEC, 2020



Source: EGEDA (2022)

Transformation

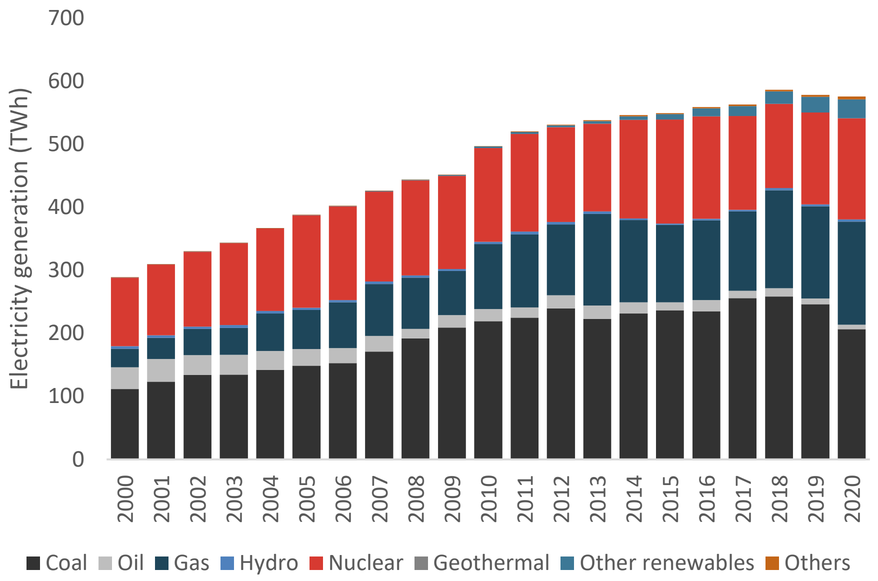
Power sector

Energy use in Korea's transformation sectors has grown rapidly since 2000, driven by a steady expansion of electricity generation capacities. Between 2000 and 2020, the total power generation increased two-fold, from 289 terawatt-hours (TWh) in 2000 to 575 TWh in 2020 (Figure 8). In 2011, a power outage gave rise to electricity supply restrictions in select areas. For these reasons, securing a stable supply of electricity was one of Korea's top energy policy priorities.

Looking into each source of fuel generation, 36% of Korea's electricity was generated by coal in 2020 whereas the coal generation portion in total electricity accounted for 43% in 2019. With the rise of carbon neutrality ambitions, the share of coal power generation is expected to considerably decrease in the long-term. On the other hand, the generation of gas, nuclear and renewables expanded their shares in the generation mix in 2020, compared to the previous year.

In January 2023, the Korean government announced the 10th Basic Plan for Long-term Electricity Demand and Supply as a 15-year outlook established every two years. According to the plan, facilities of nuclear power, LNG and renewables are expected to increase, while coal power plants are steadily reduced. Specifically, the replacement of old coal with LNG will occur and nuclear power and renewables will continue to be invested while considering safety and feasibility. Therefore, under the premise of high volatility, it is cautiously predicted that the share of nuclear power and renewables in total electricity generation will each increase to more than 30% by 2036.

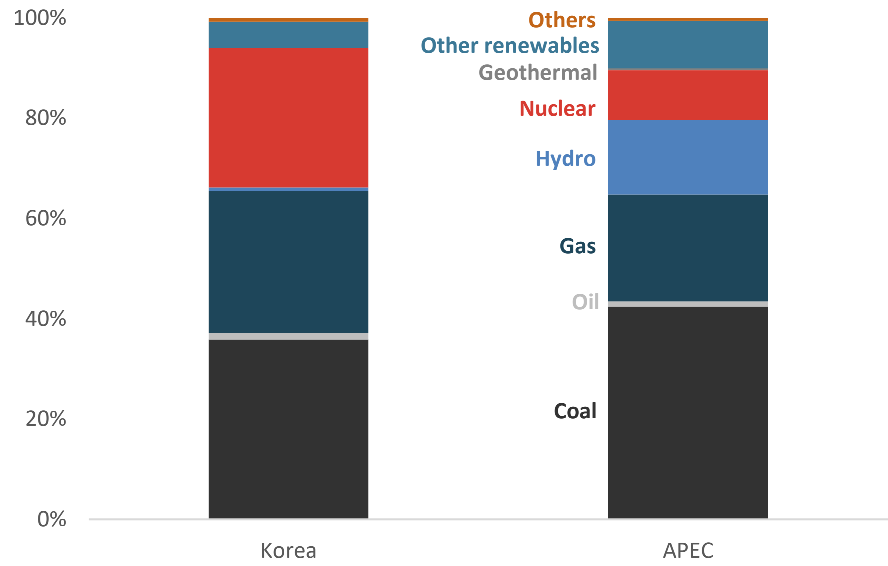
Figure 8: Korea's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In Korea's electricity generation mix, oil had similar proportions when compared to the generation mix for APEC in 2020 (Figure 9). Meanwhile, other power generation fuels showed some difference in a comparison between the Korea and APEC. Coal power generation was lower in Korea than APEC, with a share of 36% in Korea and 42% in APEC in 2020, whereas the share of coal power generation for Korea and APEC was similar in 2019. The proportion of gas in Korea's power sector was higher than that of APEC's. The Korean share of nuclear was 28%, more than double that of APEC, which was 10%. In contrast to gas and nuclear, the share of renewables was higher for APEC than Korea. Additionally, the proportion of hydro, accounting for 1% in Korea and 15% in APEC.

Figure 9: Electricity generation fuel share, Korea and APEC, 2020



Source: EGEDA (2022)

Refining

Korea has steadily promoted investments in large-scale refineries and facility improvements to enhance product quality. As a result, as of 2021, Korea's oil refining capacity was 3 572 thousand barrels per day, ranking 5th in the world (BP, 2022). Specifically, the global share was 3.5%, following the US (18%), China (17%), Russia (6.7%) and India (4.9%). Since Korea exports about 40% of oil products refined by importing crude oil from abroad, and there is not much pressure on supply against increased domestic demand in terms of volume.

Korean oil refining companies recorded huge operating losses in 2020 due to the COVID-19 pandemic, but since then they have achieved greater operating profits in the short term due to improved refining margins following the pandemic. Despite this short-term performance recovery, carbon neutrality is considered a very challenging task for Korean oil refineries and they have been contemplating portfolio reorganisation through business diversification along with persistent improvement of facilities.

Energy transition

Since the climate crisis goes beyond an environmental issue and becomes a global common problem, the Korean government continues to pay attention to the energy transition. The '2050 Carbon Neutrality Committee', a presidential body for controlling domestic carbon neutral policies, was officially launched in May 2021 and changed its name to the 'Presidential Commission on Carbon Neutrality and Green Growth' in March 2022. Additionally, energy security to respond to global energy supply chain instability is emerging as a key variable to be considered in energy transition policies.

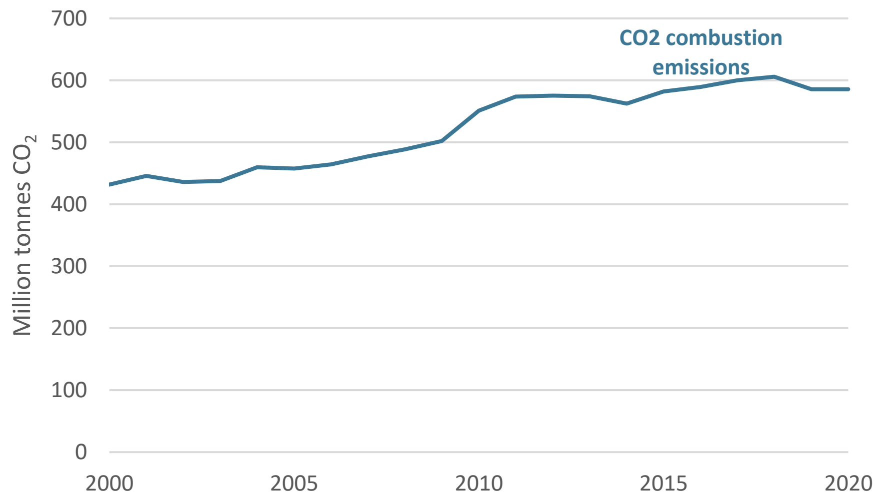
Emissions

Korea's CO_2 emissions per GDP have declined in general but the emissions growth itself has not reversed into a decline. According to EGEDA data, the emissions have generally represented an increasing trend since 2000 and historically peaked in 2018 (Figure 10). This means that stakeholders' efforts to reduce CO_2 emissions in each sector need to be accompanied by policy targets.

In October 2021, the Korean government announced a new proposal to revise the nationally determined contribution (NDC) goals to cut CO_2 emissions by 40% from 2018 levels, a drastic increase from the original target of 26%. Under the new government launched in May 2022, the Presidential Commission on Carbon Neutrality and Green Growth released vision and promotion strategies for carbon neutrality and green growth in October 2022.

In the report, four major strategies and 12 major tasks were suggested under the three major policy directions of (1) responsible practice, (2) orderly transformation, and (3) innovation-driven carbon neutrality and green growth. In addition, a carbon neutrality and green growth technology innovation strategy was also presented, including three directions: (1) technological innovation towards carbon neutrality mainly through private-sector-led missions, (2) enhanced investment in rapid and flexible carbon neutral R&D, and (3) pre-emptive building of infrastructure for innovative technology development.

Figure 10: Korea's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Since Korea is one of the world's largest importers of oil and gas, energy security has continuously been a subject of interest in terms of stable energy supply. As the recent Ukraine crisis has increased energy market uncertainty, the emphasis on energy security has been intensified even in the process of energy transition. In response to recent environmental changes, the Korean government announced new energy policy goals and directions in July 2022 to better react against global energy supply chain uncertainties and accomplish the carbon neutral government project.

These energy policy directions seek a feasible and reasonable energy mix, meaning that construction of the Shin-Hanul No. 3 and No. 4 nuclear reactors is to resume with the goal of expanding the nuclear energy ratio to a minimum of 30% by 2030. The adjustment of the energy mix includes power grid construction to accommodate the change in the power supply mix, and a power system stability plan aligned with high-renewable energy generation. In addition, the supply chain is being strengthened through increased strategic stockpiling.

Internal and external efforts are also being made to alleviate burdens on the industrial sector and the people. Import channel diversification through international cooperation is continuously pursued. For example, Korea participates in a Mineral Security Partnership (MSP) to stabilise the supply chain for critical minerals with other economies. To relieve the financial burden for those vulnerable to energy poverty, energy vouchers and support for energy efficiency improvement are being increased.

APEC energy goals

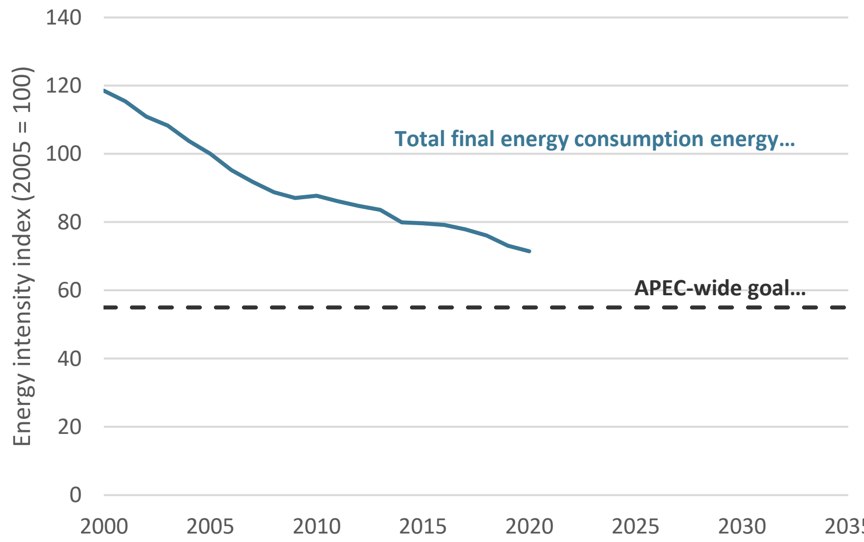
There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Figure 11: Korea's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

Since 2005, Korea's total final energy consumption (not including non-energy) intensity has continued to improve, though it retreated only slightly in 2010 (Figure 11). In 2020, this improvement was 29% relative to the 2005 baseline. This is a 2% improvement compared to last year, and an 8% improvement over the recent five years (2016-2020).

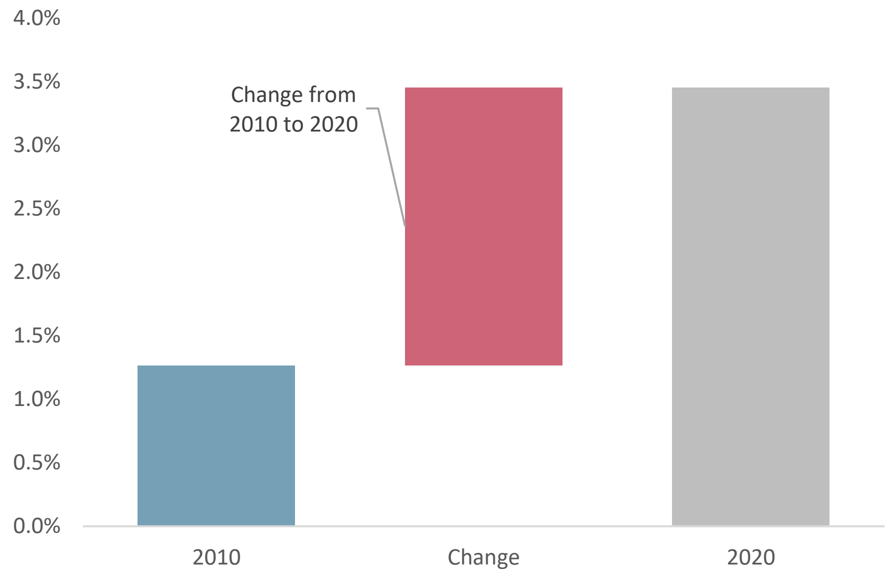
Since the COVID-19 pandemic started globally from 2020, APEC members' economic growth and energy consumption may show a different trend than before. Therefore, it is necessary to carefully monitor whether the energy intensity improves over the next few years in Korea as well.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Korea has continuously promoted policies to expand renewable energy in response to climate change and for sustainable growth. In 2017, the Korean government released the 3020 Renewable Energy Initiative Implementation Plan. According to the plan, the share of renewables in the energy mix will increase from 7% in 2016 to 20% in 2030. As a result, while APEC increased from 6.0% to 9.5% in 2020 compared to 2010, Korea had a higher rate of increase, more than doubling from 1.3% to 3.5%.

Figure 12: Korea's modern renewable energy share, 2010 and 2020



Source: EGEDA (2022)

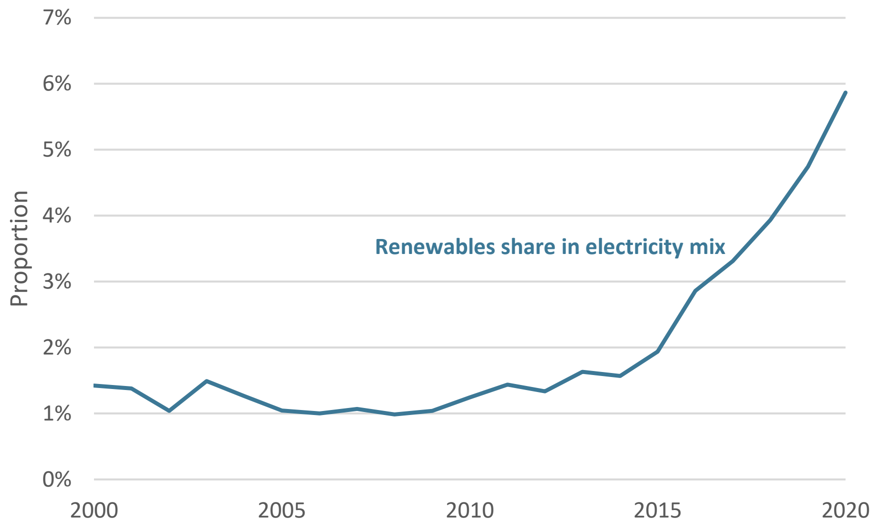
Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Between 2000 and 2020, Korea's renewable energy showed a steeper increase from around 2015 (Figure 13). Korea is promoting various distribution projects for the stable supply of renewables, including the Renewable Energy Portfolio Standards (RPS). RPS is a system that makes it mandatory for power generation companies to supply a certain amount of annual electricity production as renewable energy.

It is expected that the Korean government will continue to promote the expansion of renewables in order to achieve stable power supply. The

10th Basic Plan for Long-term Electricity Demand and Supply (2022–36) announced that it would promote phased renewable supply along with renewable energy back-up facilities, keeping in view the feasibility of renewable energy sources. According to this plan, the share of renewables in the total generation mix is presumed to reach around 30% in 2036.

Figure 13: Korea's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis	This purpose of the Act is to adapt to climate change for preventing serious impacts of the climate crisis and to resolve economic, environmental, and social disparity that may arise in the course of transition to a carbon neutral society.	NATIONAL LAW INFORMATION CENTER
3rd Energy Master Plan	The plan was announced in June 2019 to provide a mid- to long-term (2019–2040) framework for coordinating energy policies throughout the economy, identifying several problem areas affecting Korea's energy system.	MOTIE (2019)
3020 Renewable Energy Initiative Implementation Plan	MOTIE released in December 2017 this plan in which renewables' share of the energy mix would be increased from its 7% rate in 2016 to 20% in 2030 through the provision of 49 GW in new generating capacity.	MOTIE (2017)
Support for RE 100	MOTIE announced in January 2021 that it will allow domestic electricity consumers to purchase electricity from renewable sources as part of the RE100 initiative, a global campaign for transition to 100% RE.	MOTIE (2021)
14th Plan for Long-term Natural Gas Demand and Supply	MOTIE released in April 2021 this plan to maintain a stable gas demand and supply and support the energy transition policy by including a long-term natural gas demand forecast from 2021 to 2034.	MOTIE (2021)
New Energy Policy Goals and Directions	These new energy policy directions were announced in July 2022, including that a feasible and reasonable energy mix must be re-established and support for low-income households will be expanded in response to recent environmental changes.	MOTIE (2022)
Vision and Promotion Strategies for Carbon Neutrality and Green Growth	The Presidential Commission on Carbon Neutrality and Green Growth announced major strategies in October 2022 with regard to reestablishment of the energy mix, optimisation of energy efficiency, establishment of a local-led implementation system and prompt support across government departments.	Carbon Neutrality and Green Growth Commission (2022)
Carbon Neutrality and Green Growth Technology Innovation Strategy	This technology innovation strategy was released with 'Vision and Promotion Strategies for Carbon Neutrality and Green Growth', including promotion of 100 main carbon neutrality technologies need for rapid commercialisation.	Carbon Neutrality and Green Growth Commission (2022)
Resources Development Plan	MOTIE released in May 2020 this plan to increase the government's investment in private-sector companies' resource exploration projects and proposed a new policy goal covering resources security.	MOTIE (2020)

5th Basic Plan on Integrated Energy Supply	The plan was announced in February 2020 to provide a mid- to long-term (2019–2023) framework to expand combined heat and power plant (CHP) by 2023, targeting a total of 4.8 million units, an increase of about 31% from 2018.	MOTIE (2020)

Notable energy developments

Energy development	Details	Reference
10th Basic Plan on Electricity Demand and Supply	The plan for 2022–2036 was released in January 2023 to provide a mid- to long-term power demand forecast and expansion of power facilities, proposing a feasible and reasonable energy mix for energy security and carbon neutral goals.	MOTIE (2023)
Action Plan for a Clean Hydrogen Ecosystem	The plan was released in November 2022 to prepare for large-scale demand for hydrogen by preparing a clean hydrogen ecosystem in terms of the establishment of a clean hydrogen supply chain.	MOTIE (2022)
Hydrogen Technology Strategy for the Future	MSIT released in November 2022 this plan with the Action Plan for a Clean Hydrogen Ecosystem to help secure hydrogen-related technologies such as development of clean hydrogen production technology.	MSIT (2022)
The Korean Green Taxonomy Guideline (Revision)	This guideline provides principles and standards on what types of economic activities are considered green activities and serves to assist in allowing more funds to be allocated to green projects and green technologies. Edited version was released in December 2022.	ME (2022)
Metal Stockpiling Contemporary Plan	MOTIE released in December 2022 this plan to support the stable growth of the domestic industry and to respond promptly to global supply chain uncertainties.	MOTIE (2022)

Useful links

Korea Electric Power Corporation – https://home.kepco.co.kr/kepco/main.do

Korea Energy Economics Institute – http://www.keei.re.kr/main.nsf/index.html

Korea Energy Agency – http://www.energy.or.kr/web/kem_home_new/new_main.asp

Korea Gas Corporation – https://www.kogas.or.kr:9450/portal/index.do

Korea National Oil Corporation – https://www.knoc.co.kr/

Presidential Commission on Carbon Neutrality and Green Growth – https://www.2050cnc.go.kr/base/main/view

Ministry of Trade, Industry and Energy – http://english.motie.go.kr/www/main.do

Ministry of Environment – http://eng.me.go.kr/eng/web/main.do

Statistics Korea – http://kostat.go.kr/portal/eng/index.action

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ME (Ministry of Environment) (2022), *The Korean Green Taxonomy Guideline (Revision)*, https://www.me.go.kr/home/web/board/read.do?pagerOffset=110&maxPageItems=10&maxIndexPages=10&searchKey=&searchValue=&menuId=10525&orgCd=&boardId=1569770&boardMasterId=1&boardCategoryId=&decorator=

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MSIT (2022), (Ministry of Science and ICT) (2022), *The Hydrogen Technology Strategy for the Future*, https://www.msit.go.kr/bbs/view.do?sCode=user&mId=113&mPid=238&pageIndex=1&bbsSeqNo=94&nttSeqNo=3182333&searchOpt=ALL&searchTxt=%EC%88%98%EC%86%8C%EA%B8%B0%EC%88%A0

Presidential Commission on Carbon Neutrality and Green Growth (2022)

—(2022a), *Vision and Promotion Strategies for Carbon Neutrality and Green Growth*, https://www.2050cnc.go.kr/base/board/read?boardManagementNo=3&boardNo=1049&searchCategory=&page=2&searchType=&searchWord=&menuLevel=2&menuNo=17

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UNFCCC (United Nations Framework Convention on Climate Change) (2020), *2050 Carbon Neutral Strategy of the Republic of Korea,* https://unfccc.int/documents/267683

Malaysia

Introduction

Malaysia submitted its revised Intended Nationally Determined Contribution to the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat in July 2021, increasing its mitigation ambition with an unconditional target to reduce greenhouse gas (GHG) emissions intensity against Gross Domestic Product (GDP) by 45% by 2030 compared to the 2005 level.

A desire to comprehensively deal with the issue of climate change was further strengthened by the announcement in September 2021 of the aspiration to become a carbon-neutral economy by 2050, which is also supported by the policy of zero new coal-fired plants in electricity generation. The announcement was released together with the Twelfth Malaysia Plan 2021-2025 (RMK12), comprising the energy sector's plan to address the energy trilemma, especially on energy security and sustainability.

Apart from the medium-term energy security and sustainability plan stated in RMK12, the Malaysia Renewable Energy Roadmap 2022-2035 was released in December 2021. The roadmap highlights the role of renewables and the details of programs and targets for decarbonising the electricity sector through 2035.

In September 2022, Malaysia emphasised its commitment towards a carbon-neutral economy by 2050 by releasing a comprehensive long-term National Energy Policy (NEP) covering the period from 2022 to 2040. Realising that the global economic situation and high energy prices resulting from tight supply and geopolitical issues could affect Malaysia's decarbonisation efforts and energy transition pace, the NEP lays out the roadmap, including initiatives and key action plans with the participation of stakeholders in energy-related sectors to achieve the environmental sustainability and energy security targets, while at the same time enhancing macroeconomic resilience and achieving social equitability and affordability.

Malaysia showed a strong economic performance in 2022 despite slowed global economic growth, including the energy crisis. Its GDP rose by 8.7% to MYR 1 507 billion (GDP at constant 2015 prices), more than double the previous year's growth and the highest since 2000. GDP per capita also showed an improvement in 2022, increasing by 7.5% per annum to MYR 44 413 and surpassing the pre-COVID-19 level.

The strong growth was supported by the revenue increase in almost all economic activities except agriculture, which remained at the same level as the previous year. Services activity accounted for 58% of the total GDP, followed by manufacturing at 24%, agriculture at 6.6%, mining and quarrying at 6.4%, and construction at 3.5%.

In 2021, Malaysia was the second-largest oil producer in Southeast Asia and the fifth-largest global liquefied natural gas (LNG) exporter. However, Malaysia's annual oil and gas proved reserves have decreased slightly for the last decade, partly reflected by the lack of new hydrocarbon discoveries due to low upstream exploration activities. The declining proved reserves have led to a lower level of oil production from the existing matured fields over the same period, while gas production remains stable due to long-term supply commitments.

On top of declining oil production from the matured fields, Malaysia's oil production is expected to decrease further in 2023 as Malaysia decided to cut its oil production by 27 000 to 567 000 barrels per day, effective in November 2022, in line with the Organization of the Petroleum Exporting Countries and allied producers (OPEC+) decision in October 2022.

Table 1: Malaysia's macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c]	
Area (million km²)	330 441	Oil (billion barrels)	4.4
Population (million)	33	Gas (trillion cubic feet)	76
GDP (2017 USD billion PPP)	857	Coal (million tonnes)	1 938
GDP per capita (2017 USD PPP)	26 472	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a DOSM, EPU (2022); b World Bank (2022); c EC (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

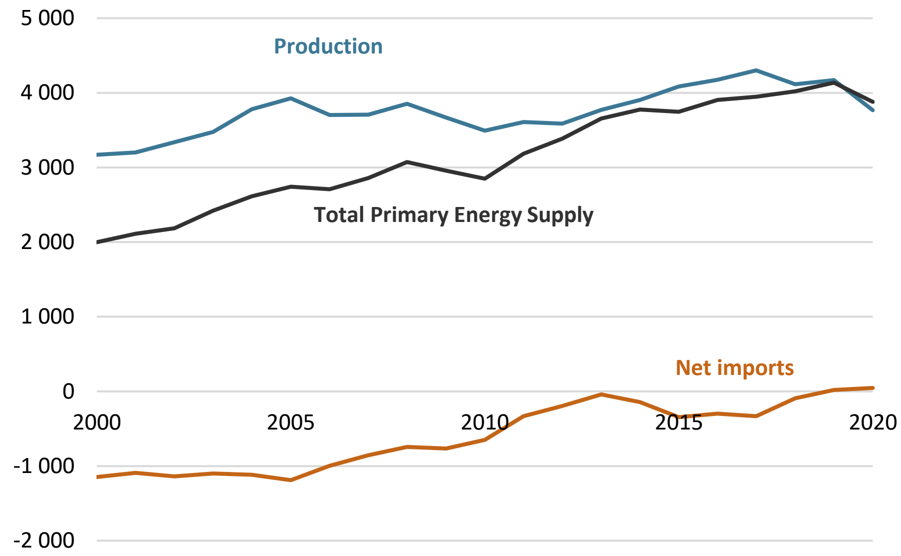
High global oil and natural gas prices contributed to the increase in upstream exploration activities in Malaysia in 2022, leading to ten discoveries of oil and gas fields off the coast of Peninsular Malaysia, Sabah and Sarawak. The discoveries will help to sustain the level of oil and gas production, prolong the production period and improve the annual volumes of proved reserves in the next few years.

Energy supply and consumption

Total primary energy supply

The total energy supply in Malaysia has shown a growing trend since 2000 at an annual average rate of 3.4%, reaching 3 879 PJ in 2020 (Figure 1). Low energy demand due to the outbreak of the COVID-19 pandemic caused a 6.2% drop in total primary energy supply in 2020 compared to the previous year.

Figure 1: Malaysia's energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

A similar trend has been observed in total energy production for the past two decades, increasing at an annual average rate of 0.9%, reaching 3 766 PJ in 2020. Total energy production declined in 2020, 9.7% lower than in 2019, due to reduced oil and natural gas production as a result of low global and domestic oil, natural gas and electricity demand.

Malaysia remained a net energy importer in 2020. Total energy trade volume contracted for two consecutive years, decreasing by 4.1% in

2019 and 10% in 2020 due to declining imports and exports of crude oil and petroleum products, and exports of LNG.

In 2020, the Asia region remained the major export destination for Malaysian crude oil, piped natural gas and LNG, while Malaysia diversified its sources of imported crude oil from around the world, where more than half of its imports were from Europe, the Middle East and Africa.

The trend of the fossil fuel mix in electricity generation influenced the changes in Malaysia's total energy supply mix in the past two decades, as electricity generation consumed almost a quarter of the annual energy supply. Fossil fuels remained dominant over the same period, even though their share declined slightly from 99% in 2000 to 96% in 2020 (Figure 2).

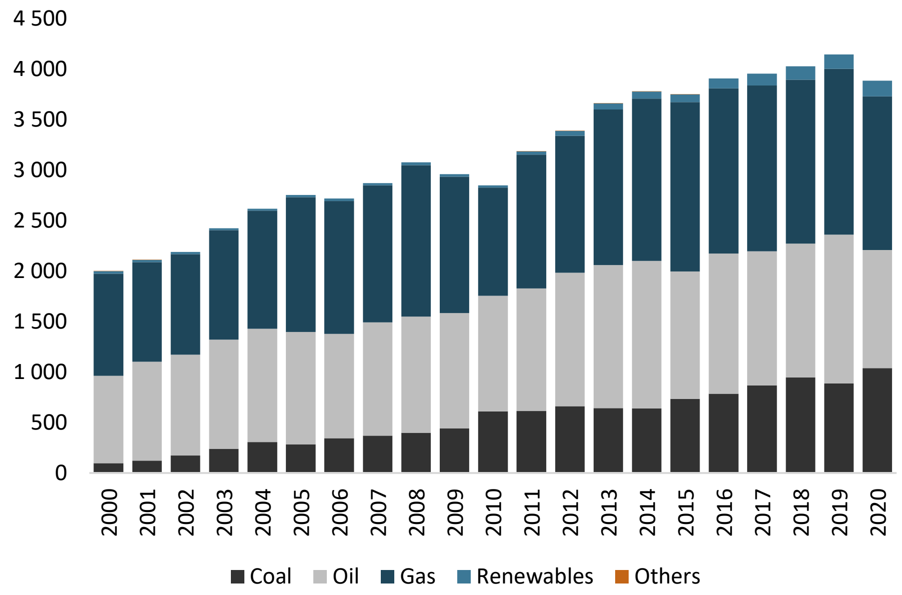
Coal supply has grown substantially at 13% per annum since 2000, increasing more than tenfold by 2020. The total coal supply in the last decade doubled from the previous decade, triggered by fuel supply security issues in electricity generation at the end of 2010 and supported by stable coal prices and lower generation costs compared to natural gas and oil over the same period.

The introduction of the Five-Fuel Diversification Policy in 2000 and Malaysia's commitment towards climate change targets have driven the rapid growth of renewables in total energy supply at 9.5% per annum since 2000, reaching about 157 PJ in 2020.

Gas and oil hold the top two largest shares in the total energy supply mix, although both have grown slower than coal and renewables since 2000, 2.1% and 1.5% per annum, respectively.

In 2020, oil and natural gas supply declined by 21% and 7.5% per annum, respectively, caused by falling demand from the transportation and power sectors due to movement control orders and the retirement of three gas power plants in Peninsular Malaysia. In contrast, coal and renewables increased by 17% and 10% per annum, partly due to a higher dispatch of both fuels for electricity generation.

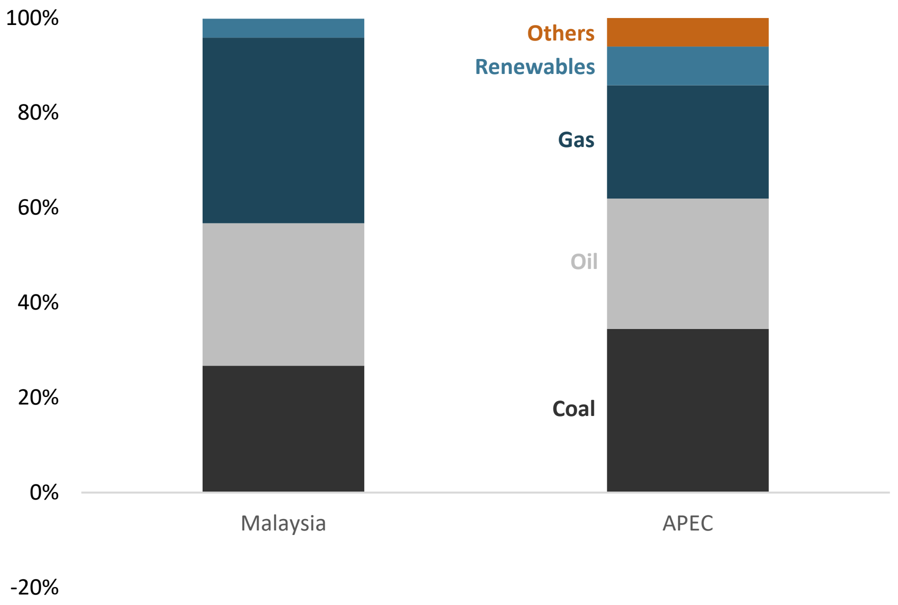
Figure 2: Malaysia’s energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

The availability of indigenous oil and gas resources in Malaysia and the low global fossil fuel prices in 2020 continued to be contributing factors to higher reliance on fossil fuels than the APEC region (Figure 3). Oil and gas shares were about 18% higher than in the APEC region, while coal was lower as Malaysia imported about 90% of its coal supply. Renewables and others’ shares were also below that in the APEC region.

Figure 3: Energy supply mix – Malaysia and APEC, 2020



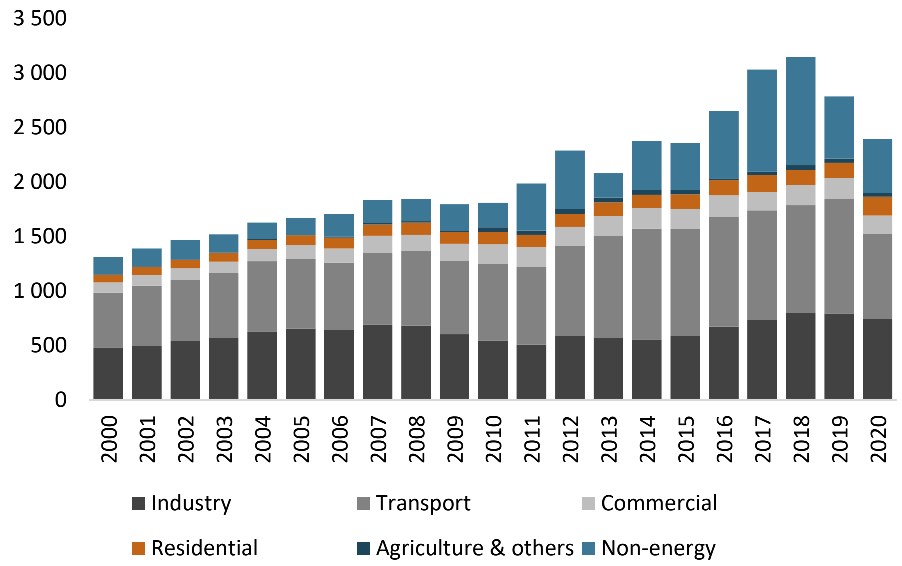
Source: EGEDA (2022)

Total final consumption

Malaysia's total final consumption grew about 1.8 times from 1 307 PJ in 2000 to 2 393 PJ in 2020, representing the significant role of energy in supporting the growing economic activities and population (Figure 4). Even though annual total final consumption dropped a few times over the past 20 years, the 14% per annum drop in 2020 due to the outbreak of the COVID-19 pandemic was the largest recorded.

All sectors recorded a drop in energy consumption in 2020 except for the residential sector, as working from home became the new norm during the implementation of control movement orders. The transport sector was the one most affected by the control movement orders, falling by 25% from 2019. This was followed by the non-energy and commercial sectors, which both declined at 13%, the industry sector declining by 6.5%, and agriculture and others by 6.4%.

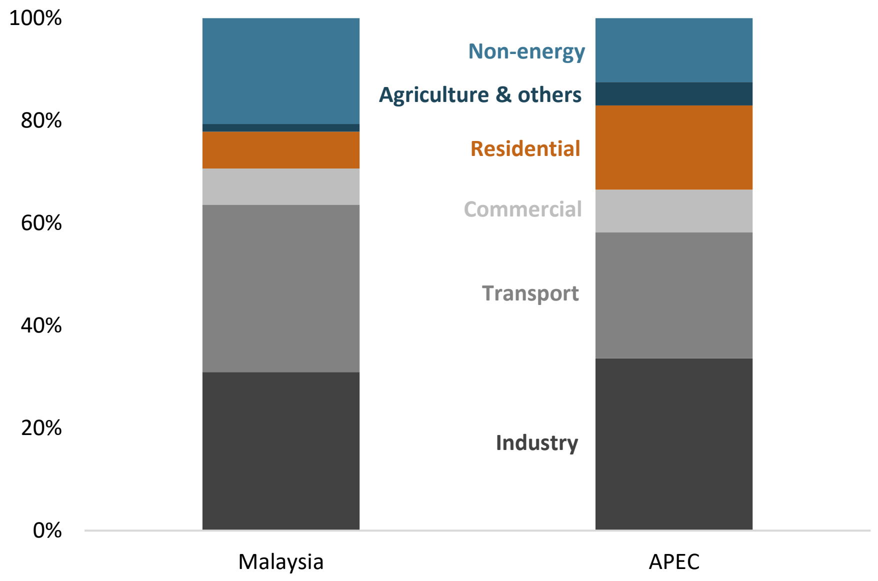
Figure 4: Malaysia’s final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

Like the APEC region, the transport and industry sectors represented the most significant portion of Malaysia's final consumption, about 60% in 2020 (Figure 5). The non-energy consumption share was larger in Malaysia than in the entire APEC region in 2020, as Malaysia has a significant number of petrochemical plants, including fertiliser plants located in Peninsular Malaysia, Sabah and Sarawak. The growth in energy consumption by the non-energy sector was mainly driven by feedstock availability, including natural gas and petroleum products, at a competitive price.

Figure 5: Final consumption by sector, Malaysia and APEC, 2020



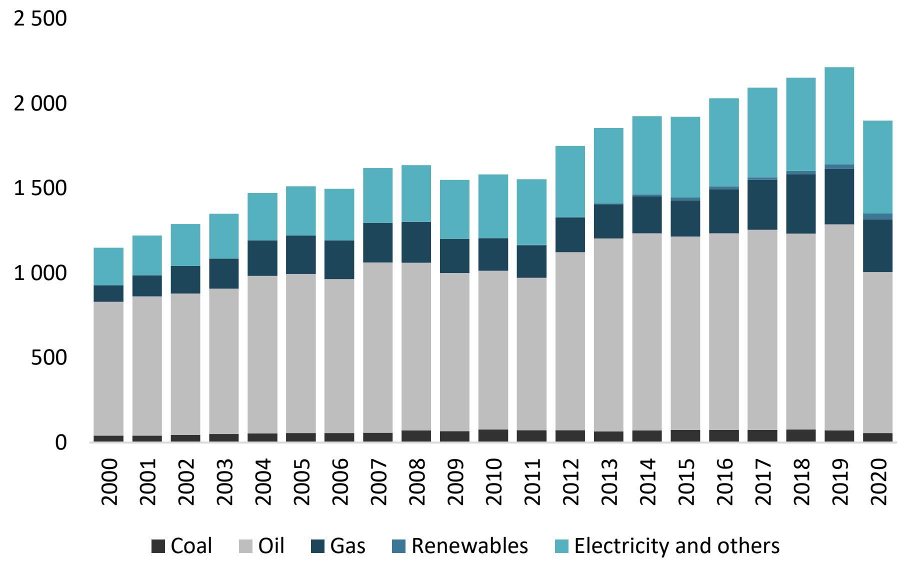
Source: EGEDA (2022)

Final energy demand

Malaysia's final energy demand grew by 2.5% per annum, from 1 149 PJ in 2000 to 1 899 PJ in 2020 (Figure 6). Fossil fuels accounted for almost 70% of the fuel share consumed by end-users in 2020, which decreased by 14% from the previous year. Oil in the form of petroleum products dominated slightly above half of the end-user fuel share in 2020. The transport sector consumed 70% of the total oil demand, followed by the industry sector at 10.4%, the non-energy sector at 10.3%, and other sectors at 7.0%.

Electricity was the second dominant fuel, increasing from 26% of the end-user fuel share in 2019 to 29% in 2020. In 2020, electricity demand was less affected during the COVID-19 pandemic, represented by a slight decrease in volume following a significant rise from the residential sector and offset by a large drop from other sectors.

Figure 6: Malaysia's final energy demand by fuel (PJ), 2000 to 2020



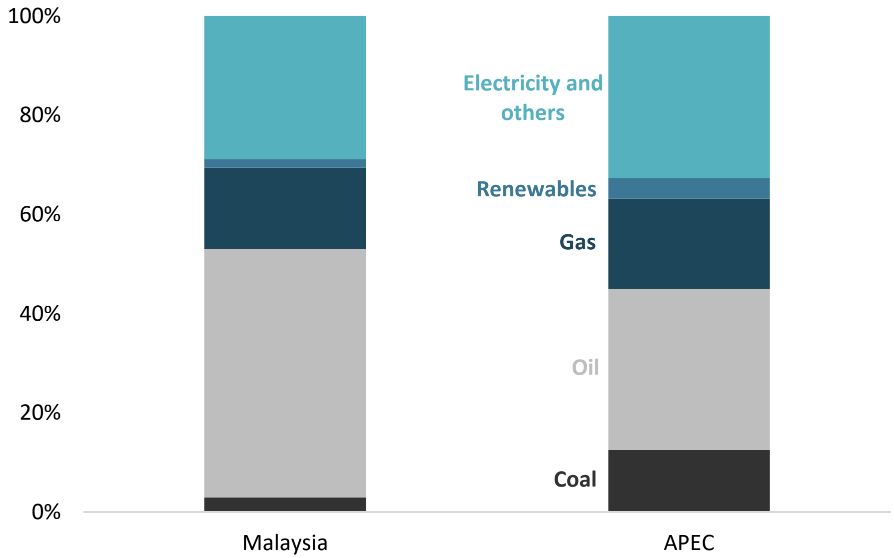
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Gas and coal accounted for 19% of the fuel share consumed by end-users in 2020. Both fuels experienced a decline in volume for two consecutive years due to decreasing demand from the industry sector as a result of high regulated gas prices in 2019 and the impact of COVID-19 in 2020. Gas demand showed a recovery trend from the effects of the global financial crisis in 2008, while coal was stable at an average of 74 PJ before declining in 2019 and 2020.

High consumption of petroleum products in the transport sector contributed to a larger share of oil in Malaysia's final energy demand than the APEC region in 2020 (Figure 7), even though the share shrank from 55% in 2019 to 50% in 2020. Meanwhile, other fuels' shares were lower than those of APEC, ranging between 1.8% and 9.5%.

Figure 7: Final energy demand fuel share, Malaysia and APEC, 2020



Source: EGEDA (2022)

Transformation

Power sector

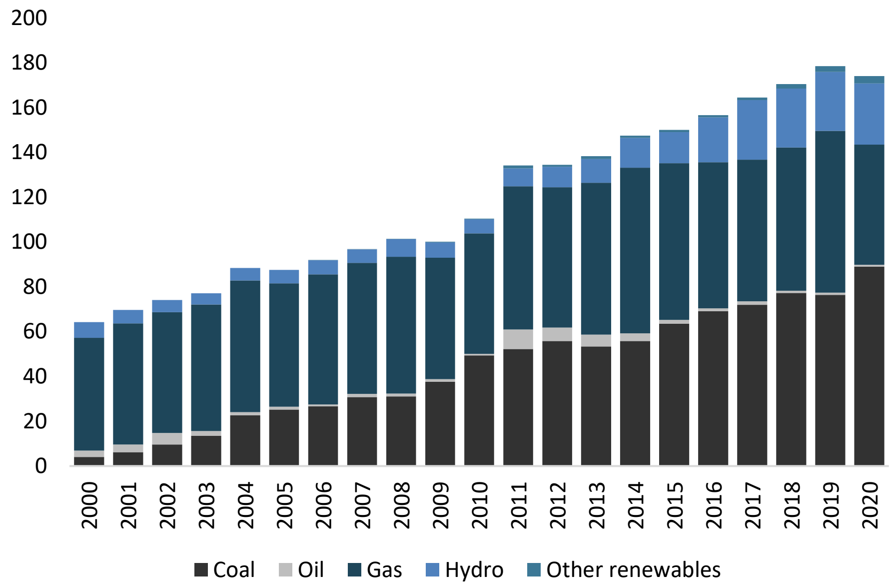
Mainly fossil fuels have fuelled Malaysia's electricity generation since 2000 (Figure 8). Coal and gas have continued to dominate Malaysia's electricity generation with a total share of 85% in 2000, increasing steadily and peaking at 93% in 2010. The coal and gas share in electricity generation began to fall in 2011. It decreased to 82% in 2020 as Malaysia is striving to achieve the target of a 20% renewable energy capacity mix by 2025, as stated in the National Renewable Energy Policy and Action Plan (NREPAP), and to fulfil the commitment to reduce carbon emission intensity per GDP unconditionally by 35% in 2030 relative to the 2005 level and conditionally by 45% as announced in July 2017 following the pledge during the 21st Conference of Parties (COP21) in 2015.

As a result of the mentioned renewable energy target and climate change commitment, the electricity generation share from renewables tripled, from 6% in 2010 to 18% in 2020. On the other hand, the oil share remained the smallest in electricity generation for the past two decades.

In 2020, electricity generation in Malaysia recorded a drop of 2.5% per annum, being less affected by COVID-19 compared to other sectors. Electricity generation from gas dropped the most in 2020, falling 26% from the previous year. However, the impact of the drop was reduced by the increase in coal at 17% per annum. Apart from lower coal prices in 2020, decommissioning of three gas-fired power plants located in Peninsular Malaysia (i.e. Powertek Berhad, Sultan Ismail Power Station and Pahlawan Power) and the delay of the commercial operation date for two new gas-fired power plants (i.e. SPG Block 1 and SPG Block 2) from 2020 to 2021 contributed to the increase of coal in electricity generation.

There were no significant changes in the electricity generation mix in Sabah and Sarawak in 2020. Natural gas and oil accounted for the largest share in Sabah at 86%, while hydro had the largest share in Sarawak at 79%.

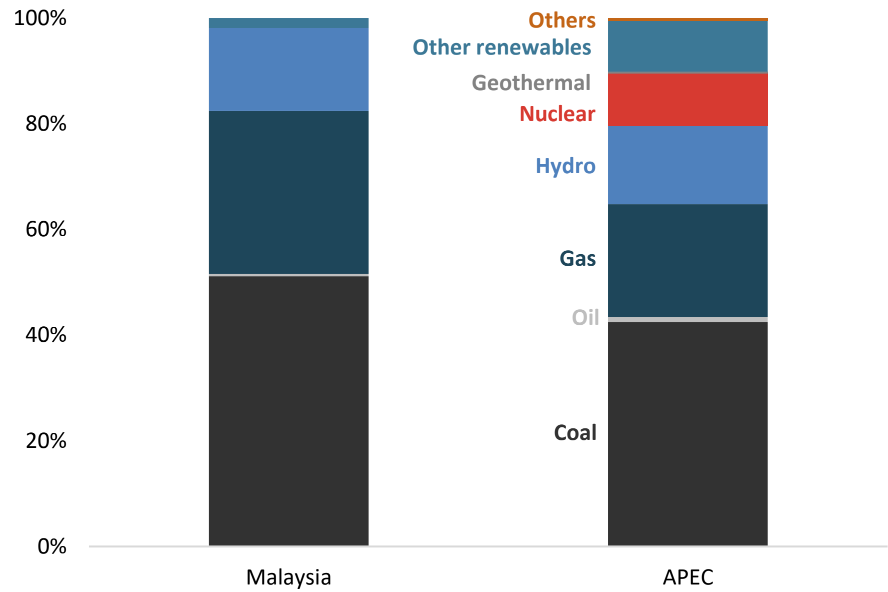
Figure 8: Malaysia's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In Malaysia's electricity generation, the share of coal, gas and hydro was larger than in the APEC region. Oil was half, while other renewables was much smaller in 2020 (Figure 9). The comparison showed that Malaysia's electricity generation relied more heavily on fossil fuels compared to the APEC region.

Figure 9: Electricity generation fuel share, Malaysia and APEC, 2020



Source: EGEDA (2022)

Refining

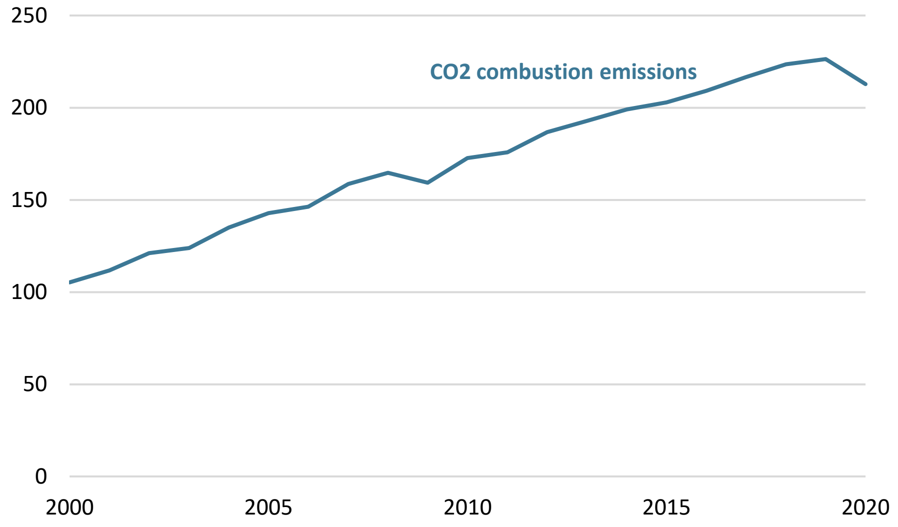
Malaysia has seven refineries with an estimated total licensed capacity of 792 000 barrels of crude oil per day, including the Pengerang refinery, which restarted in May 2022 after a fire incident in March 2020. The additional capacity at Pengerang will support Malaysia's target to achieve self-sufficiency in refined product supply and to produce gasoline and diesel that comply with Euro 4 and Euro 5 specifications.

Energy transition

Emissions

CO_2 emissions in Malaysia have been escalating steadily over the past two decades, reflecting the increasing trend for fossil fuels in the total energy supply. However, the growth of CO_2 emissions was higher than fossil fuel growth in energy supply due to a significant increase in coal use for electricity generation over the same period.

Figure 10: Malaysia's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Higher global oil and gas prices during the recovery period from the COVID-19 pandemic has stimulated Malaysia's oil company, PETRONAS and international investors to focus on exploration activities in Malaysia for the past two years. The exploration activities resulted in a total of 10 hydrocarbon discoveries in 2022, doubling the number of 2021 discoveries, which were mostly located offshore of east Malaysia. Other than prolonging the estimated oil and gas production period, the discovery will stabilise the growing reliance on imported oil and natural gas.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

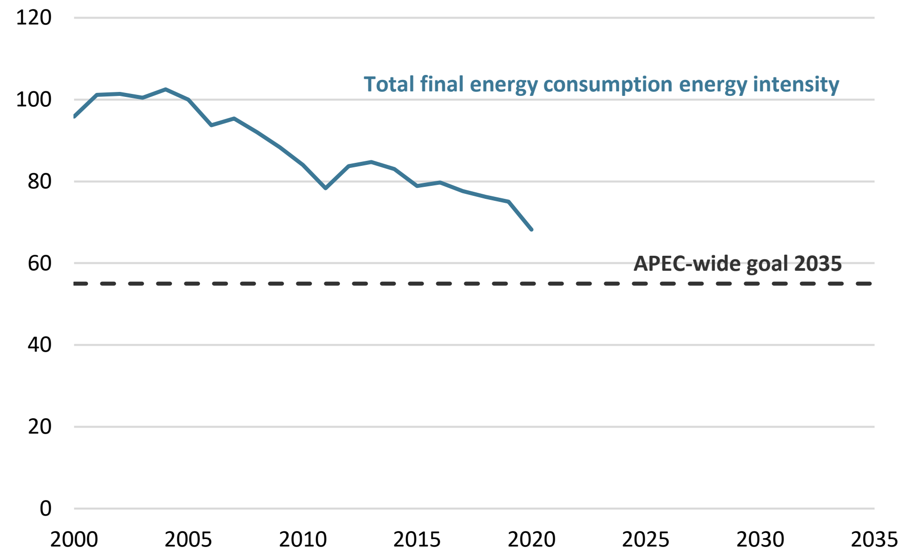
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Malaysia's total final energy consumption energy intensity (excluding non-energy) has been improving at an average rate of 2.0% annually, reaching a total reduction of 26% in 2020 compared to 2005 (Figure 11).

Figure 11: Malaysia's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



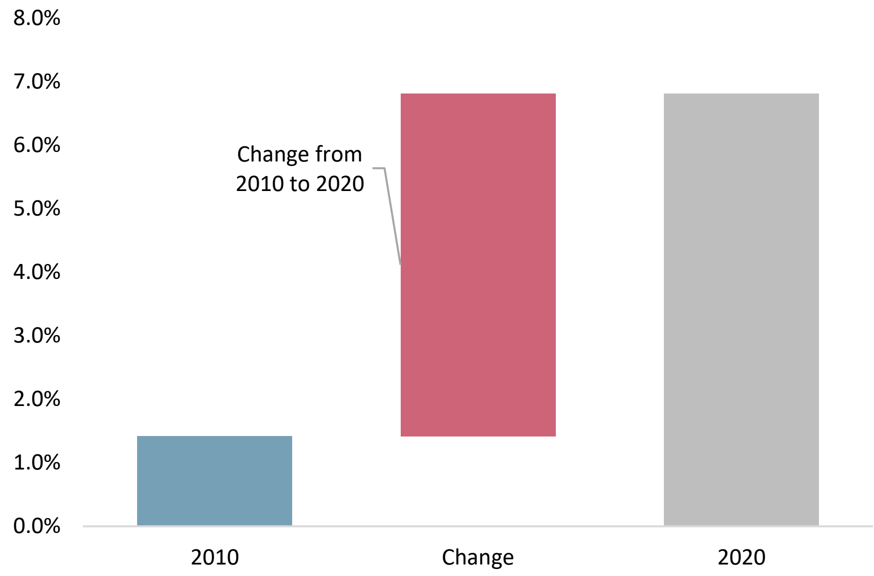
Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Malaysia's consumption of modern renewables has been increasing since the introduction of the NREPAP in 2010. In 2020, the proportional share was increased to 6.8%, representing a more than fourfold increase in modern renewables compared to 2010 (Figure 12).

Figure 12: Malaysia's modern renewable energy share, 2010 and 2020



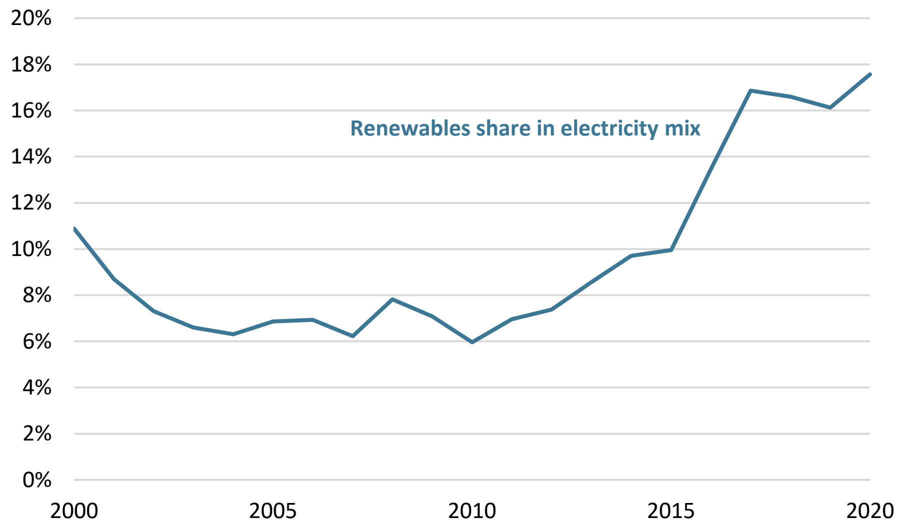
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Malaysia's electricity generation from renewables grew to 18% in 2020, which was almost tripled the 2010 level (Figure 13). Furthermore, the electricity generation from renewables grew substantially, from 7 TWh in 2010 to 31 TWh in 2020, driven by NREPAP 2009 and supported by various renewables energy (RE) plans and initiatives, including the Feed-in Tariff (FiT) scheme, solar auctioning and the rooftop solar quota through the Large-Scale Solar (LSS), Net Energy Metering (NEM) and Self Consumption (SELCO) Programme.

Other than the increase in electricity generation from renewables in 2020, the annual rise in renewables share was also partly due to 4.1% lower electricity generation from fossil fuels, specifically from oil and gas.

Figure 13: Malaysia’s renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
National Petroleum Policy 1975	To ensure the efficient utilisation of indigenous petroleum resources and to facilitate industrial and economic development while ensuring effective regulation and economy majority control in the ownership, management and operation of the oil and gas industry.	Ministry of Economy
National Energy Policy 1979	To achieve an efficient, secure and environmentally sustainable supply of energy. • Supply: To ensure adequate, secure and cost-effective energy supply. • Utilisation: To promote efficient energy utilisation and discourage wasteful and non-productive energy consumption patterns. • Environment: To minimise the negative impact on the environment of energy production, transportation, conversion, utilisation and consumption.	Ministry of Economy
National Depletion Policy 1980	To prolong the lifespan of economy's oil and gas reserves by safeguarding against over-exploitation and prioritising domestic needs for future energy security, with production caps imposed on oil and, subsequently, natural gas reserves.	Ministry of Economy
Four-Fuel Diversification Policy 1981	To enhance the reliability and security of energy supply by reducing over-dependence on oil as the single fuel source by diversification to four primary fuels: oil, natural gas, hydroelectricity and coal.	Ministry of Natural Resources, Environment and Climate Change
Five-Fuel Diversification Policy 2000	To introduce RE as an alternative fuel source to complement the existing four focus fuel sources identified in the Four-Fuel Diversification Policy 1981 and to encourage efficient energy utilisation.	Ministry of Natural Resources, Environment and Climate Change
National Policy on the Environment 2002	To promote continuous economic, social, and cultural progress and enhance the quality of life of Malaysians through environmentally sound and sustainable development, including stewardship of the environment, continuous improvement of environmental quality and sustainable use of natural resources, patterns of energy consumption and production.	Ministry of Natural Resources, Environment and Climate Change

National Biofuel Policy 2006	To promote the use of biofuels, in alignment with the Five-Fuel Diversification policy, as an environmentally friendly, sustainable and viable energy source, and to reduce dependency on fossil fuels and promote the well-being of all stakeholders in agricultural and commodity-based industries through stable and remunerative prices.	Ministry of Plantation and Commodities
National Green Technology Policy 2009	To promote energy efficiency while enhancing economic development to facilitate the growth of the green technology industry, increase economic capability and capacity in green technology development, ensure sustainable development and conservation of the environment for future generations, and enhance public awareness of green technology.	Ministry of Natural Resources, Environment and Climate Change
National Renewable Energy Policy and Action Plan 2009	To enhance the utilisation of indigenous RE resources and contribute towards economic supply security and sustainable socioeconomic development by increasing the RE contribution in the economy's power generation mix, facilitating the growth of the RE industry, ensuring reasonable RE generation costs, conserving the environment for future generations and enhancing awareness of the role and importance of RE.	Ministry of Natural Resources, Environment and Climate Change
National Policy on Climate Change 2010	To promote the effective management of resources and enhanced environmental conservation, strengthen economic competitiveness and improve quality of life, integrate climate change considerations into economy policies, and strengthen institutional and implementation capacities to address challenges and opportunities related to climate change.	Ministry of Natural Resources, Environment and Climate Change
New Energy Policy 2010	To promote energy security, economic efficiency, and environmental and social objectives through the five key pillars of energy pricing, energy supply, energy efficiency, governance and change management. Highlights include the gradual reduction of energy subsidies, such as gradual gas price revisions to converge with market pricing, initiatives to secure and manage a reliable energy supply with third-party access and the building of regasification terminals (RGTs) and RAPID. It also highlights FiT for RE sources and encouraging studies on alternative energies for increased energy source diversification, increased energy efficiency and various enablers such as energy sector governance.	Ministry of Economy
National Biodiesel Program	To utilise palm oil in the domestic biodiesel mix, which will boost domestic consumption and act as a means for the palm oil industry to manage the excess palm oil stock.	Ministry of Plantation and Commodities
Nationally Determined Contribution to the UNFCCC 2015	To unconditionally decrease the GHG emission intensity of GDP by 35% in 2030 compared to the 2005 level and by a further 10% on the condition of receipt of climate finance, technology transfer and capacity building from developed economies.	Ministry of Natural Resources, Environment and Climate Change

National Energy Efficiency Action Plan 2016-2025	To enhance energy efficiency with a target of an 8% reduction (saving up to 594 MWh) in electricity demand by 2025 through energy efficiency initiatives, enabled by implementation of the energy efficiency plan, strengthening of the institutional framework and capability development, implementation of a sustainable funding mechanism and promotion of private sector investment in energy efficiency initiatives.	Ministry of Natural Resources, Environment and Climate Change
Green Technology Master Plan 2017–2030	Outlines the strategic plans/immediate course for green technology development to create a low-carbon and resource-efficient economy.	Ministry of Natural Resources, Environment and Climate Change
Green Technology Financing Scheme 1.0, 2.0 and 3.0	A special financing scheme to support the development of green technology in the energy, building, manufacturing, transport, waste management and water sectors.	Malaysia Green Technology and Climate Change Corporation
Malaysia's Roadmap Towards Zero Single-Use Plastics 2018–2030	Towards zero single-use plastics for a cleaner and healthier environment by 2030.	Ministry of Natural Resources, Environment and Climate Change
National Automotive Policy 2020	To encourage new growth areas through the integration of technologies such as the Next Generation Vehicle (NxGV), Mobility as a Service (MaaS) and Industrial Revolution 4.0 (IR4.0) that are in line with the development of future technologies.	Ministry of Investment, Trade and Industry
Peninsular Malaysia Generation Development Plan 2020 (2021–2039)	Electricity demand is projected to grow by 0.6% p.a. for the 2021–2030 period and 1.8% p.a. for the 2030–2039 period. To achieve the RE capacity mix target from 20% to 31% by 2025, large hydro resources will be included as part of the RE for consistency, and 1 178 MW of new RE capacity will be developed in Peninsular Malaysia from 2021 onwards. To increase RE capacity to 40% by 2035, an additional 2 414 MW of RE capacity will be developed. The total new RE capacity would then consist of 93% solar and 7% non-solar energy. To develop 6 077 MW of new capacity (thermal energy and RE) by 2030 and 9 924 MW of new capacity (thermal energy and RE) beyond 2030.	Energy Commission
Low-Carbon Mobility Blueprint 2021–2030	To focus on improving vehicle fuel economy and emissions, adopting electric vehicles (EVs), low-emission vehicles and alternative fuels, and reducing GHG emissions and energy via mode shifts.	Ministry of Natural Resources, Environment and Climate Change

National Low-Carbon Cities Masterplan 2021	To guide the implementation of low-carbon developments and initiatives.	Ministry of Natural Resources, Environment and Climate Change
Nationally Determined Contribution to the UNFCCC 2021	To decrease GHG emission intensity of the GDP unconditionally by 45% in 2030 compared to the 2005 level.	Ministry of Natural Resources, Environment and Climate Change
The Twelfth Malaysia Plan	A medium-term plan for Shared Prosperity Vision 2030, with the objective of 'A Prosperous, Inclusive, Sustainable Malaysia'. Under the plan, the energy sector will address the energy trilemma, especially on energy security and sustainability.	Ministry of Economy
Malaysia Renewable Energy Roadmap 2022–2035	To support further decarbonisation of the electricity sector in Malaysia through the 2035 milestone, from 2022 to 2035.	Ministry of Natural Resources, Environment and Climate Change
Sabah Gas Master Plan	A collaborative effort between the Sabah State Government and PETRONAS to sustainably pursue the full potential of Sabah's domestic natural gas industry.	Sabah State Government and PETRONAS
National Energy Policy 2022-2040	To enhance macroeconomic resilience and energy security, achieve social equitability and affordability, and ensure environmental sustainability. The document is subject to periodic reviews every three years to ensure that the targets are achievable and to keep in line with international development in the energy transition pace.	Ministry of Economy

Notable energy developments

Energy development	Details	Reference
LNG Plant at Sipitang Oil and Gas Industrial Park	A 2.0 million tonnes per annum LNG facility to be operated in 2026.	Sabah State Government
Green Electricity Tariff Program	A voluntary program offered to Tenaga National Bhd customers to purchase green electricity generated from RE sources. The program started in January 2022 with a quota of 4 500 GWh and at the premium rate of 3.7 sen/kWh. In 2023, the quota has been increased to 6 600GWh at the same premium rate.	mGATS
Bursa Carbon Exchange	Malaysia's Voluntary Carbon Market Exchange or Bursa Carbon Exchange (BCX) was launched in December 2022, with the first auction is scheduled in March 2023. BCX provides a platform for companies to purchase carbon credits for meeting their emissions targets either immediately or in future.	Bursa Malaysia
RAPID Refinery	RAPID refinery with a capacity of 300 000 bbl per day came online in May 2022 after a two-year shutdown due to a fire incident in 2019.	Reuters
FLNG2	Malaysia's second Floating Liquefied Natural Gas was commissioned in February 2021 and sent its first LNG cargo to its customer in March 2021.	APERC Gas Report 2022

Useful links

Bank Negara Malaysia — www.bnm.gov.my

Bursa Malaysia — www.bursamalaysia.com

Department of Statistics Malaysia — www.dosm.gov.my

Energy Commission — www.st.gov.my

Grid System Operator — www.gso.org.my

Malaysia Energy Information Hub — www.meih.st.gov.my

Malaysia Green Technology Corporation — www.mgtc.gov.my

Malaysian Palm Oil Board — www.mpob.gov.my

Ministry of Economy — www.epu.gov.my

Ministry of Natural Resources, Environment and Climate Change — www.ketsa.gov.my and www.kasa.gov.my

Ministry of Finance — www.mof.gov.my

Ministry of Investment, Trade and Industry — www.miti.gov.my

Ministry of Plantation and Commodities — www.mpic.gov.my

Ministry of Science, Technology and Innovation — www.mosti.gov.my

MyHIJAU — www.myhijau.my

PETRONAS — www.petronas.com

Prime Minister's Office — www.pmo.gov.my

Sabah Electricity Sdn. Bhd. — www.sesb.com.my

Sarawak Energy Berhad — www.sarawakenergy.com

Single Buyer Department — www.singlebuyer.com.my

Sustainable Energy Development Authority — www.seda.gov.my

Tenaga Nasional Berhad — www.tnb.com.my

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Energy Commission (EC) (2023), *National Energy Balance 2020,* https://meih.st.gov.my/documents/10620/2923c46a-8324-4133-a0df-aba45dee3a92

FitchSolutions (2023), *Grassroots Refineries Shaping The Future of Malaysia's Downstream Industry,* https://www.fitchsolutions.com/oil-gas/grassroots-refineries-shaping-future-malaysias-downstream-industry-30-12-2022

Ministry of Natural Resources, Environment and Climate Change (NRECC) (2022), Fourth Biennial Update Report Under the United Nations Framework Convention on Climate Change, https://unfccc.int/documents/624776

OEC (2023), *Crude Petroleum in Malaysia,* https://oec.world/en/profile/bilateral-product/crude-petroleum/reporter/mys

PETRONAS (2022), *Malaysia Doubles Exploration Success in 2022 with 10 Discoveries*, https://www.petronas.com/mpm/press-release/malaysia-doubles-exploration-success-2022-10-discoveries

Sarawak Energy (2021), *Annual and Sustainability Report 2020,* https://www.sarawakenergy.com/assets/pdf/INTERACTIVE-Sarawak-Energy-ASR20.pdf

Mexico

Introduction

Mexico's favourable geographic location, i.e. close to the United States and with access to the Atlantic and Pacific coast, allows it to import natural gas produced in the US through its robust and interconnected pipeline system. In 2022, a high demand for natural gas and a rise in gas prices accelerated the construction and announcements of liquefied natural gas export projects in Mexico. Increased demand for US natural gas globally has positioned Mexico as a future exporter of imported US gas. The economy's Comisión Federal de Electricidad (CFE), which holds most of the pipeline capacity, is a key player in the development of these projects, together with the private sector.

Despite having abundant hydrocarbon resources and being one of the top 10 economies in terms of shale oil and gas reserves, Mexico's oil and gas production has been insufficient to satisfy a growing energy demand. In 2014, Mexico enacted energy reforms to open the sector to private sector participation and thereby increase energy production growth.

In 2021, Mexico's natural gas production fell to its lowest level in 45 years. In 2022, natural gas domestic production saw a rebound, increasing by 1.3% to a volume of 4 804 million cubic feet, which was still slightly below its 2019 level. Private sector natural gas production from the contracts awarded during the oil and gas bidding rounds over five years ago has contributed to this growth trajectory, increasing the participation of these industries from 0.38% to 5.6% of domestic production.

In 2022, oil production dropped to 1.62 million barrels per day, its lowest level since 1979, and 2.5% lower compared to 2021. The private sector saw a 31% growth in crude oil while PEMEX saw a drop in production, largely driven by the decline in its mature fields, which represent the largest share in production.

The government has an energy self-sufficiency strategy with the objective of increasing domestic production of crude oil and refined products. Mexico's oil company, Petróleos Mexicanos (PEMEX), is the key pillar of this strategy. The Energy Ministry's key infrastructure project consists of a new refinery with a capacity of 340 000 barrels per day, which is under construction in the state of Tabasco and is scheduled to begin operations in July 2023.

Table 1: Mexico's macroeconomic data and energy reserves

Key data [a, b]		**Energy reserves** [c, d]	
Area (million km²)	2.0	Oil (billion barrels)	6.1
Population (million)	127	Gas (trillion cubic feet)	6.3
GDP (2017 USD billion PPP)	2 569	Coal (million tonnes)	1 211
GDP per capita (2017 USD PPP)	19 086	Uranium (kilotonnes U < USD 130/kgU)	0 000

Source: a <reference> (2022); b World Bank (2022); c BP (2022); d UN (2022)

Note: Reserves are total proved reserves and identified recoverable resources for uranium.

In November 2022, during COP 27, Mexico's government made the commitment to increase its Nationally Determined Contributions by 5% in order to reduce greenhouse emissions by a total of 35%. Mexico seeks to deploy more than 30 additional gigawatts of combined wind, solar, geothermal, and hydroelectricity capacity by 2030, reaching more than 40 gigawatts of combined wind and solar power (US Embassy, 2022).

Energy supply and consumption

Total primary energy supply

Mexico's energy production has declined by 44% since reaching an oil production peak of 11 058 PJ in 2004. Total primary energy supply, which includes imports, exceeded domestic production for the first time in 2016, and it is expected that this trend will continue due to a lack of domestic production and a substantial growth in energy imports and demand.

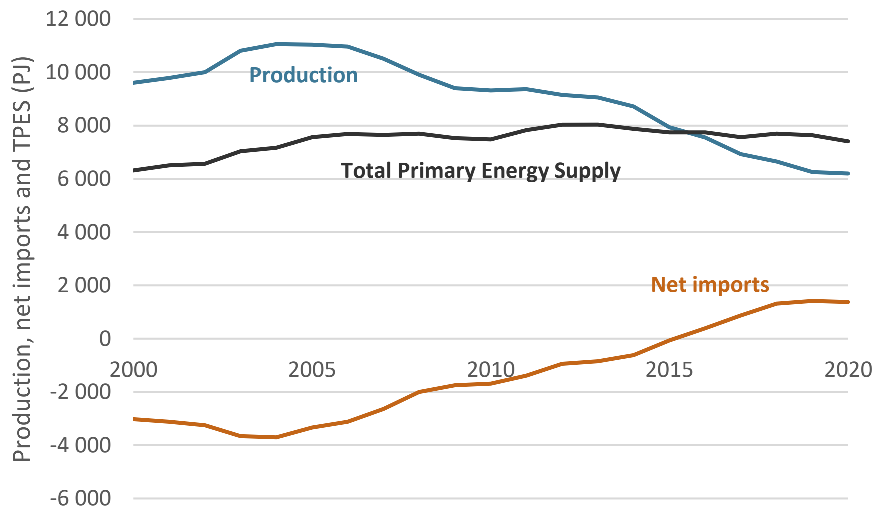
From 2000 to 2015, Mexico was a net energy exporter, mainly of crude oil exports. The volume of exports has gradually declined, together with a decline in oil and gas production. In 2016, Mexico became a net energy importer. The volume of net imports increased by 72% from 2016 to 2020.

Mexico receives relatively affordable oil and gas imports from the United States. The United States-Mexico-Canada Agreement (USMCA), is the framework for energy trade between North American economies.

Over the next decades, natural gas imports are expected to continue growing, to satisfy a growth in domestic demand, and to be re-exported from Mexico to the international market. Due to its geographic location and logistical advantages, it has become more efficient and competitive to export US gas from Mexico than from the US, in some cases. Most of these projects are geared to the Asian and European markets. Several liquefied natural gas (LNG) export projects have been announced and are under construction, such as Sempra's Costa Azul project in Baja California.

Over the long term, as the Asian and European markets pursue decarbonisation strategies, Mexico could become well positioned to export low-carbon energy sources such as green and blue hydrogen, as well as LNG using carbon sequestration.

Figure 1: Mexico's energy supply, production, and net imports (PJ), 2000 to 2020



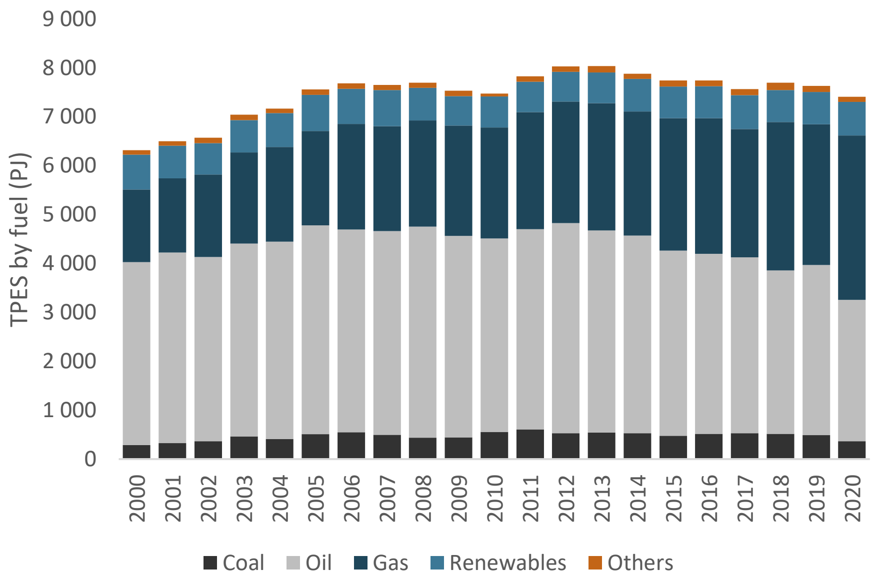
Source: EGEDA (2022)

From 2010 to 2019, Mexico's total primary energy supply volume grew modestly (4%). In terms of composition, fossil fuels still represent the largest share (89%), with oil accounting for the largest share (45%) in 2020.

In 2020, TPES saw a 3% annual contraction. During this period, the coal and oil supply reduced, while natural gas continued to increase. Oil saw a 17% drop, due in large part to confining measures that reduced the transport sector oil demand.

In the power sector, coal has reduced its participation, while natural gas has increased. Although there is significant potential for renewable energy generation, from 2000 to 2020 the volume of renewables supply saw a marginal decrease.

Figure 2: Mexico's energy supply by fuel (PJ), 2000 to 2020



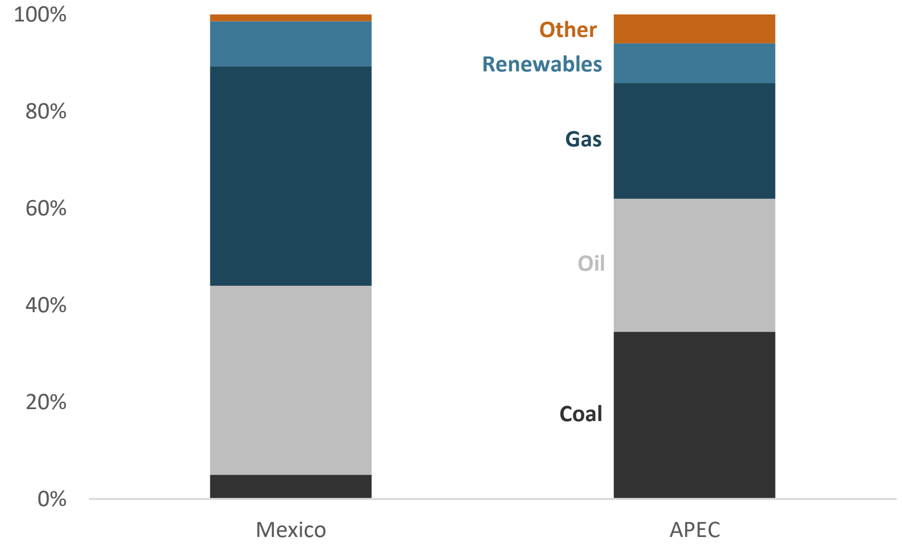
Source: EGEDA (2022)

Natural gas and renewables supply increased by 14% and 3.7% from 2019 to 2020, while oil and coal reduced by 17% and 25%, respectively. A fuel switch in power generation is increasingly displacing coal from Mexico's energy mix, as less carbon-intensive natural gas increases its participation.

Natural gas is increasingly replacing oil in electric power generation. From 2010 to 2020, the share of oil supply reduced from 53% to 39%, while the share of natural gas supply increased from 30% to 45%. Since mid 2000s, a host of factors, including an abundance of natural gas in the US, a fall in domestic production, better affordability, increased efficiency, and a natural gas infrastructure build-out have increased the flow of natural gas from the US into Mexico.

A significant expansion of natural gas infrastructure with flows from the US to Mexico has increased Mexico's imports of US gas. Throughout Mexico there is an economy integrated pipeline network that increasingly allows natural gas to reach demand centres to satisfy industrial and power sector demand.

Figure 3: Energy supply mix – Mexico and APEC, 2020



Source: EGEDA (2022)

One of the main differences between Mexico's energy mix and APEC's is the volume of coal consumption. In comparison to the APEC region, Mexico has readily available domestic and imported natural gas. In Mexico, natural gas is a more competitive fuel source than coal.

In Mexico, the share of oil in the energy supply mix is larger (39%) than in APEC (28%). This is due to Mexico's domestic production and imports of refined products. Mexico has six oil refineries, and it is building a seventh, called Dos Bocas, located in the state of Tabasco in the southern region of Mexico.

The new refinery will have a capacity of 340 000 barrels per day. The current government aims to increase Mexico's energy self-sufficiency, by increasing domestic fuel production. Currently, about 60% of Mexico's refined products are imported from the United States.

Total final consumption

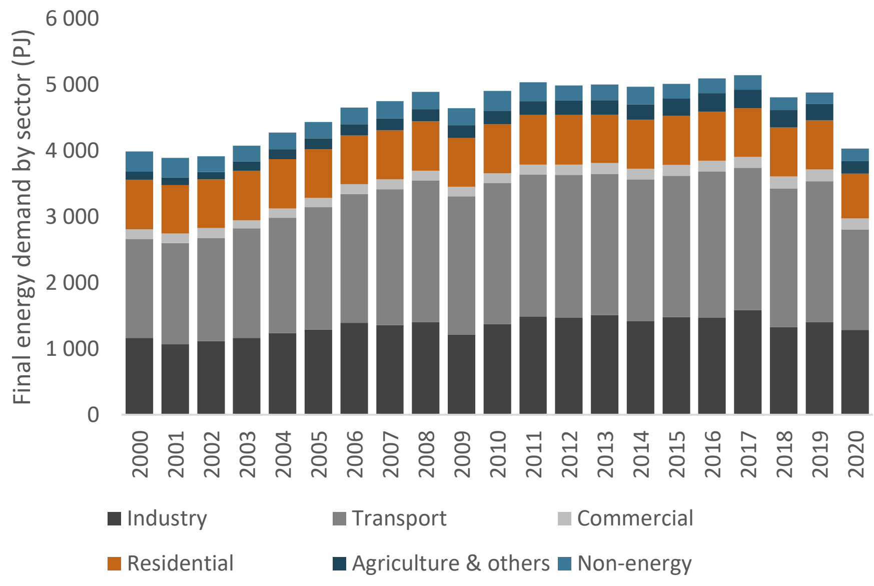
Mexico's energy consumption has been largely driven by the transport sector. The transport sector in Mexico is largely dependent on oil and other refined products such as diesel. Mexico's transport sector has a large energy consumption in comparison to other APEC economies.

Population growth and increased purchasing power have led to increased vehicle ownership in Mexico, which has contributed to increased energy consumption. From 2000 to 2019, the transportation sector final energy consumption grew at a compound annual growth rate of 3.7%.

From 2019 to 2020, due to COVID-19, and reduced mobility, oil consumption saw the largest yearly drop, declining by 29%. Total consumption declined by 17% which was the largest annual drop seen since 2000.

Since 2000, industrial energy consumption has increased by 17%, while residential energy consumption growth has remained flat.

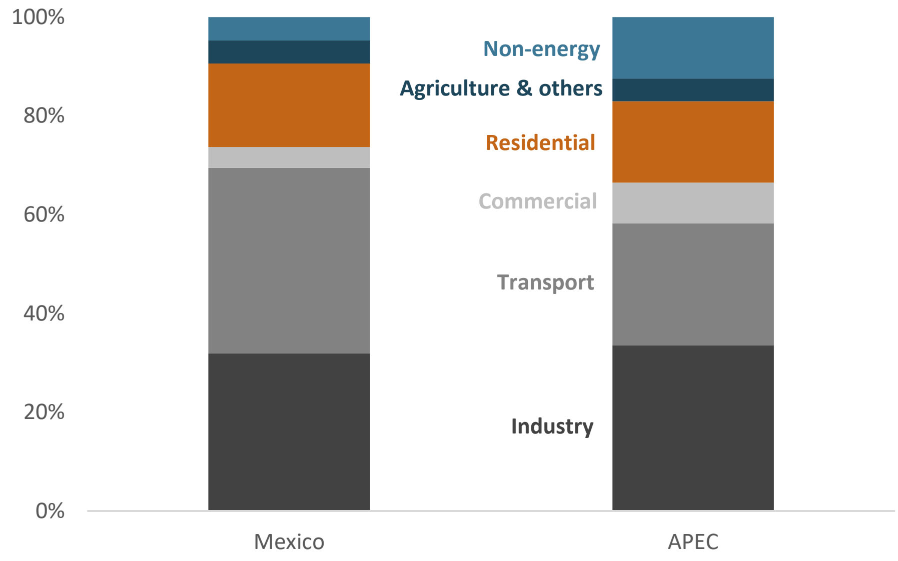
Figure 4: Mexico's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

In Mexico, the transport sector is the largest energy-consuming sector, followed by the industry sector. The transport sector in Mexico has a 38% share in final energy consumption (FEC), which is higher than APEC's share of 25%. Mexico's industry FEC represents a 32% share of total consumption, which is comparable to APEC's industry consumption share of 34%. The residential sector's share in Mexico is also similar to APEC's, with shares of 17% and 16%, respectively.

Figure 5: Final consumption by sector, Mexico and APEC, 2020

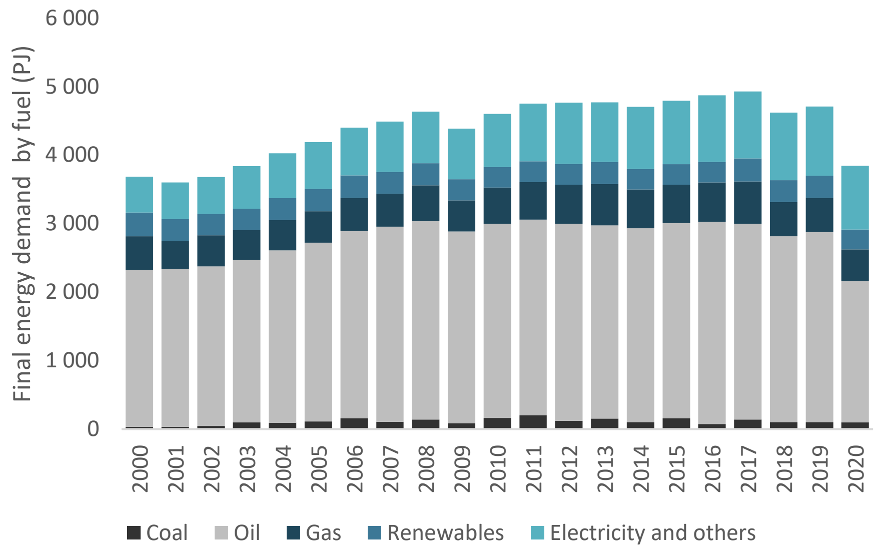


Source: EGEDA (2022)

Final energy demand

In 2020, final energy demand in Mexico fell to its lowest level since 2003, at a volume of 3 843 PJ. Oil saw the largest annual drop of 25%, largely due to the confinement measures and reduced mobility. Natural gas consumption declined by 8.7% as a result of reduced industrial activity, which was partly offset by an increase in residential demand for natural gas. Renewables' final energy demand remained steady at 322 PJ in 2019.

Figure 6: Mexico's final energy demand by fuel (PJ), 2000 to 2020



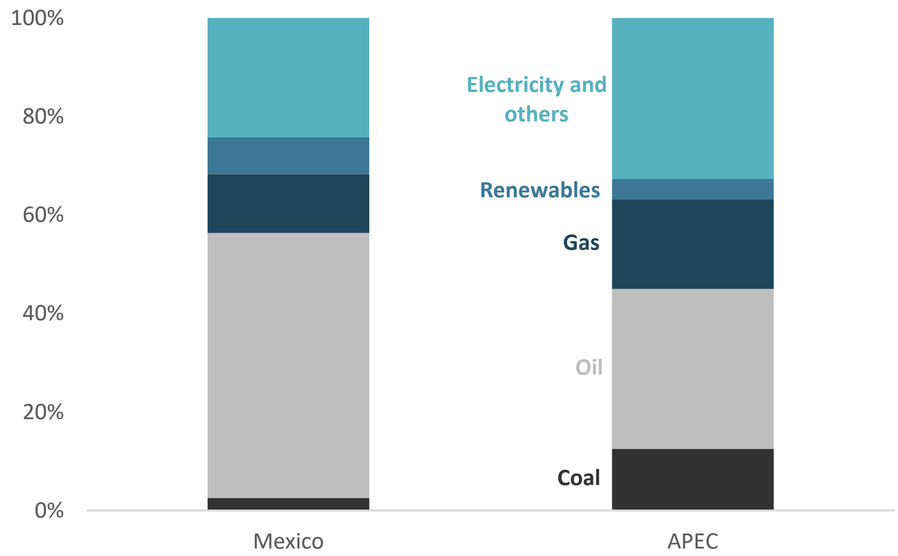
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Historically, Mexico has been an energy producer, although since its oil production peaked in 2004, it has become a fuel importer. Mexico relies heavily on petroleum and other liquids and natural gas for mobility and economic activity. However, compared to APEC it consumes less carbon intensive fossil fuel like coal. In Mexico the share of coal is 2.5%, while in APEC coal represents a share of 13% of final energy demand.

Mexico's renewables represent a 24% share in final energy demand, while in APEC they account for 33%. Relatively affordable natural gas in Mexico has undermined renewables demand growth. An increase in the price of natural gas could accelerate renewables demand growth.

Figure 7: Final energy demand fuel share, Mexico and APEC, 2020



Source: EGEDA (2022)

Electricity in Mexico comes mostly from combined cycle turbines that run on natural gas. The private sector accounts for a little less than half of the total electricity generation and its main sources of electricity generation are natural gas and renewables. CFE, is responsible for the majority of electricity generation. It has a large power generation fleet that runs on coal, oil, and natural gas mostly. CFE has recently announced the development of new renewable energy projects, and it has also set out the objective of increasing investment in renewables in its 2023-2027 business plan.

In 2023, Mexico's economy-owned utility company announced the construction of a 300 MW solar project in the state of Sonora, which seeks to increase renewable energy supply and export renewable energy to the United States.

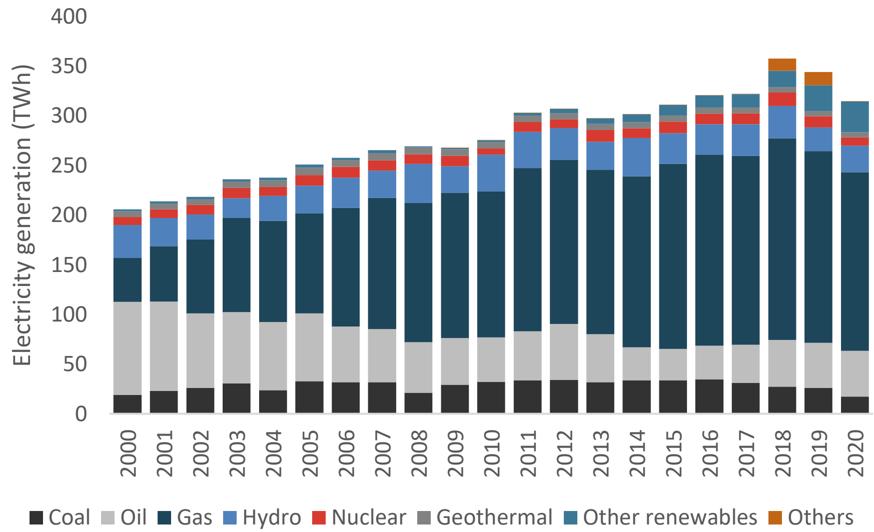
Transformation

Power sector

Since 2000, Mexico has been gradually displacing oil from its electricity generation mix. The share of oil reduced by half from 2000 to 2020. Conversely, natural gas has grown significantly, and it has become the most prominent fuel source for electricity generation, a trend that is likely to continue over the long term.

Natural gas for power in Mexico has several benefits, including increased efficiency and reduced energy intensity, relatively affordable costs and dispatchability. For these reasons, natural gas has been increasingly displacing coal and oil for electricity generation.

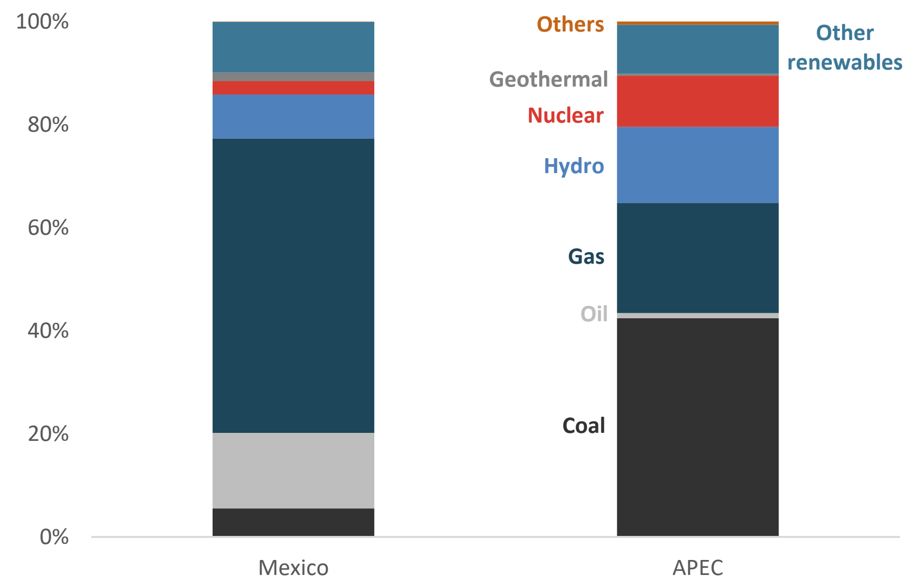
Figure 8: Mexico's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In Mexico, oil is still an important source of electricity generation, accounting for a share of 15% in 2019, compared to APEC's share of 1%. Mexico imports about 70% of its natural gas from the United States and this accounts for 57% of total electricity generation. Since the 2000s, Mexico's pipeline capacity has expanded, and its ability to import natural gas at a relatively affordable cost has contributed to a fuel switch from coal and oil to natural gas. Since the mid-2000s, Mexico's pipeline capacity has expanded significantly, and its ability to import natural gas at a relatively affordable cost has contributed to a fuel switch from coal and oil to natural gas. In the APEC region, high domestic availability for coal and competitive prices have led to higher use than in Mexico.

Figure 9: Electricity generation fuel share, Mexico and APEC, 2019



Source: EGEDA (2022)

In Mexico in comparison to the APEC region, the domestic availability of hydrocarbons and renewables has discouraged nuclear capacity additions, as it is more competitive to use other sources of energy over nuclear. The volume of renewables in Mexico and in the APEC region is very similar at around 9% of total electricity generation fuel share.

Refining

Mexico has the policy priority of increasing its domestic refineries and it is building a seventh refinery in the state of Tabasco called Dos Bocas that will have a capacity of 340 000 barrels per day. In recent years, Mexico's oil company Petróleos Mexicanos (PEMEX), acquired the Texas Deer Park refinery to have increased control over its refined product imports from the US.

Energy transition

Emissions

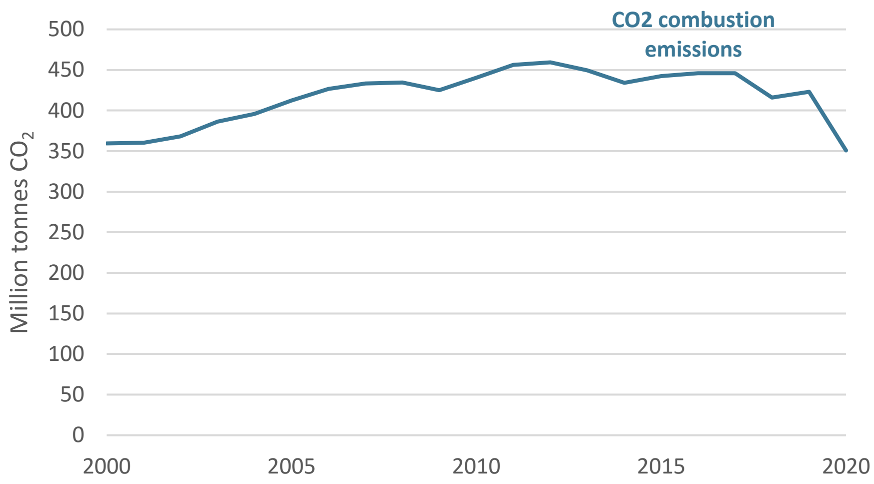
In November, during COP 27, Mexico's government made the commitment to reduce greenhouse emissions by 35% by 2030. Increased investments in renewable energy are expected to help meet this goal.

A decline in coal and oil use in the power sector has been the largest driver of CO_2 emissions reductions in Mexico. From 2000 to 2010, oil use in the power sector declined by half, while natural gas saw a 70% increase. Coal increased by 40%, offsetting emission reduction gains from a switch from oil to natural gas during that period. After peaking in 2017 with a volume of 34 PJ, coal declined by almost 26% through 2019. From 2019 to 2020, coal saw the largest annual fall, declining by almost 36%.

From 2010 to 2020, electricity capacity additions came from less intensive carbon sources than during the prior decade, reducing carbon dioxide emissions by 20%. Natural gas increased by 18%, oil-fired generation remained flat, and renewables increased by 90%.

In 2020, the share of renewables for power generation reached a record 20%, while coal accounted for 5%.

Figure 10: Mexico CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Mexico has abundant hydrocarbon resources and renewable energy potential. Oil and natural gas production in Mexico have been on a declining trend due to lack of investment in upstream activity and a natural depletion of its large oilfields. At the same time, macroeconomic factors have been increasing demand for energy in Mexico. A decline in domestic production and increased demand is increasing the need for energy imports. Over the last decade Mexico's oil and gas imports have increased significantly. A rise in import dependence and a lack of natural gas storage is compromising Mexico's energy security.

To increase energy security in Mexico, an increase in natural gas storage, increased domestic energy production and diversification of its supply base will be important.

APEC energy goals

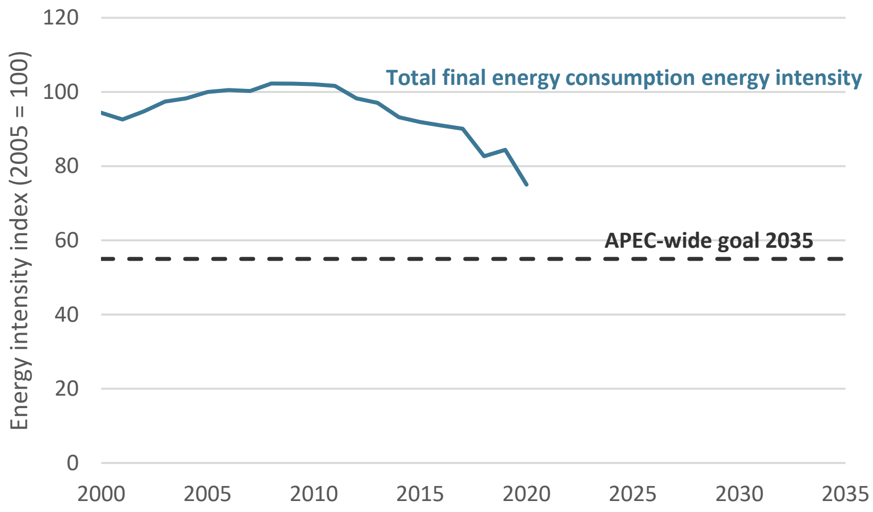
There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target for to reducing energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Figure 11: Mexico's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

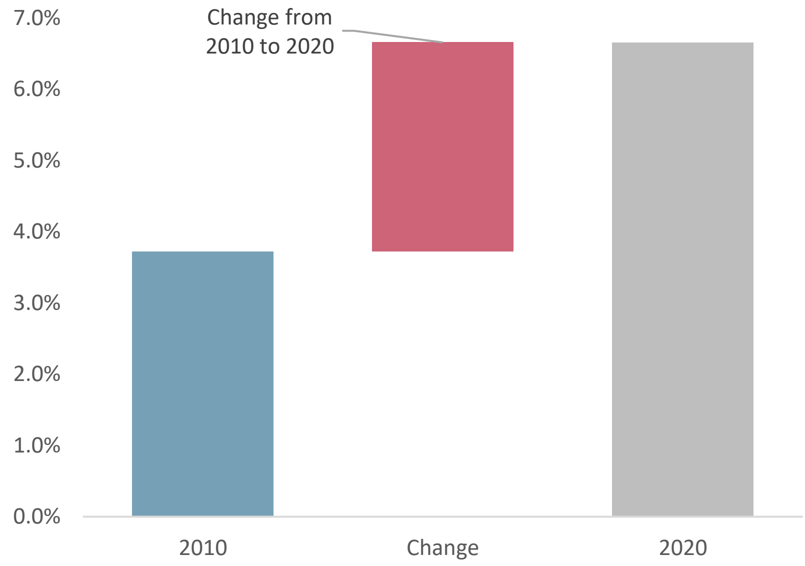


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: Mexico's modern renewable energy share, 2010 and 2020



Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

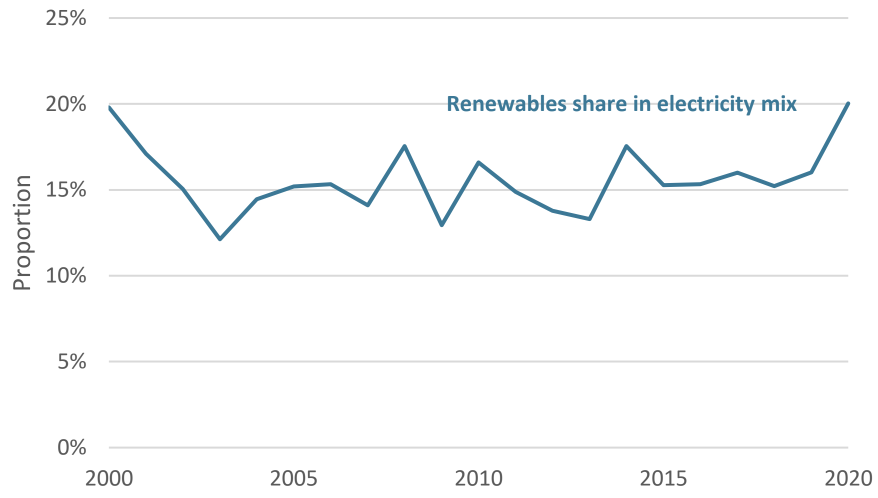
From 2010 to 2020, there was a 2.9% increase in Mexico's modern renewable share, reaching a total of 6.7% in 2020. Increased private sector participation in electricity generation contributed to an increase in wind and solar electricity generation growth. Mexico is one of the most competitive producers of wind and solar energy. Going forward, it is expected that the CFE, will play an increased role in the development of modern renewable energy projects.

Mexico's renewable generation share in 2020 was at the same level as in 2000, at 60%. One of the reasons why Mexico's renewables share in electricity mix has remained flat has been the use of efficient natural gas, as well as limited private sector participation until 2015 when the energy reform was implemented.

The government of Mexico has been cautious in its approach to incorporating larger volumes of renewable energy, due in part to grid reliability concerns. There was a policy to expand transmission and distribution networks together with renewable energy generation, but this policy has been discontinued by the current government.

It is likely that new investments across the energy sector will come from close private-public sector partnerships. The government is increasingly interested in developing new renewable energy projects to satisfy its growing energy demand, although there is not a clear timeframe or scale for these projects.

Figure 13: Mexico's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
National Development Plan 2019–2024	This plan outlines the main policy objectives and priorities of the current six-year (2018–2024) presidential administration.	Office of the President
Energy Sector Program 2020–2024 (PROSENER)	PROSENER is a planning instrument that determines the current administration's strategies and actions towards achieving six priority objectives: to ensure energy self-sufficiency, strengthen economy-owned companies, organise research and development activities, attain energy efficiency and sustainability, ensure universal energy access and make the energy sector a lever of development.	Official Federal Gazette
Transition Strategy to Promote the Use of Cleaner Technologies and Fuels	The Transition Strategy serves as the medium- and long-term guiding instrument for the economic policy regarding clean energy obligations, sustainable energy use and energy productivity improvements.	Official Federal Gazette
Paris Agreement Nationally Determined Contribution (NDC) 2022 Update	In November 2022, during COP 27, the Mexican government submitted an updated NDC. The submission includes an unconditional emissions reduction target from BAU by up to 35% in 2030 for all greenhouse gases.	Ministry of Environment and Natural Resources (SEMARNAT)
Paris Agreement Nationally Determined Contribution (NDC) 2020 Update	Mexico updated its NDC in 2020, but it did not improve upon the ambitions of its original NDC, in which the economy pledged to reduce greenhouse gas emissions by 22% by 2030, compared to a business-as-usual 2013 baseline. No additional emission reduction or decarbonisation plans have been published to date.	Ministry of Environment and Natural Resources (SEMARNAT)
National Electricity System's Development Program 2021-2034 (PRODESEN)	This program details the annual plans for the power sector with a 15-year horizon. It includes key elements for generation capacity additions and retirements as well as for grid extensions and modernisation.	Ministry of Energy (SENER)
Oil and gas exploration and production five-year plan 2020–2024	This is a planning instrument that identifies the priority areas for oil and gas exploration and production, emphasising the potential for onshore and shallow-water resources. It excludes the development of any unconventional resources for the time being. The document also reaffirms the administration's moratorium on oil and gas auctions.	Ministry of Energy (SENER)

Five-year plan for the expansion of the economy's integrated transportation and storage system of natural gas (SISTRANGAS) 2020–2024	This five-year plan provides an overview of the natural gas transportation and storage infrastructure as well as the consumption and supply observed in recent years. The planning document details a set of infrastructure projects that can help expand the storage and transportation networks.	Ministry of Energy (SENER)
National Program for the Sustainable Use of Energy 2020–2024 (PRONASE)	This instrument establishes actions, projects and activities derived from the Transition Strategy for the accomplishment of the stated energy efficiency goals.	Official Federal Gazette
Energy Efficiency Roadmap	This roadmap on energy efficiency details the energy efficiency goals, potential and sectoral scenarios and the sectoral barriers to tapping into the full energy efficiency potential.	National Commission for the Efficient Use of Energy (CONUEE)
Energy Transition Law (LTE)	The LTE provides a framework for clean energy, energy efficiency and greenhouse gas emission reduction. It establishes four planning instruments: a strategy to meet the clean energy and energy efficiency goals, two special programs to implement this strategy and a program focused on smart grids. The clean energy goals for power generation are as follows: 25% in 2018; 30% in 2021; 35% in 2024.	Official Federal Gazette
Second Regulation of the Energy Transition Law	This secondary regulation or reglamento specifies, in greater detail, the obligations given in the LTE. Among other issues, it provides the requirements for the methodologies involved in planning and publishing progress reports and other clean energy benchmarking data.	Official Federal Gazette
Roadmap for Building Energy Codes and Standards for Mexico	This document provides a pathway and policy framework for increasing energy efficiency in Mexico's building sector.	Ministry of Energy (SENER)
Minimum energy performance standards for 12 appliance groups	This set of standards regulates the energy consumption of appliances that, due to their energy demand and massive use, offer substantial energy and cost savings to end users.	National Commission for the Efficient Use of Energy (CONUEE)
National Program for Energy Management Systems (PronasgeN)	This program aims to support and bring together Energy Management Systems (EnMS), contributing to EnMS market consolidation in Mexico. Case studies have demonstrated energy efficiency improvements of at least 10% in industrial facilities upon implementing EnMS.	Official Federal Gazette

Guidelines for the Prevention and Comprehensive Control of Methane Emissions from the Oil and Gas Sector	These guidelines apply to new and existing sources across the value chain. Under the regulation, facilities must develop a Program for Prevention and Integrated Control of Methane Emissions (PPCIEM). As a starting point, facilities must identify all sources of methane and calculate an emissions baseline (base year must be within the last five years).	Ministry of Environment and Natural Resources (SEMARNAT)
Pilot Emissions Trading System (ETS)	In 2020, this pilot ETS began its operations as part of a two-phase process to gradually establish a fully-fledged ETS. The pilot ETS covers the power, oil and gas and industrial sectors, which account for approximately 40% of Mexico's green-house gas emissions. Entities with annual emissions from direct sources greater than 100 ktCO_2 were covered under the pilot.	National Commission for the Efficient Use of Energy (CONUEE)
Municipal Energy Efficiency Project (PRESEM)	PRESEM focuses on making energy efficiency investments in selected municipal sectors (pumping water systems, street lighting and public buildings).	Department of Industry, Science, Energy and Resources
Electricity Subsidies for the Residential and Agricultural Sectors	The Ministry of Finance (SHCP) provides subsidised electricity rates to most users in the residential and agricultural sectors. The final rates vary due to inflation but remain constant in real time. This rate was roughly 0.12 USD/kWh in 2020, which was about 46% of the total cost of the service.	Inter-American Development Bank (IADB)
Statistical Record 2021	This is a compendium of data on natural gas and petrochemicals, and it is presented in a clearly summarised and accessible format on a monthly basis.	Ministry of Energy (SENER)

Notable energy developments

Energy development	Details	Reference
Amendment to the Electricity Industry Law	After approval in both legislative chambers, this amendment – proposed by the President – was published in March 2021. The ultimate purpose of the law is to strengthen the Comisión Federal de Electricidad (CFE). Some of the changed provisions in the law include granting a dispatch preference for CFE power plants, removing the obligation for service suppliers to procure electricity, and revoking self-supply permits.	Official Federal Gazette

Electricity Industry Law Court Suspension	The recently approved amended electricity law is in an ongoing judiciary process. It was granted a definitive suspension by a Mexican court, citing competition concerns and irreparable environmental damage. Accordingly, the new amendment cannot take effect until a tribunal or the Supreme Court of Justice makes a decision.	Official Federal Gazette
Amendment to the Hydrocarbons Law	This presidential initiative was passed into law in May 2021. Among other provisions aimed at enhancing PEMEX (the economy-owned company), the law grants the Ministry of Energy and the Energy Regulatory Commission (CRE) power to suspend or revoke permits for oil and gas midstream activities, including international trade, should they pose any 'imminent danger' to security; energy security or the economy.	Official Federal Gazette
Hydrocarbons Law Partial Suspension	As with the Electricity Industry Law, this amendment was also challenged in court. However, unlike the Electricity Industry Law, a court granted a partial suspension of certain provisions of the law. The process is ongoing, and a tribunal or the Supreme Court of Justice can overturn such a ruling.	Reuters
Revocation of Asymmetrical Regulation to PEMEX	This law amendment takes away the CRE's faculty to impose asymmetrical regulations for PEMEX's oil, gas, fuel and petrochemical activates. Asymmetrical regulation measures were initially aimed at limiting PEMEX's former monopoly of storage and sales of these products.	Official Federal Gazette
Reliability Energy Policy	The Ministry of Energy published the 'Policy on Reliability, Stability, Continuity and Quality in the National Electric System' in May 2020, imposing stricter rules for new non-CFE generation permits and additional restrictions for wind and solar plants. After a series of injunctions, a federal judge ordered its general suspension. In March 2021, SENER cancelled the application of the policy ahead of the legislative vote for amending the Electricity Industry Law, which contains many of the same provisions.	Official Federal Gazette
Supreme Court's Invalidation of the Reliability Energy Policy	The above-mentioned Reliability Energy Policy was the subject of a constitutional controversy promoted by the Federal Economic Competition Commission. Mexico's Supreme Court of Justice invalidated some of the key points of this policy, considering them unconstitutional.	Supreme Court of Justice
National Centre for Energy Control of Mexico (CENACE), Resolution to Guarantee the Efficiency, Quality, Reliability, Continuity and Stability of the National Electric Grid	In April 2020, CENACE, the grid operator, indefinitely suspended pre-operational tests for new solar and wind projects and modified the rules for grid access. CENACE tried to justify these as part of a series of measures to assure grid stability amidst decreases in demand caused by the COVID-19 pandemic. Private generators began legal proceedings, and the procedure was definitively suspended by a court in June 2020.	National Centre for Energy Control of Mexico (CENACE)

PEMEX's Purchase of the Deer Park Refinery	The economy-owned oil company PEMEX agreed to a USD 596 million deal to buy Shell's majority interest in the joint venture 340 000 b/d refinery in Deer Park, Texas. PEMEX has acquired full ownership of the refinery, thus increasing its share of gasoline and diesel.	PEMEX
Construction of the Dos Bocas Refinery	A key aim of Mexico's oil policy is to boost domestic refining. The construction of the emblematic Dos Bocas refinery was one of the landmark infrastructure projects of this administration. The 340 000 b/d refinery, with a wholly government-funded investment of over USD 8 billion, is expected to be operational by 2024 and to increase refining capacity by 25%.	Dos Bocas Refinery
Lakatch dry natural gas offshore field	Located in the state of Veracruz. Joint venture between New Fortress Energy and PEMEX. Potential production capacity of 300 million cubic feet per day over 10 years starting in 2024. 190 million cubic feet per day will be sold to New Fortress Energy who will liquefy and sell the gas to the international market. Initial LNG production of 1.4 million tonnes per year will increase to 7 million tonnes per year.	Argus Media
Announcement of Coatzacoalcos LNG export project	CFEnergia, CFE, gas commercialisation unit. Capacity: 4.5 million tonnes per year. Export project from the port of Coatzacoalcos in the Gulf of Mexico, to sell gas to the international market.	Ministry of Energy (SENER)
Altamira floating storage regasification unit export project	Located in the state of Tamaulipas. US firm New Fortress Energy and CFE joint venture. Total capacity estimated: 4.2 million tonnes per year to come into operation next year. To export gas to Europe.	ECA LNG
Announcement of CFE Solar park in Sonora	Economy-owned utility company CFE with private sector. Located in the state of Sonora, in the port of Penasco.	New Fortress Energy

Useful links

Banco de México (Banxico) – www.banxico.org.mx

Centro Nacional de Control de Energía (CENACE) – www.cenace.gob.mx

Centro Nacional de Control del Gas Natural (CENAGAS) – www.cenagas.gob.mx

Comisión Federal de Electricidad (CFE) – www.cfe.gob.mx

Comisión Nacional para el Uso Eficiente de la Energía (CONUEE) – www.conuee.gob.mx

Comisión Nacional de Hidrocarburos (CNH) – www.cnh.gob.mx

Comisión Regulatoria de Energía (CRE) – www.cre.gob.mx

Comisión Nacional de Seguridad Nuclear y Salvaguardias (CNSS) – www.cnsns.gob.mx

Instituto Mexicano del Petróleo (IMP) – www.imp.mx

Instituto de Investigaciones Eléctricas (IIE) – www.iie.org.mx

Instituto Nacional de Investigaciones Nucleares – www.inin.gob.mx

Instituto Nacional de Estadística y Geografía (INEGI) – www.inegi.org.mx

Petróleos Mexicanos (PEMEX) – www.pemex.com

Presidencia de la República – www.gob.mx/presidencia

Rondas México – https://rondasmexico.gob.mx/

Secretaría de Energía (SENER) – www.gob.mx/sener

Secretaría de Hacienda y Crédito Público (SHCP) – www.gob.mx/hacienda

Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) – https://www.gob.mx/semarnat

Sistema de Información Energética (SIE) – http://sie.energia.gob.mx

References

US Embassy (2022), https://mx.usembassy.gov/united-states-welcome-mexicos-commitments-announced-during-cop-27/

New Zealand

Introduction

During the COVID-19 pandemic, New Zealand employed strict border controls to take advantage of being an island economy and eliminate the virus until vaccines were rolled out. In 2020, there were still a few lockdowns, including one stricter one, which was about a month long in April. The data for the year shows significant effects on energy supply and demand because of these actions; however, the economy was less affected than other APEC economies.

Renewables made up a large share of New Zealand's energy supply and accounted for approximately 80% of electricity generation in 2020. Hydro generation is the dominant renewable energy source, followed by geothermal and wind. New Zealand's wind resources have excellent potential but have not been fully utilised yet.

The possible closure of the Tiwai Point Aluminium Smelter, which accounts for 13% of the economy's annual electricity consumption, remains a major factor in shaping New Zealand's electricity generation landscape. It is still not clear whether it will close, but the increase in demand for low-carbon aluminium is improving its prospects.

Coal and natural gas are the most abundant fossil energy resources in New Zealand. However, in 2018, the government banned new offshore exploration for oil and gas except for onshore Taranaki. Efforts are being made to ensure the existing natural gas reserves are enough to meet current and future consumption.

New Zealand’s economic situation is like the rest of the world. Its Reserve Bank is raising interest rates to curb inflation, and the Treasury forecasts expect a shallow recession in 2023. This is having significant effects on energy transition plans, such as the need to scrap a proposed biofuel mixing mandate to help keep fuel prices down for consumers.

Table 1: New Zealand’s macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (thousand km^2)	268	Oil (billion barrels)	63
Population (million)	5.1	Gas (trillion cubic feet)	2 074
GDP (2017 USD billion PPP)	219	Coal (million tonnes)	7 580
GDP per capita (2017 USD PPP)	42 900	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a Stats NZ (2022); b World Bank (2022); c MBIE (2021); d BP (2021)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Energy supply and consumption

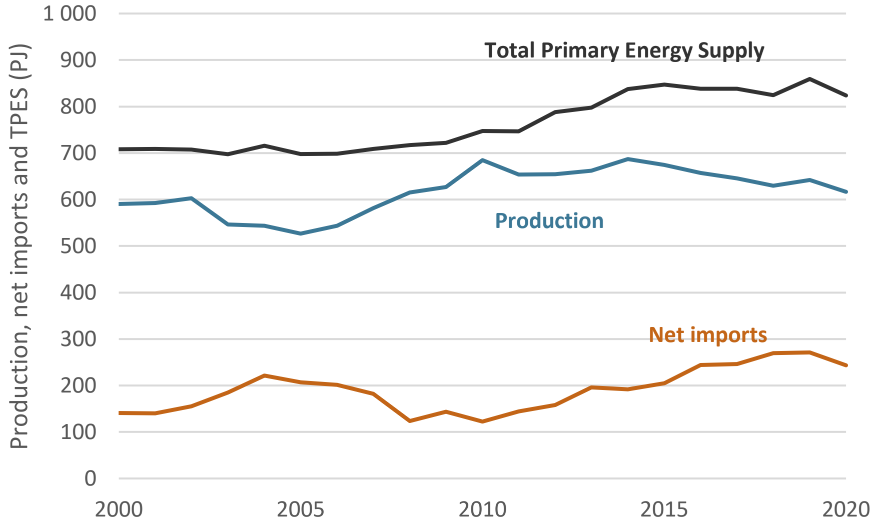
Total primary energy supply

TPES (Total primary energy supply) in New Zealand in 2020 was 824 PJ, which was a 4% decrease compared to 2019. The decrease was mainly COVID-related, and led to reduced activity, especially in the industrial and transport sectors.

Production of all fossil fuels (about 260PJ) continues to stagnate, largely because of the oil and gas exploration ban, which means that offshore oil and natural gas exploration and production can only occur within a permitted area. New Zealand’s crude and coal production is also mostly used for export so the transition to renewable energy types in New Zealand has little effect on the production of those fuel types.

The majority of New Zealand’s energy exports are crude oil (39PJ, 55%) and coal (32PJ, 45%). In 2020, total energy exports fell by 24%. One major cause of this was coal mines shutting down for about a month during a COVID-19 lockdown.

Figure 1: New Zealand’s energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

New Zealand’s imports are mostly made up of crude oil (159PJ), petroleum products (128PJ) and coal (43PJ). The oil is mainly used for transport and the coal is mostly used for electricity generation at the Huntly Power Station.

The economy maintains a high share of renewables in its energy mix, with them making up 40% of TPES, and 80% of its electricity generation in 2020. The potential closure of the Tiwai Point Aluminium Smelter in 2024 could have significant, unknown impacts on these numbers.

In 2020, New Zealand's net energy imports were 243 PJ, nearly double the amount in 2010, but also 10% lower than 2019. This large drop was mostly from crude and oil products, which dropped by about 50PJ, a result of COVID-related travel restrictions.

The economy's only oil refinery, at Marsden Point, shut down in April 2022, so all refined petroleum products must be imported. New Zealand exports all its crude oil production (40PJ).

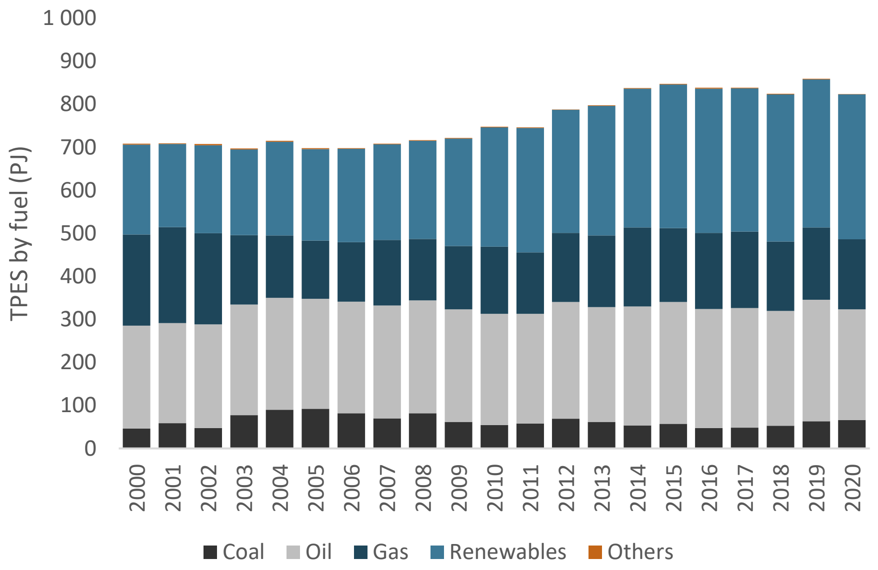
The main sources of renewable energy supply are hydro (26%) for electricity, biomass (10%) for direct use in manufacturing, and geothermal (60%) for electricity generation.

While geothermal makes up a large portion of TPES, its conversion efficiency is low (15%) resulting in a misleading view of available renewable energy in the economy. Of the geothermal energy, only 29 PJ is converted to usable electricity, and a very small amount is used for direct heat in industry and buildings.

Gas supply can be split into transformation (33%), consumption (39%) and non-energy use (22%). The gas used for transformation is almost all for electricity production. The gas for consumption is mostly industrial process heat, including heat for food processing and chemical production (urea and methanol). The non-energy use is as a feedstock for chemical production. Fluctuations due to changes in the domestic gas price and international methanol prices can cause changes in demand from the chemical sector.

Issues with the economy's largest gas field, Pohokura, caused a strain in gas supply. One effect of this was to cause the economy's methanol producer to drop production to 76% of total operating capacity. The shortage also caused an increase in electricity and gas spot prices.

Figure 2: New Zealand's energy supply by fuel (PJ), 2000 to 2020

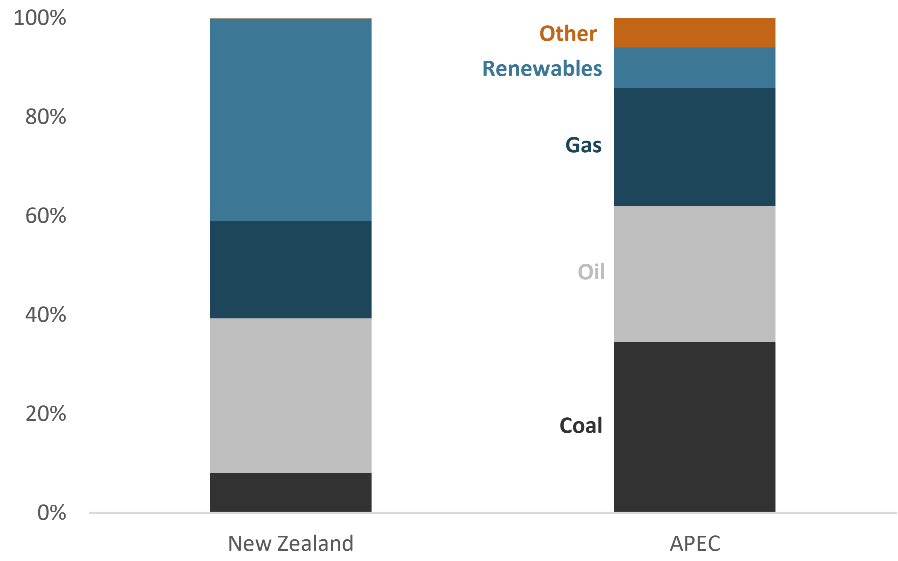


Source: EGEDA (2022)

Compared to the APEC average, New Zealand has a larger proportion of renewable energy sources. Even though geothermal electricity generation inflates this figure, New Zealand still has a larger supply of hydro and biomass.

The supply of coal in New Zealand is lower than the APEC average, due to a greater reliance on renewable energy sources for electricity generation.

Figure 3: Energy supply mix – New Zealand and APEC, 2020

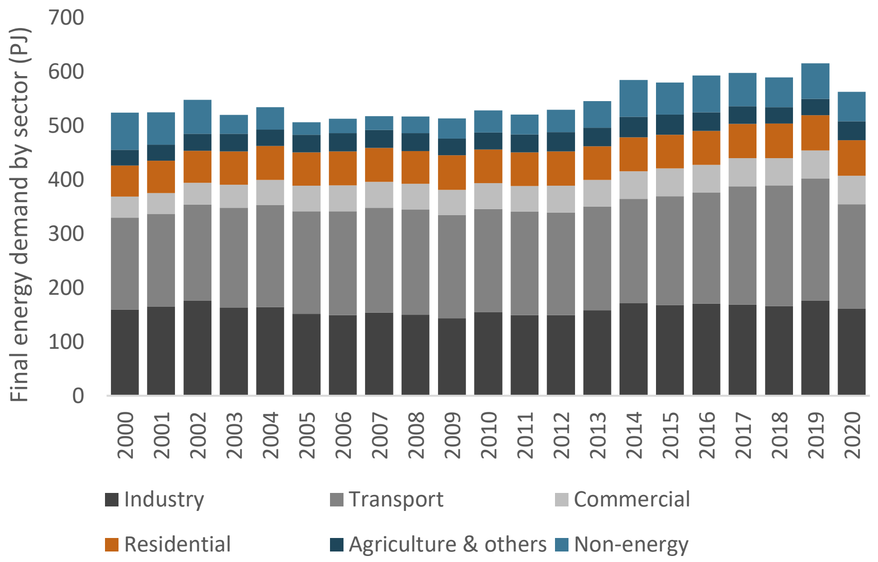


Source: EGEDA (2022)

Total final consumption

In 2020, the total final consumption of energy in New Zealand was 563 PJ, following an 8.5% drop in use since 2019. This was mostly a result of COVID-19 restrictions, especially a decrease in the amount of transport energy use (about 15%), and in some industrial energy use (about 9%).

Figure 4: New Zealand's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

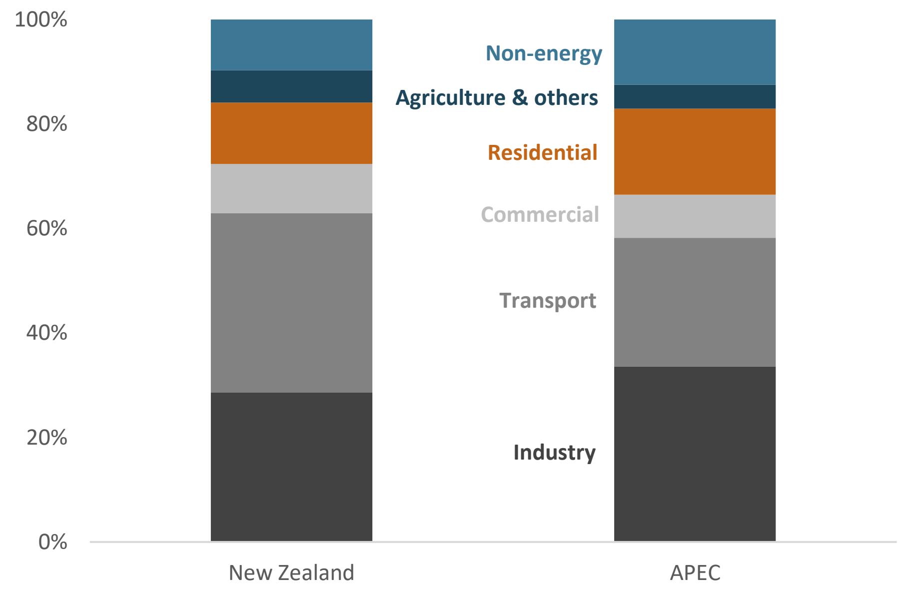
Transportation continues to be the leading energy consumer sector, accounting for over one-third of total energy consumption. There has been a rapid rise in transport activity in the last five years but 2020 saw a 15% drop in energy use due to travel restrictions because of COVID-19 lockdowns towards the latter half of the year. The fall in transport activity was most severely seen in the aviation sector, causing domestic and international jet fuel use to each drop by about half.

New Zealand's residential energy consumption is lower compared to other economies in APEC. This disparity is a result of the economy's low population and high GDP per capita, as well as improved energy efficiency in housing.

In 2020 the residential sector saw an increase in energy use of 1.6%, which was greater than the 0.6% average increase since 2010. This was largely a result of COVID-19 lockdowns, as more daytime residential electricity use was observed.

The industrial sector saw almost a 9% drop in demand. This was connected to the impact of COVID-19 lockdowns, as only the food processing and chemicals sectors were deemed essential and continued operation during certain lockdowns in the 2nd quarter of the year.

Figure 5: Final consumption by sector, New Zealand and APEC, 2020



Source: EGEDA (2022)

The Tiwai Point Aluminium Smelter decreased its output by about 9%, which led to a drop in electricity consumption by about 1PJ. This came at the same time as a near 25% fall in international aluminium prices over the previous 18 months, but COVID-19 restrictions were cited as the reason. The smelter also managed to secure a discount on its electricity price until 2024, which is when it has announced that it may close the plant due to falling profits.

The agricultural sector was deemed to be an essential service during the COVID-19 lockdowns. This, counteracted by lower-than-normal soil moisture levels, led to a 14% (1PJ) rise in demand from the agriculture, forestry and fishing sector.

Final energy demand

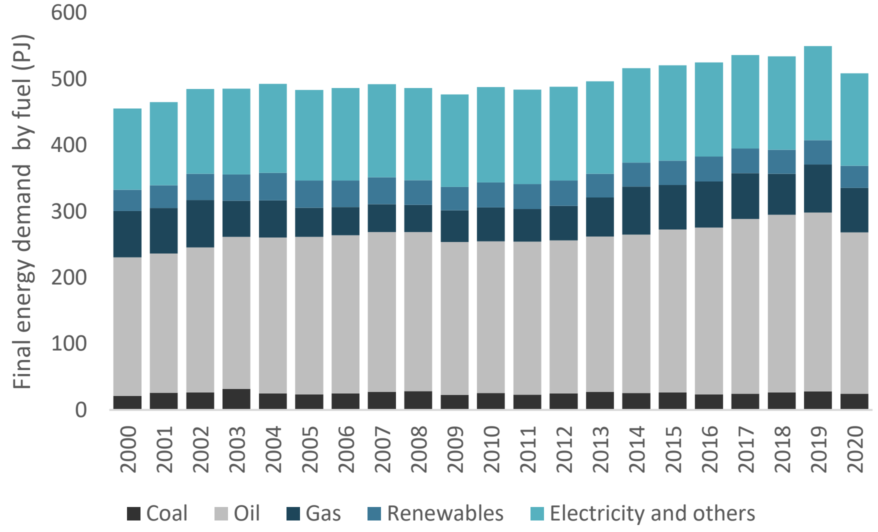
Oil consumption in New Zealand is high, accounting for 48% of the economy's energy use, compared to the average in the APEC region of 33%. Most of the oil, over 80%, is used for transport.

Electricity consumption in New Zealand represents all demand in the "Electricity and others" category. The use of electricity in New Zealand is comparable to other APEC economies in the industrial, residential, and commercial sectors. The Tiwai Point Aluminium Smelter currently consumes about 13% of New Zealand's electricity generation and is a significant factor in the economy's energy generation planning.

Almost all coal consumption in New Zealand (which excludes coal use for electricity generation) is in the industrial sector for process heat. Within the industrial sector, 18 PJ (77%) of this is used in food and beverage manufacturing, mainly by dairies for drying milk into milk powder. This year saw coal use for non-metallic mineral product manufacturing (glass, ceramics, lime, plaster and concretes) decreased from about 4 to 2PJ.

Most of the renewable energy use (excluding transformation) in New Zealand is in the industrial sector for process heat, while the rest is utilised in the residential and commercial building sectors.

Figure 6: New Zealand's final energy demand by fuel (PJ), 2000 to 2020



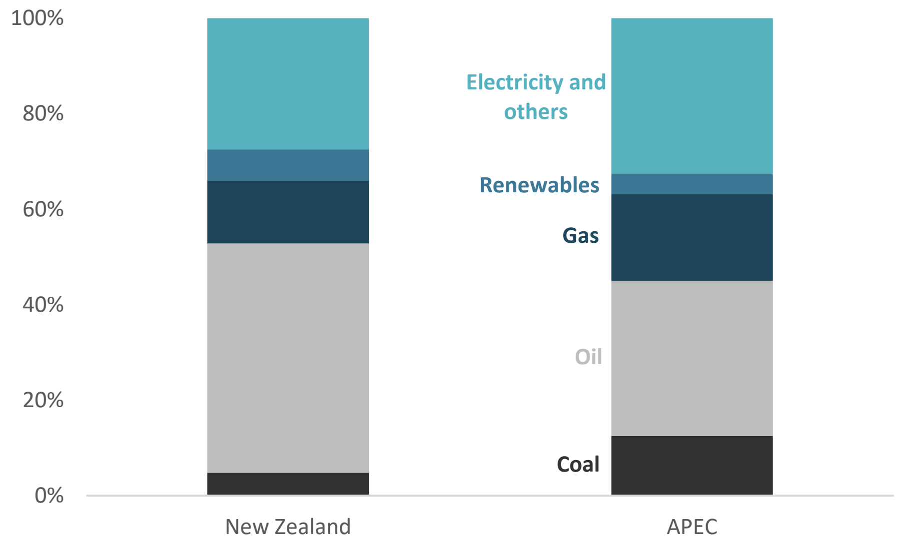
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Most of New Zealand's end-use gas consumption (excluding transformation and non-energy consumption) in 2020 was in the industrial sector for process heat, with half of that coming from the chemicals subsector. The chemicals subsector saw fluctuating consumption based on global petrochemical demand and domestic gas prices, which have been lower in the past. The remaining gas is used in residential and commercial applications including for heating buildings, water heating and cooking.

The government is focusing on reducing the economy's fossil fuel consumption in the short to medium term and sees industrial process heat as a prime opportunity, as it accounts for 80% of industrial energy use. This could lead to a shift away from coal and (to a lesser extent) natural gas to low-emission energy sources such as biomass, electricity, and geothermal heat.

Figure 7: Final energy demand fuel share, New Zealand and APEC, 2020



Source: EGEDA (2022)

In New Zealand, energy demand is divided among fuels similarly to other APEC economies, but with some variations. The use of coal, gas and electricity is lower while the use of oil and renewables is higher. The lower consumption of electricity, gas and coal can be attributed to reduced energy demand in the industrial sector, which is a key driver of energy use. Additionally, the industrial sector in New Zealand relies more heavily on renewables, which further reduces the prominence of other fuel types. In addition, the high transport activity in New Zealand results in a higher proportion of oil use.

Transformation

Power sector

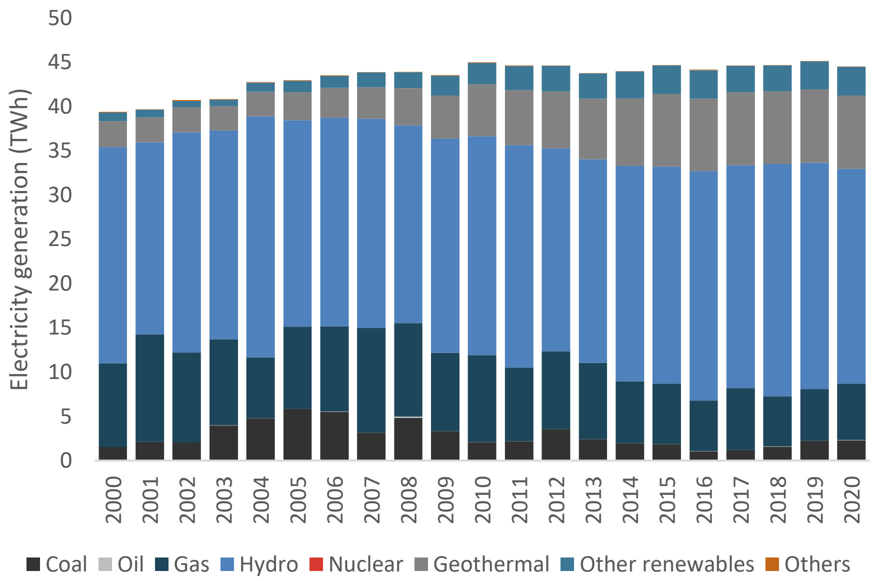
In New Zealand, hydro power is the leading source of electricity generation due to the economy's favourable natural landscape for hydropower. However, dry years, which occur when there is a shortage of rain or snowmelt and the water levels in lakes become low, pose a challenge, and require backup generation, which is currently provided by fossil fuels.

Geothermal energy plays a significant role in New Zealand's generation mix, accounting for 1 035 MW (about 10%) of installed capacity. This energy source, like hydro, provides baseload generation, which means it operates continuously, and helps to counteract the unpredictability of newer generation sources such as wind and solar. While geothermal energy is a renewable resource, it can result in emissions, depending on the geology and technology used. These emissions are generally lower compared to those from fossil fuel generation.

Solar and wind power are quickly becoming major players in the generation mix, with wind energy accounting for about 5% of total generation and solar making up 0.05%. New Zealand has favourable wind conditions, which have contributed to its growth without the need for subsidies and is expected to do so in the future.

Gas made up 14% of New Zealand's generation in 2020 and is useful for flexible generation, particularly during hydro dry years. Coal also serves this purpose, but only provides 5% of generation. The Huntly Power Station is the only coal-fired power station in the economy and accounts for about 5% of the total installed capacity.

Figure 8: New Zealand's electricity generation by fuel, 2000 to 2020

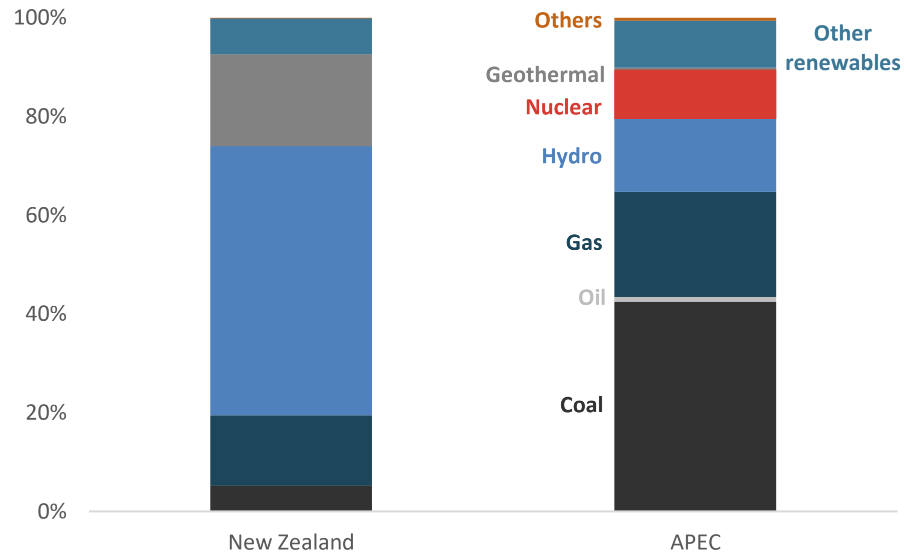


Source: EGEDA (2022)

In 2020 the share of renewables in generation fell to 80%. This was mainly due to a 5% decline in hydro generation because of below-average rainfall. As a result, electricity generated from natural gas and coal increased by 10% and 2% respectively.

Gas supply strain, causing an increase in gas spot prices also meant that coal use increased more than expected, to make up 5% of total generation, the highest share since 2013.

Figure 9: Electricity generation fuel share, New Zealand and APEC, 2020



Source: EGEDA (2022)

Refining

The closure of New Zealand's Marsden Point Refinery came as a result of dwindling profits and increased competition from overseas refineries. The decision was finalised halfway through 2021 and the refinery closed on 31 March 2022. In the last ten years the refinery has been producing around half of the petrol and diesel used by the economy, and almost all the jet fuel. However, New Zealand's indigenous crude production is too sweet to be refined at Marsden Point, so imported crude was used. This meant that New Zealand was still entirely reliant on the international oil market. Fuel was also traded at international parity prices, so the closure will likely have no effect on consumers. The government is working on a new bill for minimum fuel stockholding obligations for fuel importers. This is expected to improve fuel security above what it was while the refinery was in use.

Energy transition

New Zealand's share of renewables in electricity generation is among the highest in the world, at 80%. This makes it tough for the economy to achieve additional gains in its renewable generation share, since the cheapest and best sources are already being utilised. Most of the future growth in generation is expected to be seen in wind and solar. This topic is explored further in the APEC Energy Outlook, 8th Edition.

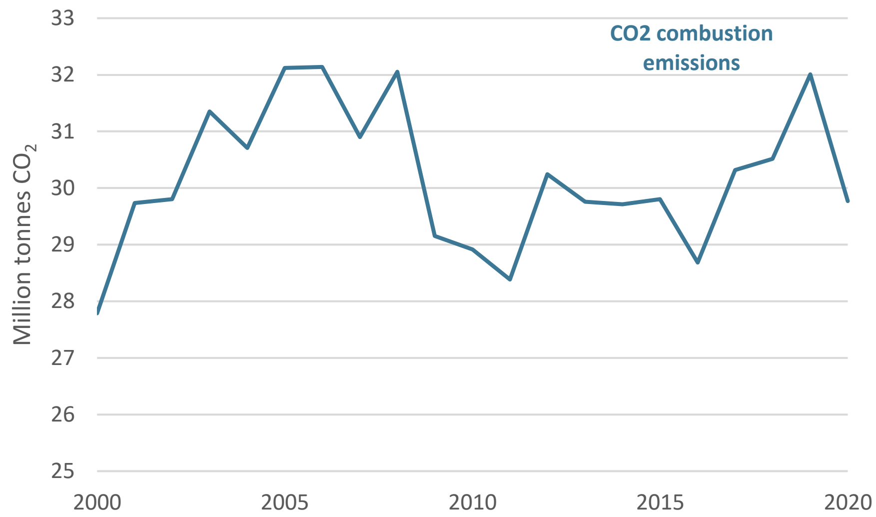
New Zealand's Energy Efficiency and Conservation Authority (EECA) is making efforts to decarbonise process heat[2] since about one-third of total energy use is for this. Just over half of process heat is supplied by fossil fuels (mainly gas and coal), and the majority of this is in the industrial sector. The best opportunities are in low and medium-temperature process heat (two-thirds of process heat energy use) since those temperatures are easier to reach with current technologies and renewable fuels (or electricity). The New Zealand government is investigating solutions to achieve decarbonisation in high temperature process heat.

Emissions

The COVID-19 pandemic brought about a significant fall in CO_2 emissions of about 6% in 2020. However, largely because of increased oil use in transport, emissions had been trending upward beforehand.

Future emissions are expected to be affected majorly by efforts to decarbonise transport and process heat. There is significant uncertainty related to the potential closure of the Tiwai Point Aluminium Smelter in 2024, which could free up a significant portion of New Zealand's generation capacity, resulting in less need for coal and gas generation, which are also the most expensive forms of variable generation.

Figure 10: New Zealand's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

On 16 May 2022, the government released New Zealand's first Emissions Reduction Plan (ERP), which outlines the details for meeting the economy's first emissions budget (2025) and sets the course for meeting future emissions budgets. Chapter 11 of the ERP outlines New Zealand's plans to reduce emissions in the energy and industry sectors. These sectors make up just over a quarter of New Zealand's total gross greenhouse gas emissions. In the ERP, the government sets out its long-term vision for the energy sector in 2050 – for New

[2] 'Process heat' refers to heat created from energy, for use in industrial processes and heating in buildings.

Zealand to have a highly renewable, sustainable, and efficient energy system that supports a low emissions economy.

Energy security

With increasing growth in wind and solar, and decreasing shares of natural gas and coal generation, hydro and geothermal are becoming more important sources of base load generation. As such there is increasing risk and cost from hydro dry years, which are bound to occur. Based on analysis of the comparative costs of new capacity sources, New Zealand has a few options. Due to the government's aspiration to reach 100% renewable generation by 2030, fossil fuels are not considered as an option. However, solutions are being explored by the NZ Battery Project, which is most focused on an NZD 15.7 billion, 3 to 8.5TWh pumped hydro scheme (called Lake Onslow) that would take about 7 to 9 years to build. However, other options are being explored for use together or alone, these are:

- Wood pellets or wood chips to replace coal and gas in electricity generation.
- Geothermal energy, including novel approaches to using it.
- Hydrogen or other green vectors (e.g. green ammonia)

Another significant risk to New Zealand's energy transition is its declining supply of natural gas. Due to the offshore exploration ban, future offshore exploration is unlikely, but uncertainty around the future of the industry is also diminishing prospects on the demand side. Based on forecasts from the Climate Change Commission (CCC) and the Ministry of Business, Innovation and Employment, New Zealand's demand for gas could be between 2 290 and 3 170PJ from 2022 to 2050. These scenarios represent an average annual usage of between 79 and 109PJ (as compared to 2020 total usage of 182PJ). While this level of use exceeds New Zealand's 2P natural gas reserves of 1 970PJ, contingent resources of 2 920PJ could provide sufficient gas if partially developed.

There is likely no negative effect of New Zealand's closure of its Marsden Point Oil Refinery (its only refinery) on energy security or affordability. This is explained in the Refining Section above. The government is also working on a new bill for minimum fuel stockholding obligations for fuel importers which will improve fuel security beyond what it was before the closure.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

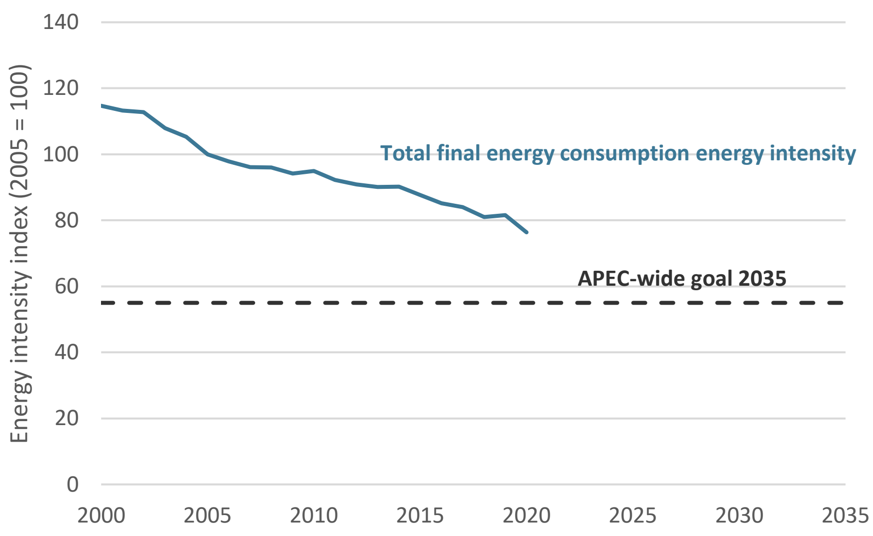
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

In 2020, New Zealand's energy intensity was 76 PJ per billion USD purchasing power parity (PPP) of GDP, which represents a 24% improvement since 2005. This improvement is occurring at a similar pace to that of the wider APEC region.

Figure 11: New Zealand's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

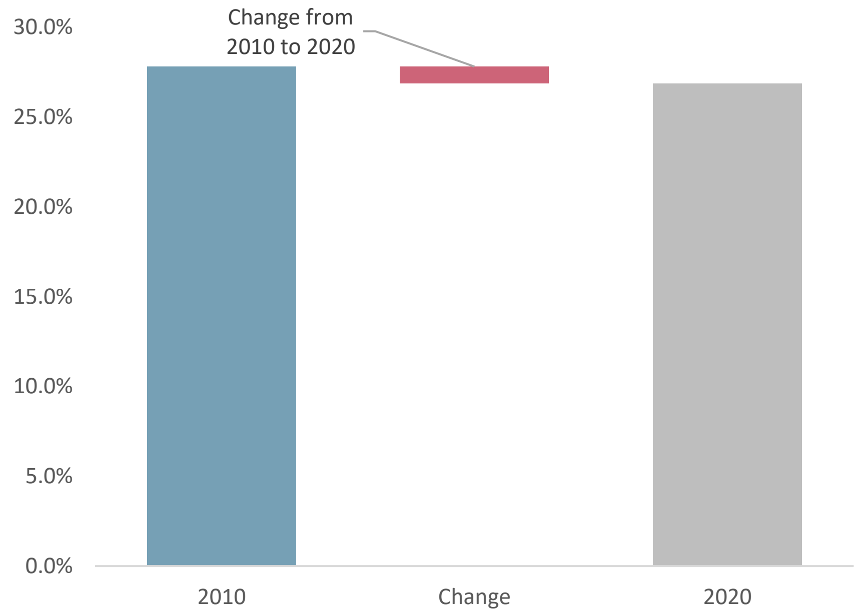


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: New Zealand's modern renewable energy share, 2010 and 2020



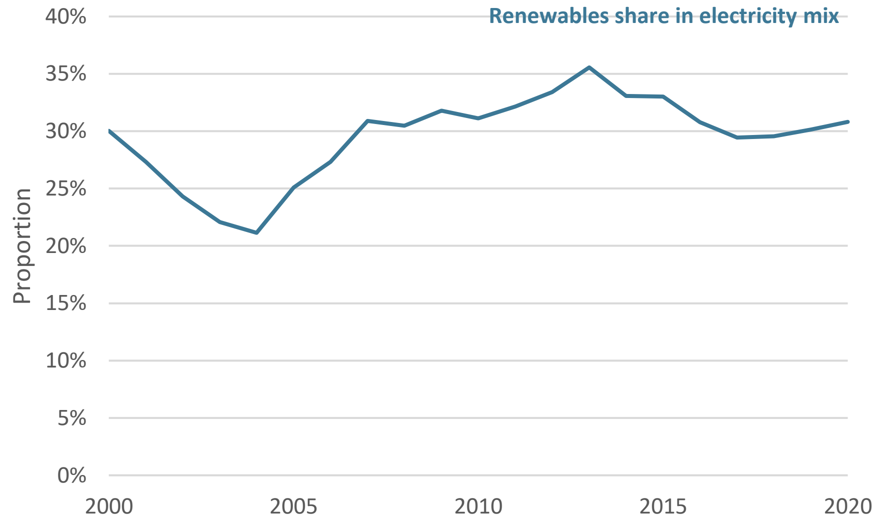
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

New Zealand has the highest proportion of renewables in its energy mix of all other APEC member economies. Despite this, there has been a slight decrease in New Zealand's renewable share since 2010, when it was at 30%. In 2019, New Zealand's renewable share was 28%, lower than APEC's overall 9.1% renewables share. Although New Zealand has the potential to contribute to APEC's goal of doubling renewables by 2030, its current high levels of penetration make it challenging to achieve further growth compared to economies with lower renewable penetration rates.

The use of renewables in electricity generation has been increasing in recent years due to the installation of new renewable energy capacity. However, dry weather affecting the levels of water in hydro storage lakes has caused some fluctuations. For instance, in 2020 the share of renewables in generation fell to 80%, mainly due to a 5% decline in hydro generation because of below-average rainfall. As a result, electricity generated from natural gas and coal increased by 10% and 2% respectively.

Figure 13: New Zealand's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Climate Change Response (Zero Carbon) Amendment Act	In 2019, the Climate Change Response (Zero Carbon) Amendment Act set into law new domestic 2050 targets of net zero emissions of all greenhouse gases other than biogenic methane by 2050, and 24 to 47% below 2017 biogenic methane emissions by 2050, including 10% below 2017 biogenic methane emissions by 2030.	Ministry for the Environment
NDC 2030 Target (2021-2030)	Updated in 2021, the NDC sets a headline target of a 50% reduction of net emissions below the gross 2005 level by 2030.	Ministry for the Environment
Emissions trading scheme	This is currently limited to domestic credits and excludes agriculture; the emissions limits are set on a five-year basis. The first period runs from 2021 to 2025, with a budget of 354 Mt CO_2-e. It contains price ceiling and price floor mechanisms to maintain market stability. Currently, it excludes emissions from the agricultural sector.	Ministry for the Environment
Electric Vehicles Program, incl. exemption for EVs and hybrids from road user charges	Among other developments which will be a part of this, the exemption from road user charges will be available for electric light vehicles until 2024, and heavy vehicles until 2025.	NZ Transport Agency
Renewable energy target	The government has set a target that 50% of total energy consumption will come from renewable sources by 2035, and an aspirational target of 100% renewable electricity generation by 2030	Ministry of Business, Innovation and Employment
Oil and gas exploration ban	The Crown Minerals Amendment Bill has ended all new offshore oil and gas exploration and limited onshore exploration to a small region.	Ministry for the Environment
New Zealand energy efficiency and conservation strategy (NZEECS)	Between 2017 and 2022 it had the aim of decreasing the intensity of industrial emissions. In 2022 a new five-year energy efficiency and conservation strategy began development. It is intended that the new NZEECS will complement, and integrate with, the broader government-led energy strategy.	NZEECS
NZ Battery Project	In 2020 the government announced an investigation into pumped hydro and other possible energy storage solutions for New Zealand's dry year electricity problem. Around 2023, the government hopes to make final feasibility decisions about which option or combination of options to take through for further investigation as part of a detailed plan, which will cost up to NZD 70 million.	Ministry of Business, Innovation and Employment
Government Investment in Decarbonising Industry (GIDI)	NZD 69 million worth of capital grant co-investment has been made available to support projects. The fund is available to New Zealand-based private sector businesses that have committed to decarbonising their business and industrial processes and where government co-investment will help remove barriers to accelerating their decarbonisation goals.	Energy Efficiency and Conservation Authority

Māori and Public Housing Renewable Energy Fund	The government has allocated NZD 28 million to trial small-scale renewable energy technologies to help decrease energy bills and encourage greater use of heating, leading to warmer and healthier homes.	Ministry of Business, Innovation and Employment
Funding for heaters and insulation	Warmer Kiwi Homes is a government program offering grants covering two-thirds of the cost of ceiling and underfloor insulation.	Energy Efficiency and Conservation Authority
Public sector decarbonisation	The Carbon Neutral government program requires public sector agencies to measure and publicly report their emissions and deliver offsets. The program is backed by the NZD 200 million Sector Decarbonisation Fund.	Energy Efficiency and Conservation Authority
The Gas Amendment Act 2021	Parliament has passed an Act that will improve information disclosure and increase the maximum financial penalty for breaching gas regulations.	Ministry of Business, Innovation and Employment

Notable energy developments

Energy development	Details	Reference
Marsden point oil refinery converted into an import terminal	In 2022, Refining NZ shut down NZ's only oil refinery and it is being converted into an import terminal with the potential to improve New Zealand's security of supply.	Argus Media
New Zealand Aluminium Smelters	New Zealand Aluminium Smelters is supposed to remain in operation until at least 2025. This is an important issue for the government as it must weigh up the loss of jobs and economic activity with the subsidisation of renewable electricity for a multinational company.	Business Wire
Emissions Reduction Plan (ERP) released in 2022	Chapter 11 of the ERP outlines how New Zealand will meet its first emissions budget (2022-2025) and also sets out the government's long-term vision for the energy sector in 2050. The Transport chapter (10) is also related to energy.	Ministry for the Environment
Hydrogen development	Numerous hydrogen projects are currently under development or investigation in New Zealand, including partnerships with Singapore, Japan and Korea, signalling their intention to jointly develop hydrogen technology and supply in the future.	Ministry of Foreign Affairs and Trade
Geothermal research funding	GNS (Geological and Nuclear Sciences) was awarded a NZD 10 million grant by the Ministry of Business, Innovation and Employment (MBIE) Endeavour Fund Research Program in 2019 to undertake a five-year project on supercritical geothermal resources in New Zealand.	GNS Science
Investigation into power outages	An investigation was completed regarding the power outages that left more than 34 000 households without electricity on 9 August 2021.	Ministry of Business, Innovation and Employment

Resource Strategy for minerals and petroleum	In 2019 the government developed a Resource Strategy for minerals and petroleum, intended to cover 2019 to 2029.	Ministry for the Environment
Review of the energy efficiency regulatory system for products and services	In December 2021, the Energy and Resources Minister decided a new five-year energy efficiency and conservation strategy was to be developed. This will replace the current New Zealand Energy Efficiency and Conservation Strategy 2017-2022 (NZEECS), which sets the overarching policy direction for government support and intervention for promoting energy efficiency, energy conservation and the use of renewable sources of energy.	Ministry of Business, Innovation and Employment
New energy research development centre (Ara Ake)	MBIE has funded Ara Ake, which provides support and funding for energy innovators to help them commercialise and enter the market.	Ara Ake
Electricity Price Review (EPR)	The EPR investigated whether the current electricity market delivered a fair and equitable price to consumers. Following the government's response, agencies are now progressing several work streams related to it.	Ministry of Business, Innovation and Employment
Huntly Coal Power Station transition plan	The Huntly Power Station, NZ's only coal power station, has been determined to be able to be maintained to 2030 and could be extended to at least 2040. There is an intention to trial biomass as an alternative fuel to coal.	Genesis Annual Report 2022
New Zealand Energy Strategy	MBIE will develop the New Zealand Energy Strategy by the end of 2024. It will set out how the energy sector will decarbonise and ensure that steps are coordinated across the whole energy system. It will help to signal pathways to reduce reliance on fossil fuels, and towards greater levels of renewable energy and other low-emission alternatives.	Ministry of Business, Innovation and Employment
Gas Transition Plan	The Gas Transition Plan will outline the necessary steps to decarbonise and reduce reliance on natural gas, while still providing for some natural gas use in 2035.	Ministry of Business, Innovation and Employment
New Zealand's Battery Project	New Zealand's parliamentary cabinet has approved funding to investigate pumped hydro against other possible solutions to New Zealand's dry year electricity problem.	Ministry of Business, Innovation and Employment

Useful links

Emissions Reduction Plan - https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/emissions-reduction-plan/

Energy statistics and modelling (Ministry of Business Innovation and Employment [MBIE]) - https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/

Energy and Natural Resources homepage (MBIE) - https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/

Energy in New Zealand annual report (MBIE) - https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-publications-and-technical-papers/energy-in-new-zealand/

Industrial heat pumps for process heat - https://www.eeca.govt.nz/insights/eeca-insights/industrial-heat-pumps-for-process-heat/

References

EGEDA (Expert Group on Energy Data Analysis, APEC Energy Working Group) (2021), *APEC Energy Database.* - https://www.egeda.ewg.apec.org/egeda/database_info/index.html

Papua New Guinea

Introduction

Papua New Guinea (PNG) is a Pacific Ocean island economy consisting of roughly 600 islands stretching from just south of the equator to near Cape York, Australia. It is the largest of the Pacific Island economies, with a land area of 462 840 square kilometres, the major islands being New Britain, New Ireland, and Bougainville. The capital, Port Moresby, is located in south-eastern New Guinea on the Coral Sea.

PNG lies on the "Ring of Fire," a region prone to earthquakes and tsunamis. The economy is rich in natural resources, including gold, copper, oil, gas, timber, and crops for export (coffee, cocoa, tea, palm oil, and copra), and has mountainous terrain and tropical rainforests. The economy has a hot and humid climate with wet and dry seasons.

In 2020, PNG's real gross domestic product (GDP) was US dollars (USD) 36 billion (2017 USD purchasing power parity [PPP]). The GDP growth rate has been increasing at an average rate of 1.8% every year since 2000.

PNG was hit hard by the COVID-19 pandemic, and this is probably the cause of a 3.5% decrease in GDP between 2019 and 2020[3].

PNG exports almost half of its total energy use as Liquid natural gas (LNG)(438PJ), of which the majority is sent to China and Japan. It is important that PNG can maximise its return on these exports to increase their economic growth. As such, the private gas companies have agreed to supply 15% of gas output to the economy, which, according to the National Energy Policy, is planned to be used for industrial purposes in the 2030s.

PNG has a high rate of poverty and poor infrastructure. The poor infrastructure can be seen in the low rate of access to electricity. Only about 20% of the population has access to the grid, and so households use alternative energy sources, especially firewood which is very inefficient. A significant part of the economy's development plan is the National Electrification Rollout Plan, which will increase access to electricity to 70% of the population. This will have substantial impacts on the economy's energy supply and demand.

PNG has substantial difficulty in estimating the data for its wide range of informal energy use. To improve the quality of their energy data the PNG government has enacted the National Energy Authority Act 2021 for energy producers to start reporting their energy use back to the government. This will help improve policy analysis and research.

PNG also has significant reserves of cobalt, which is an important material for the energy transition. They produced 3 thousand tonnes in 2021, which was 2.2% of the world total. They have 47 thousand tonnes of reserves remaining, which again is 2.2% of the world total.

[3] imf.org/en/Countries/PNG

Although PNG has no proven coal reserves, it is expected that there is some potential.

Table 1: PNG's macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (km²)	462 840	Oil (billion barrels)	0.16
Population (million)	8.8	Gas (trillion cubic feet)	5.6
GDP (2017 USD billion PPP)	38	Coal (million tonnes)	-
GDP per capita (2017 USD PPP)	4 350	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a <reference> (2022); b World Bank (2022); c BP (2022); d UN (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

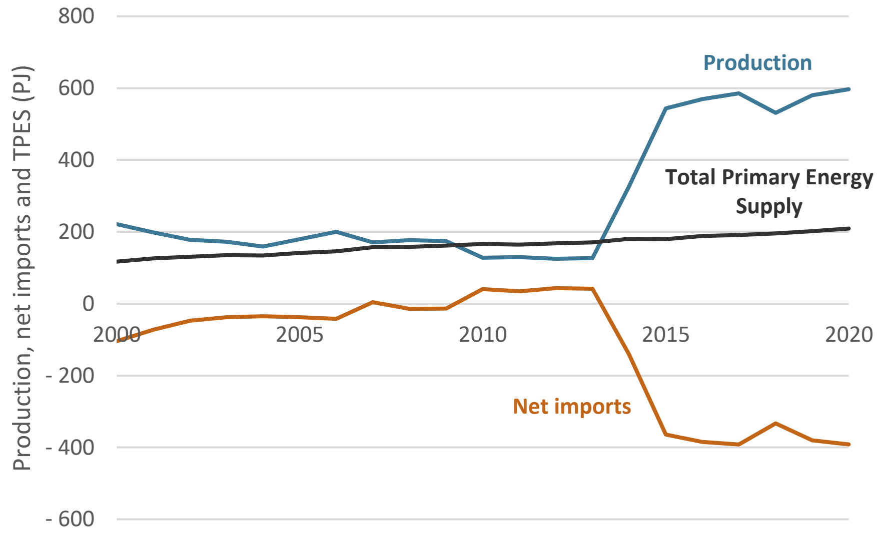
Energy supply and consumption

Total primary energy supply

In 2020, the Total Primary Energy Supply (TPES) was 209PJ, a quarter higher than 2010. The growth was driven by increased oil and gas supply in the transport and industry sectors. Renewable energy supply remained steady with most demand coming from residential firewood use.

Oil was the largest contributor to TPES in 2020, making up 40%. It was used in the transport, industry, and electricity generation sectors. Renewables made up 43% of TPES, while natural gas accounted for 17%.

Figure 1: PNG's energy supply, production, and net imports (PJ), 2000 to 2020

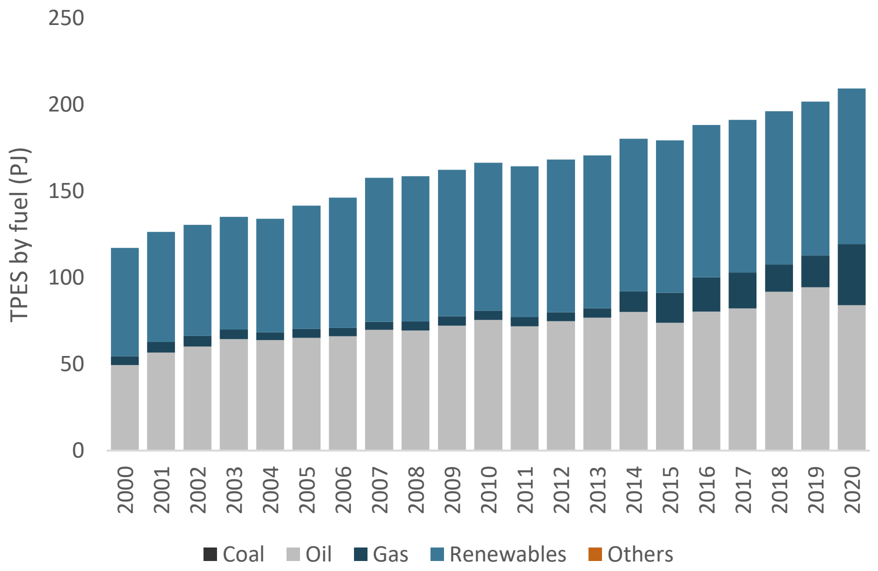


Source: EGEDA (2022)

Most of PNG's oil supply is split between diesel and heavy fuel oil, which is mainly used for power generation.

PNG has abundant gas resources, with significant production starting in the mid-2010s. Most of this gas is exported as LNG. In 2020, 96% of the production was exported as LNG, totalling 438 PJ, compared to 35 PJ of TPES for domestic use. The high volume of exported gas results in a large negative net import balance.

Figure 2: PNG's energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

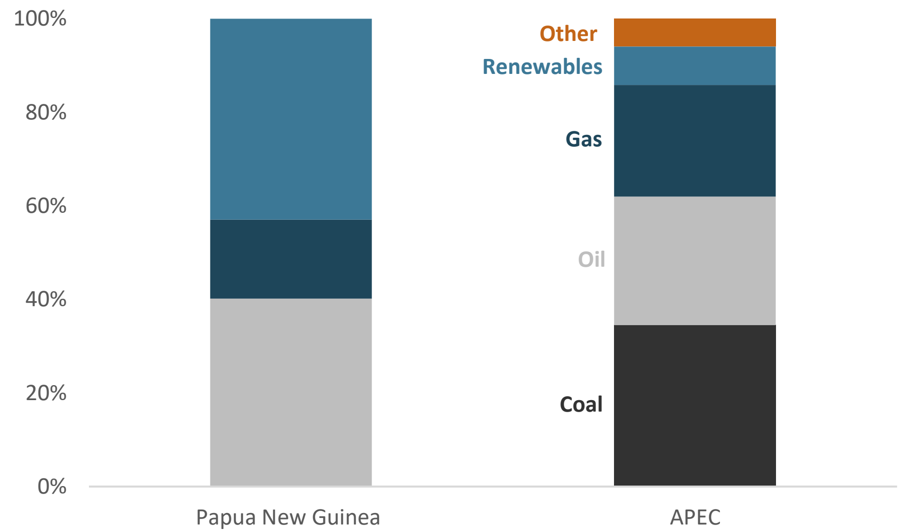
The PNG LNG plant (475PJ capacity pa.) which is near Port Moresby uses about 24 PJ of gas in the production process, including own use and losses. This makes up two-thirds of the total gas supply for the domestic economy. The other third (10PJ) is for electricity generation, of which 5PJ is for the grid connecting Port Moresby Gas Power Plant near Port Moresby and the LNG plant. The other 5PJ is used by auto producers (non-grid-connected industrial producers). Total gas supply has doubled since 2019.

TPES of renewables in PNG is mostly (75%) traditional biomass, which is mostly used for residential use, while a small amount is used for industry, mainly palm oil plant/s using their own waste for heat and electricity production.

Besides the use of biomass, 16% of renewables TPES is geothermal for electricity generation, and 4% is hydro for electricity generation. The geothermal TPES is slightly exaggerated because of the low conversion efficiency of geothermal energy to electricity.

PNG's TPES composition differs significantly from the wider Asia-Pacific Economic Cooperation (APEC) region since the economy lacks coal-fired electricity generation and any significant coal consumption. Oil and renewables have a larger share of TPES compared to the APEC average.

Figure 3: Energy supply mix – PNG and APEC, 2020



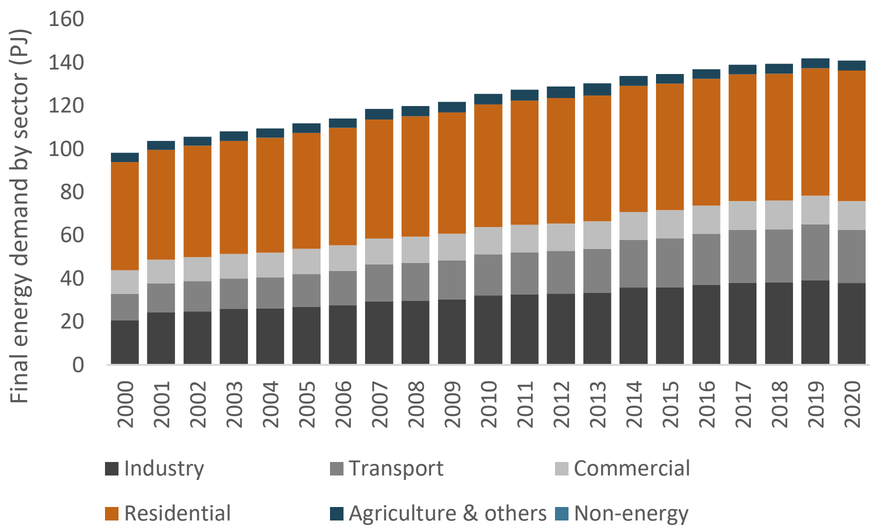
Source: EGEDA (2022)

Total final consumption

In 2019, PNG's total final energy consumption was around 141 PJ. The residential sector accounted for about two-fifths of energy use, followed by the industrial sector (about a third) and the transport sector (about a fifth). The agricultural sector accounted for 5 PJ (4%) of energy use, of which the majority (about 90%) was diesel.

Energy demand in PNG has been growing since 2000, albeit at a slower pace than GDP. The transport and industrial sectors have almost doubled their energy use, highlighting the crucial role of energy in driving economic growth.

Figure 4: PNG's final consumption by sector (PJ), 2000 to 2020



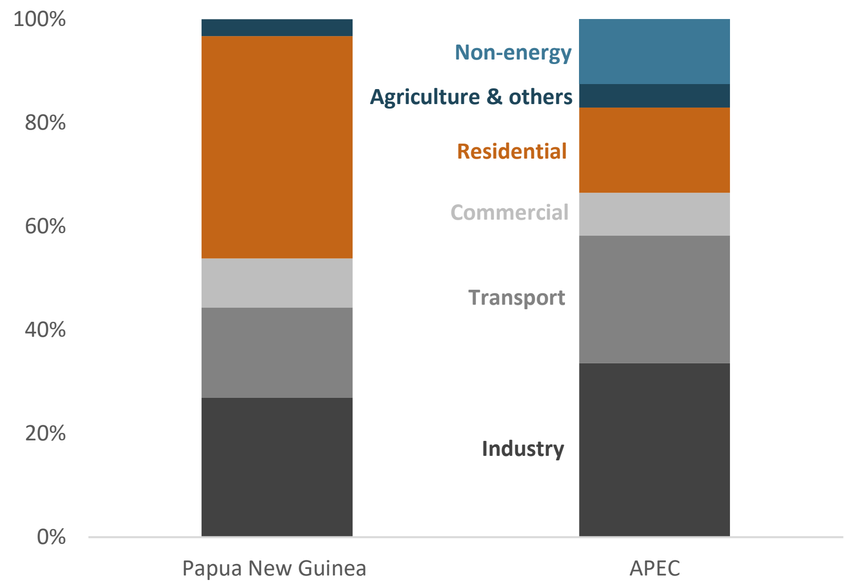
Source: EGEDA (2022)

The poor infrastructure in the economy does not just affect electricity access but also makes transport costly. The economy has few roads, and many of them get no maintenance. This problem is exacerbated by the relatively high rural population proportion compared to the rest of APEC and other Pacific economies. This in turn leads to a low amount of transport activity and energy use, especially for road vehicles compared to the rest of APEC.

The combined residential and commercial buildings sector is the largest energy consumer, despite seeing only about a 20% increase since 2000. This is due to the inefficiency of traditional biomass, which makes up most of the residential sector's energy use. This leads to higher energy consumption compared to if more efficient fuels were used.

The mountainous areas, called the Highlands, have an especially low rate of access to electricity. This, and being relatively cold compared to the shoreline areas, results in an increase in firewood use there for heat.

Figure 5: Final consumption by sector, PNG and APEC, 2020

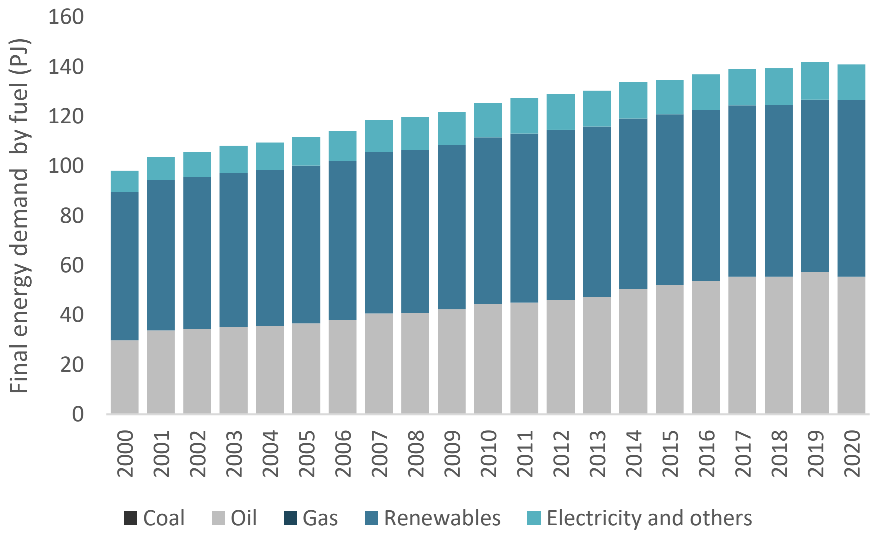


Source: EGEDA (2022)

Final energy demand

PNG's energy demand in 2020 was dominated by oil (39%) and renewables (51% of which is firewood). The residential sector accounted for 43% of final energy consumption, while the industrial sector accounted for 27% and the transport sector 17%. Electricity consumption was 10% of final energy demand and is mostly consumed by the industrial sector. Renewable energy, mostly firewood, contributes the largest share of final energy consumption, partially due to limited access to electricity. The National Electrification Rollout Plan is expected to reduce traditional biomass use as access to electricity increases.

Figure 6: PNG's final energy demand by fuel (PJ), 2000 to 2020

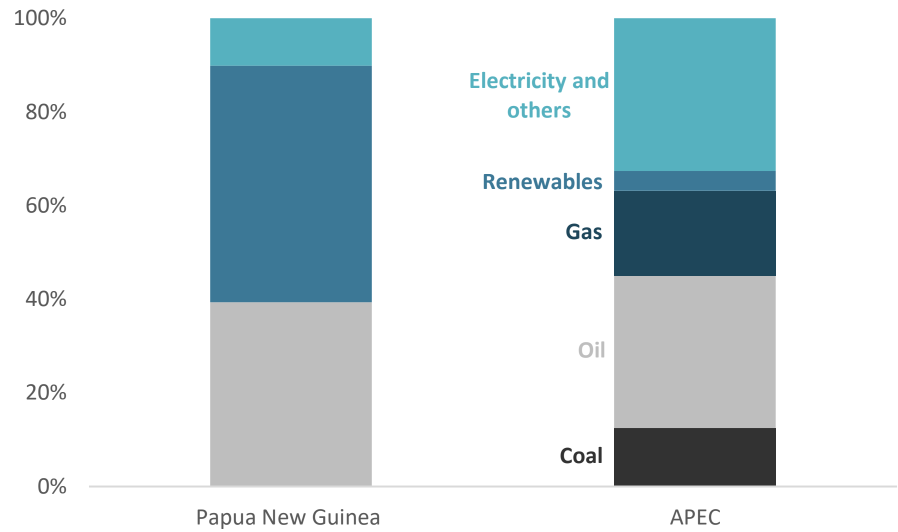


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Compared to the rest of APERC, PNG's energy use comprises much more oil and renewables. This largely stems from having no use of coal, and a negligible amount of gas use, so the other fuel types take their place. Use of renewables is especially high because PNG relies more on firewood for heating and cooking in buildings, compared to electricity, gas and coal, which are much more efficient, in other economies.

Figure 7: Final energy demand fuel share, PNG and APEC, 2020



Source: EGEDA (2022)

Transformation

Power sector

PNG's electricity network is relatively undeveloped. Only around 15% of the population have access to the grid, and it is also known to have reliability issues.

The electricity network is split into different grids because of the rough topology of the land. The main grids are the Port Moresby and Ramu grids, which the government intends to connect in the future. One of the government's most important projects, The National Electrification Rollout Plan, [4] with financial assistance from other APEC economies, is to increase access to electricity to 70% of the population by 2030. This will help to stimulate economic activity and quality of life throughout the economy.

Partly due to the poor infrastructure, PNG's electricity use is low compared to the APEC average, and total electricity generation is also low. Electricity is mostly generated using diesel and heavy fuel oil (50%), but there is one gas power plant which uses gas from the LNG project and provides 19% of total generation. Hydropower is the largest source of renewable energy (20%) and geothermal contributes 9%. Most of the electricity consumption is by the industrial sector (70%).

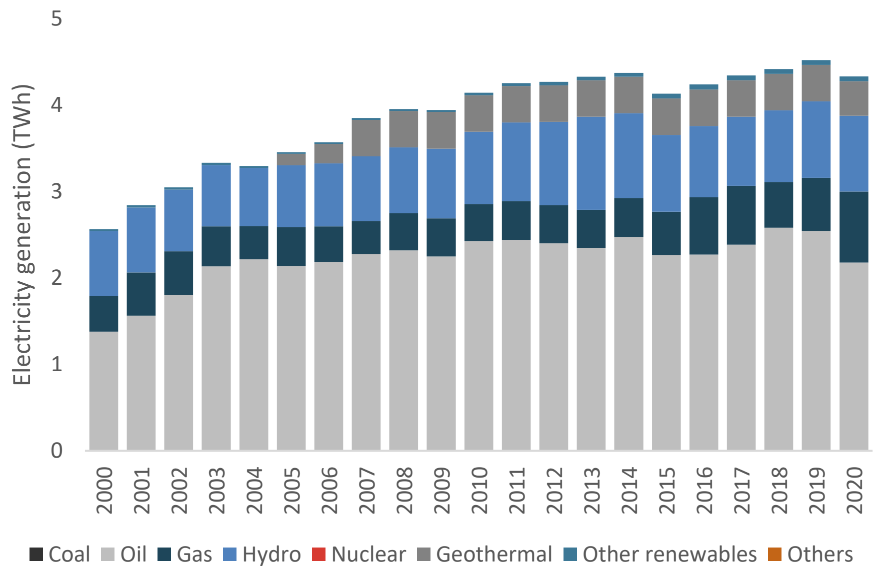
The use of firewood is prevalent in the residential and commercial sectors where there is no access to electricity, or it is too unreliable, which is a common issue.

Diesel and heavy fuel generators are used a lot because oil can be easily transported and they can be turned off and on easily when there are blackouts, which occur often. However, the use of oil for electricity generation is expected to decrease in future years with more investment in PNG's large reserves of renewable and natural gas resources.

About two-thirds of electricity generation in PNG is carried out by auto producers, such as mining facilities, which are quite far away from urban centres and are therefore not connected to the grid.

One area of improvement has been the development of off-grid solar for lighting, which means that around 60% of the population has access to electricity if off-grid solar (for lighting) is considered. However, firewood is still needed for cooking and heating.

Figure 8: PNG's electricity generation by fuel, 2000 to 2020

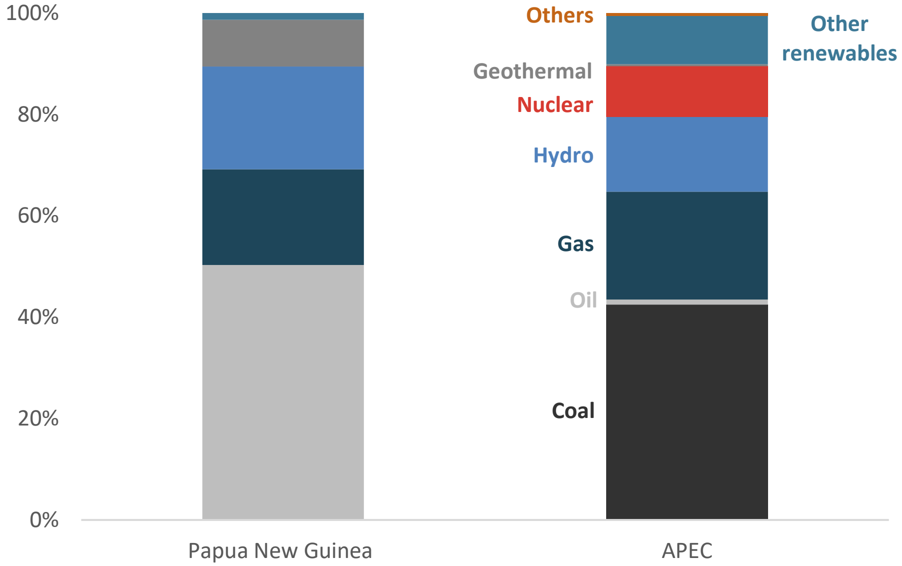


Source: EGEDA (2022)

PNG uses a large proportion of oil for generation compared to the APEC average, as it relies heavily on oil generators for electricity generation. The prominence of hydro and geothermal generation in PNG is partly due to the small amount of generation capacity needed to make those sources significant, relative to the APEC average and the economy's total.

[4] The National Electrification Rollout Plan,

Figure 9: Electricity generation fuel share, PNG and APEC, 2020



Source: EGEDA (2022)

Refining

PNG has an oil refining capacity of 33 thousand barrels per day (73 PJ per year), and the economy produced 59 PJ of petroleum products in 2020. This is not enough to satisfy domestic consumption, so the economy imports the majority of the refined oil it uses, and most of its production is actually exported. Furthermore, the crude oil that is refined in PNG is imported because the crude oil extracted indigenously is too sweet.

The economy's LNG plant, just outside of Port Moresby, has a capacity of 8.3 Mtpa, which is equivalent to 475 PJ of natural gas. There is a new project, the Papua LNG project, expected to be completed by the end of 2027, which will increase this to almost 14 Mtpa.

One benefit of the development of the LNG plant is that the locals have been able to access cheap LPG (liquid petroleum gas), which is a much cleaner alternative to kerosene (kerosene makes up about 1.3PJ of total energy use) or firewood for heating and cooking.

Energy transition

PNG's energy transition goes hand-in-hand with its growth. One of Papua's biggest challenges is building the infrastructure it needs to enable the supply of new energy types to the majority of its population. This is made even harder by the rough topography of the economy.

The major project of increasing access to electricity will help to give 70% of the population alternatives to firewood and kerosene (kerosene makes up about 1.3PJ of total energy use). Increased access will probably also result in an increase in the reliability of the electricity network. These two improvements may help to counter the reliance on oil generators, which are especially widely used because they can be transported to remote areas, as well as provide backup capabilities.

The economy has abundant gas resources, and currently exports most of its gas as LNG. There are potential areas where this gas could be used domestically, such as electricity generation and ammonia production, or for industrial purposes[5]. Even the use of LPG as a cleaner alternative to kerosene in households is becoming prevalent. Conversely, as the rest of the world transitions to gas instead of coal and oil, LNG exports could become more profitable for the economy.

Although a high share of final energy consumption is currently coming

[5] Energy outlook mentions the National Energy Policy which stipulates 15% of all natural gas output should go to industrial use in the future.

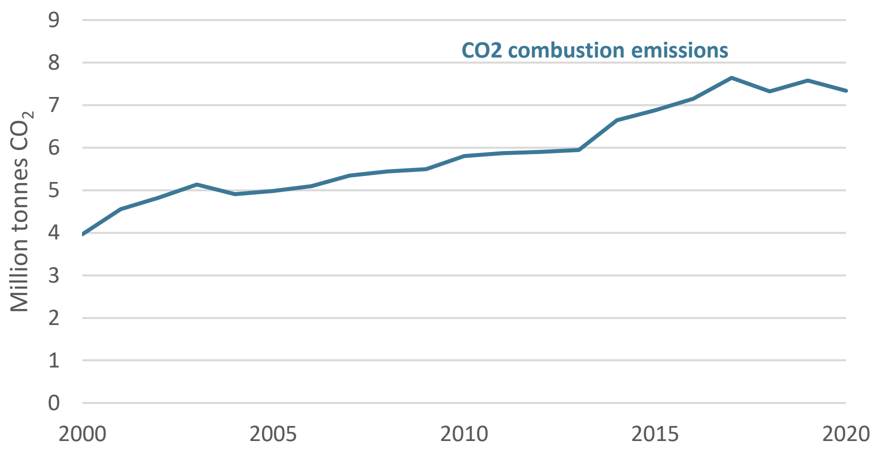
from traditional biomass, the economy also has significant potential for non-traditional renewable energy, especially renewable electricity generation types. As the government continues to invest in electrification and renewable energy, the energy mix in PNG is expected to shift away from imported oil and towards renewable energies and natural gas which are more economically and environmentally sustainable energy sources for the future.

Energy transition topics are further covered in the PNG chapter of the APERC Energy Outlook.

Emissions

PNG emitted about eight million tonnes of CO_2 in 2020, but this is only aboutone thousandth of APERC's total emissions. PNG's low amount of emissions is expected to grow quickly over time as the economy increases power generation, as well as industrial and transport activity.

Figure 10: PNG's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

The majority of PNG's emissions currently come from electricity generation (40%), transport (20%) and industry (20%). The emissions from burning firewood are not considered.

Energy security

PNG's energy security issues are defined by its reliance on imports for the majority of its oil use (40% of total consumption). In 2023 there was a 30-day shortage of aviation fuel in PNG, forcing local airlines to suspend flights. This was very costly for the economy, especially since much domestic transport is by plane. For example, the capital, Port Moresby, is not connected by road to the second largest city, Lae, and the nearby, highly populated, Highlands region.

Means of improving the economy's energy security could include increasing the oil stockholding limits or diversifying the sources of energy supply.

PNG's effort to improve access to and reliability of its electricity network can be considered an important project for increasing energy security as it will decrease reliance on oil for electricity generation. This will in turn decrease the negative effects of supply shocks.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline.

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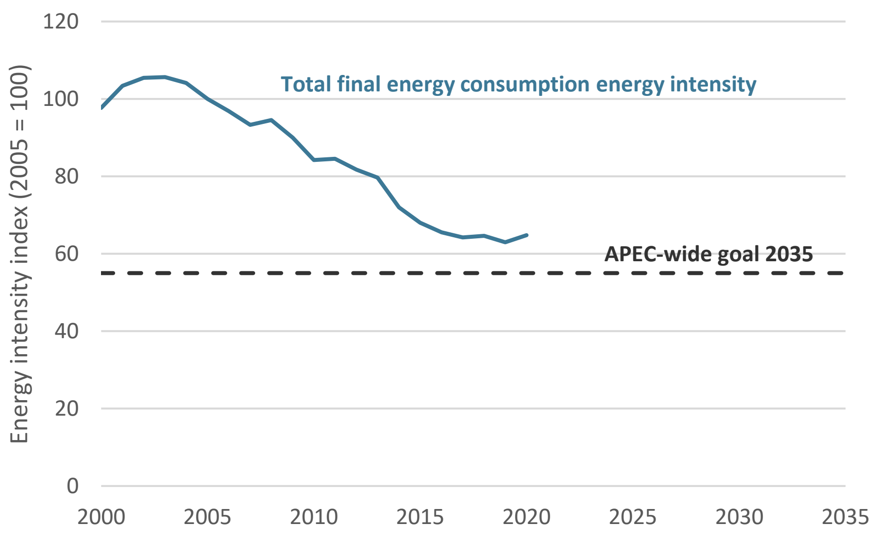


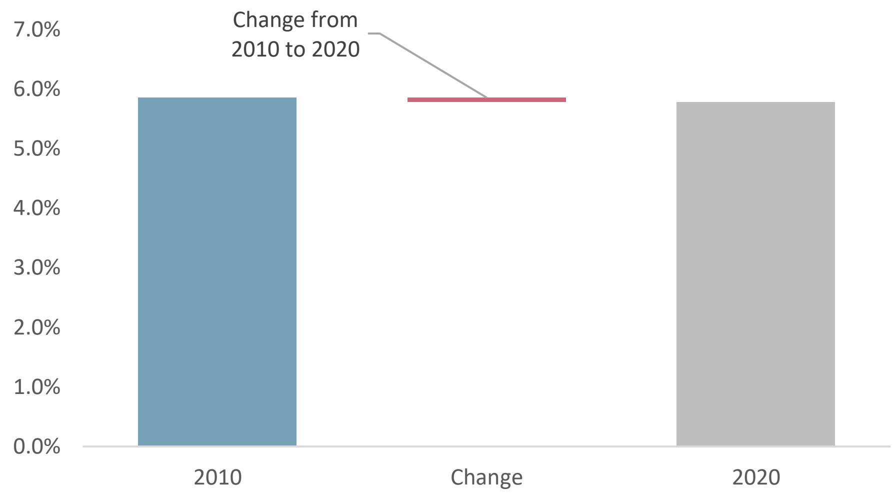
Source: EGEDA (2022)

PNG has improved its energy intensity over the past two decades and this improvement is expected to continue, particularly with the implementation of the National Electrification Rollout Plan which aims to increase access to electricity and will replace the use of inefficient firewood. The economy's energy intensity was 65 PJ per billion USD PPP in 2020, which was a 34% improvement from 2000. The improvement in energy intensity is also driven by the growth of the economy through LNG exports since 2014. The APEC region has set a goal of reducing energy intensity by 45% by 2035, compared to the 2005 baseline, but this target is not applicable to individual economies.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: PNG's modern renewable energy share, 2010 and 2020



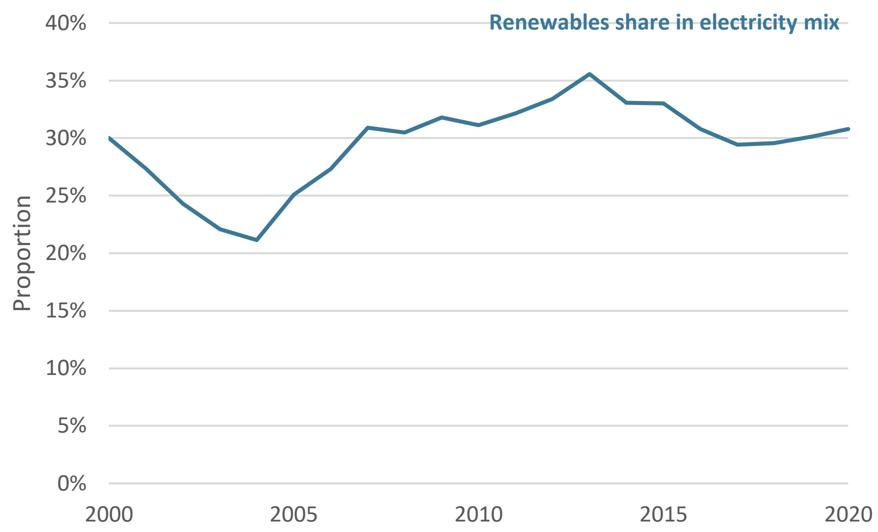
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

PNG has a modern renewable energy share of 5.8%. This has changed very little since 2010, which is because all energy types increased by about the same amount. Traditional biomass consumption is not included in PNG's modern renewables share, but if it was included, the renewables share would be around 50%.

PNG has a renewable generation share of 31% and the majority of this comes from hydro and geothermal electricity generation (60%). The rest comes from modern biomass generation in the industrial sector (40%). This share has remained at about the same level since 2000. The intermediate variation was due to new capacity developments such as the expansion of the Lihir Gold Mine geothermal generation scheme.

Figure 13: PNG's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
100% renewable energy	This is a target to achieve 100% renewable electricity by 2050.	Vision 2050
Economy-wide electrification	Electrification rate of 70% by 2030 and 100% by 2050.	Vision 2050
Enhanced Nationally determined contribution (NDC)((2020)	The NDC was revised to target a 78% share of installed capacity of renewable energy by 2030.	Enhanced Nationally Determined Contribution
Domestic resource utilisation	The government will ensure 15% of gas reserves in new oil and gas projects will be made available for domestic gas utilization.	National Energy Policy 2017-2027
Energy Efficiency	Develop and enforce energy efficiency standards.	National Energy Policy 2017-2027
Governance	Build stronger institutions and governance frameworks for the energy sector.	National Energy Policy 2017-2027
National Energy Authority Act 2021	Passed in April 2021, it will decommission all the regularity powers and functions of PNG Power Limited and vest them with the National Energy Commission. The National Energy Authority Act also gives governments powers for collecting energy data from private groups for statistics.	Energy Authority Act

Notable energy developments

Energy development	Details	Reference
Amendment to the Mining Act and the Oil and Gas Act	The Mining Amendments introduce a 'live data' reporting obligation and give entities priority in tenement applications over 'reserved land'. The O&G Amendments give the minister greater flexibility in determining whether to grant or refuse petroleum development licences and affect the sanctity of petroleum agreements and gas agreements.	New PNG Energy laws commence
Papua LNG Project	The project participants and the government have re-affirmed their commitment to this project, and it is expected to proceed. When complete it will add six Mpta of LNG production.	NASDAQ

PNG Electrification Partnership	USD 1.7 billion of international funding from Australia, Japan, New Zealand, and the United States has been pledged to support achieving the target of 70% of electrification by 2030. Some of this money is already being committed to projects.	Post Courier
Proliferation of Off-grid Solar Lighting	60% of Papua New Guinean households are now using off-grid solar technology with off-grid solar lighting products and battery-based torches and lanterns, which are now effectively replacing kerosene lamps.	PNG Off-Grid Report

Useful links

United Nations - https://papuanewguinea.un.org/

The World Bank - https://www.worldbank.org/en/country/png

International Monetary Fund - https://www.imf.org/en/Countries/PNG

PNG Environmental Data Portal - https://png-data.sprep.org/

Asian Development Bank - https://www.adb.org/countries/papua-new-guinea/main

Peru

Introduction

Despite severe measures being adopted through most of 2020 and 2021, Peru has been severely impacted by the COVID-19 pandemic. Peru's economy grew 2.9% during the first three trimesters of 2022 (Instituto Nacional de Estadísticas e Informática [INEI], 2023) after the economic rebound in 2021. Mining contributed to the economy growth through Quellaveco, a large copper mine, which started operations in 2022 (BBVA, 2023b). The largest wind farm in Peru, 187 MW Punta Lomitas, is currently under construction and will provide electricity to Quellaveco.

In January 2022, a crude oil spill occurred on the coast during the unloading of crude oil at the La Pampilla refinery. La Pampilla represents approximately half of the crude refining capacity of Peru and supplies fuels to 40% of the domestic market and is the main supplier to maritime bunkers and aviation. The government ordered operations to cease but, facing the risk of a fuel shortage, the refinery resumed production.

Also, Peru issued a law establishing climate emergency as emergency of the utmost interest. The decree established a goal of introducing 20% of non-conventional renewable energies[6] into the electric generation fuel mix by 2030 and prioritised, among other actions, the development of programs to promote green hydrogen.

Peru is a net importer of oil products; therefore, the global energy crisis impacted Peru's economy. To mitigate the increase of prices, Peru implemented several measures. However, despite these efforts, fuel increased in price during 2022: by 23% for diesel and 12% for gasohol (INEI, 2023a)

Table 1: Peru's macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	1.3	Oil (billion barrels)	0.7
Population (million)	33	Gas (trillion cubic feet)	0.7
GDP (2017 USD billion PPP)	422	Coal (million tonnes)	0
GDP per capita (2017 USD PPP)	12 500	Uranium (kilotonnes U < USD 130/kgU)	14

Source: a INEI (2022, June 10); b World Bank (2022); c BP (2022); d Nuclear Energy Agency & International Atomic Energy Agency (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Peru also suffered LPG scarcity several times during 2022 due to extreme sea conditions, because Lima, the capital city of Peru, is supplied mainly by sea. In the case of shortages, vehicular LPG supply, fuel used in light passenger vehicles, is restricted to protect LPG supply to buildings (El Comercio, 2023a). These extreme events are becoming

[6] In Peru, 'non-conventional renewable energy resources' refers to biomass, wind, solar, geothermal, and tidal. Hydro can be considered a non-conventional renewable if the installed capacity is less than 20 MW, This definition is according to the Legislative Decree 1002

more frequent.

On the other hand, improvements to the energy structure have been announced. 500 MW of wind and 136 MW of solar projects have begun construction and are expected to start operations in 2023. Natural gas connections expanded 14% in 2021, reaching 1 554 300 natural gas users mainly residential and commercial consumers (Peru Energia, 2022). Rural electrification advanced during the last year, reaching 84% of coverage in 2022.It is expected to reach 93% by 2023 (MINEM, 2022 Jun 30).

Energy supply and consumption

Total primary energy supply

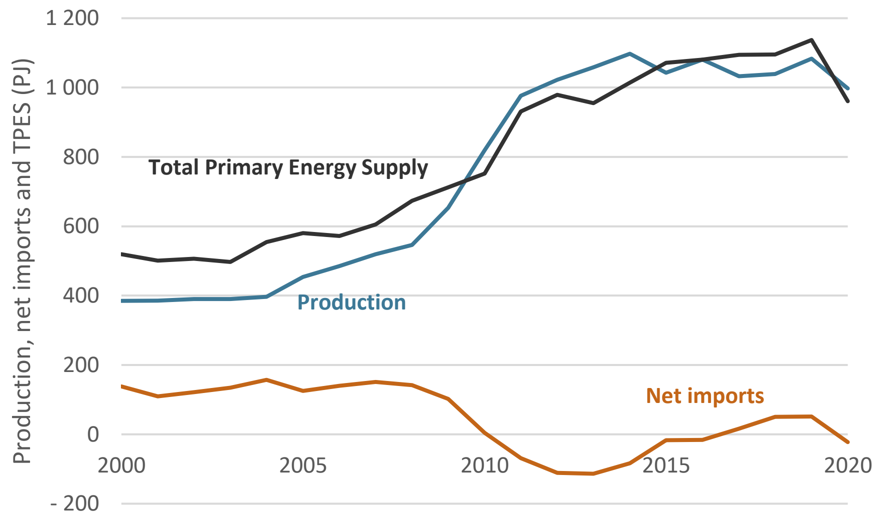
Energy statistics in 2020 show the impact of the pandemic on the Peruvian energy system. Strict lockdowns and restrictions on several economic activities, such as transport, were imposed, affecting fuel demand and supply.

Oil production was reduced, especially in some oil blocks located in the Amazon basin where production was suspended. Oil production fell almost 25% during 2020. Additionally, Petroperú, the economy-owned oil company, temporarily suspended operations in the North Peruvian Oil pipeline that transport crude oil from the jungle to the coast because of the implementation of upgraded safety measures against the pandemic, and social conflicts that appeared at the end of the year.

On the other hand, associated natural gas liquids and natural gas production fell 10% during the same period. Consequently, Peru's total primary energy production (TPES) fell 7.9% in 2020 from 2019 levels, reaching 961 PJ (Expert Group on Energy Data Analysis [EGEDA], 2022).

However, due to the drastic reduction in domestic fuel demand, imports of oil and oil products were reduced and Peru became a net energy exporter for the first time since 2016 (EGEDA, 2022).

Figure 1: Peru's energy supply, production, and net imports (PJ), 2000 to 2020



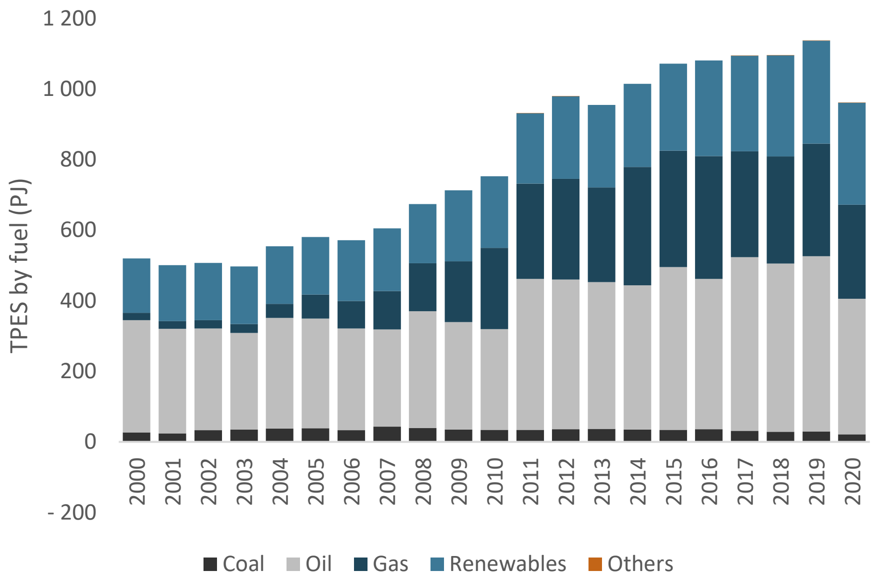
Source: EGEDA (2022)

The energy supply from renewable energy was affected the least as it was reduced only by 1.2%, falling from 292 PJ in 2019 to 288 PJ in 2020 (EGEDA, 2022). Renewable energy is used mainly in electricity generation where renewable energy plants have priority to dispatch electricity to the grid. Other important use of renewable energy is in cooking in the residential sector.

Additionally, the gas supply decreased 16%, from 319 PJ in 2019 to 266 PJ in 2020, and the oil supply decreased 23%, from 497 PJ in 2019 to 385 PJ in 2020.

On the other hand, the coal supply was reduced by 8 PJ in 2020 from 29 PJ in 2019, representing a decrease of 30%, although coal represents just 2% of the total primary energy supply.

Figure 2: Peru's energy supply by fuel (PJ), 2000 to 2020

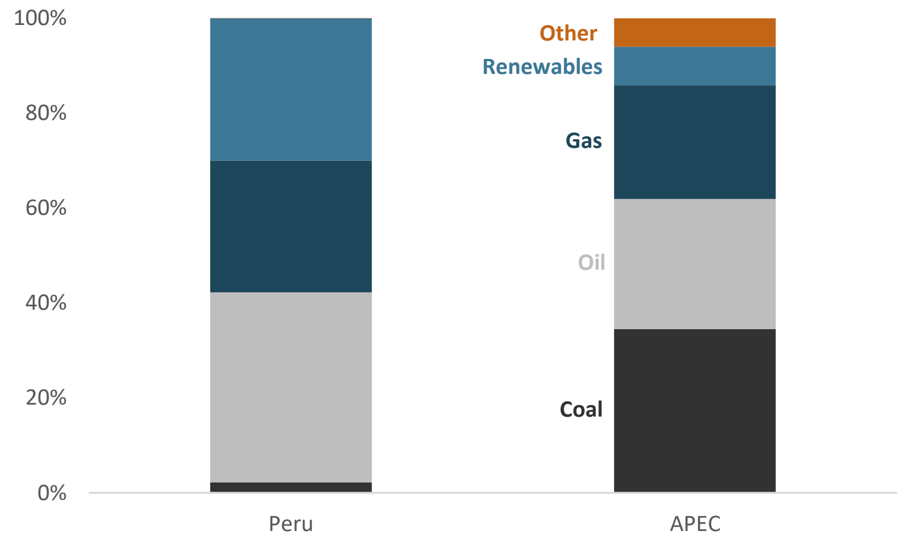


Source: EGEDA (2022)

The differences between Peru's and APEC's energy supply mix provides some insights into the energy demand characteristics of the economy. Natural gas and renewable energies supplied around 54% of the energy in 2020. Most of these fuels are used in power generation in Peru. The share of these fuels in APEC is lower at 32%. In contrast, coal is an important fuel in APEC at 35% while it plays a minor role at 2%.

Other important difference is observed in the share of oil, this share in Peru was 40% while in APEC it was 28% in 2020.Because oil and oil products are mainly used in transport, figure 3 indicates the importance of transport's energy demand in shaping Peru's energy mix, while production of electricity has a greater influence in defining APEC's energy mix.

Figure 3: Energy supply mix – Peru and APEC, 2020



Source: EGEDA (2022)

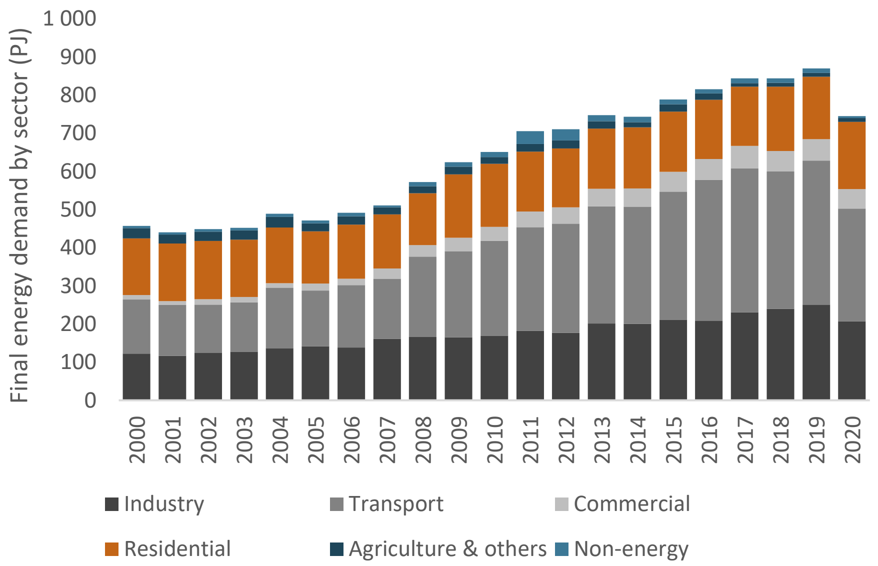
Total final consumption

In March 2022, after the first cases of COVID-19 were reported in Peru, the government imposed compulsory social isolation, which required most people to stay at home most of the time and restricted various activities such as services and commerce. Even though some of the restrictions were loosened up after some time, several remained throughout the year.

Energy demand in the residential sector grew 7.7% from 163 PJ in 2019 to 176 PJ in 2020. This growth was higher than the average annual rate of 0.6% in the previous decade and was the result of the compulsory social isolation and the implementation of teleworking and distance education.

Energy demand in the other sectors was reduced drastically. Transport, the main energy consumer, decreased 22% from 377 PJ in 2019 to 295 PJ in 2020. This was a consequence of the measures of immobilisation implemented by Peru that restricted travellers' long-distance trips, closed international borders, reduced local transport capacity to 50% and promoted teleworking.

Figure 4: Peru's final consumption by sector (PJ), 2000 to 2020

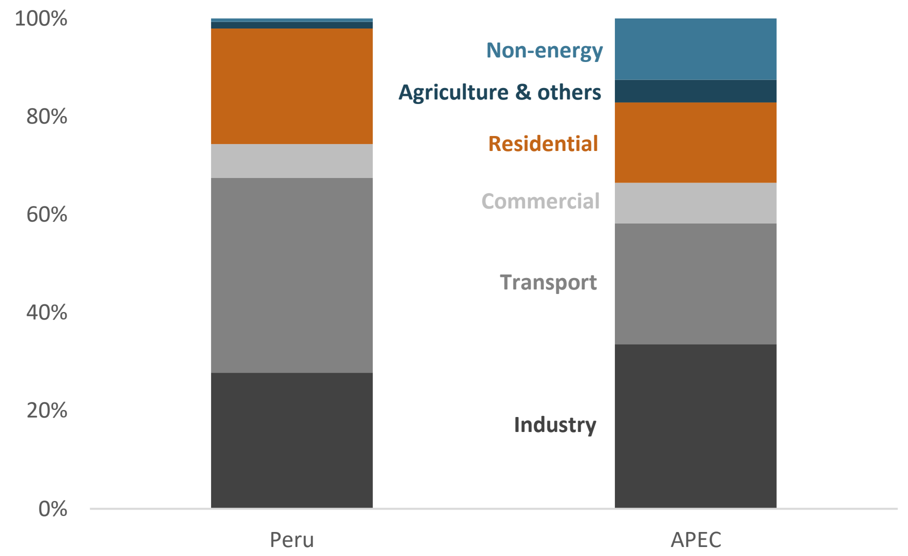


Source: EGEDA (2022)

Industry energy demand was reduced by 17% from 251 PJ in 2019 to 207 PJ in 2020. Several industrial activities were suspended or restricted because new safety protocols needed to be implemented before activities could be resumed.

Commercial, which includes public and services, also reduced its energy consumption in 9.2% from 57 PJ in 2019 to 51 PJ in 2020. Commercial sector gradually resumed activities in accordance with a calendar published by the government.

Figure 5: Final consumption by sector, Peru and APEC, 2020



Source: EGEDA (2022)

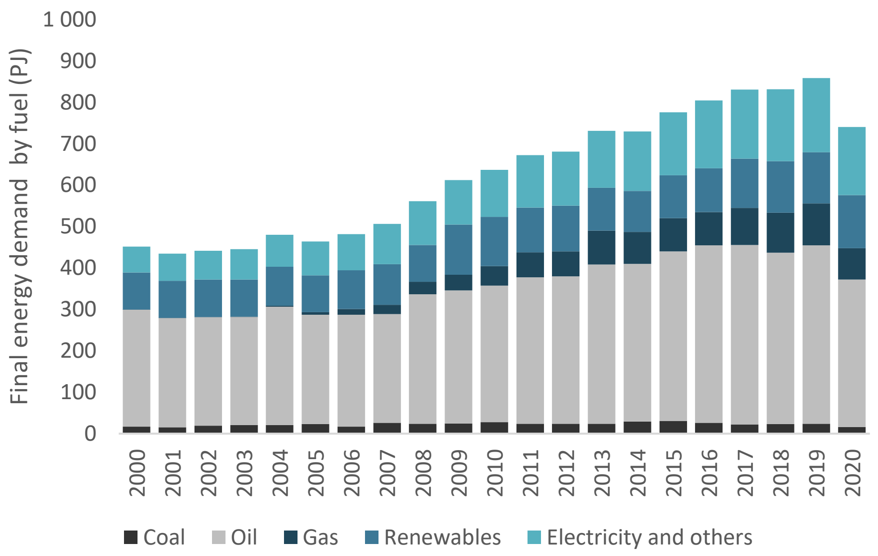
Despite the serious restrictions imposed on transport, this sector was the main energy consumer in 2020, using 40% of total energy. Industry consumed 28% and was the second largest consumer, while the residential sector consumed 24% and was the third main energy consumer in Peru. The main difference between Peru and APEC concerns the share of transport. In APEC, transport represented 25%, but industry was 34%, indicating the importance of the industrialised economies in defining APEC's final energy consumption.

Another important difference is observed in the share of non-energy, which includes the use of fuels as raw material for non-energy products such as lubricants. In APEC, non-energy use represents 13% of final energy consumption while in Peru it is 0.7%.

Final energy demand

Demand for all fuels except for renewable energy was reduced in 2020. Coal demand was reduced by 33%; oil and oil products demand by 17%; natural gas by 26%. In contrast, renewable energy demand increased 4.2%. This trend is explained by a decrease of activities in the industry and commercial/services sectors, and restrictions in transport. Increased demand for renewables is indicated by the estimated increase in traditional biomass consumption in the residential sector.

Figure 6: Peru's final energy demand by fuel (PJ), 2000 to 2020



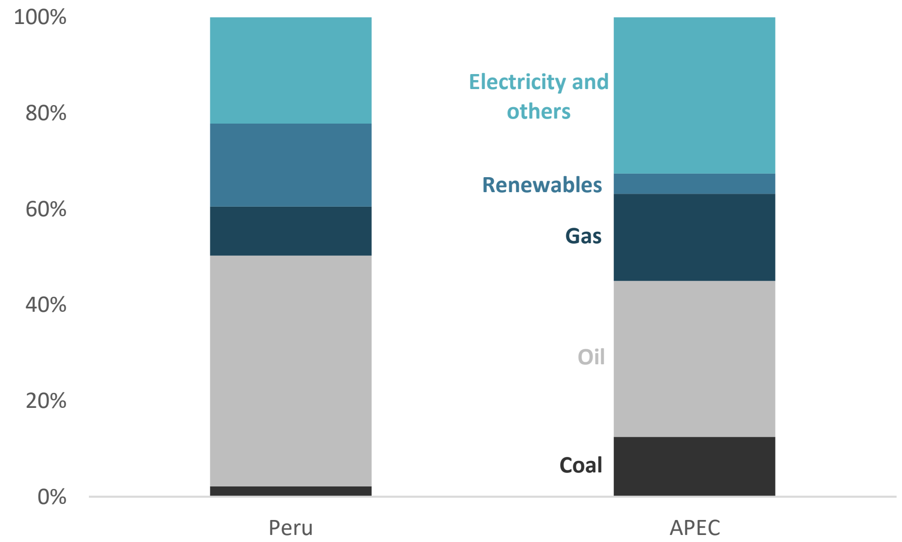
Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Almost half of the final energy demand in Peru is satisfied by oil and oil products. Peru's final energy demand fuel share did not change drastically if compared with 2019's fuel share. The main differences were the decrease of the natural gas share that was used in industrial activities and the increase of renewables because of the use of biomass in the residential sector. Renewables that are used in electricity generation are demanded.

Demand for electrification is more advanced in APEC where it represents 33% of the final energy demand, indicating the potential for improving the demand for electrification in Peru.

Figure 7: Final energy demand fuel share, Peru and APEC, 2020



Source: EGEDA (2022)

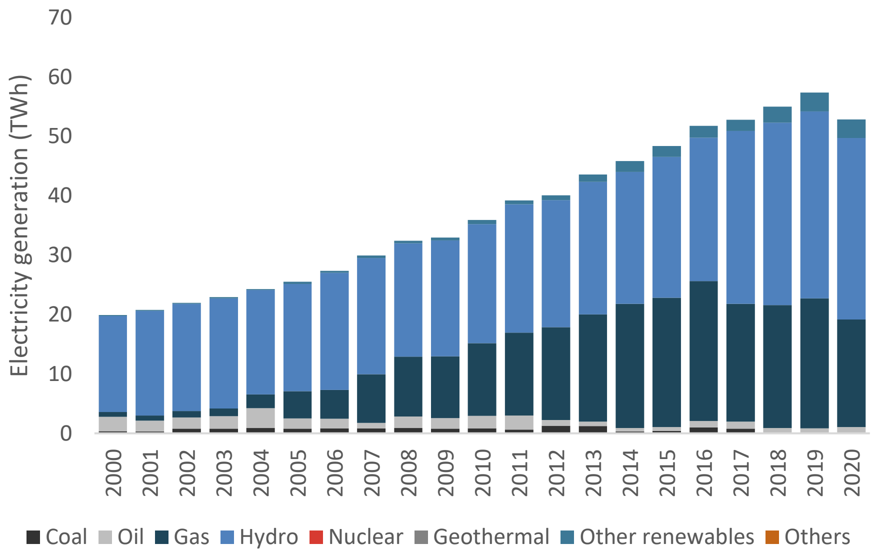
Natural gas appeared in Peru's final energy demand mix in 2004 when Camisea, the main natural gas project, started operation. Since then, natural gas has increased its share in the final energy demand to approximately 10%. This share is half of APEC's share, indicating the challenges to expand natural gas coverage in the economy, although advancements have been reported constantly.

Transformation

Power sector

In 2020, Peru's electricity generation totalled 52 803 gigawatt-hours (GWh), a fall of 7.9% from 2019. Renewable sources provided 64% of electricity: hydropower produced 58% and non-conventional renewable energy produced 5.9% of electricity. The rest of the electricity was produced in thermal plants, mainly natural-gas-based. (EGEDA, 2022).

Figure 8: Peru's electricity generation by fuel, 2000 to 2020

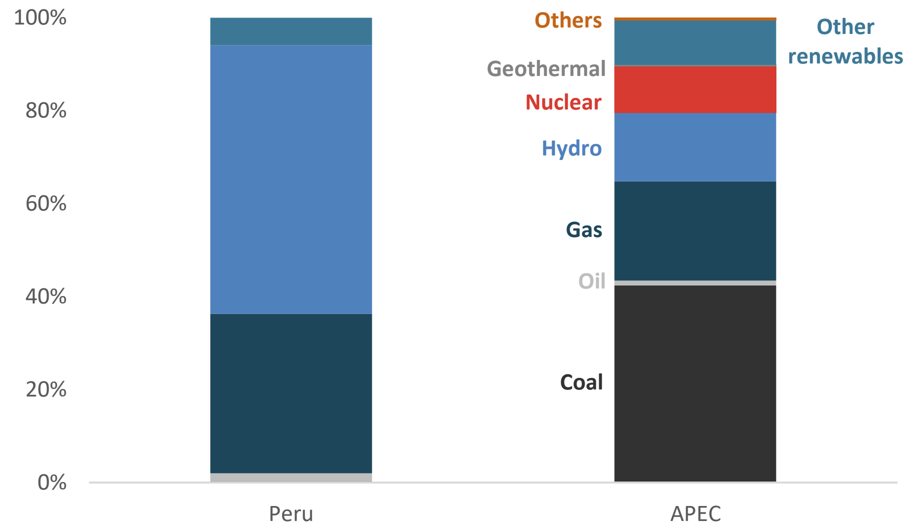


Source: EGEDA (2022)

The decrease in electricity demand observed in 2020 caused a reduction of electricity generation of gas-fired power plants. Consequently, the monthly share of non-conventional renewable energy in electricity generation reached 7.2% in April 2022 (MINEM,2020).

The Peruvian electricity generation mix is mainly composed of hydropower, non-conventional renewable energy, and natural gas that is used mainly in combined cycle turbines (MINEM, 2021). Peru's power generation mix differs drastically from APEC's mix as coal has a minor role in electricity generation and there are no nuclear power plants in Peru. Because some studies estimate 57 GW of hydro, 20 GW of wind power, and 25 GW of solar power potential, among other renewable energy sources (MINEM, 2021), it is very likely that Peru will continue to have a comparatively clean grid.

Figure 9: Electricity generation fuel share, Peru and APEC, 2020



Source: EGEDA (2022)

Refining

In addition to the event in La Pampilla refinery in January 2022, refining was impacted by the pandemic as the work to modernise the Talara refinery stopped until June 2020. Talara refinery is expected to return to full operation in 2023. This project will increase capacity from 65 000 barrels/day to 95 000 barrels /day.

Energy transition

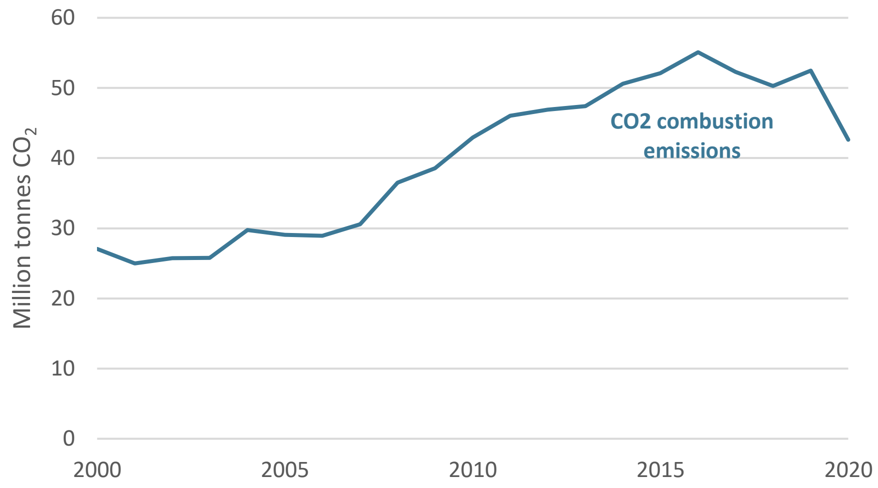
In 2020, Peru submitted its revised National Determined Contributions (NDCs), increasing its mitigation goal from 30% to 40% in 2030 and restricting emissions to 179 MtCO_2-eq by 2030 if there are favourable conditions (UNCC, 2022).

In January 2022, Peru issued the supreme decree Nº 003-2022-MINAM that declared the climate emergency as an emergency of the utmost interest. This law created the framework to design and execute measures to implement these NDCs.

Emissions

Due to the observed decrease in energy demand, the Peruvian energy sector reduced emissions by 19% in 2020. However, an economy rebound is expected to increase emissions in future years.

Figure 10: Peru CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Biofuels also play a role in Peru's transition plan. Since 2007, Peru has established a mandatory mix of biofuels with diesel and gasolines that are traded throughout the economy, except in some areas. Social conflicts put the domestic supply of fuels at risk and Peru issued a ministerial decree that stopped this mandatory mix for 15 days.

As mentioned before, Peru suffered LPG supply restrictions during 2022 due to extreme sea levels. The Ministry of Energy and Mines responded by authorising the release of LPG stocks to maintain the LPG supply to the domestic market; however, the recurrence of these shortage events highlights the importance of switching away from this fuel to alternative energy sources such as natural gas.

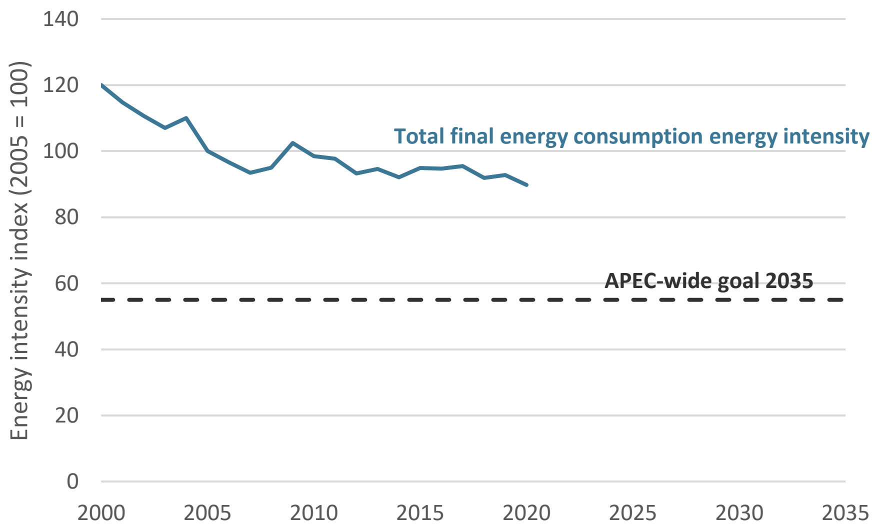
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective: to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 11: Peru's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

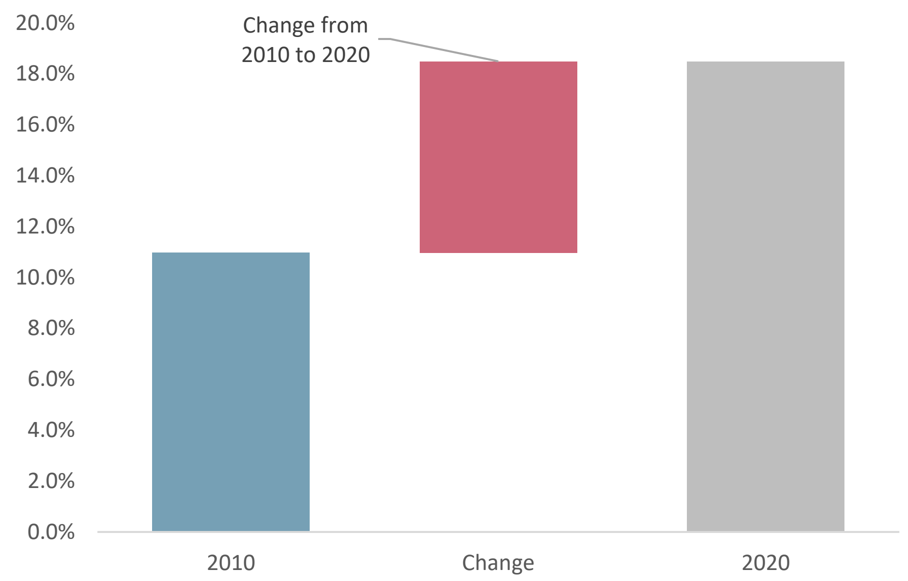
APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Despite the impact of the COVID-19 pandemic, energy intensity showed an improvement of 3% in 2020 with respect to 2019. This represents an improvement of 10% from the 2005 level. The reduction of energy intensity from the 2005 level was 10%. However, this decreasing trend might be affected in future reports as economy growth will be affected by several internal and external factors.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: Peru's modern renewable energy share, 2010 and 2020

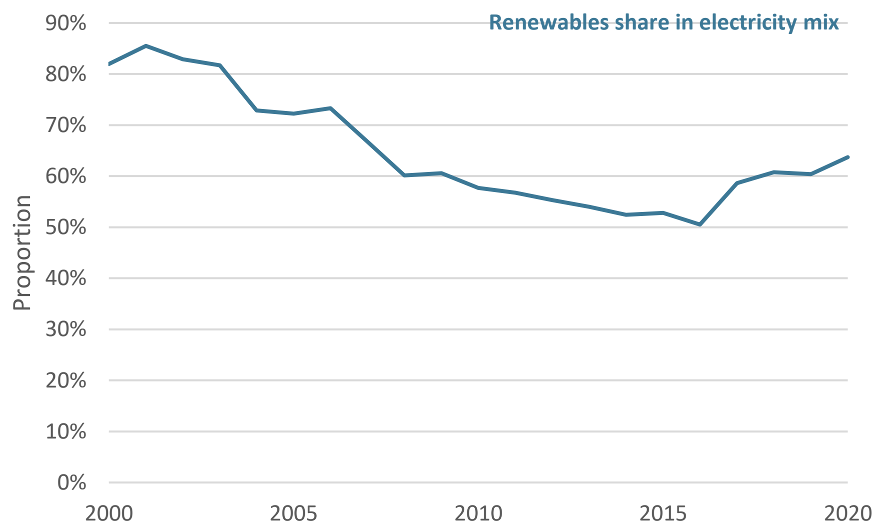


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Peru has almost double its share of modern renewables, going from 11% in 2010 to 19% in 2020. This share is one of the highest registered in APEC, the fourth after New Zealand, Canada, and Chile. Considering the important undeveloped potential of renewable energy in Peru, it is possible to assume that Peru might double its modern renewable energy share before 2030.

Figure 13: Peru's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

The renewable share in electricity mix increased in 2020, maily due to the decrease of thermal generation that was the consequence of reduced electricity demand. The newest wind energy plants, Huambo and Dunas with a combined capacity of 36 MW, started operations in mid 2021. However, due to an expected growth of electricity demand due to economy reactivation, the renewable share might not improve in 2021 or 2022.

On the other hand, several renewable energy power plants have been announced. During 2022, 136 MW solar and 500 MW wind energy projects started construction so an increase of the renewable share in the electricity mix is likely after 2023.

Energy policy

Energy policy	Details	Reference
Natural Gas Massification	Massification of natural gas via the use of the Social Energy Inclusion Fund. The government plans to build a natural gas distribution network for seven regions.	ProInversion
Modernisation of Talara Refinery	The project involves the construction and extension of facilities aimed at increasing refining capacity from 65 000 to 95 000 barrels per day (bpd) by 2022, producing cleaner fuels, reducing imports of such products, and thereby improving Peru's trade balance. It is expected to start full operations in 2023	Petroperú
2021 to 2030 Transmission Plan	The transmission plan, elaborated by the Comité de Operación Económica del Sistema (COES) and approved by the MINEM, defines a list of projects that reinforce the electric transmission grid. The estimated investment is USD 981 million.	Ministry of Energy and Mines
National Plan for Rural Electrification	The objective of the Rural Electrification Plan is to achieve a reduction in greenhouse gas emissions using renewable energy in rural areas for the provision of electricity. In 2018, rural electrification reached 87% of coverage; economy-wide electrification was 92%. The policy target is to reach 100% by 2022.	Ministry of Energy and Mines
The Southern Peruvian Gas Pipeline	This pipeline will increase the natural gas transportation capacity to 800 million cubic feet per day by 2025 through the following pipelines: - Camisea–Lima (500 km); Peru LNG (300 km) - Ica–Marcona (300 km); Marcona–Mollendo loop (500 km) - Central Highlands–Trujillo (1 100 km); Trujillo–Piura (500 km); Piura–Tumbes (400 km)	Ministry of Economy and Finance
Electric Vehicle Charging Infrastructure	Peru has approved statutory provisions for the charging infrastructure and electricity supply for electric vehicles. A proposal for specific regulations for the installation and operation of electric vehicle charging stations has been presented.	Ministry of Environment
Energy Efficiency Audits	In 2021, Peru approved legal requirements for energy efficiency audits to promote energy efficiency in public and private buildings.	Ministry of Environment
Energy Efficiency Labelling Regulation	In 2017, the technical regulation for energy efficiency labelling for 12 types of equipment was approved. However, the requirement of presenting a certificate of conformity before using the labels was postponed.	Ministry of Energy and Mines
Energy Efficiency Standards	A new set of technical specifications for washing machines and lights for street lighting has been approved. The government is obligated to acquire new products according to these new specifications.	Ministry of Energy and Mines

National Determined Contributions (NDCs)	Peru has updated the unconditional and conditional NDCs. The unconditional target changed from 20% to 30% and the conditional target changed from 30% to 40% emission reductions by 2030.	Ministry of Environment
Declaration of climate emergency as utmost interest	Peru declared the climate emergency as an emergency of the utmost interest and prioritised actions to implement NDCs, including setting a goal of achieving 20% non-conventional renewable energy in the electricity mix.	Ministry of Environment

Notable energy developments

Energy development	Details	Reference
Crude Oil Spill at La Pampilla	A crude oil spill occurred on the coast during the unloading of crude oil at the La Pampilla refinery in January 2022.	Ministry of Environment
Declaration of Climate Emergency as Utmost Interest	Peru decreed climate emergency as an emergency of the utmost interest	Ministry of Environment
Quellaveco Started Operation	Quellaveco started operations in 2022. This large copper mine will consume green energy from Punta Lomitas, a wind energy project, that is currently under development	Ministry of Energy and Mines
Renewable Energy Projects	The wind projects Punta Lomitas, Wayra Extension, San Juan, and Caraveli and the solar projects Clemesi and Milagros started in 2021. These projects will increase capacity by 500 MW for wind projects and 136 MW for solar projects.	OSINERGMIN

Useful links

Government

Central Reserve Bank, *Banco Central de Reserva*– https://www.bcrp.gob.pe/

Committee for the Efficient Operation of the System**,** *Comité de Operación Económica del Sistema Interconectado Nacional*– https://www.coes.org.pe/portal/

National Institute of Statistics and Information, *Instituto Nacional de Estadísticas e Informática* – https://www.gob.pe/inei/

Ministry of Energy and Mines, *Ministerio de Energía y Minas* – http://www.minem.gob.pe/index2.php http://www.minem.gob.pe/index2.php

Ministry of the Environment, *Ministerio del Ambiente*– https://www.gob.pe/minam

Supervisory Body of Investment in Energy and Mining, *Organismo Supervisor de la Inversión de Energía y Minería*– https://www.osinergmin.gob.pe/Paginas/en/index.html

Official National Newspaper El Peruano, *Diario oficial el Peruano*– https://elperuano.pe/

Energy associations

National Society of Mining, Oil and Energy— https://www.snmpe.org.pe/

National Society of Industries — https://sni.org.pe/

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The Philippines

Introduction

The Philippines increased its efforts to provide energy access for all during the Duterte Administration in 2016. As an archipelago with 7 641 islands and separated into three major islands (Luzon, Visayas and Mindanao) attaining a 100% household electrification level was a challenge. Nevertheless, in December 2021, the economy recorded a 95% household electrification level. Luzon has the highest household electrification level at 99%, Visayas followed closely at 97%, and then Mindanao at almost 86%. The National Capital Region, where the economy's capital sits (Manila), and CARAGA[7] have attained total electrification status (DOE, 2022).

The economy is likewise committed to developing a more resilient energy infrastructure. The Philippines is among the member economies in APEC that are frequented by natural calamities such as typhoons, earthquakes and volcanic eruptions. In the 2022 World Risk Index, the Philippines ranked first among 193 economies with the most disaster and it had suffered a billion pesos worth of damage and losses due to tropical cyclones alone (NEDA, 2023). In 2018, a circular mandated all energy industry players to formulate and submit their Resiliency Compliance Plan (RCP), and as of December 2021, the government had received 161 RCPs. A Task Force on Energy Resiliency was also activated by the circular, and likewise, in APEC-EWG (Energy Working Group), the Philippines co-chairs the Energy Resiliency Task Force with the United States.

In addition to the policies developed in response to COVID-19 mentioned in the previous edition, the government issued several energy-related policies to help curb the effect of the pandemic on the energy sector. These were the "*Rationalizing the Utilization of ER 1-94 Fund by Host Local Government Units in Response to COVID-19 Public Health Emergency*," which allowed host Local Government Units (LGUs) to use ER 1-94 funds for COVID-19 responses.

Table 1: The Philippines' macroeconomic data and energy reserves

Key data [a, b]		**Energy reserves** [c, d]	
Area (thousand km^2)	343	Oil (million barrels)	97
Population (million)	110	Gas (billion cubic feet)	637
GDP (2017 USD billion PPP)	827	Coal (million tonnes) [d]	2 370
GDP per capita (2017 USD PPP)	7 960	Uranium (kilotonnes U < USD 130/kgU)	

Sources: agov.ph, b (World Bank, 2021b), c, d (DOE, 2021)
Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Other issuances related to COVID-19 include: a) Administrative Order No. AO2020-05-0001 entitled, "*Providing for a COVID-19 Response Protocol in the Energy Sector*"; b) compliance to EO 113, entitled "*Temporarily Modifying the Rates of Import Duty on Crude Petroleum Oil and Refined Petroleum Products under Section 1611 of RA 10683*",

[7] Officially called the Caraga Administrative Region and consists of provinces in the northeastern section of Mindanao.

otherwise known as the "*Customs Modernization and Tariff Act*"; and c) DC2020-05-0012 or the *"Guidelines Implementing the Temporary Modification of Import and Duty Rates on Crude Petroleum Oil and Refined Petroleum Products as Provided under EO 113".*

The Philippines is one of the fast-growing economies in southeast Asia; however, the economy has struggled to recover from the effects of the COVID-19 pandemic. In 2020, its GDP dipped almost 10% to USD 872 billion (2017 USD PPP), the biggest drop recorded since the 1998 financial crisis. Relatedly, the GDP per capita dropped more than 10%.

Since the enactment of the Renewable Act in 2008 (RE Act of 2008), the economy has made considerable progress in advancing the economy's domestically produced energy sources, consequently increasing the renewable share in the economy's energy mix. Specific policies relating to RE ACT of 2008 were summarised in the Energy Policy table. One important policy was allowing 100% foreign ownership of large-scale geothermal exploration, development, and utilisation projects. The Philippines continued to place as the third-largest geothermal producer in the world (1 930 MW) in terms of installed capacity, behind the United States and Indonesia (DOE, 2022).

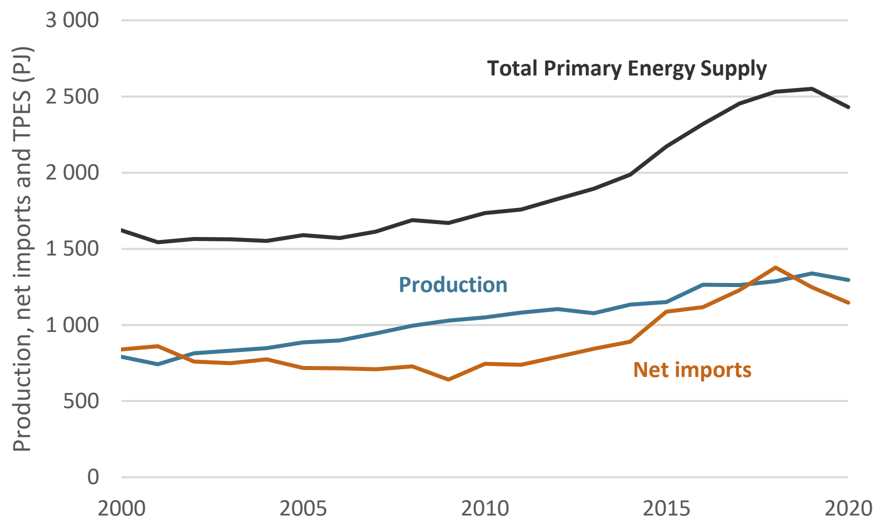
The economy has a modest amount of domestic resources. As of December 2021, the indigenous petroleum production reached 7 million barrels (MMB) of crude oil, 23 MMB of condensate and 848 billion cubic feet (BCF) of natural gas, while coal production stood at 81 million metric tons (MMMT) (DOE, 2022).

Energy supply and consumption

Total primary energy supply

The Philippines was historically a net importer, mostly of oil and coal. Net imports peaked in 2018 and in 2020 declined by 8.2%. While a similar trend was seen in the previous year, something of note was the huge drop of oil imports by 21%, resulting in a reduction of its share of total imports to 57% in 2020, historically, it was more than 60% (Figure 1).

Figure 1: The Philippines' energy supply, production, and net imports (PJ), 2000 to 2020

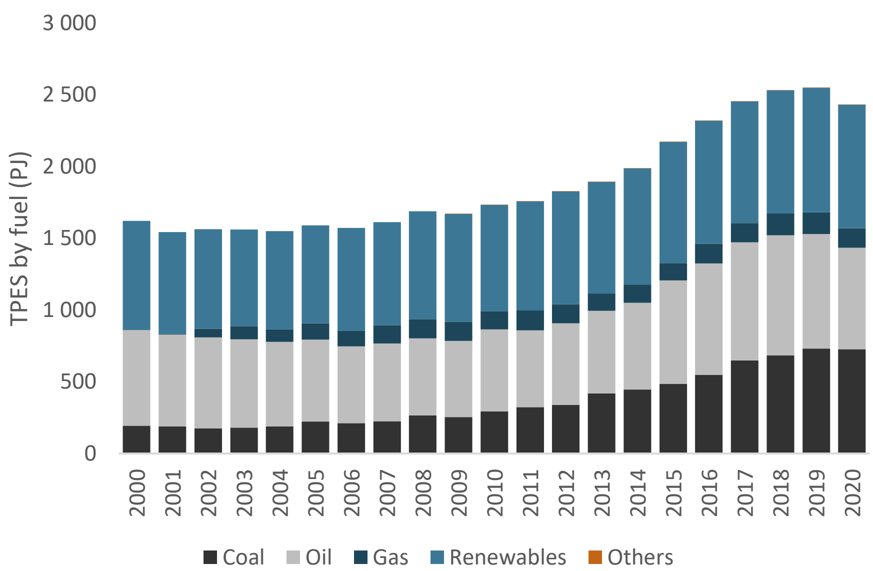


Source: EGEDA (2022)

The year 2020 marked the period when the COVID-19 pandemic was declared, and this brought new trends in the energy supply. The Philippines' total primary energy supply (TPES) plunged almost 5% to reach 2 430 PJ in 2020. Other fuel sources which included non-renewable energy wastes, decreased more than 20% in 2020. As a result of the decline in oil imports, the oil supply decreased by more than 11%. The looming depletion of the economy's single gas source coupled with reduced demand due to the pandemic has contributed to a dip in the gas supply of more than 9%.

Renewables (35%) and coal (30%) which accounted for more than 60% of the economy's energy supply, both dropped 1% in 2020. Among the renewables supply, biomass (49%) and geothermal (45%) accounted for the lion's share, biomass dropped 1%, but in contrast geothermal increased almost 1%. Due to the significant declines in the oil supply, coal overtook oil (29%), as the largest fuel source of the economy for the first time in 2020 (Figure 2).

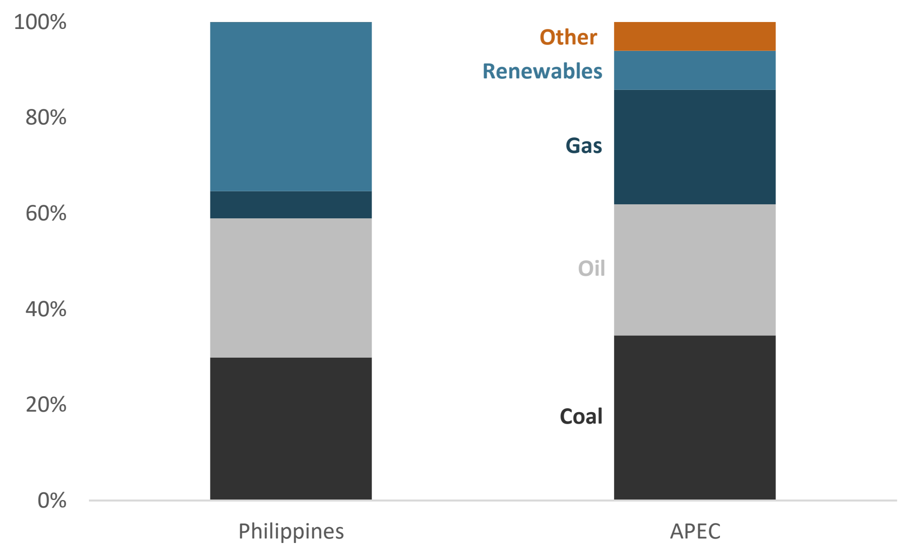
Figure 2: The Philippines' energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

The Philippines energy supply is relatively small as compared with other economies in APEC, but the Philippines takes pride in harnessing its own domestic energy sources. In particular, renewable energy that was mostly produced locally was relatively prominent in the economy compared with APEC as a whole in 2020. Oil's share, while decreasing, was relatively on a par with the APEC oil supply. Similarly, as the Philippines rely mostly on coal for power generation, the coal share was relatively significant compared with APEC. On the other hand, gas and other fuel sources were relatively small compared with APEC (Figure 3).

Figure 3: Energy supply mix – The Philippines and APEC, 2020

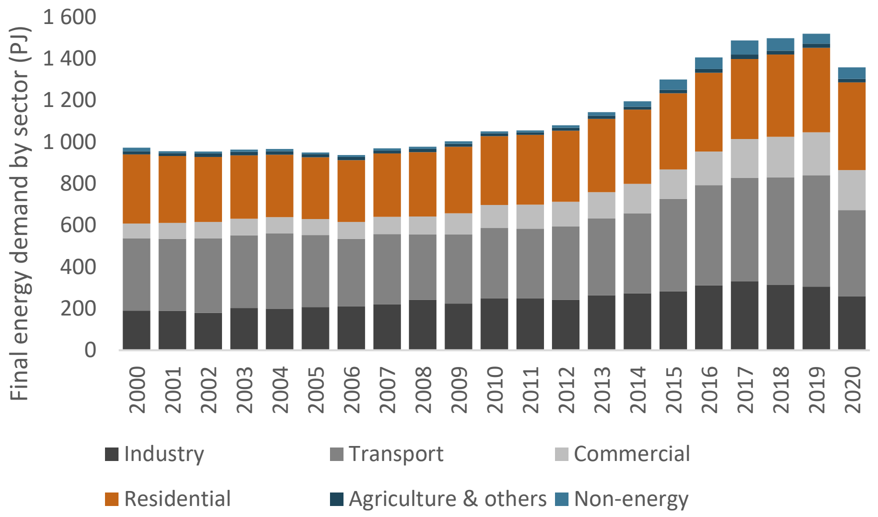


Source: EGEDA (2022)

Total final consumption

The significant drop in the economy's energy supply brought by the COVID-19 shock resulted in an unprecedented drop in total final consumption (TFC-including non-energy) in 2020. The economy's TFC plunged dramatically by almost 11% to reach 1 360 PJ in 2020–equivalently a 2.6% increase on average for the last two decades. While commodities for non-energy use had increased by more than 10% (14% to 54 PJ), and energy consumption in the household sector slightly increased by 3.3%, these were not enough to offset the huge energy consumption declines in the sectors in 2020, in particular, the more than 20% reduction in energy consumption in the transport sector (413 PJ) in 2020 and in part the energy consumption decreases in the industry (-15%), agriculture (-7.4%) and services sectors (-6.3%).

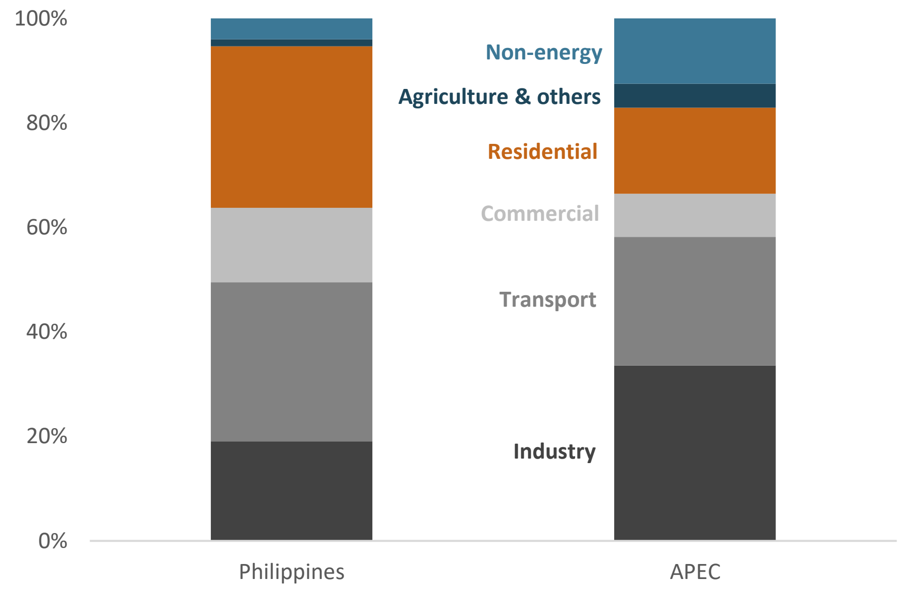
Figure 4: The Philippines' final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

The Philippines was not spared from the closing of borders due to the pandemic, which limited mobility and caused stagnation of all other activities. This has led to a record high decrease in energy consumption in all modes of transport. Likewise, the work forces' place of activity has shifted from offices to residential locations due to the work-from-home/teleworking scheme imposed during the lockdown. This may have contributed to the large decline in the service sector's energy consumption and gains in the residential sector from 2019 to 2020 (Figure 4).

Figure 5: Final consumption by sector, The Philippines and APEC, 2020



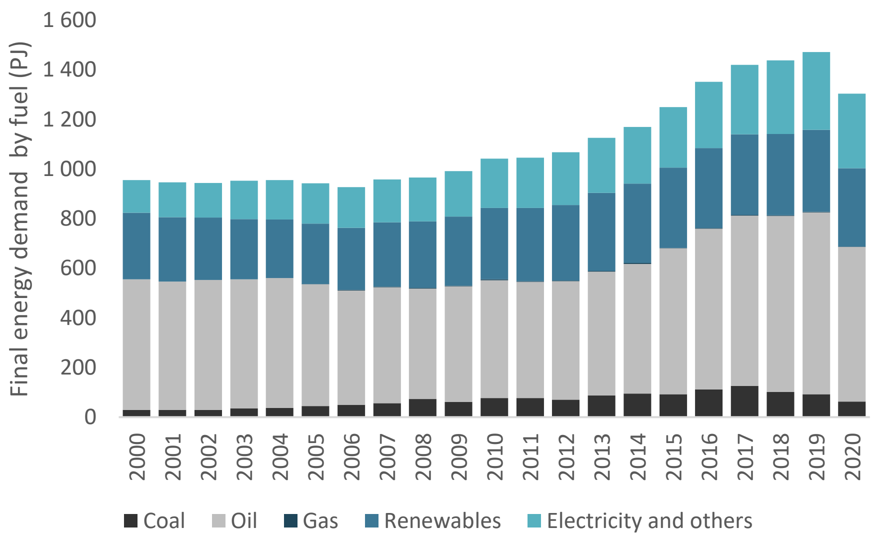
Source: EGEDA (2022)

The transport, residential and services sectors were more prominent in the Philippines than in APEC generally. These sectors were directly associated with the purchasing capacity of the consumers. Despite the reduction in energy consumption due to the pandemic, increased income indicates an increasing ability to purchase goods and services associated with these sectors (Figure 5).

Final energy demand

Total final energy consumption (TFEC-excluding non-energy) fell to a little over 1 300 PJ in 2020 or an unprecedented annual drop of more than 11%. Gas consumption took the brunt of the COVID-19 pandemic, dipping almost 40%. The low demand during the pandemic has resulted in the closing of the sole gas refinery. Electricity was the major fuel source, occupying a third of the Philippines' TFEC, but this fell 4% in 2020 as well. Renewables also fell by 4% in 2020.

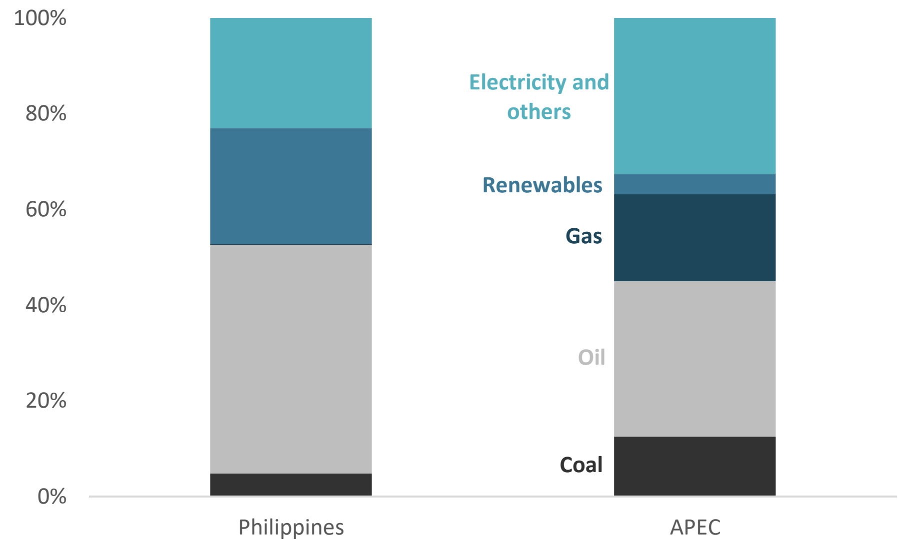
Figure 6: The Philippines' final energy demand by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

Coal consumption associated mostly with industry use fell almost 33%, while oil consumption, almost 100% of which was for transport use, reduced by almost 15%. Electricity was the major fuel source in the services and household sectors. The major lockdowns caused a 19% reduction of electricity consumption in the services sector, and in contrast a 12% increase in the household sector (Figure 6).

Figure 7: Final energy demand fuel share, the Philippines and APEC, 2020



Source: EGEDA (2022)

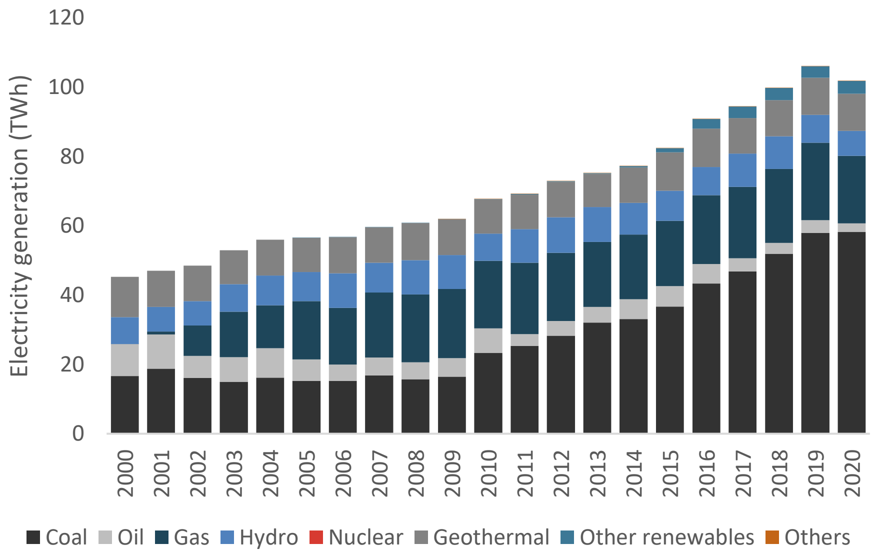
The Philippines continued its reliance on oil for transport use, which was clearly evident in the relative share compared with APEC as a whole. As most households still consume a large amount of biomass for household use, and the Philippines is increasingly harnessing its renewables sources, the share was larger than that of APEC. Electricity use seemed smaller in the Philippines than in APEC, but the share of electricity in the Philippines' fuel mix was significant. Direct use of coal is limited to a sub-sector of industry in the Philippines and hence the share was smaller than in APEC (Figure 7).

Transformation

Power sector

The Philippines' electricity generation recorded an unprecedented decline of 4% to 102 TWh in 2020 (Figure 8). Electricity output from oil which has fluctuated for the last 10 years, plummeted by 34%, the biggest drop among the fuel sources for power generation in 2020. Coal, which accounted for more than 50% of the economy's power generation mix, slightly increased by almost 1% (58 TWh) in 2020.

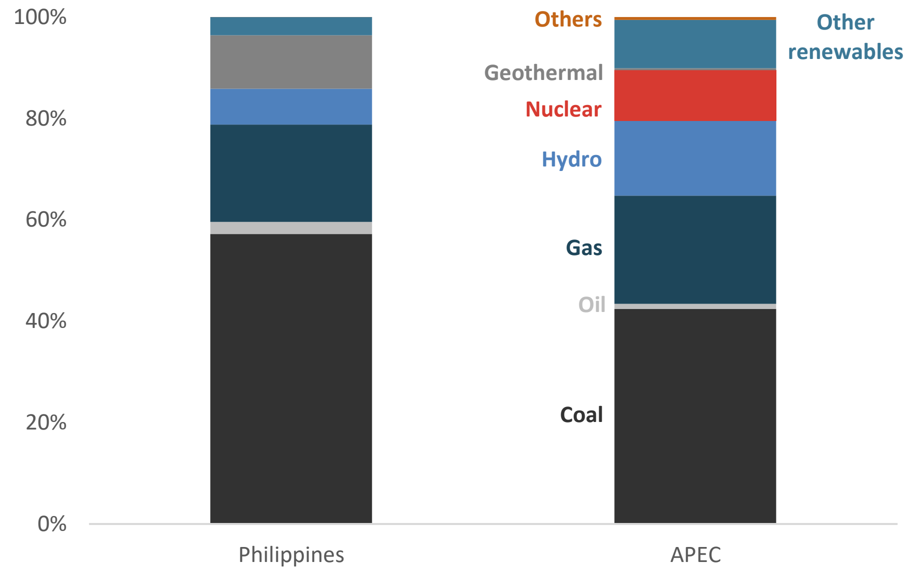
Figure 8: The Philippines' electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

Electricity generation from renewables was surprisingly the winner among the fuels used for power generation. In particular, biomass, solar and other renewables saw a 10% rise in 2020, although this was not enough to offset the declines in fossil fuels. The significant hikes of capacity generation from biomass, wind, etc. helped provide the needed power requirements during the pandemic. Although minimal, geothermal provided an almost 1% increase to boost the electricity generation in 2020. Aside from the pandemic, electricity generation from hydro, which has been affected by "El Niño" since 2019, fell further by 10% in 2020.

Figure 9: Electricity generation fuel share, the Philippines and APEC, 2020



Source: EGEDA (2022)

While the increase in power generation from geothermal was minimal in 2020, its relative share was quite significant compared with APEC. As the economy relies mostly on coal for power generation, its relative share compared with APEC was more prominent in 2020. Power generation from oil is slightly larger than APEC while gas was as almost on a par with APEC. The relative shares of the remaining generation modalities were either zero (in the case of nuclear) or smaller than the APEC-wide power generation mix (Figure 9).

Energy transition

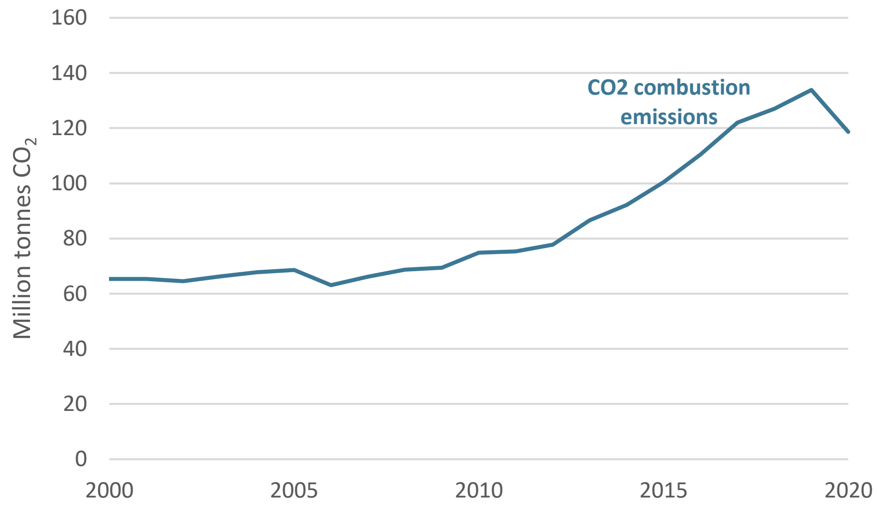
The Philippines submitted its Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change in 2021. The NDC stated that the Philippines commit a 75% reduction in GHG emissions against the business-as-usual scenario (2020-2030). This mitigation target comprises 2.7% unconditional, and 72% are conditional on resources to be provided by developed economies to implement mitigation actions in the agriculture, waste, industrial processes and product use, transport, and energy sectors (NEDA, 2023).

In its Philippine Development Plan 2023-2028 under the new Marcos Administration, the *Low carbon economy transition enabled* is one of the government's strategies in its climate action and strengthening disaster resilience Strategy Framework (NEDA, 2023).

Emissions

As highly expected, the slump in energy consumption across sectors resulted in an almost 8% decline in 123 mt-CO_2 emissions in 2020. A decline of this magnitude was first seen in 2006 when the population was about 80 million. Emissions due to activities in the transport and industry sectors contributed greatly to the significant drop, mostly related to the restrictions on mobility and other economic activities.

Figure 10: The Philippines' CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Energy security has been at the forefront of the economy's Philippine Energy Plan (PEP) 2020-2040. The PEP 2020-2040 advocates for the development and use of existing and emerging technologies in the most efficient and sustainable manner (DOE, 2023).

Recent events such as the COVID-19 pandemic, fast-paced changes in the technology environment and geopolitical situation, and other factors posed a challenge to the economy's supply security, for example the liquified petroleum gas (LPG). In February 2022, the global price of LPG soared dramatically due to the Russia-Ukraine conflict. Sanctions imposed on Moscow required buyers to look for supply elsewhere, and along with surging spot premiums and freight rates, this put additional upward pressure on LPG prices.

These events called for the economy to increase the use of alternative fuels and explore more of the economy's local energy sources such as renewables (DOE, 2023). The depletion of the Philippines sole natural gas resources is also threatening a shortage of more than 20% in the power supply. Six proposed liquefied natural gas (LNG) terminal projects with a combined capacity of 22 million tons per annum (MTPA), are expected to start operating between 2022 and 2023 (DOE, 2022).

As of the end of December 2021, the economy maintained a 38-day inventory level of crude oil and petroleum products equivalent to 2 610 million litres, comprising 26 days of in-economy stocks (onshore) and 13 days of crude oil and petroleum products still in transit (DOE, 2022).

The Philippines is one of the signatories to the ASEAN Petroleum Security Agreement (APSA). APSA was launched in 1986 with the aim of ensuring regional cooperation in energy security in times of oversupply or undersupply of oil and/or petroleum products. Although APSA has not yet come into force, the Philippines as one of the active members of the ASEAN is looking forward to its implementation.

With the expected rebound of activities after the pandemic, the government assured the consumers with a sufficient and steady supply of power. In December 2021, the rehabilitation and refurbishment of facilities, both grid and off-grid, were ongoing, and the expansion of installed capacities was recorded.

APEC energy goals

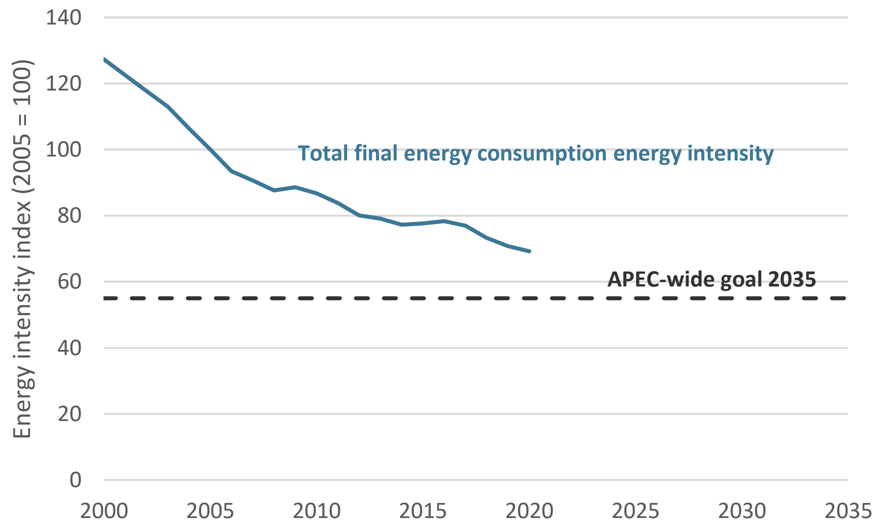
There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Figure 11: The Philippines' total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



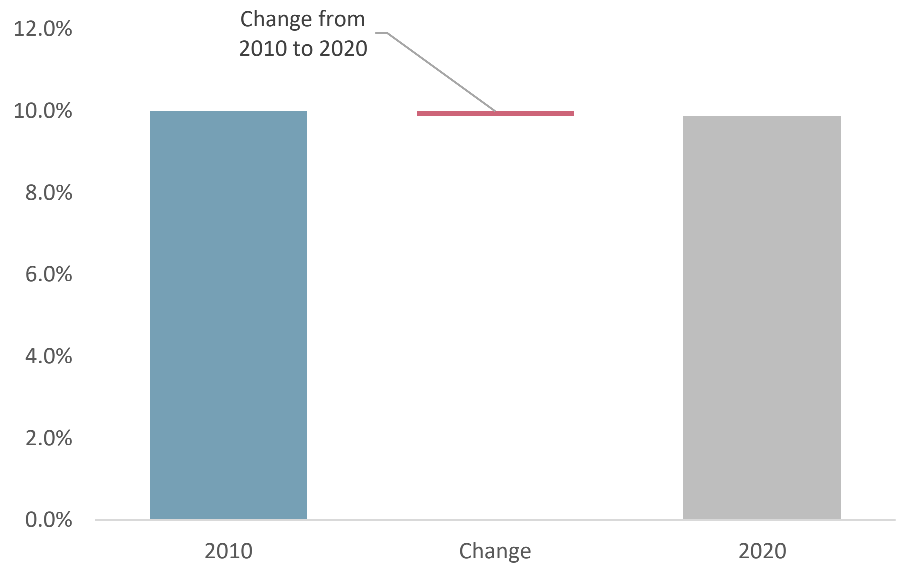
Source: EGEDA (2022)

The Philippines final energy intensity has been improving by 2% on average annually since 1990. In 2020, final energy intensity improved 31% compared with 2005. The biggest improvement in magnitude year-on-year since 2005, may be due to strong implementation of energy efficiency and conservation programs or just an effect of the restrictions imposed during lockdown. It would be interesting to see if the Philippines will continue this trend in the following two years post pandemic.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: The Philippines' modern renewable energy share, 2010 and 2020



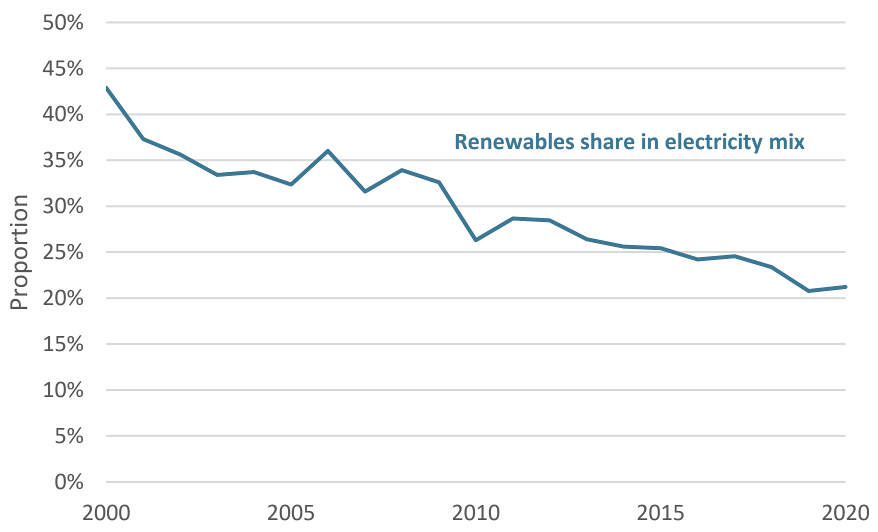
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

The Renewables Act in 2008 laid the groundwork for advancing the Philippines' renewable and locally produced energy. Efforts had been made to promote utilisation of renewable resources both for end-users and power generation. However, in 2020, the share of renewables in final energy consumption fell very minimally—from 10% in 2010 to 9.9% in 2020. If the economy aimed to double the share of renewables in final energy demand, the economy would need an additional 10% by 2030 (Figure 12).

In terms of power generation, the share of renewables in the generation mix increased by 2.2% in 2020 from 2019. Looking closely, however, the share of renewables in power generation since 2010 has been on a declining trend, falling 2% annually on average. This has brought the share of renewables from 26% in 2010 to 21% in 2020. If the economy wants to double the share of renewables in the power generation mix, the trend should be increasing by 2% annually on average to reach 53% by 2030 (Figure 13).

Figure 13: The Philippines' renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

The energy sector is continuously guided by its long-term vision known as *AmBisyon Natin 2040* (NEDA, 2023). To realise this vision, the sectoral roadmap was formulated, and this is updated for each energy sub-sector. It contains long-term objectives, deliverables and targets consistent with the Strategic Directions and Nine-Point Energy Agenda cited in PEP 2018-2040 and will provide direction on how to achieve the clean energy path. (DOE, 2022).

Energy policy	Details	Reference
NDC Targets	* This policy targets an economy-wide 75% reduction of GHG emissions by 2030, relative to the business-as-usual scenario from 2000 to 2030. * Of the 75% reduction target, identified policies and measures (PAMS) account for 11% or 365 $MTCO_2e$ reduction from the business-as-usual (BAU)/Reference Scenario. Of this total, the energy sector is expected to contribute 46 MTCOe (13% share of total), which translates to a 1.4% reduction in the sector's GHG emission over the BAU. PAMS yet to be identified will account for 64% avoidance, thereby completing the target of 75% GHG.	UNFCC
Philippine Development Plan PDP 2023-2028	A plan framed by the new administration's 8-Point Socioeconomic Agenda which seeks to address both short-term issues and medium-term constraints to growth and inclusion.	NEDA
Philippine Energy Plan (PEP) 2020-2040 ***Towards a Sustainable and Clean Energy Future***	* The DOE's blueprint to secure the economy's energy future was created following regional consultations and information, education and communication campaigns (IECs). * This is a comprehensive energy blueprint supporting the government's long-term vision known as ***AmBisyon Natin 2040***. * PEP 2020-2040 is a transformational plan to bring in more of the clean energy fuels and technologies that will dominate the economy's portfolio of plans and programs for the next two decades.	Department of Energy
Power Development Plan 2020-2040	* This is a master plan that integrates all the development plans for the generation, transmission, distribution and supply sectors in grid and off-grid areas. * It also outlines the recent developments in the electricity market and in off-grid and missionary areas, household electrification, and the institutional support mechanisms.	Department of Energy
Republic Act (RA) 9367 (Biofuels Act 2006)	* Approved on 12 January 2007, this act directs the use of biofuels by establishing the biofuel program and appropriating funds for said program and for other purposes.	Department of Energy

RA 9513 (Renewable Energy Law)	* The National Renewable Energy Program (NREP) outlines the policy framework stipulated in Republic Act 9513. * The strategies set out in the Biofuels Act of 2006 form part of the implementation of the Renewable Energy Law.	Department of Energy
National Renewable Energy Program (NREP)	* The NREP outlines the policy framework stipulated in Republic Act 9513. * The strategies set out in the Biofuels Act of 2006 form part of the implementation of the Renewable Energy Law, which is included in the NREP. * 20-year RE target capacity in addition to tripling the 2010 installed capacity from 5 440 MW to 15 300 MW by 2030.	Department of Energy
National Energy Efficiency and Conservation Program (NEECP)	* This is a continuing program that aims to make energy efficiency and conservation (EE and C) a way of life. It also aims to increase awareness and attain measurable targets for the period from 2011 to 2030 through the following measures: - Reduction in the economy's final energy demand by 10% - Energy savings of 69 100 ktoe - Deferment of 6.8 Mwe of additional capacity - Reduction of 178 980 kT of CO_2 emissions	Department of Energy
Energy Efficiency and Conservation Act of 2019	* This Act institutionalises EE and C, enhancing the efficient use of energy and granting incentives to energy efficiency and conservation projects. * It facilitates the implementation of projects and programs under NEECP.	Department of Energy
RE Roadmap	* This focuses on attaining the target of at least a 35% renewable energy share in the power generation mix by 2030 and 50% by 2040.	Department of Energy
FiT Installation Target (MW)	* Policy mechanism under RE Law - Run-off river hydro (250 MW) - Biomass (250 MW) - Wind (400 MW) - Solar PV (500 MW) - Ocean (10 MW)	Department of Energy
Biofuels Roadmap	* The aim is to continue the implementation of blending targets set in the Biofuels Act of 2006, with the following measures from 2020 to 2040: - Implement a 5% biodiesel blend (B5) and maintain 10% ethanol (E10). - Revisit the biofuel blend requirements and available feedstock. - Implement Research and Development (R and D) activities and demonstration projects using Jatropha, waste cooking oil, microalgae, rubber and seed oil for biodiesel; and sweet sorghum, cassava, microalgae, Nipa sap and cellulosic material for bioethanol.	Department of Energy

Power Generation Roadmap	* Short-term goals (2021–2022): - Implement the coal moratorium. - Establish guidelines for power plant decommissioning. - Firm-up the privatisation plan for the government’s remaining power generation assets. * Long-term goals (2023–2040): - Utilise cleaner technologies for power generation. - Increase flexibility in power generation.	Department of Energy
Off-Grid Development Roadmap	* Energy access for all by 2040 - Graduation and rationalisation of the Universal Charge-Missionary Electrification (UC-ME) subsidies in off-grid areas, while the “electricity access for all by 2040” is the objective of the Total Electrification Program (TEP)	Department of Energy
Alternative Fuels and Energy Technologies (AFET) Roadmap	* This roadmap lays down the framework for the adoption and commercialisation of emerging and efficient energy technologies in the economy. * Medium-term goal (2020-2022): - Identification of AFETs for application * Long-term goal (2023–2040): - Preparation of the regulatory and infrastructure requirements of the identified AFETs	Department of Energy
Upstream Oil and Gas Roadmap	* This roadmap focuses on attaining the following objectives by 2040: - Increase indigenous petroleum reserves to 116 MMB oil and 5.9 TCF gas. - Produce 66 MMB crude oil and 3.5 TCF natural gas.	Department of Energy
Upstream Coal Roadmap	* Targets the increase of delineated mineable coal reserves up to 766 MMMT by the end of 2040 with additional reserves of 65 MMMT in the medium-term and 223 MMMT in the long-term.	Department of Energy
Downstream Oil Roadmap	* Improved policy governing the downstream oil industry to ensure a continuous supply of high quality, and the right quantity of petroleum products in the market by 2040.	Department of Energy
Downstream Natural Gas Roadmap	* To establish a world class, investment driven and efficient natural gas industry that makes natural gas the preferred fuel by all end-use sectors by 2040.	Department of Energy
Energy Efficiency and Conservation Roadmap	* Measurable reduction in energy intensity and consumption per year versus BAU by 2040 - Medium-term and long-term framework focusing on two priority areas, namely, the Strengthening and Sustaining of EE and C policies and initiatives	Department of Energy
Executive Order (EO) 116	Establishes the NEP-IAC, an inter-agency Task Force led by the DOE which is tasked to conduct a study for the adoption of the economy position on Nuclear Power Plant (NPP) in accordance with pertinent International Atomic Energy Agency (IAEA) guidelines, relevant laws, rules and regulations	Department of Energy

DC2020-11-0024	Adopting the Guidelines Governing the 3rd Open and Competitive Selection Process (OCSP3) in the award of the Renewable Energy Service Contract, and for other purposes	Department of Energy
DC2022-02-0002	Prescribing the Policies and Programs to Promote and Enhance the Development of Biomass Waste-to-Energy (WTE) Facilities	Department of Energy

Notable energy developments

The Philippines EWG representative reported the following at EWG 64 hosted by Malaysia online on 1-3 November 2022.

Energy development	Details	Reference
Department Circular No. DC2022-10-0031 *Declaring All Renewable Energy Resources as Preferential Dispatch Generating Units in the Wholesale Electricity Spot Market*	A circular signed by the DOE Secretary regarding the preferential dispatch of all generating units utilising RE resources in the wholesale electricity spot market on 5 October 2022. It will boost RE development and utilisation.	Department of Energy
DC2022-06-0019 *Declaring the Interim Commercial Operations of the Renewable Energy Market*	A circular released by the DOE declaring the interim commercial operation of the renewable energy market, the venue for trading renewable energy certificates.	Department of Energy
Department Circular No. DC2022-11-0035 *Expanding the Coverage of the Philippine Energy Labelling Program (PELP) for the Compliance of Importers, Manufacturers, Distributors, Dealers and Retailers of Energy-Consuming Products (ECPs)*	The DOE conducted the second public consultation on the draft department circular to expand the coverage of the Philippine Energy Labelling program for the compliance of importers, manufacturers, distributors and dealers in energy-consuming products on 30 September 2022.	Department of Energy
Gas Policy Development Project 2 (GPDP 2	The DOE and the University of the Philippines Statistical and Research Foundation have completed a natural gas development plan to attract investment in the economy's downstream natural gas industry.	Department of Energy

Useful links

Asian Development Bank — www.adb.org

Climate Change Commission (CCC) — www.climate.gov.ph

Department of Energy, Republic of the Philippines (DOE) — www.doe.gov.ph

Department of Science and Technology (DOST) — www.dost.gov.ph/

Department of Trade and Industry (DTI) — www.dti.gov.ph/

Department of Transportation and Communication (DOTC)/Land Transportation Franchising and Regulatory Board (LTFRB) — www.dotc.gov.ph

National Power Corporation (NPC) — www.napocor.gov.ph/

National Transmission Corporation (TransCO) — www.transco.ph/

Philippine National Oil Company (PNOC) — www.pnoc.com.ph/

Wholesale Electricity Spot Market (WESM) — www.wesm.ph/

World Bank — https://www.worldbank.org/en/country/philippines

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DOE (Department of Energy) (2021). DOE. Retrieved from Philippine Energy Plan: https://www.doe.gov.ph/pep.

— (2020). Philippine Energy Situationer and Key Energy Statistics, https://www.doe.gov.ph/energy-statistics?q=energy-statistics/2020-key-energy-statistics-kes.

—(2022). Energy Sector Accomplishment Report 2016-2022. https://www.doe.gov.ph/esar

— (2023). Philippine Energy Plan 2020-2040: *Towards Sustainable and Clean Energy Future.* https://www.doe.gov.ph/pep

EGEDA (Expert Group on Energy Data Analysis, APEC Energy Working Group) (2022), *APEC Energy Database.* https://www.egeda.ewg.apec.org/egeda/database_info/index.html

NEDA (National Economic and Development Authority) (2023). Philippine Development Plan 2023-2028. https://neda.gov.ph/philippine-development-plan-2023-2028/

WB (World Bank) (2022). https://databank.worldbank.org/source/world-development-indicators.

Russia

Introduction

Russia has the largest land area globally, spanning over 17 million square kilometres in both Eastern Europe and Northern Asia. The combination of geography and population settlement in Russia makes it necessary to use a significant amount of energy to provide comfortable living conditions for most of the population for most of the year, which is one of the critical factors contributing to the economy having the highest energy intensity of GDP among APEC economies.

These factors have determined the development in Russia of not only centralised power supply systems but also of centralised heat supply systems, which, in turn, has led to the widespread development of thermal power plants with combined heat and power generation. Now Russia has the world's largest district heat supply systems in most major cities.

Its population of 146 million people lives mostly in urban areas (74%), and 68% of the population lives in the European part of Russia, which accounts for 21% of the territory.

In 2020, Russia's GDP declined 4% to 3 893 billion 2017 USD PPP because of the lockdowns due to the COVID-19 pandemic. GDP remained the 4th largest in APEC. Russia's GDP per capita declined 4% as the population remained constant.

Russia was the third-largest energy producer in APEC. About half of this energy was consumed within the economy, while the rest was exported. Russia was the world's largest energy exporter overall, exporting about 29 EJ in 2020. In the same year, exports declined almost 9% while oil exports declined 12%.

Russia was the third-largest power producer in APEC, accounting for 6.2% of APEC's total electricity generation in 2020, and the largest heat producer.

Russia has significant reserves of fossil fuels and uranium.

Table 1: Russia macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	17	Oil (billion barrels)	108
Population (million)	146	Gas (trillion cubic feet)	1 321
GDP (2017 USD billion PPP)	3 893	Coal (million tonnes)	162 166
GDP per capita (2017 USD PPP)	27 019	Uranium (kilotonnes U < USD 130/kgU)	211

Source: a ROSSTAT (2022); b World Bank (2022); c BP (2022); d UN (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Energy supply and consumption

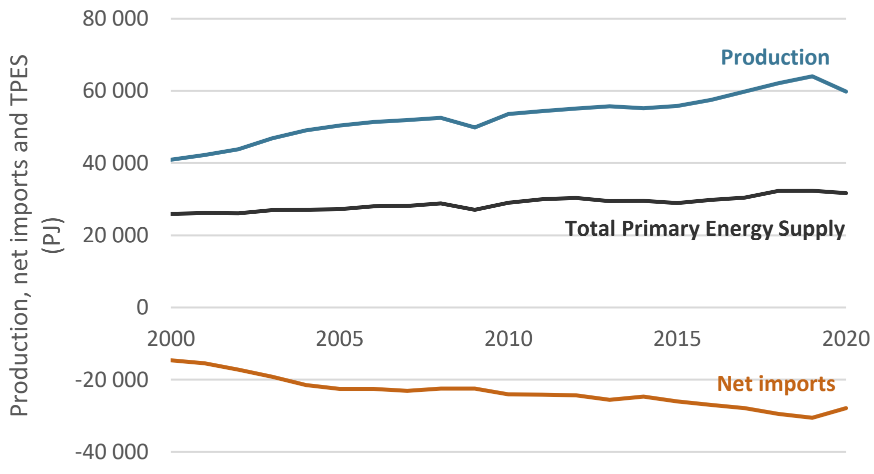
Total primary energy supply

Russia is the third-largest energy producer in both APEC and the world, after China and the US. Russia's total primary energy supply (TPES) in 2020 was 31 729 PJ, a decline of 2% compared to 2019 levels

(EGEDA, 2022). This decline was comparable to the drop in TPES in 2015 after the first wave of sanctions was imposed.

Energy production has grown consistently since 2000 with a CAGR of 2.4%. The only year of decline for the period was in 2009 due to lower domestic consumption. In 2020, production declined more than 6% to 59 868 PJ. Net exports grew at a much higher rate than production, with a CAGR of 3.9% from 2000 to 2019 but declined by nearly 9% in 2020.

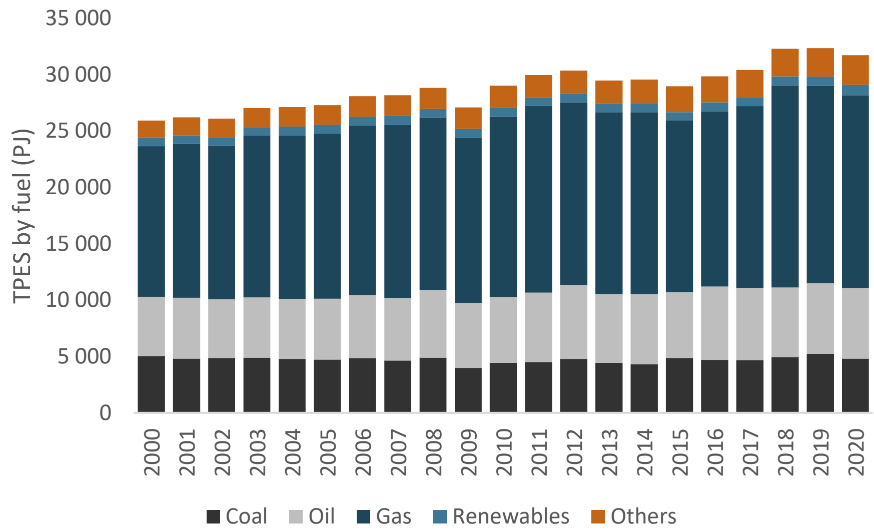
Figure 1: Russia's energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

Russia's TPES fuel mix remained stable for 2000–2020; natural gas accounted for more than half with a slight decrease in the share of coal. In 2020, the TPES fuel mix comprised the following: natural gas (54%), crude oil and petroleum products (20%), coal (15%) and others, including nuclear and hydro (11%) (EGEDA, 2022). For the 2000–2019 period, TPES volumes of coal remained stable; oil increased by 19%, others, including nuclear and hydro, increased by 67%, and renewables increased by 10%, while the volume of gas increased by 31% or over 4 000 PJ. In 2020, TPES decreased by 2% due to reduced consumption of coal and natural gas in the power sector.

Figure 2: Russia's energy supply by fuel (PJ), 2000 to 2020

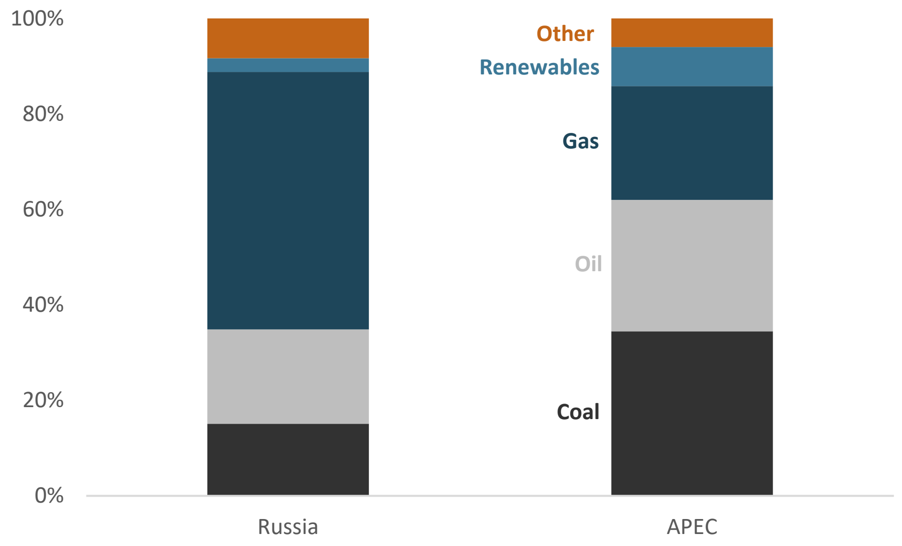


Source: EGEDA (2022)

Russia's TPES fuel mix is substantially different from the entire APEC region. The share of natural gas in Russia is more than twice as high, which is explained by its large natural gas reserves and the predominance of gas-fired power plants, which account for more than 70% of the electricity produced by thermal power plants.

Gas consumption is distributed unevenly across the regions, as the developed network of distribution pipelines is concentrated in the western part of the economy. In contrast, the shares of coal and renewables in Russia are less than half of APEC's. The modest share of renewables in electricity generation is due to the uneven distribution of renewable energy sources, a large share of which is concentrated in remote areas and limited government support for new projects.

Figure 3: Energy supply mix – Russia and APEC, 2020



Source: EGEDA (2022)

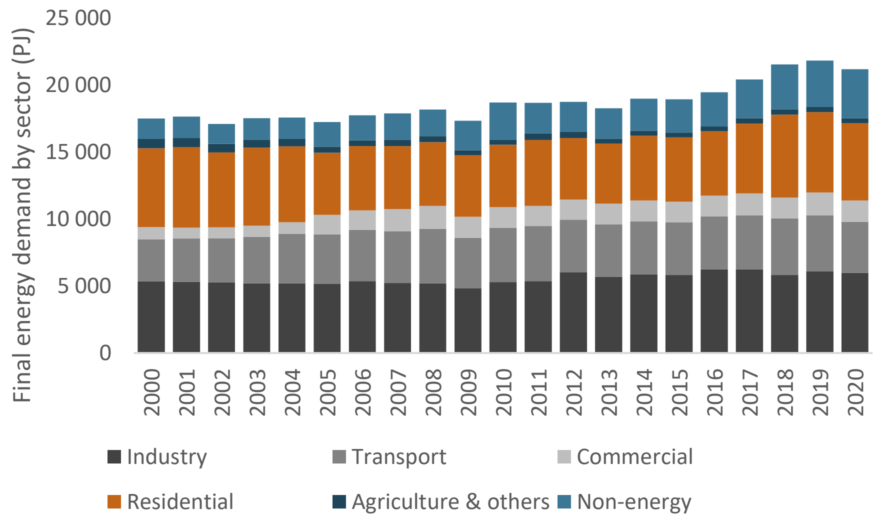
Total final consumption

Russia's final consumption in 2020 was 21 187 PJ, almost 3% lower than in 2019 (EGEDA, 2021). Russia remained the third-largest energy consumer in APEC after China and the US (EGEDA, 2022).

The industrial (6 002 PJ, 28%) and the residential sector (5 760 PJ, 27%) accounted for the two most significant shares of final energy consumption. Energy consumption in industry dropped by almost 2% due to restrictions caused by the pandemic. In residential buildings, consumption decreased by more than 4%, largely due to seasonal factors. One of the main reasons residential buildings are the largest consuming sector is the significant energy consumption for heating for more than half of the year. According to EGEDA, consumption in buildings began to increase significantly from 2017. This notable increase was due to the rise in gas consumption in residential buildings, which does not correspond to the member economy statistics. The third-largest sector was transport (3 786 PJ, 18%). Energy consumption in the transport sector fell by almost 9% due to lockdowns and travel restrictions.

Non-energy use has more than doubled since 2000 and accounted for 17% of Russia's energy product use in 2020. Agriculture and the commercial sector accounted for the remaining 10%.

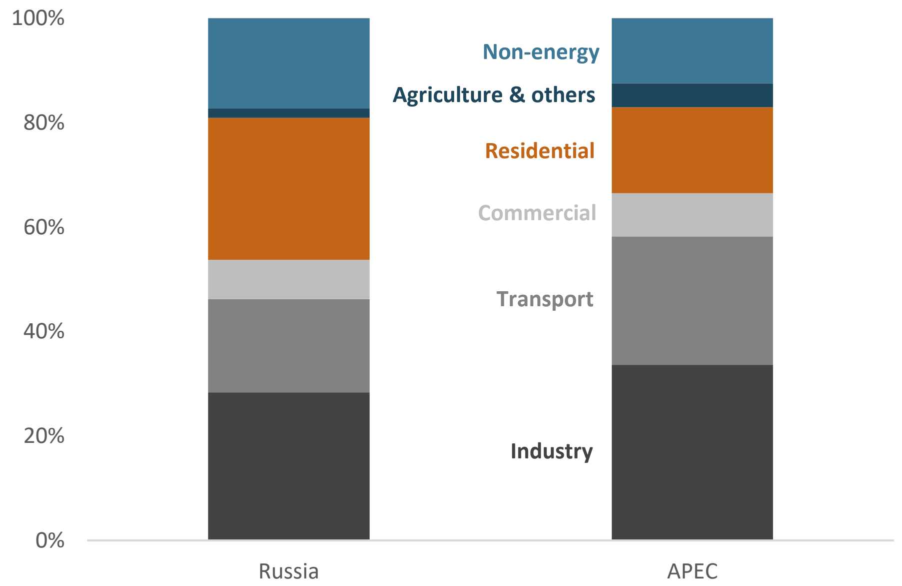
Figure 4: Russia's final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

Russia, like APEC, has the same major consumer sectors: industry, transport and residential. Their overall share is almost the same, accounting for about three-quarters of total consumption. However, the fraction of each sector is different. The share of the residential sector in Russia is much higher than in APEC due to its significant heat consumption, while the share of industry and transport is lower. The non-energy use share is higher than in APEC due to considerable consumption of petroleum products and natural gas as a feedstock in the chemical industry.

Figure 5: Final consumption by sector, Russia and APEC, 2020

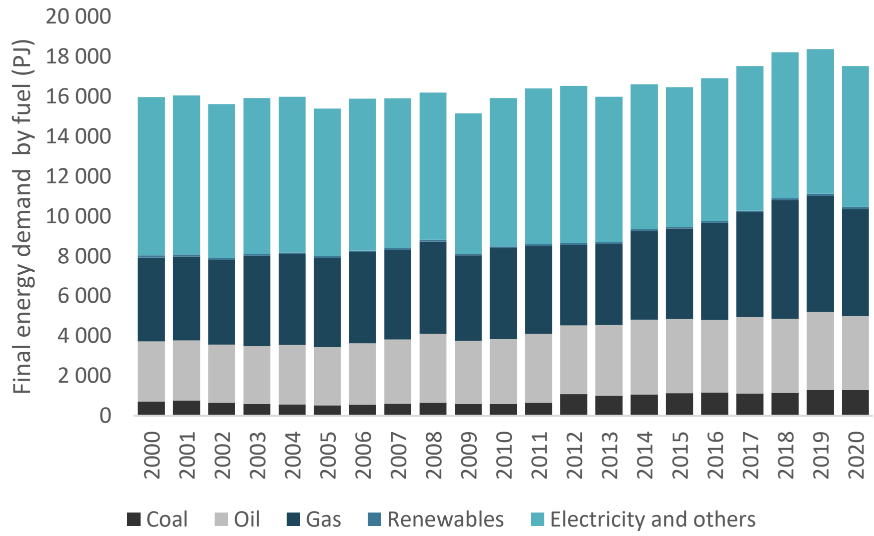


Source: EGEDA (2022)

Final energy demand

Russia's final energy consumption in 2020 was 17 524 PJ, almost 5% lower than in 2019 (EGEDA, 2022). About 40% of the final energy consumption in 2020 was supplied by electricity and heat, the share of which decreased by 10% compared to 2000 due to a significant decrease in heat consumption. Correspondingly, the share of fossil fuels increased from 50% in 2000 to 59% in 2020. Natural gas accounts for more than half of the consumption of fossil fuels, and oil and petroleum products for slightly more than a third. The share of coal, despite a slight increase in consumption, is gradually decreasing. The share of renewable sources does not exceed 1%. According to EGEDA, gas consumption has started to increase significantly since 2017. However, the noticeable increase in gas consumption was in residential buildings, which does not correspond to the economy statistics.

Figure 6: Russia's final energy demand by fuel (PJ), 2000 to 2020

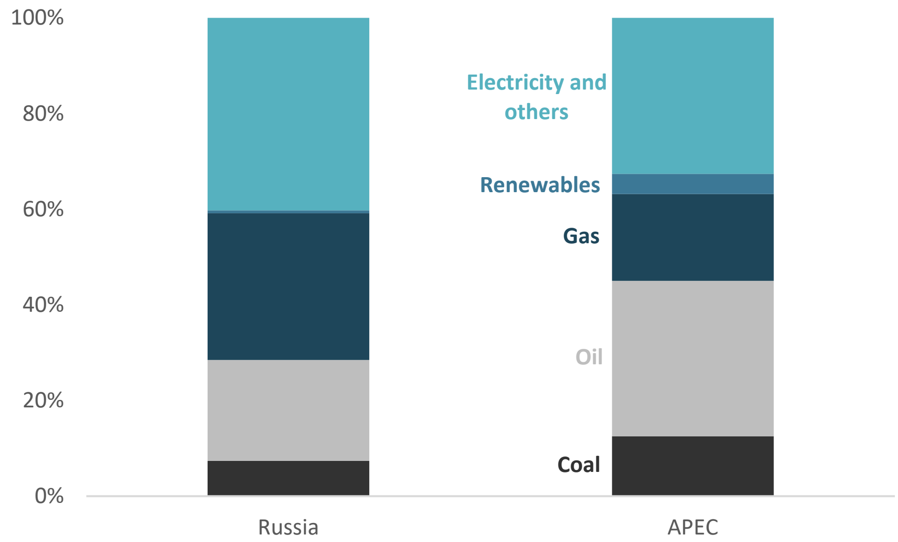


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

In Russia, fossil fuels accounted for almost 60% of final energy consumption in 2020, 4% less than the APEC total. Electricity and heat accounted for about 40%. In the APEC region, the share of electricity (and to a much lesser extent heat) was almost a third. The share of renewables was less than 1%, several times lower than for the entire APEC region.

Figure 7: Final energy demand fuel share, Russia and APEC, 2020



Source: EGEDA (2022)

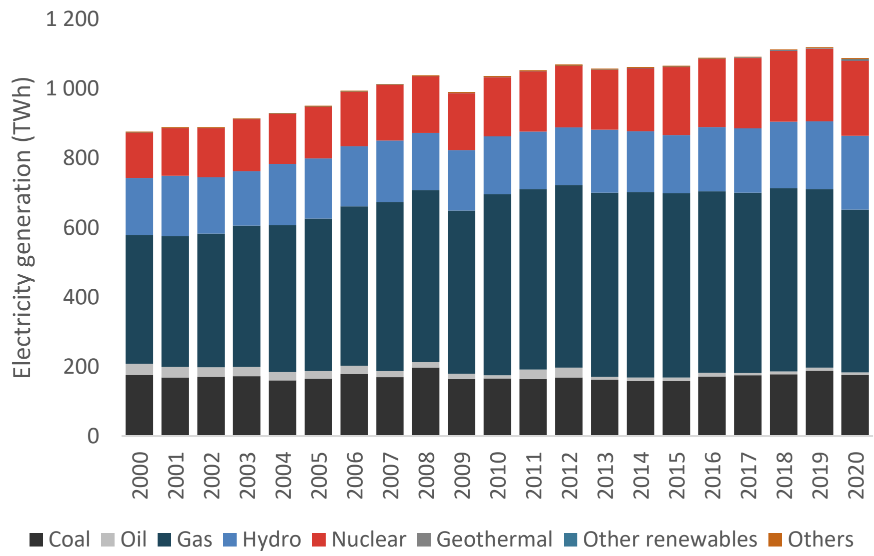
Transformation

Power sector

Electricity generation has grown consistently since 2000 (except in 2009) with a CAGR of 1.3%. In 2020, Russia generated 1 088 TWh of electricity, almost 3% less than the previous year. Fossil fuels accounted for the largest share of this generation (60%), of which natural gas contributed more than 70%. The remaining 40% of electricity generation came from hydropower and nuclear power in roughly equal shares.

Electricity generation at gas-fired power plants decreased by almost 9% due to a significant increase in generation at hydro power plants (more than 9%) and nuclear power plants (more than 3%).

Figure 8: Russia's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

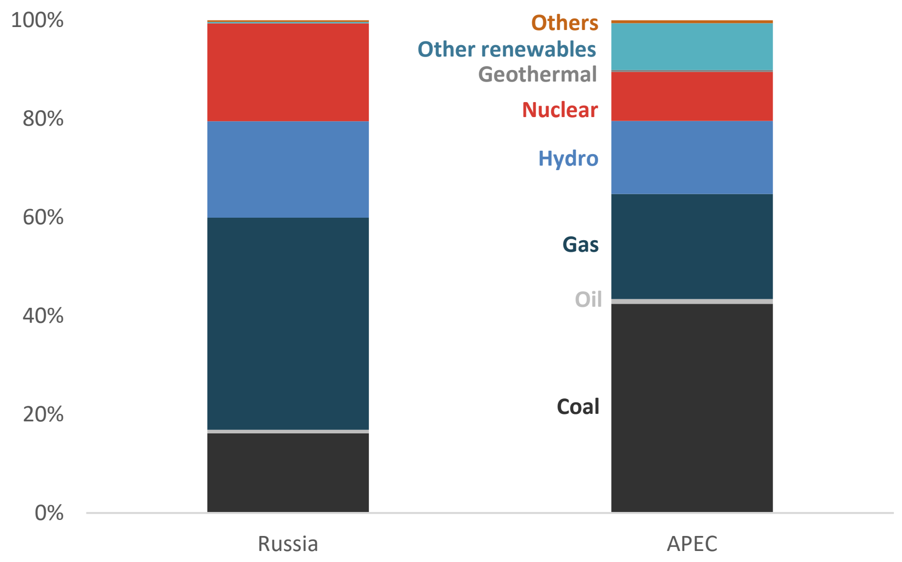
The fuel mix for power generation in Russia and the APEC region is quite similar in terms of the shares of fossil and non-fossil fuels. In Russia, fossil fuels comprise 64% of the generation mix, and in APEC, they account for 66%. However, the fossil fuels with the largest share in Russia and APEC differ. Natural gas accounts for a much larger share

(46%) in Russia, while coal accounts for a much larger share (44%) in APEC.

The share of hydro is also different, amounting to 17% in Russia and 14% in APEC. Nuclear energy in Russia accounts for 19%, almost twice as much as in APEC.

Russia lags far behind in solar and wind power generation in relation to the APEC-wide region. In APEC, the share of other renewables (primarily solar and wind) in 2018 exceeded 8%, while that share is lower than 1% in Russia.

Figure 9: Electricity generation fuel share, Russia and APEC, 2020



Source: EGEDA (2022)

Refining

Oil refinery capacity in Russia in 2021 was about 6.9 million barrels per day (BP, 2022), which is the third highest in the world after the US and China. In 2020, 53% of all produced oil was refined domestically (EGEDA, 2022). Diesel fuel (30%), fuel oil (18%), motor gasoline (15%) and naphtha (10%) dominated in the petroleum product output mix. More than half of the top three refined products by volume are exported. The share of fuel oil exports in 2020 was 88%, naphta – 67%, diesel – 51%.

Energy transition

The presidential decree “On Reducing Greenhouse Gas Emissions”, adopted in November 2020 led to significant activity. It instructed the government of the Russian Federation to develop a Strategy for Socio-Economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050.

The Strategy of Socio-Economic Development of the Russian Federation with Low Greenhouse Gas Emissions up to 2050 was approved at the end of October 2021, just before the COP26 summit. The strategy recognises the development of nuclear power generation and the expansion of the AFOLU absorption capacity as the most significant contributors to the reduction of greenhouse gas net emissions. From the point of view of the global community, both areas seem insufficient to reduce Russia’s contribution to greenhouse gas emissions. Nevertheless, even these statements demonstrate significant progress in understanding the problem and finding feasible ways to reduce greenhouse gas emissions. Currently, this strategy is the only document concerning strategic development until 2050 in the Russian Federation.

In 2021, essential documents were adopted that set the contours of the development of energy sub-sectors that promote decarbonisation: the

Federal Law “On Limiting Greenhouse Gas Emissions” (July 2021), “The concept of the development of hydrogen energy in the Russian Federation until 2035” (August 2021), “The concept for the development of production and use of electric vehicles in the Russian Federation until 2030” (August 2021).

The Federal Law “On Limiting Greenhouse Gas Emissions” provides the introduction of a staged model for regulating such emissions. This includes the introduction of mandatory carbon reporting, collected and summarised by the authorised government body.

The document also introduces the notion of a “greenhouse gas emission reduction target”. It will be set by the government on the scale of the Russian economy, taking into account the AFOLU and the need to ensure a sustainable and balanced socioeconomic development of the economy. The law proposes the creation of a roster of greenhouse gas emissions. This roster will be the information system, which the authorised federal executive body will maintain.

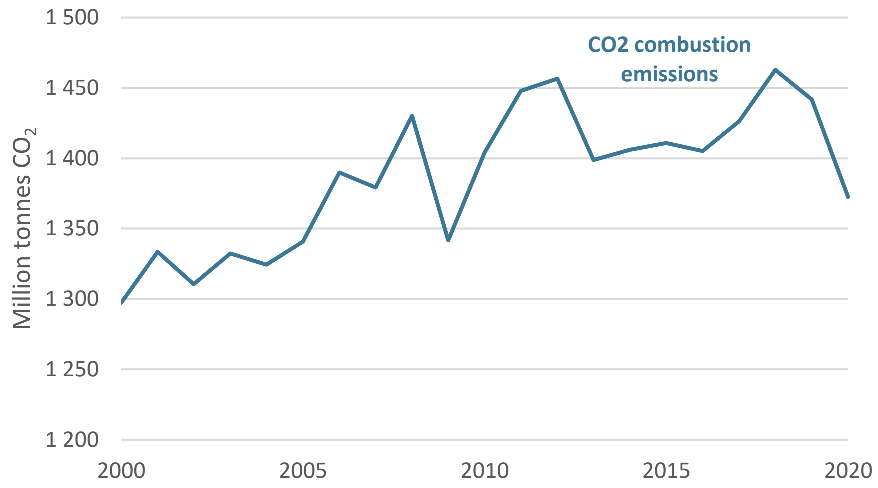
Emissions

CO_2 emissions have increased steadily since 2000 due to economic growth and development after the recession of the 1990s. The decrease in emissions, particularly in 2009 and 2020, reflects the decline in economic activity during economic crises.

After a significant decrease in 2013, the level of emissions has remained at about the same level for four years.

This notable increase in 2017-2018 was mainly due to the rise in gas consumption in residential buildings, which does not correspond to the economy statistics.

Figure 10: Russia CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

In 2019, the Doctrine of Energy Security of the Russian Federation was adopted by decree of the President of the Russian Federation. According to the Doctrine, Russia, as a major exporter of energy resources, seeks on the one hand, to provide a reliable supply of energy to consumers within the economy, and on the other hand, to ensure energy supplies to the world market.

The Doctrine refers to the following as external challenges to energy security: shifting the centre of global economic growth to the Asia-Pacific region; a slowdown in global demand for energy resources and a change in its mix, including the replacement of petroleum products by other types of energy resources and the development of energy saving and energy efficiency; an increase in the world resource base of hydrocarbons; increased competition among energy exporters; changes in the international regulatory framework in the energy sector and conditions of the world energy markets, strengthening the position of consumers; the growth of LNG production and its share on the world energy markets; the formation of a global natural gas market; an increase in the share of renewable energy sources in the global energy balance, and in general increased international efforts to implement climate policy and accelerate the transition to a green.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and to double the share of modern renewables.

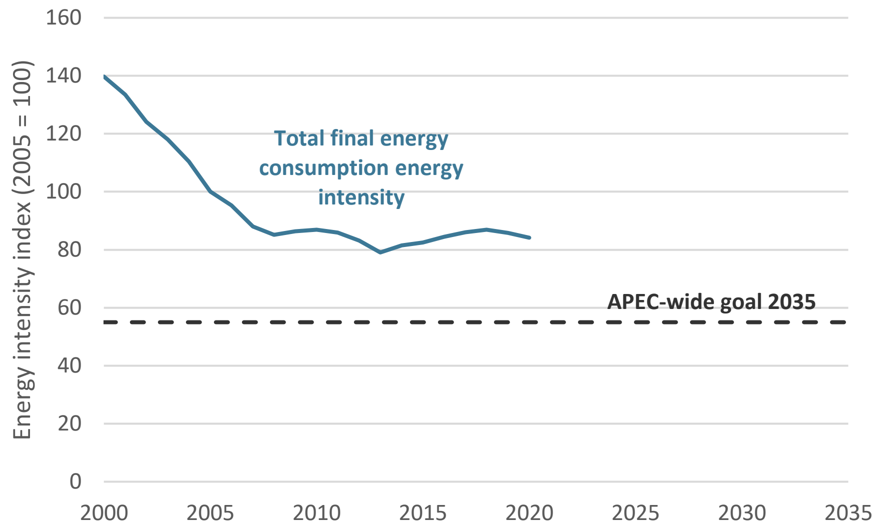
Energy intensity goal

In 2011, APEC member economies agreed to increase their target for reducing energy intensity by 45% by 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Russia is the most energy-intensive economy in the APEC region. However, improvements are taking place. In 2020, Russia's total final energy consumption (excluding non-energy) intensity improved by 16% compared to that in 2005.

Figure 11: Russia's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



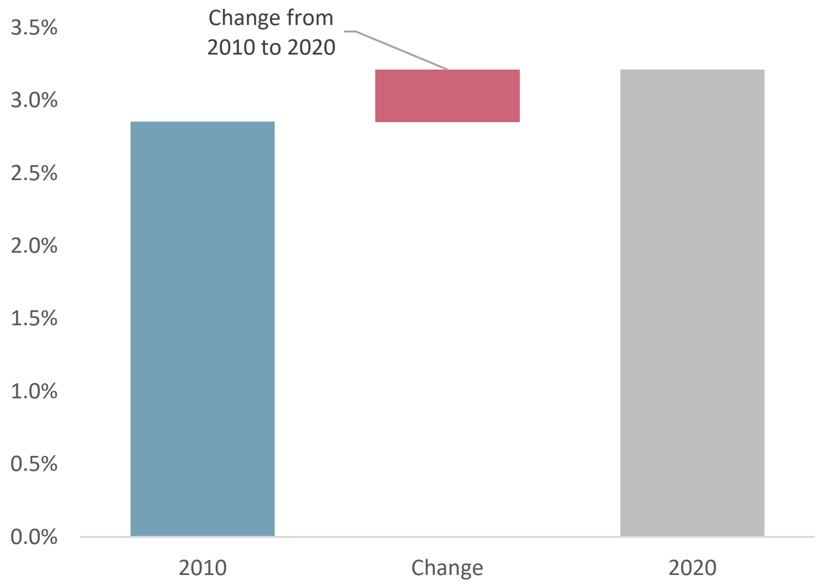
Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Russia's share of modern renewables to final energy consumption in 2010 was 2.9%. In 2020, this share increased to 3.2%, as shown in Figure 12. This slight increase highlights the complexities of expanding renewables in Russia.

Figure 12: Russia's modern renewable energy share, 2010 and 2020

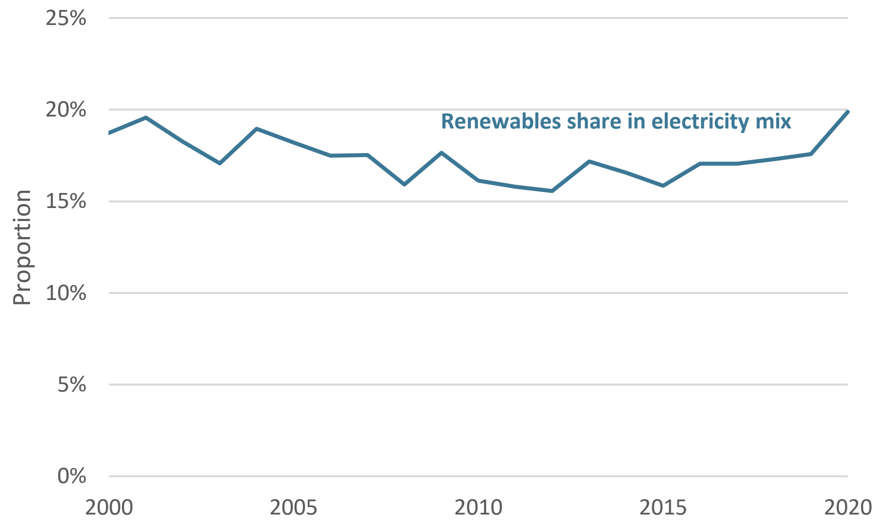


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

The share of electricity generated by renewable energy sources in 2000–2020 averaged 17–18%. Almost all electricity is generated by large hydropower plants (HPPs). In this regard, changes in the share of HPPs in some years are associated with low-water periods. The share of generation by solar and wind power plants does not exceed 1%.

Figure 13: Russia's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Export of energy resources	Russia's Energy Strategy 2035, adopted in 2020, assumes an increase in energy exports by 9–15% by 2024 compared to 2018	Ministry of Energy
LNG production	Planned increase on liquefaction capacity to 46–65 mtpa by 2024 and 80–140 mtpa by 2035 (2.4–3.4 times growth to 2018 level); development of x (or x mtpa) small-scale LNG plants	Ministry of Energy
LNG exports	The Russian government intends to ease restrictions on exports of LNG and allow new companies to export on their own, unlike exports of pipeline gas, where Gazprom is a monopoly	Ministry of Energy
Gas processing	Russia's Energy Strategy 2035 assumes the share of processed natural gas liquids (NGLs) will increase to 30% by 2024 and to 35% by 2030	Ministry of Energy
Hydrogen exports	Start hydrogen exports up to 0.2mtpa by 2024, 2–12 mtpa by 2035, 15–50 mtpa by 2050	The Russian Government
Oil production	Russia's Energy Strategy 2035 assumes that oil production by 2024 will remain at the current level of 11.6–11.7 million barrels per day, with a possible reduction to 10.2 by 2035	Ministry of Energy
Gas consumption in the transport sector	Russia's Energy Strategy 2035 assumes an increase of gas consumption in the transport sector to 2.7 bcm by 2024 and to 10–13 bcm by 2035	Ministry of Energy
Use of associated gas	Russia's Energy Strategy 2035 assumes the use of associated gas will increase to 90% by 2024 and 95% by 2035	Ministry of Energy
Own use in gas pipelines	Russia's Energy Strategy 2035 assumes a reduction of unit consumption of energy as own use in gas pipelines of 12% by 2024 and 17% by 2035, with respect to the 2018 level	Ministry of Energy
Thermal efficiency in the power sector	Russia's Energy Strategy 2035 assumes an increase of the thermal efficiency in the power sector to 43% by 2024 and 48% by 2035	Ministry of Energy
Share of regions with access to the economy gas transportation system	Russia's Energy Strategy 2035 assumes an increase in the share of regions with access to the economy gas transportation system to 75% by 2024 and 83% by 2035	Ministry of Energy
Russia's Energy Security Doctrine	A foreign policy challenge to economy energy security to step up international efforts to implement climate policy and accelerate the transition to a green economy	Ministry of Energy
Greenhouse gases emission level	Russia's NDC proposes reducing GHG emissions to 70% by 2030 from the 1990 baseline. The NDC level of emissions was approved by presidential decree in November 2020	Presidential Decree
Carbon Neutrality Commitment	After the approval of the low-carbon development strategy, the President of Russia announced that Russia will achieve carbon neutrality by 2060	The Russian Government

Limiting Greenhouse Gas Emissions	The Federal Law “On Limiting Greenhouse Gas Emissions” provides the introduction of a staged model for regulating such emissions. This model includes the introduction of mandatory carbon reporting, collected and summarised by the authorised government body. Subject to regulation will be the largest emitters of greenhouse gases with a mass equivalent of 150 000 tons of carbon dioxide per year or more for the period until January 1, 2024. Such companies will have to report on 1 January 2023. Those who produce 50 000 tons of carbon dioxide per year or more will be subject to regulation from 1 January 2024. They will have to submit reports on greenhouse gas emissions on 1 January 2025. The document also introduces the notion of a “greenhouse gas emission reduction target”. It will be set by the government on the scale of the Russian economy, taking into account the AFOLU and the need to ensure sustainable and balanced socioeconomic development of the economy. The law proposes the creation of a roster of greenhouse gas emissions. This roster will be the information system, which the authorised federal executive body will maintain.	Federal Law
Development of electric transport	The “Concept for the Development of Production and Use of Electric Vehicles in the Russian Federation until 2030” provides three scenarios for the development of electric transport until 2030. The target scenario proposes an increase in production of electric vehicles to 217 000 units (100 times) by 2030, an increase in the share of electric vehicles in the overall vehicle fleet to 15%, and an increase in the number of charging stations to over 14 000 units (eight times).	The Russian Government

Notable energy developments

Energy development	Details	Reference
Arctic LNG-2	The project includes the construction of three LNG trains, with a capacity of 6.6 mtpa of LNG each. The total LNG capacity of the three trains will be 19.8 mtpa. Arctic LNG is currently under construction. By the end of March 2021, the overall progress for Arctic LNG 2 is estimated to have reached 39%, the first train is roughly 53% completed. It is expected to reach full capacity by 2025.	Novatek
Gazprom LNG Portovaya	In September 2022 an LNG plant with a capacity of 1.5 million tons per year was put into operation near the Portovaya compressor station. The plant consists of two trains.	Gazprom
Increase in the capacity of oip pipeline system East Siberia Pacific Ocean	The capacity of the pipeline part of the ESPO oil pipeline system was increased by 4% in 2022. The capacity of the Kozmino oil port was increased from 36 to 43 million tons per year.	Transneft
Power of Siberia	Gas supplies began on December 2, 2019. Design capacity of 38 billion cubic metres of natural gas exports to China will be reached by 2025. At the end of 2022, the Kovykta gas-condensate field was connected to the gas pipeline system.	Gazprom
Power of Siberia 2	Gazprom continues surveys for the route of the new Power of Siberia-2 pipeline, which will make it possible to supply gas from the Yamal Peninsula fields to China via Mongolia with a planned export capacity of about 50 billion cubic metres per year. The feasibility study for the construction of the pipeline section that will pass through Mongolia, which is named “Soyuz Vostok”, was completed in January 2022.	Gazprom
Vostok Oil	At the end of 2020, Rosneft announced the start of the Vostok Oil megaproject. According to the plans, it is supposed to produce 30 million tons of oil by 2024 and deliver it by sea via the Northern Sea Route. This project is a challenge because it involves significant infrastructure development in the region of new development in a very short time frame.	Rosneft

Useful links

Ministry of Energy of the Russian Federation – http://minenergo.gov.ru/en

Ministry of Natural Resources and Environment of the Russian Federation – https://www.mnr.gov.ru/en/

Ministry of Economic Development of the Russian Federation – https://en.economy.gov.ru

Federal Statistics Service of the Russian Federation – https://eng.gks.ru

Ministry of Industry and Trade of the Russian Federation – https://minpromtorg.gov.ru/en/

Federal Customs Service – https://eng.customs.gov.ru

Federal Tariff Service – http://www.fstrf.ru/eng

AtomEnergoProm – http://atomenergoprom.ru/en/

Rosseti, Public Joint Stock Company (PJSC ROSSETI) – http://www.rosseti.ru/eng/

Association NP Market Council – http://www.en.np-sr.ru/index.htm

Gazprom – http://www.gazprom.com/

Rosneft – https://www.rosneft.com/

RusHydro – http://www.eng.rushydro.ru/

Transneft – http://www.en.transneft.ru/

Central Dispatching Department of Energy Sector – http://www.cdu.ru/en/

Singapore

Introduction

Singapore continued to make progress on the climate front in 2022, submitting a second update to its nationally determined contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC), strengthening its Long-Term Low Emissions Development Strategy (LEDS), and announcing a more stringent carbon pricing schedule (NCCS, 2022a, 2022b; EMA, 2022a).

However, these ambitious commitments have been overshadowed by the recent turmoil in energy markets. In late 2021, a confluence of increased gas consumption from recovering economic activity, severe weather events and a series of gas production outages disrupted supplies saw global market prices hit new highs. There were also upstream production issues in Indonesia's West Natuna gas field resulting in reduced output. Given these developments, Singapore announced temporary energy security measures to increase fuel supply availability, mitigate projected shortfalls in electricity supply and ensure the accessibility of the electricity supply at stable rates (EMA, 2021a). Amidst higher energy market uncertainty following the Russia-Ukrainian conflict, these measures have now become permanent. Singapore is also further bolstering security by empowering the EMA as a last-resort electric capacity builder and strengthening consumer protections with retail regulations and wholesale electricity market restrictions (EMA, 2022b). More detail on these policies and announcements can be found in the tables at the end of this chapter.

With the last historical year of data in the charts and tables of this report being 2020, much of the discussion will centre around the impact of the COVID-19 pandemic on the Singaporean economy and its energy system.

Table 1: Singapore macroeconomic data and energy reserves

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	728	Oil (billion barrels)	0
Population (million)	5.7	Gas (trillion cubic feet)	0
GDP (2017 USD billion PPP)	537	Coal (million tonnes)	0
GDP per capita (2017 USD PPP)	94 506	Uranium (kilotonnes U < USD 130/kgU)	0

Source: a DOS (2023); b World Bank (2022); c BP (2022); d UN (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

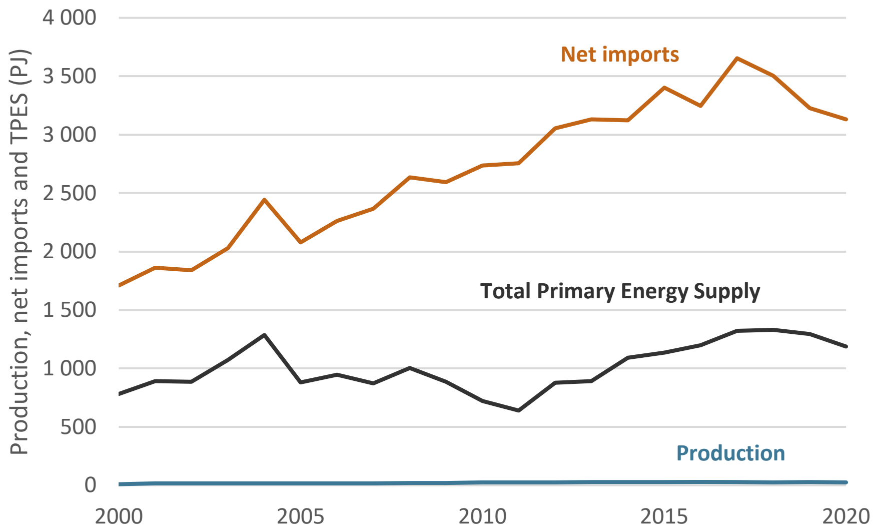
Lower economic activity stemming from the pandemic reduced Singapore's economic output by 4.1% to USD 537 billion (2017 USD purchasing power parity [PPP]) in 2020, and incomes by 3.8% to USD 98 412 (EGEDA, 2022).

Energy supply and consumption

Total primary energy supply

Without indigenous natural resources, Singapore relies on fossil fuel imports to meet its domestic demand and feed oil refineries. The economy's total energy imports were 6 897 petajoules (PJ) in 2020, their lowest level since 2014. Exports of refined products mostly land in the Asia-Pacific Economic Cooperation (APEC). Lower demand for the movement of goods and people reduced global demand for oil products, dragging Singapore's total energy exports down to 3 202 PJ, the lowest level since 2007 (EGEDA, 2022).

Figure 1: Singapore energy supply, production, and net imports (PJ), 2000 to 2020

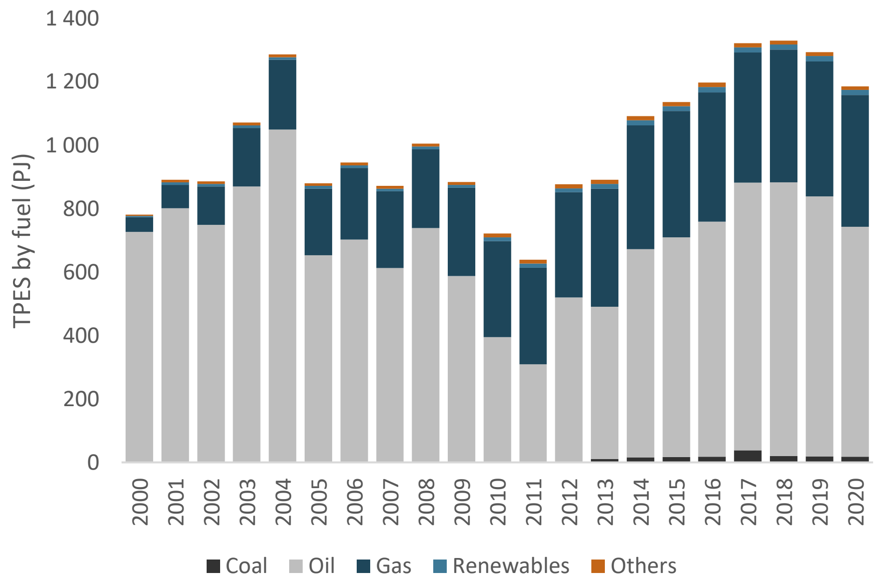


Source: EGEDA (2022)

Singapore plays an important role in international shipping and aviation. With global travel restrictions significantly curbing demand for aviation during the onset of COVID-19, Singapore put only 87 PJ of aviation fuel in aviation bunkers, a collapse of three-quarters from 2019 and its lowest level since 1992. With the movement of goods proving more resilient to the pandemic than the movement of people, shipping bunkers grew 3.5% to 1 815 PJ. Singapore's total primary energy supply (TPES) in 2020 dropped by 8.6% to 1 186 PJ, mostly due to lower oil imports.

Figure 2 depicts Singapore energy supply mix. Efforts to decrease reliance on oil imports have increased the role of natural gas, which is the dominant fuel source for Singapore's power generation, over the last two decades. Singapore is also pursuing solar targets and electricity trade to reduce its reliance on gas imports and is currently looking to reduce its reliance on fossil fuels as it forges a pathway for an energy transition. This transition will rely on the switches of natural gas, solar, regional power grids, and emerging low-carbon fuels, and will leverage energy efficiency to reduce energy supply requirements (EMA, 2022b).

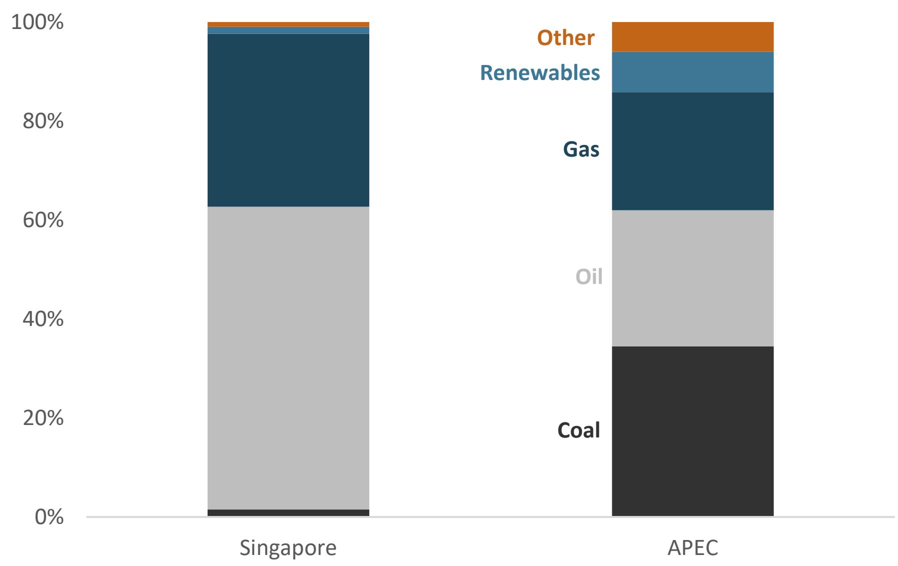
Figure 2: Singapore energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

Singapore began importing liquefied natural gas (LNG) in May 2013 to diversify its gas sources beyond piped imports from Malaysia and Indonesia. The economy's regasification and storage capabilities, along with its auxiliary services, have increased the share of gas in the energy mix and have enabled Singapore to diversify its gas supplies. Singapore has imported LNG from over 20 economies in the last five years, and LNG makes up nearly a third of gas imports (UN Comtrade, 2023; EMA, 2022d). With Indonesian gas pipeline imports set to decline in 2023, the role of LNG in Singapore's fuel mix will probably increase over the next decade (ESDM, 2019).

Figure 3: Energy supply mix – Singapore and APEC, 2020



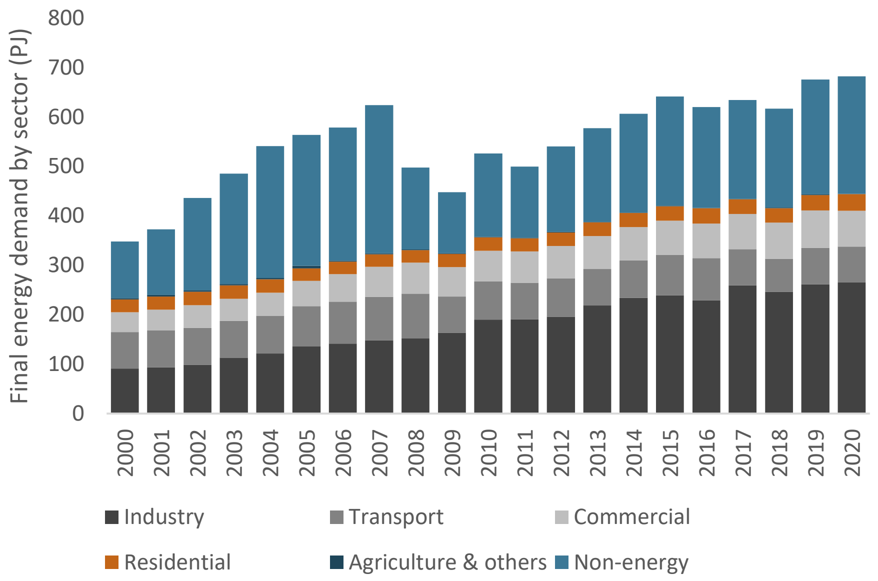
Source: EGEDA (2022)

In 2020, oil accounted for the largest share of TPES at approximately 61% (725 PJ), followed by natural gas at 35% (415 PJ), coal at 1.5% (19 PJ) and renewables at 1.4% (16 PJ) (EGEDA, 2022). Figure 3 presents a comparison of Singapore's TPES fuel shares with those of the entire APEC region. While fossil fuels play a more dominant role in Singapore than in APEC, comprising 98% of the fuel mix, Singapore sports a significantly lower share of coal in its mix. Another notable difference is the low proportion of renewables; land constraints, geological factors and geographical location are limiting factors for renewable adoption in Singapore. Hydro, wind, and tidal energies are not feasible, leaving solar PV systems and waste-to-energy (WtE) plants as Singapore's main renewable energy sources. Once thought to be infeasible, technological developments in advanced geothermal systems have opened up the possibility of geothermal application in. The feasibility of utilising these new technologies in Singapore is being studied (EMA, 2021b).

Total final consumption

Final energy consumption remained resilient during the pandemic's onset, rising by 1.0% in 2020 to 682 PJ, as industry, non-energy and residential sectors made up for declines in commercial and transport stemming from restrictions to contain the spread of COVID-19.

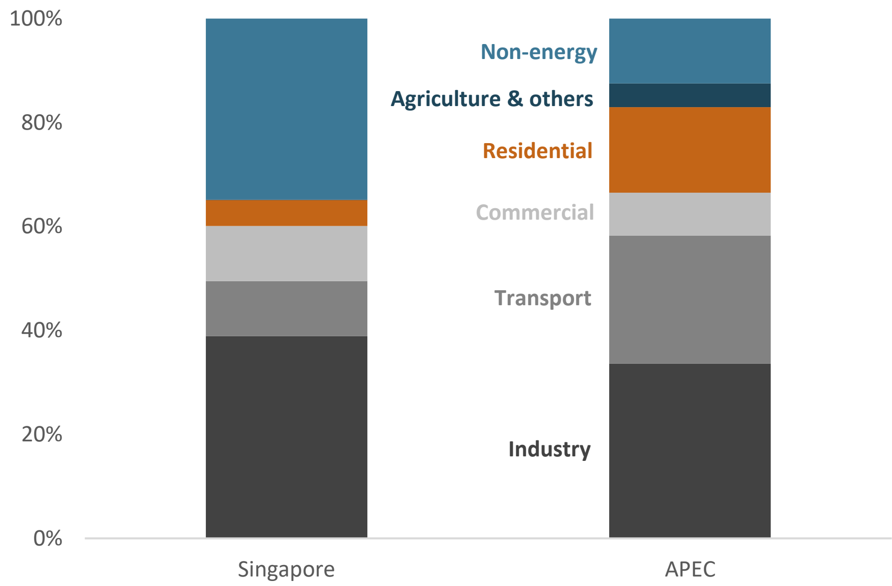
Figure 4: Singapore final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

The industry (39%) and non-energy (35%) sectors account for the largest share of total final consumption. Singapore's large-scale petrochemical industry drives much of this, using energy feedstocks to make and export chemicals. Singapore is the eighth-largest chemical exporter in the world (WTO, 2021). Compared to APEC, Singapore's sectoral shares are highly tilted towards non-energy use, reflecting the large role of the chemical sector. Buildings account for 16% of total final consumption, the transport sector 11%, and other sectors 0.1% (EGEDA, 2022). Being a small city-economy, Singapore's transport activity is lower than other economies, which results in its transport demand share being much lower than the APEC-wide share of 25%.

Figure 5: Final consumption by sector, Singapore and APEC, 2020

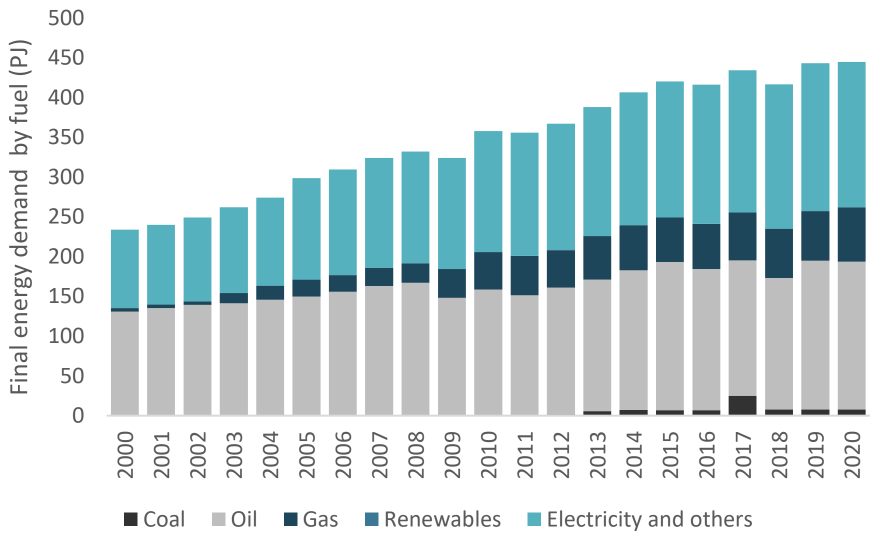


Source: EGEDA (2022)

Final energy demand

Singapore's final energy demand was 445 PJ in 2020, marking a 0.4% annual increase. Like total final consumption, final energy demand plateaued in recent years due to reduced export-oriented manufacturing output and moderate increases in energy efficiency.

Figure 6: Singapore final energy demand by fuel (PJ), 2000 to 2020

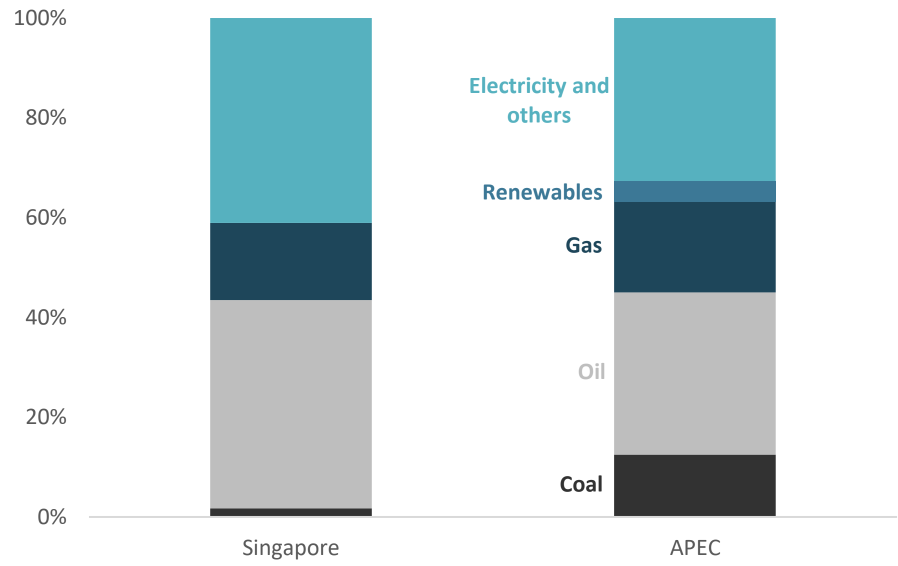


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

In 2020, fossil fuels constituted 59% of Singapore's energy demand, and electricity use accounted for the remainder. As shown in Figure 7, compared to APEC, Singapore derives its demand from a lower share of fossil fuels and renewables and a higher share of electricity. Oil made up a larger share of Singapore's demand structure than of APEC's, driven by non-energy feedstock use; this, too, reflects the significant role that the chemical sector plays in Singapore's economy and demand structure.

Figure 7: Final energy demand fuel share, Singapore and APEC, 2020



Source: EGEDA (2022)

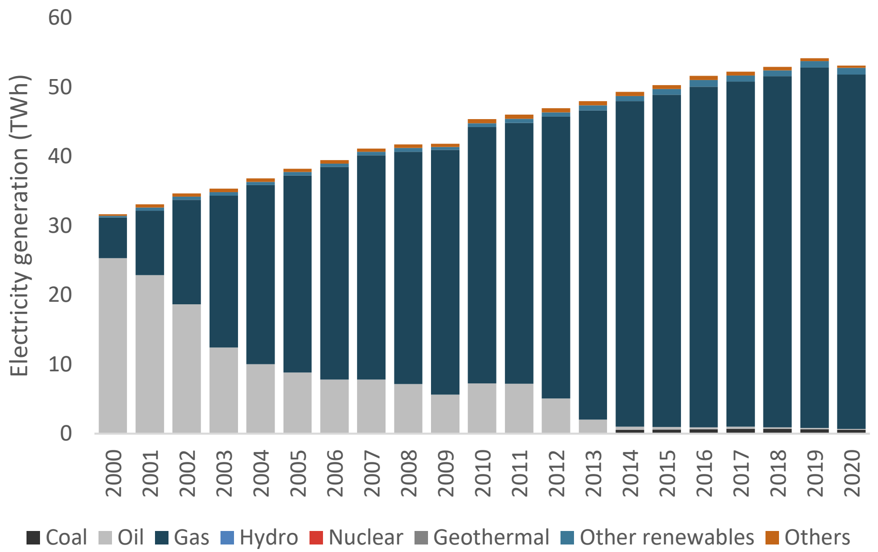
Transformation

Power sector

Singapore's electricity generation fell by 2.0% in 2020 to 53 080 gigawatt hours (GWh) due to lower use by both industry and commercial buildings (EGEDA, 2022). The peak demand for electricity saw a 0.4% annual increase and stood at 7 376 megawatts (MW) (EMA, 2022d).

Total licensed generation capacity fell to 12 025 MW in 2020, following the retirement of several steam turbines. In recent years, steam turbine plants have been displaced by the more efficient combined-cycle gas turbine (CCGT) power plants. Therefore, the share of CCGTs in the overall generation capacity increased from 46% (4 534 MW) in 2005 to 85% (10 491 MW) in 2020, while the share of steam turbine plants dropped from 48% (4 640 MW) in 2005 to 6.4% (764 MW) in 2020. Open-cycle gas turbine plants comprised 1.5% (180 MW) of the capacity in 2020, WtE plants for 2.1% (257 MW), and solar made up 2.8% (332 MW) (EMA, 2022d).

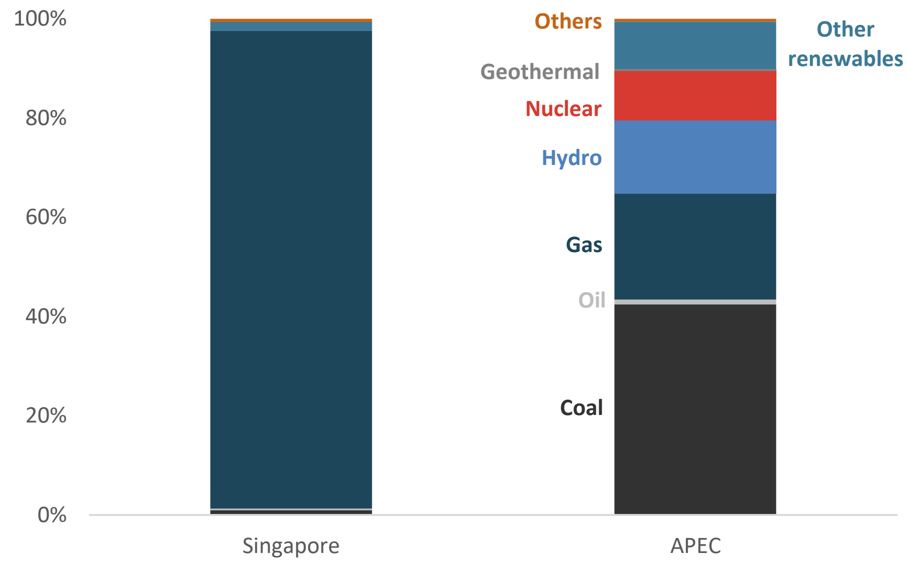
Figure 8: Singapore electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

Figures 8 and 9 illustrate how technology, markets and policy have altered Singapore's electricity mix over the past two decades. Oil-based generation fell from over 80% of the fuel mix in 2000 to 0.3% in 2020, while gas grew from under 20% to 96%. Coal and other fuels, including WtE and solar, constituted the remaining 3.4% of generation (EGEDA, 2022). Due to Singapore's limited natural resources, solar and WtE are the only viable forms of renewable energy generation in Singapore.

Figure 9: Electricity generation fuel share, Singapore and APEC, 2020



Source: EGEDA (2022)

Total grid-connected solar PV installed capacity in Singapore increased by 22% to 432 megawatt-peak (MWp) in 2020 after surpassing the economy's target of 350 MWp in 2019. Singapore has set two more targets, aiming to install 1.5 gigawatt-peak (GWp) of solar capacity by 2025 and 2.0 GWp by 2030 (Singapore Green Plan, 2021). Singapore is encouraging deployment with its rooftop PV SolarNova programme and the deployment of floating PV. As of February 2022, the Housing Development Board (HDB) has committed to installing 380 MWp on 8 400 housing blocks and has already installed modules on 2 700 blocks. HDB's solar target is for 540 MWp of installed capacity by 2030 (HDB, 2022). A 60 MWp floating solar PV system in the Tengeh Reservoir was deployed in 2021 (PUB, 2022).

Refining

Singapore is one of the leading oil refining hubs in the world. In 2020, refinery activity fell by a sixth as pandemic restrictions across the world reduced the movement of people and in turn demand for oil products.

In 2020, Shell announced plans to reduce crude processing capacity at its Pulau Bukom refinery by half as it aims to reduce the emissions of its energy product stream (Argus Media, 2022). However, following tight global markets, Shell cancelled plans to close the refinery's lubricant unit in July 2022, which could signal a change in plans to reduce Singapore refinery capacity.

Energy transition

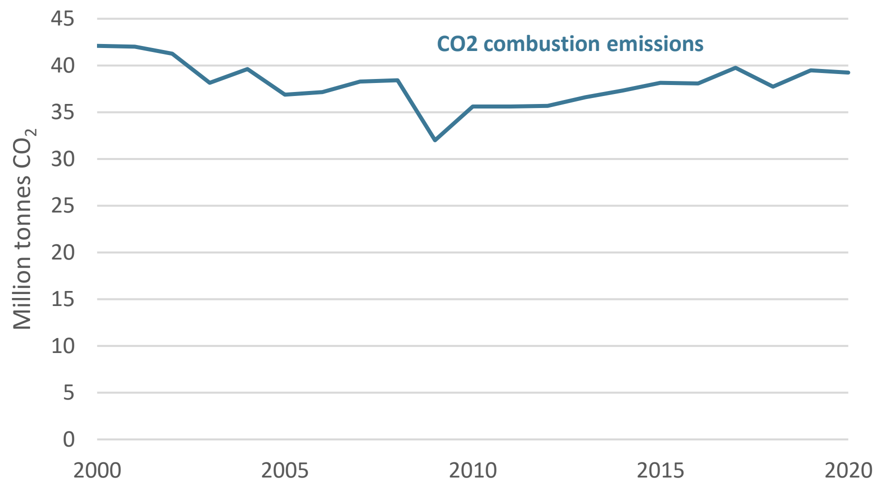
Singapore submitted its second update to its NDC to the UNFCCC in November 2022, wherein it commits to reducing emissions to around 60 $MtCO_2e$ in 2030 after peaking emissions earlier and strengthened its LEDS by committing to achieving net-zero by 2050 (NCCS, 2022a). Singapore will increase its carbon tax from SGD 5 per tonne now to SGD 25 in 2024, SGD 45 in 2026 and between SGD 50 and 80 by 2033 (NCCS, 2022b). Singapore is hoping to leverage higher solar penetration (1.5 GWp in 2025 and 2 GWp in 2030) and interconnectivity with neighbouring economies to help achieve its climate ambitions. In addition, it also launched a hydrogen strategy (EMA, 2022a). The National Hydrogen Strategy sets out Singapore's plans to develop hydrogen as a major decarbonisation pathway for its power and industry sectors.

Emissions

The expert group on energy data and analysis (EGEDA) falls under the umbrella of APEC's Energy Working Group (EWG). In addition to energy data compiled by EGEDA, CO_2 emissions from combustion activities in the energy sector are recorded. These emissions are a subset of total greenhouse gas (GHG) emissions that are considered in the context of climate change, such as under the UNFCCC.

For Singapore, CO_2 combustion emissions have maintained a high plateau for the past several years, though they fell slightly in 2020. This fall was partly due to a fall in economic activity that was brought on by the initial stages of the COVID-19 pandemic.

Figure 10: Singapore CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Energy security, particularly the security of natural gas supply and its resulting impact on electricity reliability, has become an increasingly prominent issue over the past two years. Disruptions to pipeline gas imports in late 2021 created the possibility that Singapore's gencos would lack the gas to fulfil their contracts: wholesale electricity prices became elevated and volatile; retailer bankruptcy increased; and some consumers were exposed to wholesale prices. The government implemented temporary energy security measures to increase the fuel supply availability. This included the establishment of a standby LNG facility (SLF) by the EMA for gencos to draw upon if they were short of fuel, requiring gencos to contract sufficient fuel to at least meet the demands of customers of their retail arms, and granting the right of first refusal to other Singaporean gencos or the EMA before excess gas could be diverted or sold on the global market (EMA, 2021a). EMA also worked with retailers to provide long-term electricity contracts and provide a monthly rate tied to the monthly spot LNG import cost for consumers that wanted to avoid exposure to wholesale electricity prices (EMA, 2021a). EMA's actions illustrate how governments can play an important role in the short-term bolstering of energy security during periods of significant supply disruption and market upheaval.

However, in 2022, the Russia-Ukraine war led to a further tightening of energy supplies and higher uncertainty in the security of energy suppliers across the APEC region. In response, Singapore identified three main risks inherent to its energy market structure: the risks of energy supply disruptions and price shocks; the risk of insufficient generation capacity; and the risk of market failures stemming from market participants being unequipped to deal with volatile market conditions. To address these shortcomings, Singapore will: institutionalise the SLF, empower the EMA as a last-resort generation capacity builder, and strengthen consumer protections with retail regulations and wholesale market restrictions (EMA, 2022b).

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective - to improve energy intensity and double the share of modern renewables.

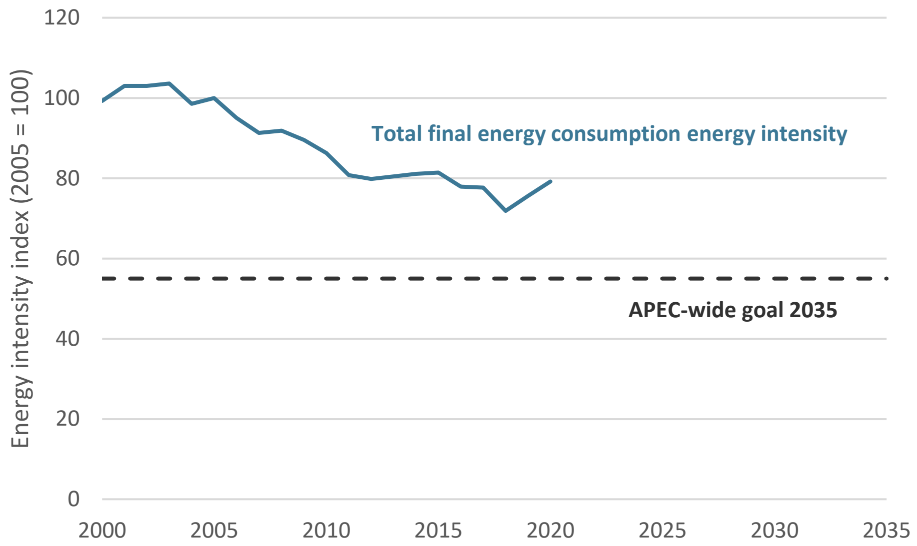
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

In 2009, Singapore targeted a 35% reduction in energy intensity by 2035 and, in 2015, issued its first NDC, pledging a 36% intensity reduction below 2005 levels by 2030 (NCCS, 2018a). Energy intensity fell as low as 28% below 2005 levels but rose to 21% below in 2020 due to the pandemic impacting Singapore's GDP at a higher level than energy demand (Figure 11).

Figure 11: Singapore total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



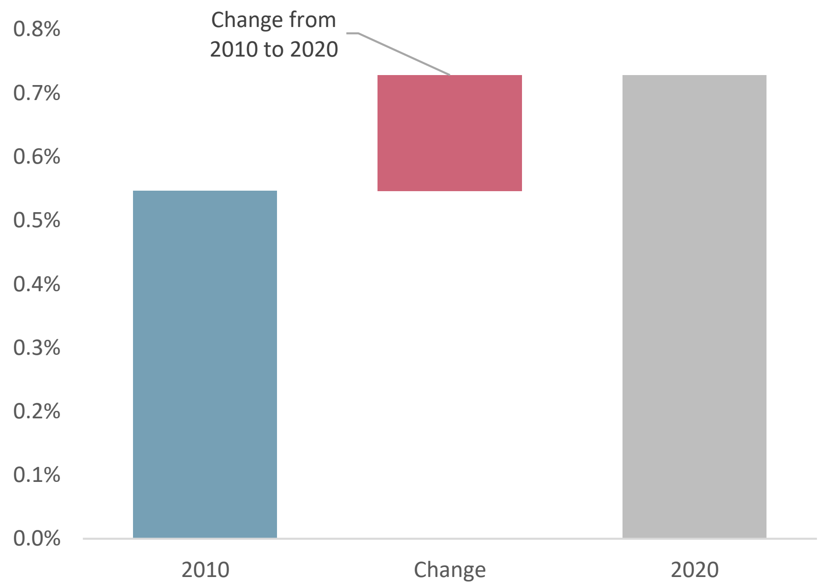
Source: EGEDA (2022)

Singapore is committed to improving its energy efficiency. Recent measures to meet this commitment include electrifying cooking and heating, reducing space cooling needs and space cooling efficiency, phasing out internal combustion engine (ICE) vehicles, improving manufacturing efficiency through digitalisation, researching improvements in industrial and manufacturing efficiency through research grants, and improving logistics to optimise the movement of goods and people and thus minimise energy usage. The establishment of a more stringent carbon price schedule will also encourage more investment in energy efficiency. Together, these policies can accelerate energy intensity reductions and further help APEC achieve its aspirational targets.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Figure 12: Singapore modern renewable energy share, 2010 and 2020

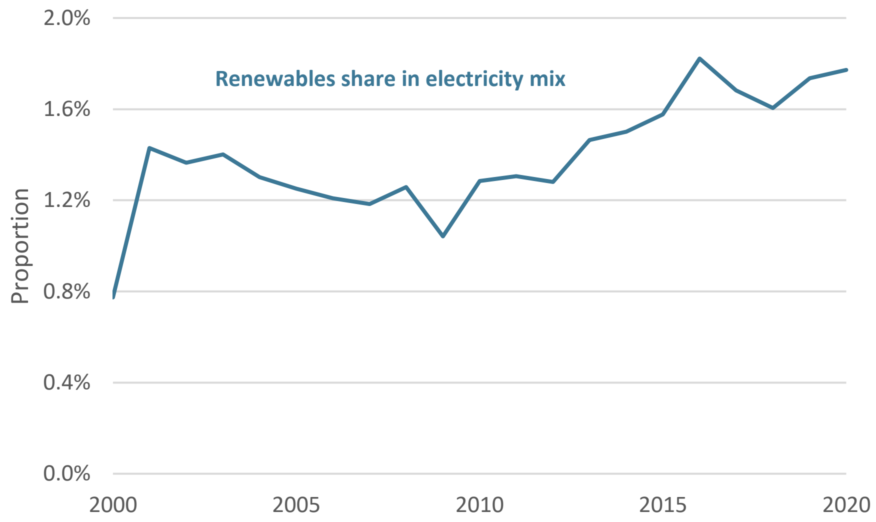


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Due to the prevalence of fossil fuels in its supply mix, Singapore started with a very low modern renewable energy share of 0.47% in 2010 (Figure 12). By 2020, this share increased to 0.73%. Singapore’s low renewable energy share is due largely to the small size of the city-economy and its dense urban landscape, which challenge the adoption of conventional variable wind and solar renewables at an island-wide scale. Renewables only accounted for 1.8% of the electricity mix in 2020 (Figure 12). However, solar targets, including both economy-wide capacity targets and a housing unit-target by the HDB, have resulted in a steady increase in renewable energy use over the past decade. Achieving its solar capacity targets throughout the current decade should enable Singapore to further increase its renewable generation share as well as its modern renewable energy share.

Figure 13: Singapore renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
UNFCCC second NDC update	Singapore aims to reduce emissions to around 60 $MtCO_2e$ in 2030 after peaking emissions earlier. Now including NF3 as a GHG.	National Climate Change Secretariat
LEDS update	Singapore strengthened its Low Emissions Development Strategy (LEDS) to a commitment to achieve net-zero emissions by 2050.	National Climate Change Secretariat
Singapore Carbon Tax	Carbon tax of SGD 5 per tCO_2e in 2019 will cover refining, LNG, power, and industrial facilities that emit 25,000 tCO_2e/yr. The price will increase to SGD 25 per tCO_2e in 2024 and SGD 45 per tCO_2e in 2026, with the aim of reaching SGD 50 to 80 per tCO_2e by 2030.	National Climate Change Secretariat
Singapore Economy-wide Solar and storage targets	Solar targets: 1.5 GWp by 2025, 2 GWp by 2030; storage target: 200 MW of energy storage systems deployed beyond 2025.	Singapore Green Plan
SolarNova Programme	Targeting 540 MWp of solar on HDB housing blocks by 2030.	Housing Development Board
Enhanced early turnover scheme (ETS)	Provides an incentive for to deregister older, more polluting vehicles and replace them with newer, less emitting models. The incentive comes in the form of a discounted certificate of entitlement on the registration of the new vehicle.	Land Transport Authority
Enhanced Vehicle Emissions Scheme	Incentive scheme that provides a rebate (up to SGD 25 000) or charge (up to SGD 25 000) to the MRSP of new vehicles based on their pollutant performance. Singapore is extending programme to 2025 with tighter pollutant thresholds emerging in 2024.	National Environment Agency
Commercial Vehicle Emissions Scheme	Incentive scheme that provides a rebate (up to SGD 30 000 until 2023, SGD 15 000 thereafter) or charge (up to SGD 10 000 until 2023, falling to SGD 5 000 for petrol vehicles and increasing to SGD 15 000 for diesel vehicles thereafter) to the MRSP of commercial vehicles.	National Environment Agency
Early EV Adoption Incentive	45% rebate on Additional Registration Fee of EV sales (capped at SGD 20,000) from 2021 - 2023)	Land Transport Authority
Vehicle Quota System	By maintaining a growth rate of zero for vehicle registrations since 2018, the VQS effectively caps vehicle ownership in Singapore.	Land Transport Authority

Cleaner-energy vehicles	Enroute to phasing out ICE vehicles by 2040, ceasing registrations for diesel cars and taxis by 2025 and mandating all new registrations for cars and taxis be clean-energy models from 2030. Furthermore, establishing 8 EV-ready towns with chargers at all HDB carparks by 2025 and targeting 60 000 charging points by 2030.	Singapore Green Plan
Green Building Masterplans	Several initiatives aimed at increasing energy efficiency and reduce energy demand in buildings.	Building Construction Authority
Mandatory Energy Labelling Scheme	Household appliances that are sold in Singapore must display an energy label, which helps consumers compare the energy efficiency of different appliances and make informed purchasing decisions.	National Environment Agency
Minimum Energy Performance Standards	Raises the average energy efficiency of household appliances, encouraging manufacturers to provide more energy-efficient appliances as technology improves.	National Environment Agency
Pre-emptive Measures to Enhance Singapore's Energy Security and Resilience	Establishes stand-by fuel power generating facilities to run if the tight global natural gas market facilitates a natural gas supply disruption that constraints electricity supply; grants the first right of refusal of excess natural gas power supply to either the EMA or other power generators.	Energy Market Authority
Guardrails to Enhance the Competitive Market Structure of the Power Sector - Generation Capacity	EMA will conduct a competitive tender, years ahead of projected generation requirements, awarding the most competitive proposal with a license to build, own and operate the new capacity, should there be a need for new capacity. All new capacity will be coordinated within this process to avoid risks of over- and under-capacity. If private sector interest is insufficient, the EMA will build the required capacity.	Energy Market Authority
Guardrails to Enhance the Competitive Market Structure of the Power Sector - Retail market	Stricter financial qualifying criteria and the imposition of higher capital / hedging requirements on retailers to increase resiliency to market volatility. Additional protections for consumers if retailers prematurely terminate contracts. Tightening the eligibility criteria for wholesale price exposure, so that only consumers who are equipped to deal with the risks are eligible.	Energy Market Authority
Green building, towns and districts targets	By 2030, targeting a 15% reduction in energy consumption in existing HDB towns; aiming for 80% of Singapore's buildings to be green and 80% of new-builds to be super low energy users; and targeting an 80% improvement in energy efficiency (relative to 2005) of best-in-class green buildings by 2030.	Singapore Green Plan
Guardrail to Enhance the Competitive Market Structure – Temporary Price Cap (TPC)	EMA introduced a TPC mechanism to mitigate extreme price volatility in the Singapore Wholesale Electricity Market on 1 July 2023.	Energy Market Authority

Notable energy developments

Energy development	Details	Reference
Neste biorefinery expansion	Increase capacity 1.4 Mtpa to 4.5 Mtpa by 2023	Neste
Pipeline gas supply disruptions and higher LNG prices encourage fuel switching in the power sector	In the face of pipeline gas disruptions from Indonesia and higher LNG spot prices, oil product use by electricity generators increased.	Energy Market Authority
Renewable electricity imports from Malaysia begin and EMA Issues Second Request for Proposal for Electricity Imports	As part of EMA's plans to import up to 4 gigawatts (GW) of electricity by 2035 to decarbonise the energy sector, Singapore begin importing 100 MW from Lao PDR through Thailand and Malaysia in 2022 and issued two RFPs to import low-carbon electricity.	Energy Market Authority
Singapore launches National Hydrogen Strategy	The National Hydrogen Strategy provides a road map of how hydrogen can support the decarbonisation efforts and the next steps for a hydrogen future.	Energy Market Authority
Singapore's first Energy Storage System (ESS) deployed at PSA Pasir Panjang Terminal	This ESS is part of the Smart Grid Management System (SGMS) which has the potential to improve the energy efficiency of port operations by 2.5% and reduce the port's carbon footprint .	Energy Market Authority
EMA seeking more LNG term importers	A tight global natural gas market sending natural gas prices to record highs is prompting some retailers to cease operations and variable consumers to pay a higher price for electricity. The tight market has prompted the EMA to establish stand-by power generating units as a back-stop to the wholesale electricity market in the event of supply disruptions.	Energy Market Authority
Singapore Looks To Develop and Deploy Low-Carbon Technological Solutions	Two recently released feasibility studies on low-carbon hydrogen and CCUS can help Singapore transition to a low-carbon future. The findings will inform the deployment of funds (including the SGD 49 million for the Low Carbon Energy Research Funding Initiative) to test-bed technologies, and development of partnership with other economies as fuel and technology suppliers, such as the current low-emission MOU with Australia and the low-carbon hydrogen MOU with Chile.	Energy Market Authority
Exploring Singapore's Geothermal Potential	EMA is exploring the feasibility of new technologies (e.g. Enhanced/Advanced Geothermal Systems) for Singapore. In 2022, it issued a Request for Information (RFI) to facilitate a geophysical investigation project to assess the geothermal energy potential across Singapore.	Energy Market Authority

Useful links

Building and Construction Authority – https://www1.bca.gov.sg/

Department of Statistics Singapore – https://www.singstat.gov.sg

Economic Development Board – https://www.edb.gov.sg/

Energy Efficiency Programme Office – http://www.e2singapore.gov.sg/

Energy Market Authority – https://www.ema.gov.sg

Housing & Development Board – https://www.hdb.gov.sg/cs/infoweb/homepage

Land Transport Authority – https://www.lta.gov.sg

Ministry of National Development – https://www.mnd.gov.sg/

Ministry of the Environment and Water Resources – https://www.mewr.gov.sg

Ministry of Trade and Industry – https://www.mti.gov.sg

National Environment Agency – https://www.nea.gov.sg

National Climate Change Secretariat – https://www.nccs.gov.sg/

Public Utilities Board – https://www.pub.gov.sg/

Singapore Department of Statistics – https://www.singstat.gov.sg/

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Chinese Taipei

Introduction

Chinese Taipei is an archipelago with GDP reaching 1 250 billion (2017 USD purchasing power parity (PPP)) in 2020, a 4% increase from the 2019 level. The population in 2020 stayed at the 24 million level but a decreasing trend in population is expected to be observed in the coming decades. In addition, Chinese Taipei's GDP per capita was still one of the highest in the APEC region, at USD 53 130 PPP, in 2020.

Chinese Taipei has tiny energy reserves. According to data from The World Factbook of CIA, Chinese Taipei holds only 1 million tonnes of proven coal reserves, 2.4 million barrels of proven oil reserves, and 6.2 billion cubic metres of proven gas reserves (CIA, 2022). Although there are some minor proportions of crude oil and natural gas production, the economy relies heavily on energy imports.

In March 2022, Chinese Taipei proposed its guideline of the "2050 Net-zero emission" target. The previous GHG net emissions target was 50% of the 2005 level by 2050; the new and ambitious GHG net emissions target was zero by 2050. Twelve key strategies were proposed to achieve this target, including wind, solar PV, hydrogen, innovative energy, storage, CCUS, carbon-free and electric vehicles, etc. (NDC, 2022).

In December 2022, under the "2050 Net-zero emission" target, Chinese Taipei further announced the 2030 milestones for the 12 key strategies. For example, the solar PV and offshore wind installed capacity are expected to reach 31GW and 13 GW in 2030, and the installed capacity of hydrogen and ammonia co-firing power plants is expected to reach 891 GW in 2030. If all the milestones are achieved, the net emission reduction in 2030 may be 24% lower than the 2005 level. (NDC, 2022)

A higher penetration rate of intermittent renewable energy, extreme climate events, and several outage incidents that in the last two years, led Taipower to announce a 10-year plan to reinforce the resilience of the power grid system (Taipower, 2022). This plan indicates that Chinese Taipei's power grid will transit from an efficient, centralised grid structure to a more resilient, decentralised grid design.

Table 1: Chinese Taipei's macroeconomic data and energy reserves

Key data [a]		Energy reserves [b]	
Area (million km^2)	36 200	Oil (million barrels)	2.4
Population (million)	24	Gas (billion cubic metres)	6.2
GDP (2017 USD billion PPP)	1 250	Coal (million tonnes)	1
GDP per capita (2017 USD PPP)	53 130	Uranium (kilotonnes U < USD 130/kgU)	--

Source: a IMF (2022); b CIA (2022)

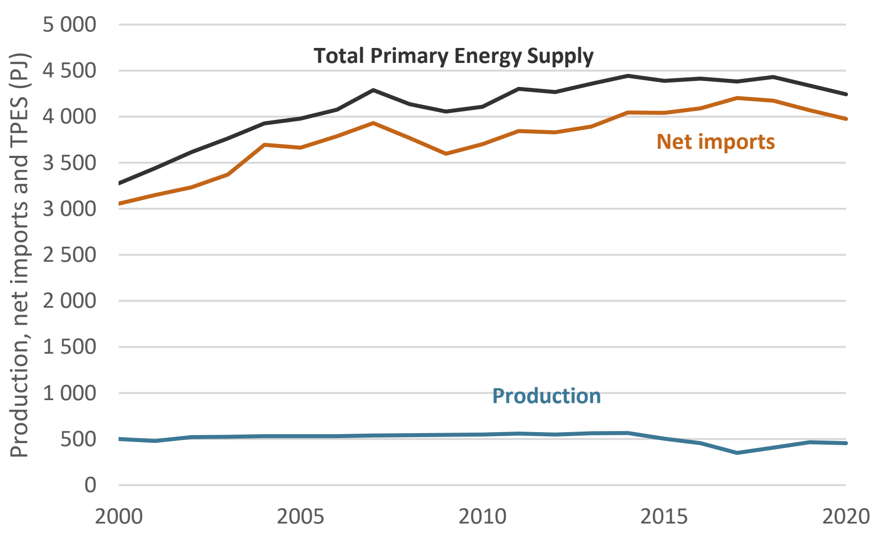
Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

Energy supply and consumption

Total primary energy supply

The total primary energy supply (TPES) in Chinese Taipei dropped 2.2% to 4 244PJ in 2020 (Figure 1). The decline can be attributed to the significant decreases in oil (-3%) and coal (-6%), which comprised 36% and 34% of TPES in 2020, respectively. On the other hand, the gas in TPES increased by 9% but could not offset the declining trend for its-(19%) share of TPES in 2020. The decline resulted in a slower compound annual growth from 2000 to 2020 (1.3%).

Figure 1: Chinese Taipei's energy supply, production, and net imports (PJ), 2000 to 2020

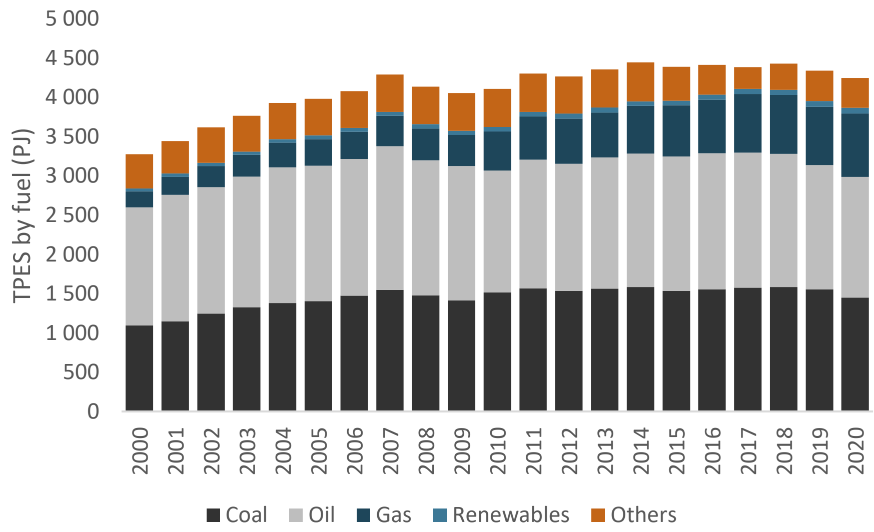


Source: EGEDA (2022)

Chinese Taipei is heavily dependent on foreign energy supplies. In 2020, net imports accounted for more than 90% of TPES, despite the 2.3% drop from the 2019 level (Figure 1).

Oil, including crude oil and petroleum products, accounted for the largest share of net imports (42%). However, oil import and export values sharply fell by 12% and 35% in 2020, respectively (due to the economic shocks brought by the pandemic). Coal is exclusively imported, accounting for 37% of Chinese Taipei's net imports in 2020. In 2020, coal and gas import volumes were 6% lower and 7% higher, respectively. Chinese Taipei has been one of the top LNG importers in the world for many years (GIIGNL, 2022).

Figure 2: Chinese Taipei's energy supply by fuel (PJ), 2000 to 2020

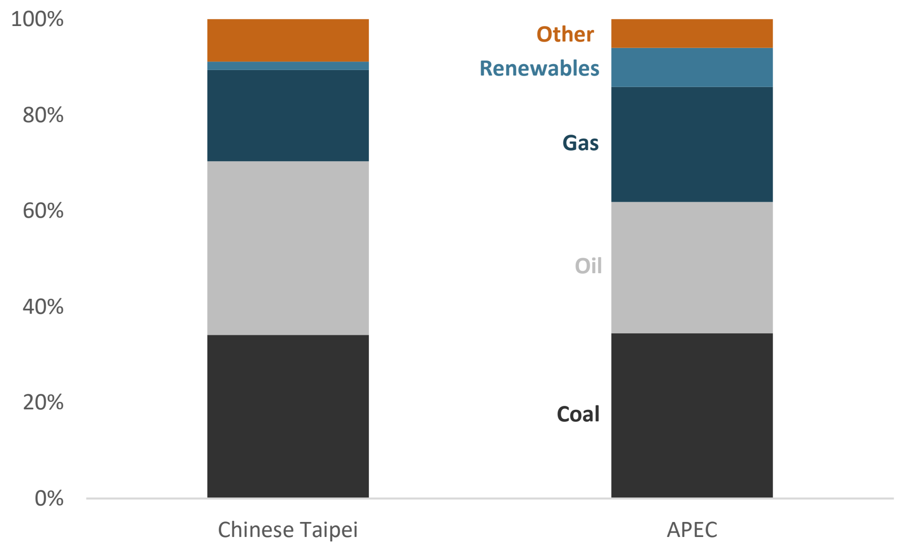


Source: EGEDA (2022)

Oil and coal account for most of Chinese Taipei's energy supply, with a total of 2 985 PJ (70% of TPES) in 2020. Coal was mainly used for power generation, and the oil supply was mainly used as a feedstock for the economy's fuel refinery. Gas supply has consistently grown for the last two decades, and it increased by 9% to 808 PJ in 2020 (Figure 2).

To achieve the energy transition target, Chinese Taipei has been actively promoting renewable energy in recent years. Although there is an increasing trend in renewables, renewables in TPES dropped by 0.7% to 74 PJ in 2020, mainly caused by a significant decrease in hydro-power.

Figure 3: Energy supply mix – Chinese Taipei and APEC, 2020

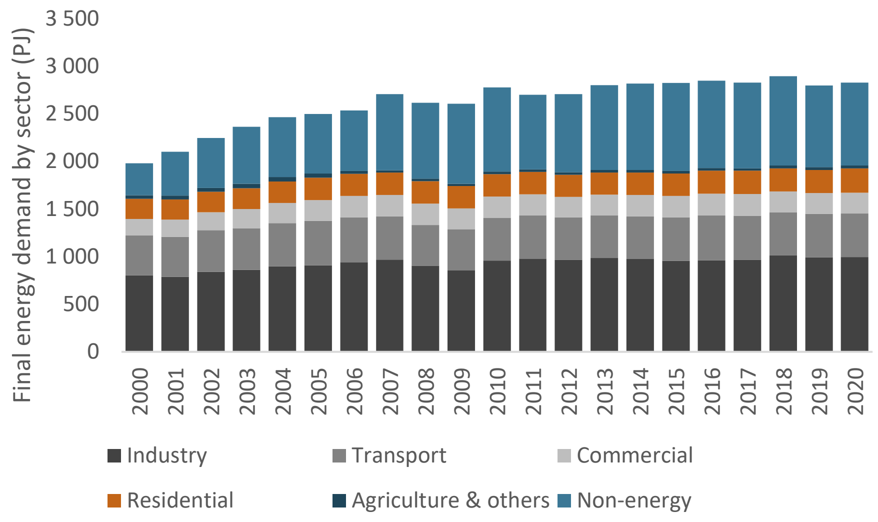


Source: EGEDA (2022)

Total final consumption

Total final consumption (non-energy included) in Chinese Taipei in 2020 was 2 825 PJ, which was 1.1% higher than the 2019 level (Figure 4). The increase can be attributed to the increase in demand by the residential and non-energy sectors in 2020. The former reached its highest recorded point in the past 20 years, while the latter was still lower than the 2018 level.

Figure 4: Chinese Taipei's final consumption by sector (PJ), 2000 to 2020

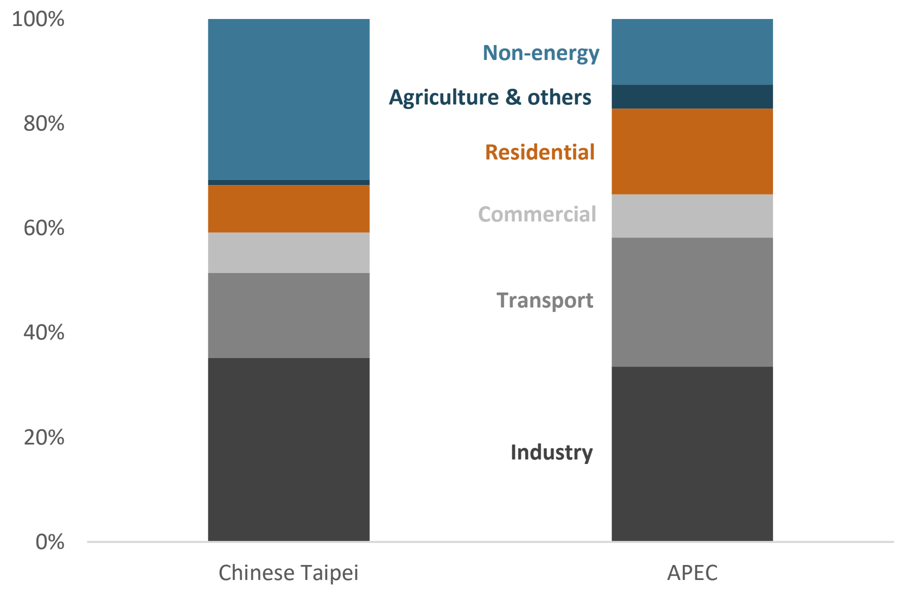


Source: EGEDA (2022)

Although the industrial sector increased by only 0.1% in 2020, it remained the largest energy-consuming sector in Chinese Taipei, with a 35% share in TFC in 2020. It is worth noting that the machinery sector (mainly comprising electrical and electronic machinery), the second-largest industry subsector, increased significantly by 6.5% in 2020 and offset the decreases from other subsectors due to the pandemic. In 2020, Chinese Taipei's transport sector slightly increased by 0.1% to 460 PJ and accounted for a 16% share of TFC.

In 2020, the share of the non-energy sector in TFC in Chinese Taipei remained greater than the whole APEC economy. This reflects the extensive use of petroleum products as feedstock for the economy's refining and petrochemical industry. In contrast, except for the industry sector, the shares of the other sectors (transportation, buildings, and agriculture and others) were all less than the APEC region (Figure 5).

Figure 5: Final consumption by sector, Chinese Taipei and APEC, 2020



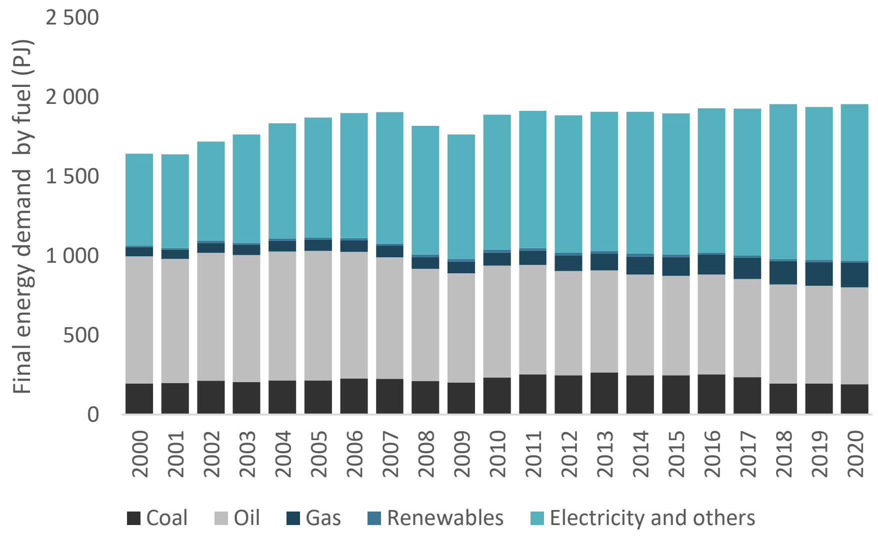
Source: EGEDA (2022)

Final energy demand

Total final energy consumption (TFEC) (non-energy excluded) in Chinese Taipei in 2020 was 1 956 PJ, slightly higher than the 2019 level. Increases were in gas, renewables, and electricity and others, whereas coal and oil both declined (Figure 6).

From 2010 to 2020, the compound annual growth rate (CAGR) of TFEC was 0.3%. Although the CAGR of coal (-1.9%), oil (-1.5%) and renewables (-3.5%) were all negative, these falls were offset by the positive CAGR of gas (6.6%) and electricity (1.5%). The strong growth trend in gas was mainly due to contributions from the industrial sector, while the moderate growth trend in electricity and others resulted from the industrial and residential sectors.

Figure 6: Chinese Taipei's final energy demand by fuel (PJ), 2000 to 2020

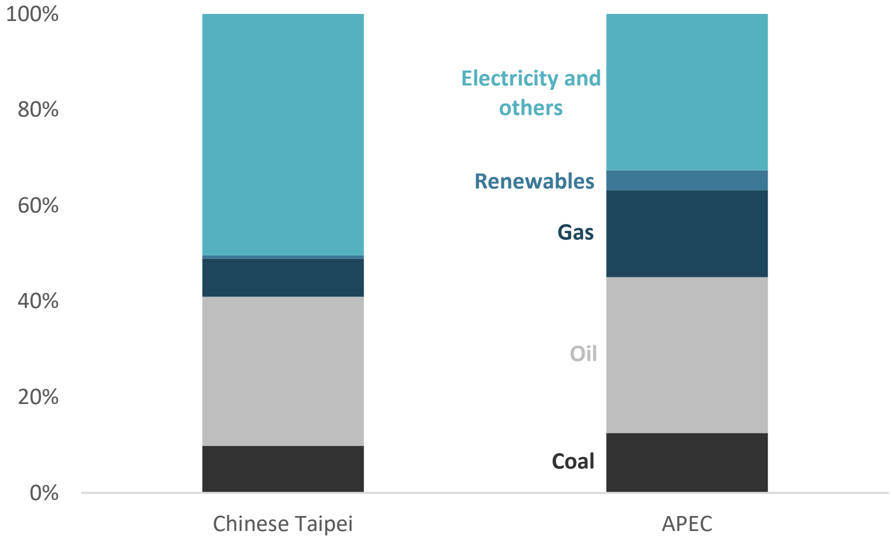


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

In 2020, electricity and others accounted for almost half of TFEC (50%) in Chinese Taipei, greater than most APEC economies except for Hong Kong, China. The relatively high share of electricity and others in TFEC was mainly due to the usage of the industry and building sectors. The share of oil in TFEC was 31%, which was slightly less than the whole APEC economy. The share of oil in TFEC was mainly driven by the transport sector (75%), and it is expected to decrease with the rise of EVs (Figure 7).

Figure 7: Final energy demand fuel share, Chinese Taipei and APEC, 2020



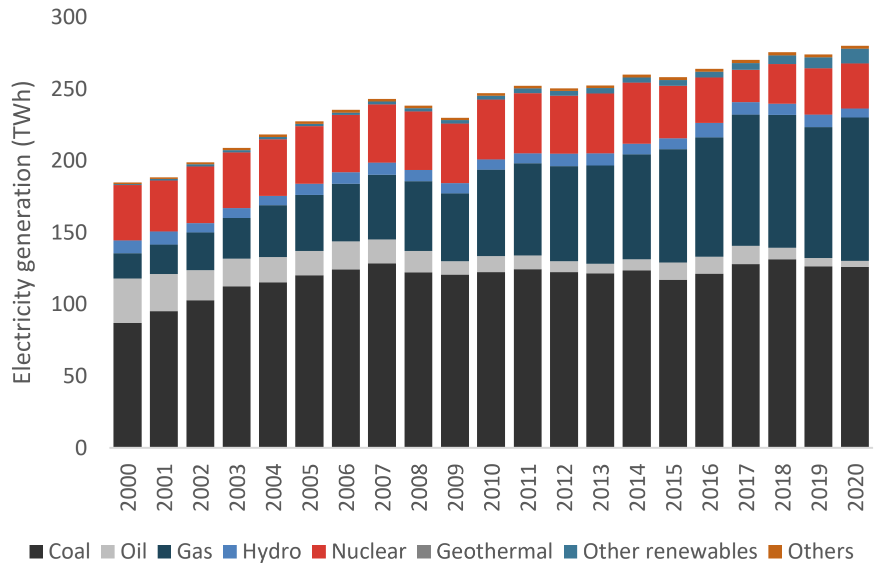
Source: EGEDA (2022)

Transformation

Power sector

Chinese Taipei's electricity generation was 280 TWh in 2020, 2.2% higher than in 2019 (Figure 8). The increase mainly came from the residential and industrial sectors in 2020. The electricity generation mix in Chinese Taipei was dominated by fossil fuel power plants (coal, gas, and oil), with a share of more than 82% in 2020. Among fossil fuel power plants, coal accounted for the largest share, accounting for 45% of electricity generation, followed by gas (36%) and then oil (2%) in 2020. From 2010 to 2020, the CAGR of the electricity generated by oil (-8.8%) and nuclear (-2.8%) was negative, while electricity generated by coal (0.3%), gas (5.2%), and renewables and others (11%), was positive. It is worth noting that the water shortage resulted in a significant drop in hydro-power by 29% in 2020. According to the CAGR of electricity generation, Chinese Taipei has transitioned to more gas and renewables and reduced the electricity generated by oil and nuclear during the past decade.

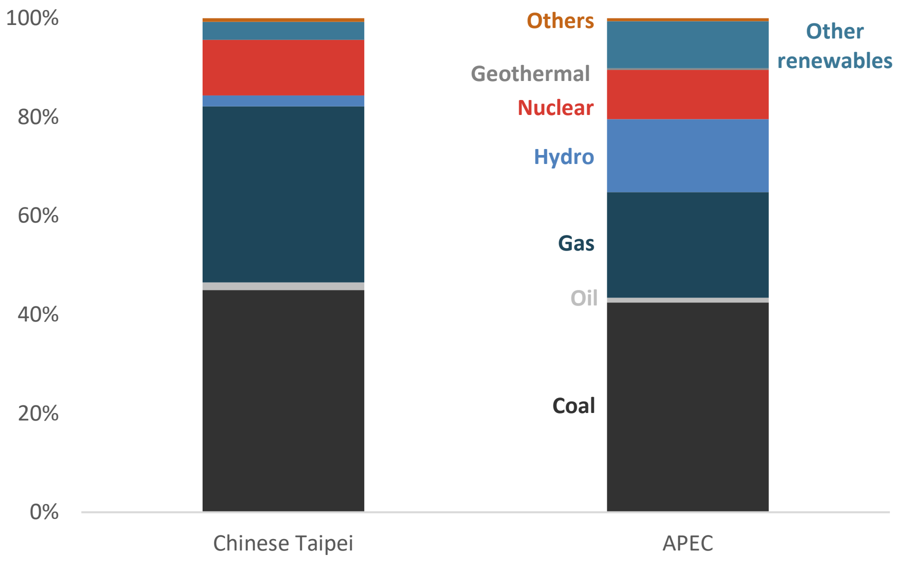
Figure 8: Chinese Taipei's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

In 2020, coal accounted for almost half of Chinese Taipei's electricity generation, which was 3% higher than the whole APEC economy (Figure 9). It is also worth noting that the share of gas-fired electricity generation in Chinese Taipei was 14% higher than the APEC economy as a whole. The percentage of gas-fired electricity generation is expected to increase because gas-fired generators can produce bridge energy under Chinese Taipei's ambitious energy transition policy.

Figure 9: Electricity generation fuel share, Chinese Taipei and APEC, 2020



Source: EGEDA (2022)

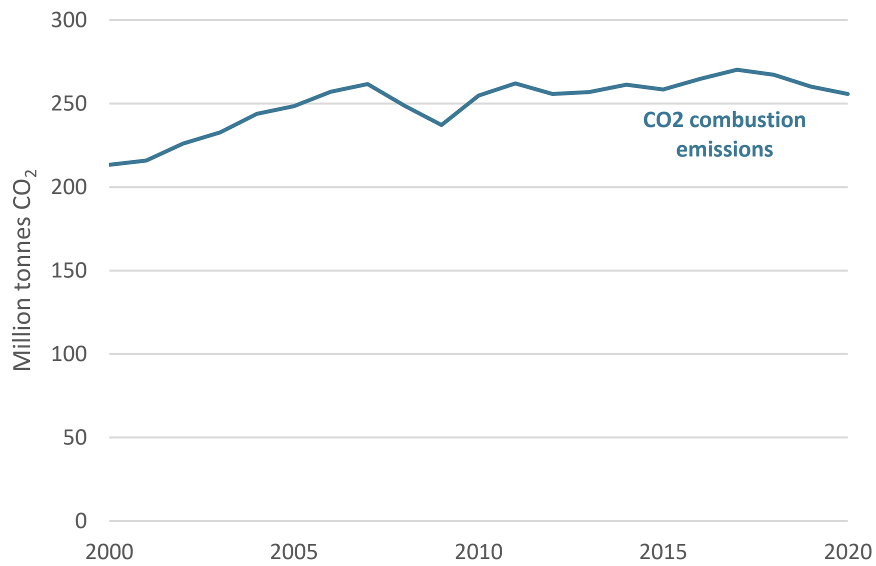
Energy transition

To stabilise the power supply, improve air quality, and create a nuclear-free homeland, Chinese Taipei aims to achieve 50% gas-fired power plants, 27% coal-fired power plants, 20% renewables, and 3% others in the power mix by 2025. All the nuclear power plants are also expected to be decommissioned by 2025. In addition, the long-term GHG emission reduction goal was initially set to be 50% lower than the 2005 level by 2050; in 2022, it was revised to be a more ambitious goal, "net-zero emission" by 2050.

Emissions

The CO_2 combustion emissions in Chinese Taipei have decreased since 2017. In 2020, the emission level was 257 million tonnes of CO_2, around 0.6% lower than the 2019 level (Figure 10). However, the emission level has exceeded 250 million tonnes of CO_2 since 2010, 0.7% higher than the 2005 level. It seems challenging to achieve the net-zero GHG emission goal by 2050 at the current reduction speed.

Figure 10: Chinese Taipei's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

One of the reasons for promoting the energy transition is "energy security." Chinese Taipei is expected to maximise renewable energy in the next few decades with adequate grid infrastructure and storage investment to lower the imported energy dependency and ensure energy stability. In addition, regarding the increasing usage of natural gas in Chinese Taipei's energy transition pathway, existing LNG terminals are being expanded and new LNG projects are under way. Furthermore, regarding energy security, the diversified LNG import sources and long-term LNG contracts may help Chinese Taipei to cope with the current energy crisis.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective — to improve energy intensity and to double the share of modern renewables.

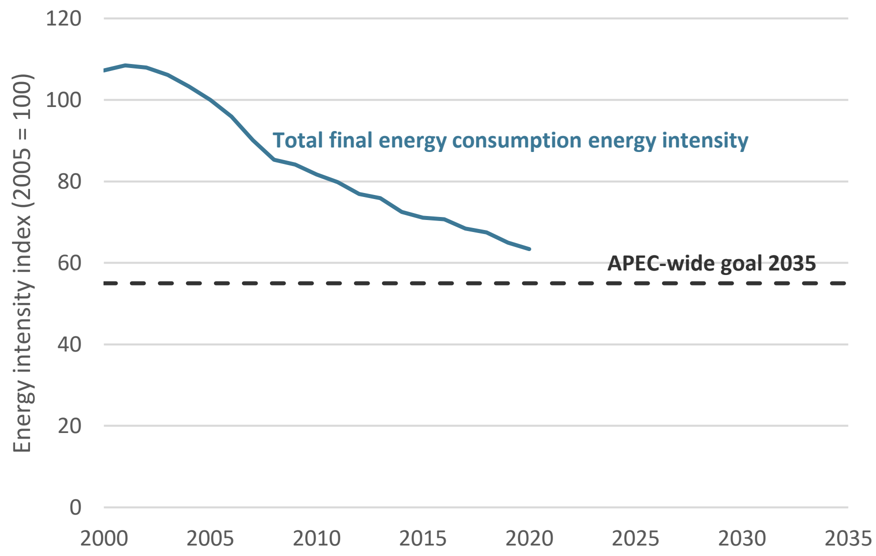
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was to improve by 25% by 2030, relative to the 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

In 2020, the energy intensity of Chinese Taipei's TFEC improved by 37%, compared with the 2005 level (Figure 11). A similar energy intensity trend is also present for energy intensity in terms of TPES and TFC.

Figure 11: Chinese Taipei's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

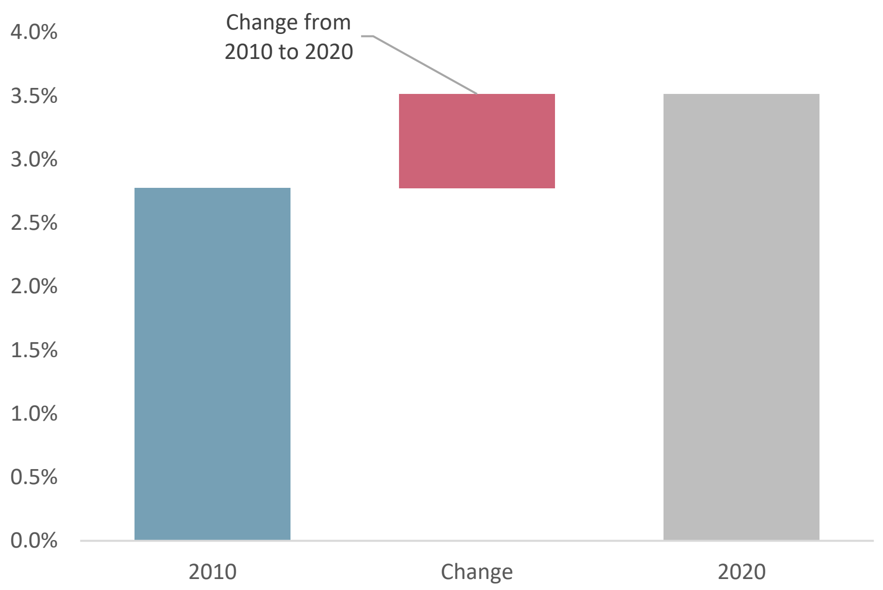


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to meeting the doubling goal.

Figure 12: Chinese Taipei's modern renewable energy share, 2010 and 2020



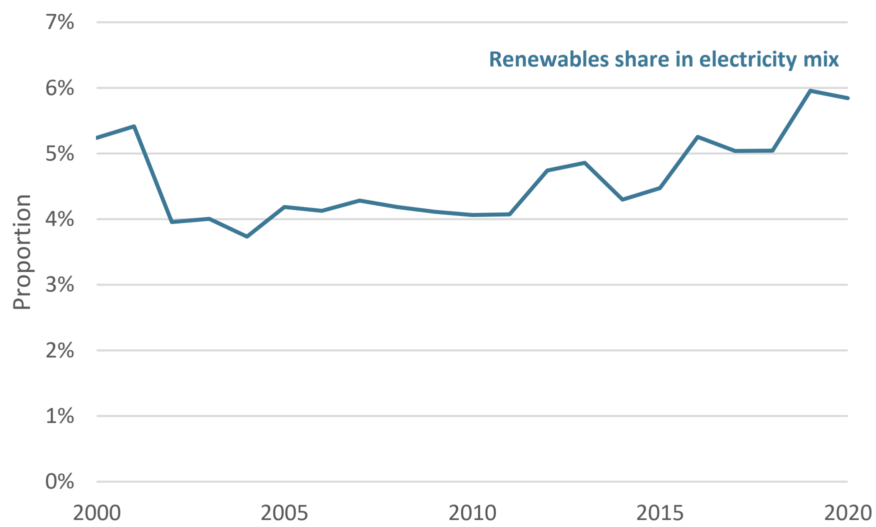
Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Chinese Taipei's share of modern renewables in TFEC was 2.8% in 2010. It increased to 3.5% in 2020, representing a 27% improvement from 2010 to 2020 (Figure 11). The APEC-wide doubling goal will require the share of APEC's modern renewables to reach 12% by 2030.

The electricity generation of renewable energy increased slightly by 2%, but its share dropped from 6% to 5.8% in Chinese Taipei in 2020. The strong growth of gas-fired generation and the massive decrease in hydro-power generation in 2020 were the main reasons for renewable generation's share drop. The share of renewables in electricity generation was relatively stable in the 2000s but has been slowly growing over the past decade. It is expected that the share of renewable generation can further grow as Chinese Taipei aims to expand its share to 60-70% by 2050. (NDC, 2022).

Figure 13: Chinese Taipei's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Energy Transition Policy by 2025	This sets up principles based on promoting green energy, increasing natural gas, reducing coal-fired power plants, and achieving nuclear-free targets to ensure a reliable power supply and reduce emissions.	Ministry of Economic Affairs [MOEA] (2019)
Climate Change Response Act	The act, an amendment to the Greenhouse Gas Reduction and Management Act, sets a new goal to reach net-zero emissions by 2050, enhances the level of climate-related governance, and builds a system to levy carbon fees from emission sources.	Climate Change Response Act (2023)
Renewable Energy Development Act (draft revision)	This provides a friendlier environment to develop renewable energy (solar PV, small hydro-power, geothermal power, etc.).	MOEA (2022)
2030 Milestone of Net-Zero Transition Goal	The emission reduction goal in 2030 is changed from 20% to 24%.	NDC (2022)
Pathway to 2050 Net-Zero Transition Goal	The emission reduction goal in 2050 is changed from 50% to 100% (net-zero emission by 2050). The pathway provides energy, industrial, lifestyle, and social guidelines to achieve the net-zero goal.	NDC (2022)
Long-term Power Development Plan	This plans to include additional gas-fired and biomass power plants to replace oil, coal, and nuclear plants by 2028.	Taipower (2022)
2030/ 2050 Milestone of Renewables	This sets 2030/ 2050 targets for offshore wind, solar PV, hydrogen, geothermal, biomass, and marine energy.	NDC (2022)
2030 Milestone of EVs	This sets 2040 100% new-sale-rate targets for electric passenger cars and scooters. It is also expected to see a 100% penetration rate of electric buses by 2030.	NDC (2022)
2025/2030 Milestone of storage	This aims to increase the installed capacity of storage to 1 500 MW and 5 500 MW by 2025 and 2030, respectively.	NDC (2022)

Notable energy developments

Energy development	Details	Reference
Solar PV Development in 2022	In 2022, the additional capacity of solar PV reached a record high of 2.5 GW, and the cumulative capacity of solar PV was 10 GW, which was far behind the 2025 target, 20GW.	MOEA (2022)
Offshore Wind Development in 2022	In 2022, the additional capacity of offshore wind power reached 1 GW, and the cumulative capacity was 1.4 GW, which was far behind the 2025 target of 5.6 GW.	MOEA (2023)
Heavy losses due to soaring energy prices	In 2022, the economy-owned energy companies, Taipower and CPC both faced around USD 6.5 billion cumulative losses because of the price stability policy. Even though Taipower adjusted parts of its rate schedules in August 2022, the adjustment could not effectively reflect the soaring price of imported natural gas.	MOEA (2023)
Demo Sites of Hydrogen/Ammonia Co-firing technology	Taipower signed MOUs with Simens Energy and Mitsubishi (MHI, MC, and MCH) to promote demo sites of co-firing technology. It is expected to realise a 5% hydrogen co-firing technology on a gas-firing unit in 2025 and a 5% ammonia co-firing technology on a coal-firing unit in 2030.	Taipower (2022)
Grid Resilience Strengthening Construction Plan	Taipower plans to invest USD 19 billion in 10 years to upgrade the power grid system. The power grid is expected to be resilient and decentralised in the future.	Taipower (2022)

Useful links

NDC – https://www.ndc.gov.tw/en/Default.aspx.

MOEA – https://www.moea.gov.tw/Mns/english/home/English.aspx.

BOE – https://www.moeaboe.gov.tw/ECW/populace/home/Home.aspx.

Energy Statistics Information System – https://www.esist.org.tw/Database

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Thailand

Introduction

Thailand is in the centre of the Malay peninsula, which connects northeast Asia with southeast Asia. The economy is surrounded by Myanmar, the Lao People's Democratic Republic (Lao PDR) and Cambodia to the north and east, and Malaysia to the south. Thailand has an area of 513 120 square kilometres (km^2) and had a population of 70 million in 2020. In 2020, its gross domestic product (GDP) dropped to USD 1 200 billion (2017 USD purchasing power parity [PPP]), a 6.2% decrease from its GDP in 2019 (World Bank, 2022) because of a slowdown in economic activities in response to the COVID-19 pandemic. Despite the impact from the pandemic, Thailand was quoted by the World Bank as one of the great development success stories. Due to smart economic policies, it has become an upper middle-income economy and is making progress towards meeting the Sustainable Development Goals[1].

Thailand has limited domestic energy resources. At the end of 2020, Thailand had proven reserves of 0.3 billion barrels of oil, 5.1 trillion cubic feet of natural gas and 1.1 billion tonnes of coal. Based on the current rates of production, its domestic supply will soon become depleted – oil and natural gas resources in about two and three years, respectively (Energy Policy and Planning Office (EPPO), 2020). Most coal-fired power plants in Thailand use domestically produced lignite and imported bituminous coal. Thailand is highly dependent on energy imports, particularly oil, with approximately 80% of its oil and 30% of its gas supply coming from imports in 2020.

Most of Thailand's proven coal reserves are lignite coal, which has a low calorific value. For this reason, Thailand relies on coal imports to meet the energy demands of both the power and industrial sectors. In 2020, the coal supply was 650 PJ — a 7% increase from the previous year's level. The increase in the coal supply was mainly for the industrial sector, with a 10% increase, while coal for power generation decreased by 6%. The natural gas supply in 2020 was 1 760 PJ, a 6.5% further decrease from 2019 due to lower consumption in both the power generation and industrial sectors, with a 10% decline in domestic production and a 5% decrease of gas imports from Myanmar, while liquefied natural gas (LNG) imports increased by 13%.

Table 1: Thailand's macroeconomic data and energy reserves

Key data [a]		Energy reserves [b, c]	
Area (km^2)	513 120	Oil (billion barrels)	0.3
Population (million)	70	Gas (trillion cubic feet)	5.1
GDP (2017 USD billion PPP)	1 200	Coal (billion tonnes)	1.1
GDP per capita (2017 USD PPP)	17 250	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a World Bank (2022); b BP (2022); c UN (2022)

Note: Reserves are total proved reserves and reasonably assured recoverable resources for uranium.

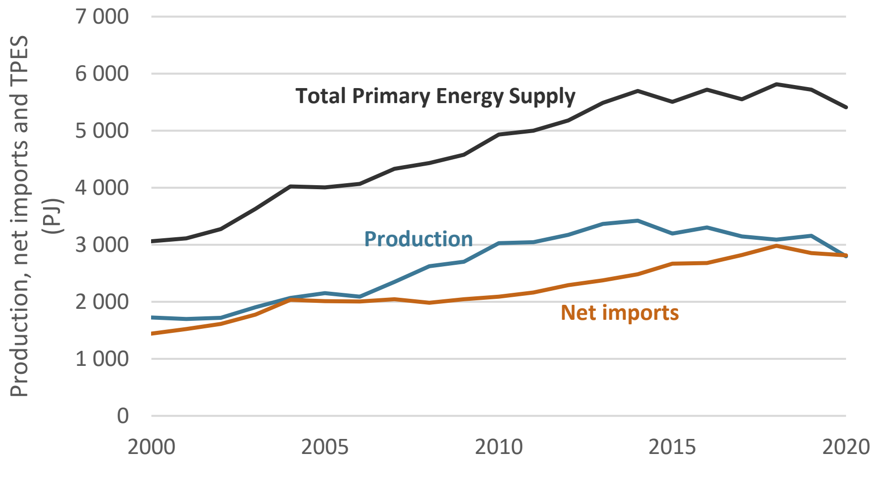
Thailand has increased its reliance on imported LNG by investing in new LNG receiving facilities. The new LNG receiving terminal (T-2 terminal) has been completed and began operations in 2022 with a 7.5 million tonnes per annum (MTPA) capacity, making Thailand's total receiving capacity 19 MTPA, expandable to 26.5 MTPA. The third terminal (T-3) which is under construction and expected to be completed in 2027 will bring the total LNG receiving capacity of Thailand to 37 MTPA, expandable to 42 MTPA.

Energy supply and consumption

Total primary energy supply

Thailand's total primary energy supply (TPES) was 5 400 PJ in 2020, down 5% from the previous year. Domestic production fell for the fourth consecutive year to approximately 2 780 PJ, representing a -4% CAGR between 2016 and 2020.

Figure 1: Thailand's energy supply, production, and net imports (PJ), 2000 to 2020



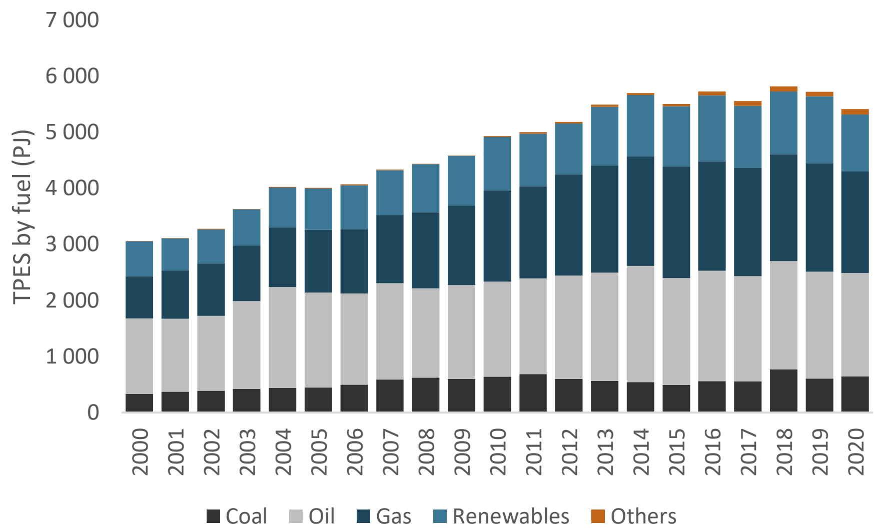
Source: EGEDA (2022)

In the mid-2010s, net imports began to rise to compensate for diminishing domestic production. However, net imports have decreased since 2019, owing to the economic slowdown induced by the COVID-19 pandemic. Consecutively, domestic production and net imports have contributed an equal share to TPES (Figure 1).

Thailand's TPES was on an increasing trend before declining in the last two years (Figure 2). Oil and gas accounted for nearly 70% of the TPES share, followed by renewables (20%). Nonetheless, the TPES of all mentioned fuels fell by an average of -8% from the previous year. In contrast, the coal supply grew by 7%, reaching roughly 650 PJ in 2020 due to fuel switching to use more coal by the industry sector.

The gas supply stood at 1 800 PJ in 2020, coming from domestic production (70%), pipeline gas imports from Myanmar (15%), and LNG imports (15%).

Figure 2: Thailand's energy supply by fuel (PJ), 2000 to 2020

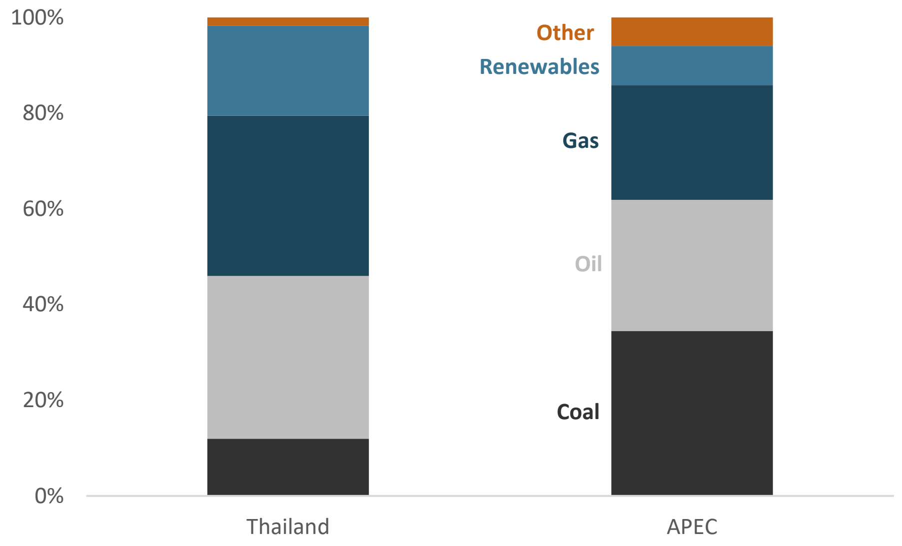


Source: EGEDA (2022)

Since the concession periods for the Erawan gas field, operated by Chevron Corporation, and the Bongkot gas field, operated by PTT

Exploration and Production (PPTEP), expire in 2022 and 2023, respectively, the Ministry of Energy has opened auctions for the G1/61 project (Erawan) and the G2/61 project (Bongkot) for exploration and production concession contracts, aiming to raise domestic natural gas production and, ultimately, to promote energy security. PTTEP was awarded the contract to serve as an official operator for both projects, with the latter under a production sharing agreement with MP G2 (Thailand) Limited.

Figure 3: Energy supply mix – Thailand and APEC, 2020



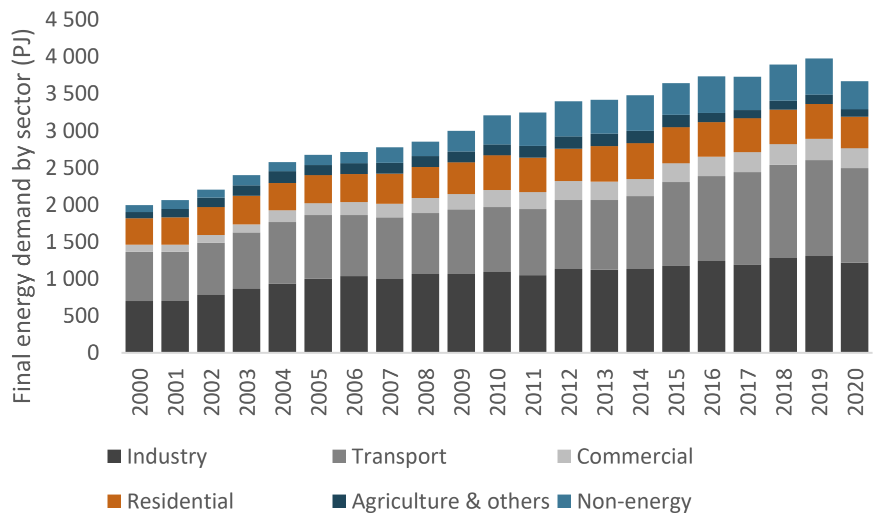
Source: EGEDA (2022)

Thailand's fuel mix differs from the APEC region (Figure 3). The share of coal is smaller, whereas the shares of oil, gas, and renewables are proportionally larger. The share of renewables at 19% in 2020 was also significantly larger than APEC. Despite declining domestic gas production, gas supply growth remains the greatest among fossil fuels, with imports accounting for much of the increase. The high gas share is projected to persist in the coming years as the power sector transitions from coal to gas.

Total final consumption

COVID-19 countermeasures, including domestic and international travel restrictions and shortened business hours, coupled with flooding during the monsoon season caused a decline in total final consumption (TFC), especially in the first half of 2020. However, economic activities resumed moderately in the second half of the year after the government announced a significant relaxation of COVID-19 protocols. As a result, TFC declined to 3 700 PJ by the end of 2020, an 8% decrease from 2019.

Figure 4: Thailand's final consumption by sector (PJ), 2000 to 2020

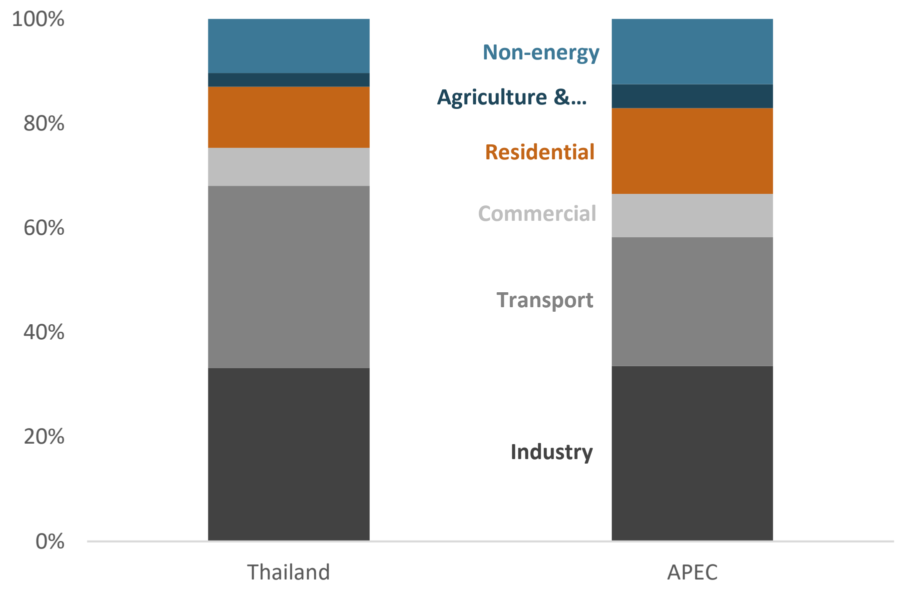


Source: EGEDA (2022)

The transport sector overtook the industry sector as the largest energy-consuming sector, accounting for 1 280 PJ and 1 220 PJ, or 35% and 33% of TFC, respectively. Buildings (commercial and residential) and non-energy sectors comprised the remaining share, at roughly 20% and 10%, respectively. The non-energy sector predominantly consists of energy products that are used as feedstock (particularly in petrochemicals) rather than for energy purposes.

Thailand represented 2% of APEC's TFC. The economy shares similar TFC sectorial characteristics with APEC, with the primary distinctions being in the transport and residential sectors. Thailand's transport sector was 10 percentage points higher than APEC's; conversely, Thailand's buildings sector was lower than APEC's by six percentage points.

Figure 5: Final consumption by sector, Thailand and APEC, 2020

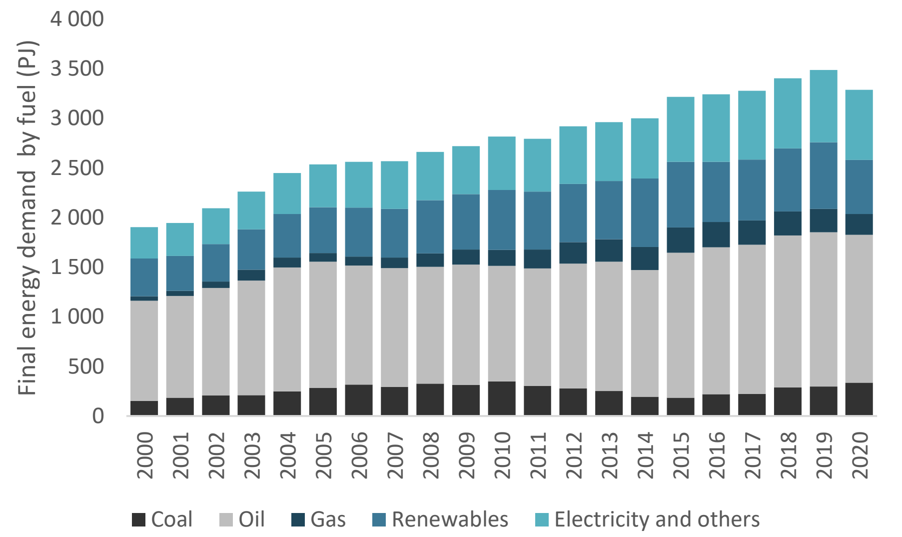


Source: EGEDA (2022)

Final energy demand

Final energy demand (FED) decreased by 6% in 2020 compared to the previous year, approaching 3 300 PJ. The majority of fuel demand decreased with renewables saw the largest percentage decline at 20%, in contrast, demand for coal increased by 15%. The significant increase in coal demand was primarily driven by higher consumption in the power sector and the industry sector, especially in the cement and paper industries where steam generating heat pumps are necessary.

Figure 6: Thailand's final energy demand by fuel (PJ), 2000 to 2020

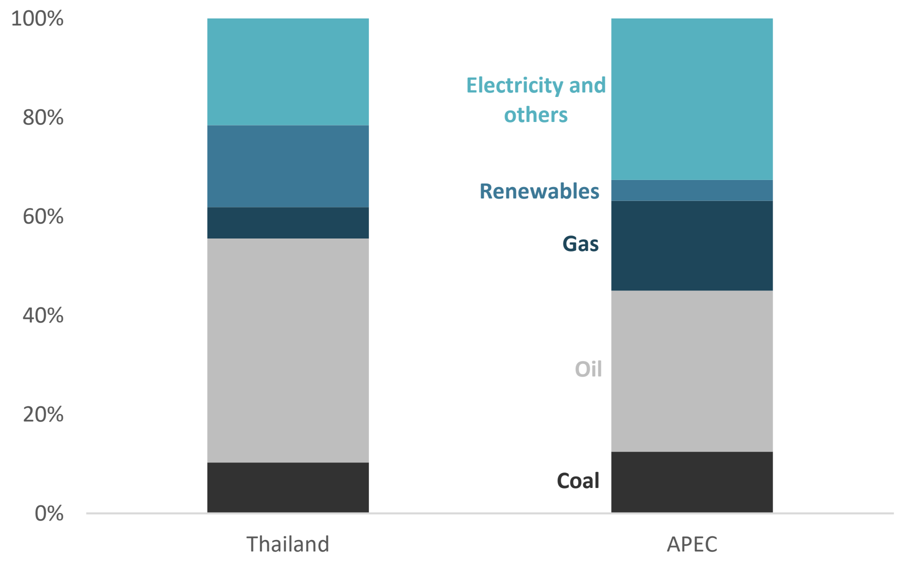


Source: EGEDA (2022)

Note: does not include non-energy sector consumption of energy products

Thailand saw a rebound in FED from the second half of 2020. This was because the economy started to recover as the Thai government eased COVID-19 restrictions, announced an economic stimulus package, and encouraged domestic tourism. Moreover, global economic recovery resulted in higher exports from Thailand, causing higher electricity consumption in the industry sector, notably in steel, automotive, and electronics manufacturing.

Figure 7: Final energy demand fuel share, Thailand and APEC, 2020



Source: EGEDA (2022)

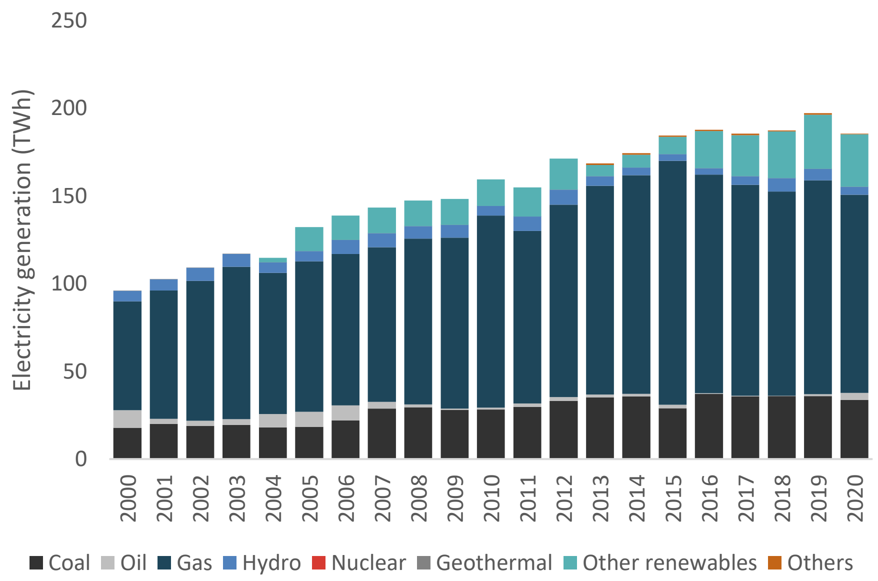
While Thailand has a similar proportion of coal FED compared to APEC, other fuel shares are diverse. For APEC, oil, electricity and others equally contributed to the APEC FED share (30% each), with renewables being the least used fuel in FED. Thailand's FED, on the other hand, is heavily reliant on oil. Oil alone accounted for the largest share of 45%, followed by electricity and others and renewables. Moreover, gas presented the lowest share of Thailand's FED, at slightly under 6%.

Transformation

Power sector

Thailand's electricity system is made up of multiple players with a combined contracted capacity of 50 GW. EGAT, an economy-owned enterprise, and independent power producers individually take 30% of total power generation. Shares of small power producers and very small power producers combined represented 30%, with the remainder coming through electricity trading with Lao PDR and Myanmar.

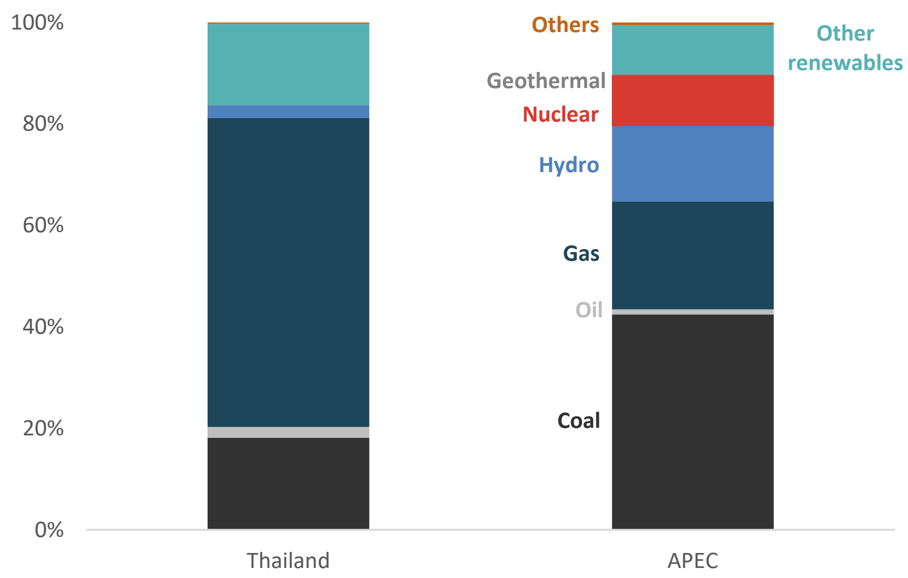
Figure 8: Thailand's electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

Two-thirds of electricity in Thailand came from gas-fired generation; nonetheless, electricity derived from other renewables has moderately substituted that from the gas-fired generation. The Thai government has promoted the deployment of renewable energy since 2007 when a feed-in premium was implemented alongside the first Renewable Energy Development Plan (2008-2022). Consequently, a growing renewables trend (excluding hydro) emerged in early 2010. Consequently, electricity generated from other renewables increased 60-fold to almost 30 TWh during 2012-2020. Meanwhile, electricity produced from gas-fired generation fell by 20% from its peak of 140 TWh in 2015.

Figure 9: Electricity generation fuel share, Thailand and APEC, 2020



Source: EGEDA (2022)

In 2020, electricity generation declined by 6% relative to 2019, falling to 190 TWh. Previously, power generation was on a rising trend before stagnating in the mid-2020s. For the last 20 years, generation has grown at 3% annually. However, the growth rate in the last five years was obviously sluggish, standing at 0.2% annually.

Thailand highly relied on thermal power generation, accounting for roughly 80% of total electricity generation, compared to the 60% share in APEC in 2020. Natural gas generation is dominant, accounting for three-quarters of Thailand's thermal generation in 2020 (Figure 9). Renewable potential and policies that support these resources have contributed to renewable generation share increasing to almost the same size as coal-fired generation in 2020.

Refining

In 2020, crude oil and condensate production and imports decreased because of lower demand for refined petroleum products caused by the spread of COVID-19. Approximately 80% of crude oil and condensate supply is imported, primarily from the Middle East region. Thailand has a total refinery capacity of 1 245 thousand barrels per day (KBD) (EPPO, 2022). Crude oil intake by refinery is slightly over 1 000 KBD, accounting for 80% of refinery capacity. Despite the lower import volume, the greater decline in domestic petroleum product consumption led to a higher export volume to regional markets such as Myanmar, Cambodia, and Viet Nam. Thailand produced more than 160 million litres of petroleum products per day, with diesel oil accounting for 45% of total petroleum products.

Energy transition

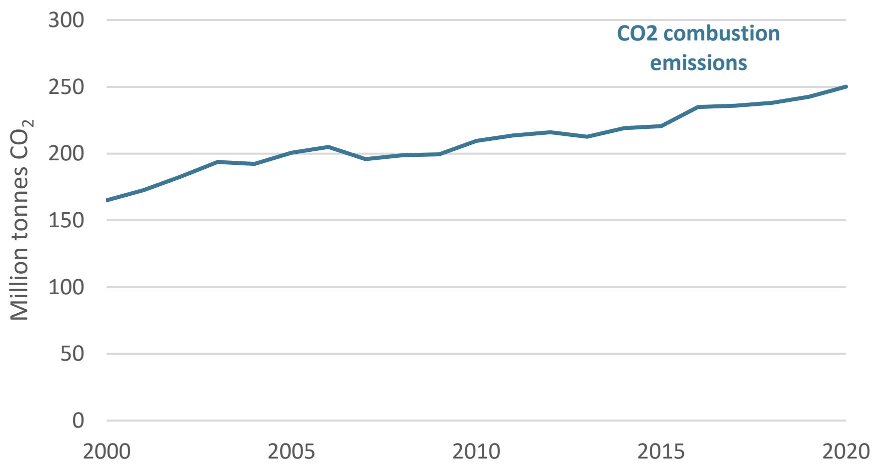
Thailand aspires to reduce its dependence on fossil fuels and to leverage the full potential of domestic renewable energy resources to enhance its energy security, energy affordability, and environmental sustainability. The Thai government has implemented several development plans and policies to realise these objectives, with the Thailand Integrated Energy Blueprint (TIEB) serving as the core strategic plan. Following the global dynamic, Prime minister Prayut

Chan-o-cha announced at the 26th UNFCCC COP (COP 26) in November 2021 that Thailand is striving for carbon neutrality by 2050 and for net-zero greenhouse gas (GHG) emissions by 2065.

Emissions

Under Thailand's 2nd Updated National Determined Contribution (NDC) published in November 2022, Thailand aims to reduce relative GHG emissions of 30-40% by 2030, with the more ambitious reduction dependent on international support. Thailand expects to emit 555 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in the 2030.

Figure 10: Thailand's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Thailand's carbon dioxide combustion emissions grew by 2.1% yearly during 2000-2020, reaching 250 million tonnes, mainly due to the economy's dependence on fossil fuels for power generation, industry, and transportation. According to the Energy Policy and Planning Office (EPPO) (2022), the power sector generated the largest share of carbon emissions at 35%, followed by the industry and transport sectors jointly, both at below 30%.

Despite Thailand's ambitious climate targets and goal to increase the share of renewable energy in final energy consumption to 30% by 2037, carbon emissions from the power sector will continue to increase from 84 million tonnes to 100 million tonnes based on the Power Development Plan (PDP) 2018-2037 (Revision 1).

Energy security

Thailand's self-sufficiency, a ratio of domestic production to primary energy supply, has been declining, accounting for around 50% in 2020. The economy produces 20%, 40%, and 70% of crude oil and natural gas liquids, coal, and gas supply, respectively. These figures show that the economy heavily relied on energy imports to meet increasing domestic demands and highlight the need for Thailand to invest in fossil fuel resource exploration and production.

The economy imported crude oil mainly from the Middle East and coal from Indonesia and Australia. 2020 was the first year when LNG imports, mainly from Qatar, surpassed pipeline gas imports from Myanmar after Thailand first received LNG in 2011.

Thailand has limited domestic energy reserves. According to EPPO (2020), Thailand's reserve to production ratios for natural gas, crude oil, and lignite are 3.3, 2.2, and 138 years. However, the government has implemented various measures to enhance its energy security, such as increasing the strategic petroleum reserve capacity.

Thailand imported energy to a value of nearly 800 billion Baht, accounting for 12% of the total import value. Conversely, the value of energy exports was five times less than that of energy imports. The value of exported energy was slightly above 2% of total exports (EPPO, 2020)

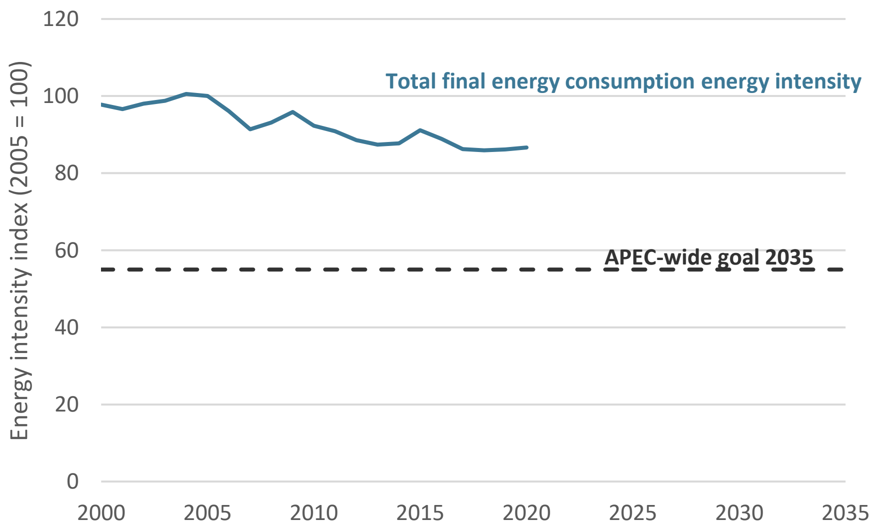
APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective – to improve energy intensity and double the share of modern renewables.

Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

Figure 11: Thailand's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Recognising APEC's energy intensity goal, Thailand implemented the Energy Efficiency Plan (EEP) 2015-2036 which targets an energy intensity reduction of 30% by 2036 in comparison to 2010. The target entails a 2 350 PJ curtailment in final energy consumption, with 85% coming from the thermal sector and the remainder from the electricity sector.

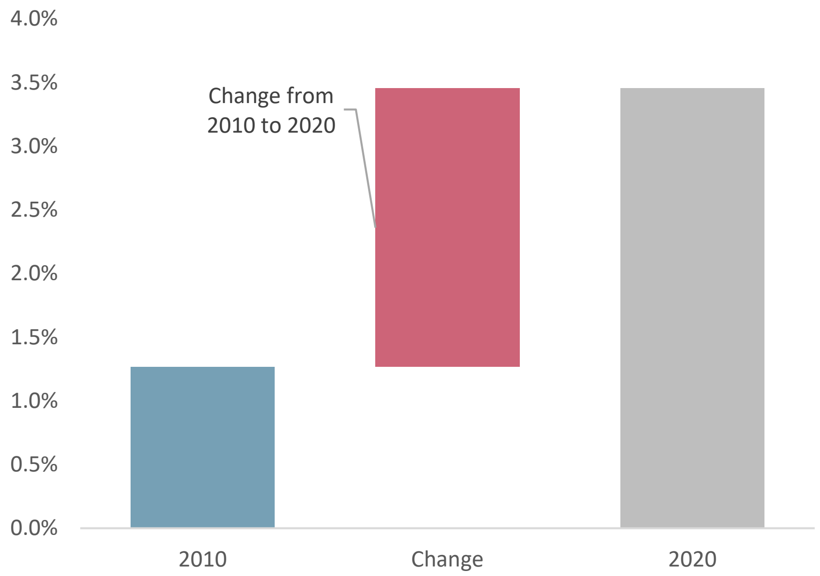
Thailand's total final energy consumption (TFEC) energy intensity has declined by 1% annually over the previous 20 years. Although final energy consumption in 2020 was 4% lower than the previous year, GDP in 2020 was much lower at 6%. As a result, Thailand's TFEC energy intensity curved up in 2020. To achieve APEC's energy intensity overall goal and the EEP 2015-2036 targets, Thailand needs to increase its energy intensity reduction to 30% by 2035 and 20% by 2036.

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Thailand's modern renewable energy share increased by 3.3% between 2010 and 2020, reaching nearly 16%. Electricity and heat as well as modern biomass equally contributed to the increase. The share dropped by two percentage points relative to 2019, with lower modern biomass consumption accounting for most of the decline. Thailand needs to increase the modern renewable energy share by almost 9% within this decade to meet the economy's goal of doubling its proportion of modern renewable energy, which is 24%.

Figure 12: Thailand's modern renewable energy share, 2010 and 2020

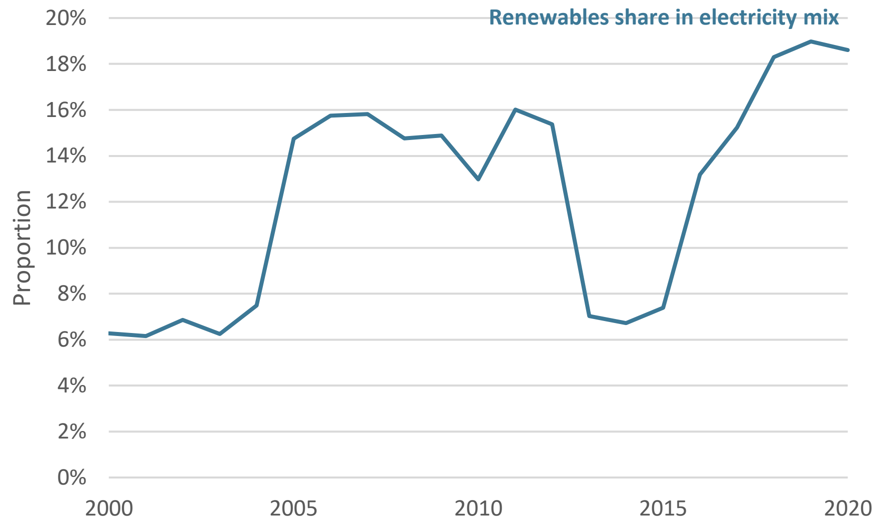


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Prior to 2015, the average share of renewable energy sources in the electricity mix fluctuated at around 10%; however, that percentage had substantially increased to nearly 20% by 2020. Higher amounts of electricity generated by other renewables (solar, wind, biomass, etc.) caused the notable increase. In the previous five years, geothermal energy contributed a negligible amount to the electricity mix, with the hydro contribution remaining consistent at 3%.

Figure 13: Thailand's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
2nd Updated NDC	30-40% GHG emissions reduction relative to a projected business-as-usual level by 2030 (555 $MtCO_2e$). Additionally, Thailand aims to achieve carbon neutrality by 2050 and net-zero GHG emissions by 2065.	UNFCCC
Long-Term Low Greenhouse Gas Emission Development Strategy (LT-LEDS) (Revised version)	Long-tern GHG mitigation actions in the energy; transport; industrial processes and product use waste; agriculture; and land use, land use change and forestry sectors.	ONEP
National Energy Plan 2022 (Expected endorsement in 2023)	Integrating five existing plans, previously known as the TIEB to support Thailand in achieving clean energy and carbon neutrality. The main policy directions include 50% of renewable energy in power generation, 30% of domestic electric vehicles production by 2030, 30% energy efficiency improvement, and energy infrastructure developments.	EPPO
Promotion of electric vehicles (EVs)	Up to 40% cut in import tax, depending on the engine size, between 2022 and 2023 to promote the use of Evs. Additionally, tax incentives and subsidies from 2022-2025 are provided to advance domestic manufacturing, 725 000 EV units/year by 2030, and the development of EV charging infrastructure.	ITA

Notable energy developments

Energy development	Details	Reference
BCG (Bio-Circular-Green) Economy model	Post-pandemic growth strategy that covers the economy, society, and the environment; emphasising efficient use of resources and waste to promote sustainable and balanced economic growth.	APEC
Chonburi Natural Gas Power Project	2.5 GW gas-fired power plants in Chonburi to support a growing industry demand under the Eastern Economic Corridor program. The anticipated completion was in October 2022.	ADB
Fifth Gas Transmission Pipeline Project	The longest onshore transmission pipeline, 415 km in length, connects Rayong and Nonthaburi. The development is being carried out by PTT to strengthen the stability of the natural gas pipeline network and to expand power generation capacity.	PTT

Green Yellow Rooftop Solar Project	Nationwide rooftop solar installations on commercial and industrial buildings, with a total capacity of 60 MW.	ADB
Liberalisation of the natural gas market	The Thai government is considering promoting a competitive market to welcome additional LNG carriers in response to the high LNG price. Regulated players are allowed to trade with PTT while partially regulated players can sell directly to consumers.	Bangkok Insight
Lomligor Wind Power Project	First private sector 10-MW wind power project, integrating a battery energy storage system. Partially funded by the Asian Development Bank (ADB) loan for USD 7.2 million.	ADB
Nong Fab LNG Receiving Terminal	Thailand's second LNG receiving terminal after Map Ta Phut LNG terminal. A 7.5 MTPA regasification unit will be deployed to improve LNG supply security.	Hydrocarbons
Omkoi Lawsuit	In September 2022, the Administrative Court revoked the concession certificate No. 1/2543 of the Omkoi coal mining project in Chiang Mai, Thailand, since the project violated human rights to a clean environment, and environmental impact assessment participation.	Grantham Research Institute
Withdrawal of coal-fired power plant development plans	Investment pullbacks of 870 MW and 2 200 coal-fired plants in Krabi and Songkhla, respectively, due to public opposition. The government approved the 1 400 MW gas-fired plants in Surat Thani as a substitute in July 2021.	EJAtlas
First Carbon Credit Exchange	Thailand implemented its first voluntary carbon credit exchange under FTIX to encourage businesses to reduce their carbon footprint and promote a low-carbon economy in September 2022. The revenue will be used to support RE and EE projects and finance climate change adaptation and mitigation measures.	Bloomberg
Approvals on 24th Bid Round for Offshore Gulf of Thailand Exploration and Productions Licenses	Government awarded contracts for three offshores exploration and production areas in the Gulf of Thailand, project G1/65 G2/65 and G3/65, to increase domestic production and petroleum reserve	DMF
Renewable Energy Procurement	Thailand's National Energy Policy Council approved new renewable capacity of 3,668.5 MW, resulting in total capacity increase from 9,996 MW to 12,700 MW to meet rising electricity demand.	EPPO

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United States

Introduction

The US produces the world's second-largest gross domestic product (GDP) when measured in purchasing power parity (PPP).

The US has one of the highest levels of per capita final energy demand in APEC. In terms of energy intensity, the US had the sixth highest level in APEC at slightly less than 3.0 PJ per billion USD of GDP (PPP). These relatively high levels of economy-wide energy intensity and per capita energy use appear across all sectors in the US; however, there are wide variations within the United States.

The US is the second-largest producer and consumer of energy in APEC and is the largest oil and largest natural gas producer in the world. The high levels of oil and natural gas production are primarily the result of technical innovations, including those that enabled the commercial production of oil and gas from shale formations.

The energy systems of the three economies in North America are well integrated, with robust energy trade between the US, Canada, and Mexico.

In 2020, the US had 69 billion barrels of proved oil reserves, 446 trillion cubic feet of proved natural gas reserves, and 249 billion tonnes of coal reserves (BP, 2022). In terms of global rankings, the US is the ninth-largest holder of oil, the fifth-largest for gas, and the largest for coal. The US has less than 1% of the world's identified recoverable uranium resources. No uranium has been extracted from underground or surface mines in the US since 2015.

Table 1: Recent United States macroeconomic and energy data

Key data [a, b]		Energy reserves [c, d]	
Area (million km^2)	9.9	Oil (billion barrels)	69
Population (million)	333	Dry Gas (trillion cubic feet)	446
2022 GDP (2017 USD billion PPP)	19 800	Coal (million tonnes)	248 900
2022 GDP per capita (2017 USD PPP)	59 760	Uranium (kilotonnes; cost < USD 130/kgU)	48

Sources: a US Census Bureau (2022); b World Bank (2022); c BP (2022); d UN (2022)

Note: Oil, gas, and coal reserves are total proved reserves at end of year 2020 as reported by BP. Uranium is reasonably assured recoverable resources as reported by the UN.

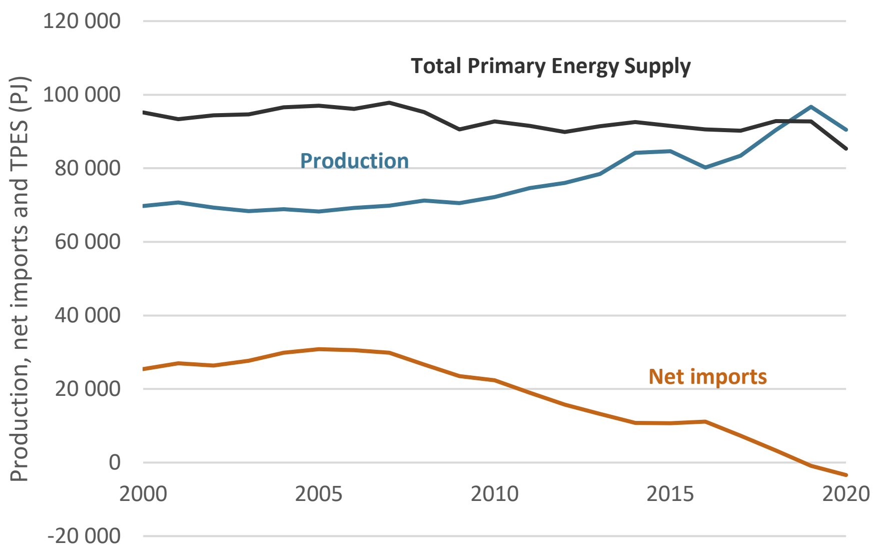
Renewable resources can be found throughout the US. Broadly speaking, the best solar resources are in the southwestern continental US as well as in Hawaii. For wind, the highest potential extends from North Dakota through Texas as well as offshore on both coasts and the western portion of the Gulf of Mexico. Geothermal potential is concentrated in the western half of the continental US, and biomass is widely available across the continent.

Energy supply and consumption

Total primary energy supply

In the US, total primary energy supply (TPES) – the sum of production, net imports, and stock changes – has declined slightly since 2000.

Figure 1: The United States' energy supply, production, and net imports (PJ), 2000 to 2020

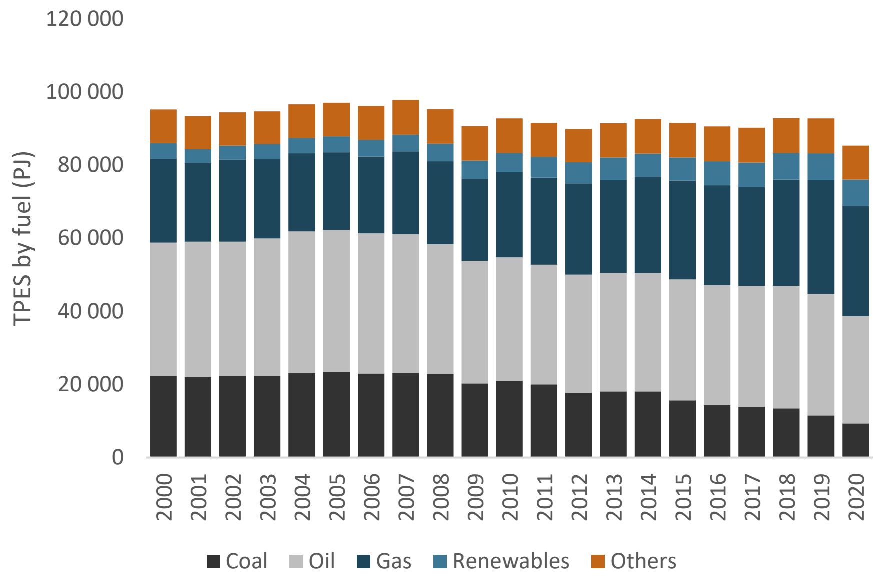


Source: EGEDA (2022)

Between 2005 and 2020, US oil and natural gas production has grown while net imports have declined. In 2019, the US became a net energy exporter. The primary drivers of this transition from energy importer to exporter were the substantial growth in both US oil and natural gas production.

In 2020, energy supply decreased by 8% from 2019 levels, reflecting the impact of COVID-19 on the US energy system. Relative to 2019, oil and natural gas production declined 5% and 2%, respectively.

Figure 2: The United States' energy supply by fuel (PJ), 2000 to 2020



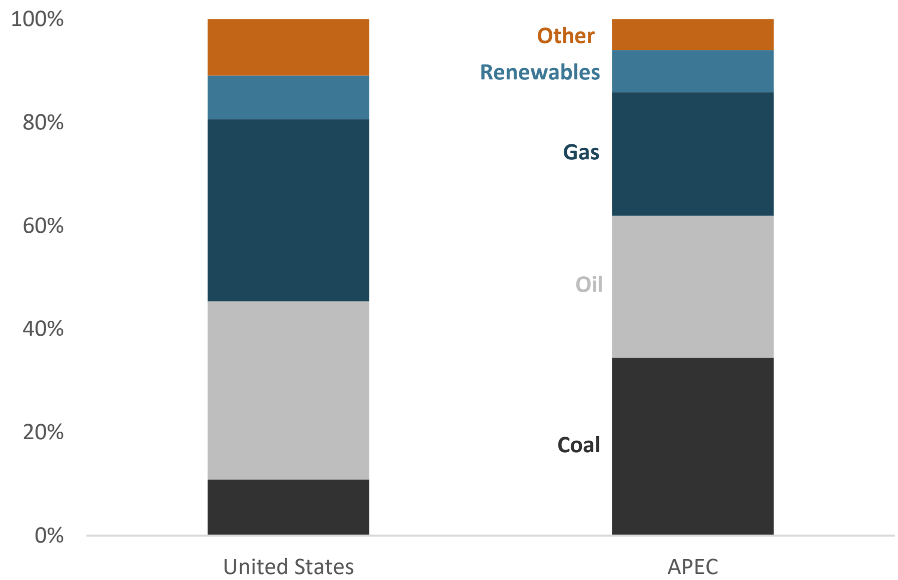
Source: EGEDA (2022)

The shares by fuel type changed slightly in 2020: 34% of TPES came from crude oil and petroleum products, 35% from natural gas, and only 11% from coal. Renewables accounted for 8% of TPES, and other sources, including nuclear and non-energy use of fuels, accounted for 10%.

Coal supply peaked in 2005 and declined by 55% through 2020. Oil supply in 2020 was 24% lower than the peak in 2005. Meanwhile, natural gas supply increased 43% through 2020 from a 21st-century low in 2006, due primarily to the proliferation of horizontal drilling and hydraulic fracturing.

These dynamics are reflected in the 2020 composition of TPES of the US compared to the aggregate APEC TPES. In terms of percentage shares, the US primary energy supply contains an eight percentage point higher share of oil and a 10 percentage point higher share of gas, but a 22 percentage point lower share of coal than APEC as a whole.

Figure 3: Energy supply mix – the United States and APEC, 2020

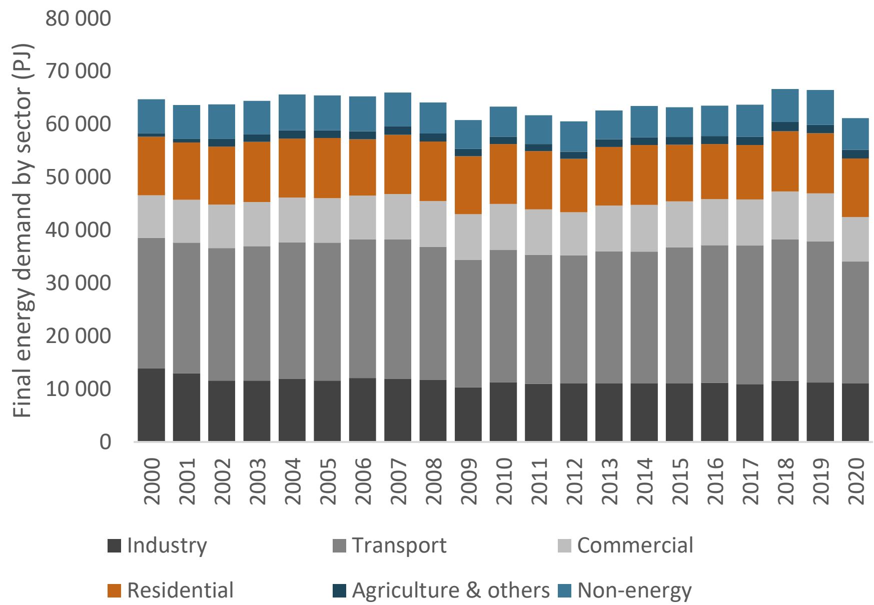


Source: EGEDA (2022)

Total final consumption

On the demand side, total final consumption (TFC), including non-energy, was 61 180 PJ in 2020, a decline of 8% from 2019. From 2000 through 2020, US TFC has maintained a reasonably consistent plateau (Figure 4), with variation associated with macro shocks like the Great Recession and COVID-19.

Figure 4: The United States' final consumption by sector (PJ), 2000 to 2020

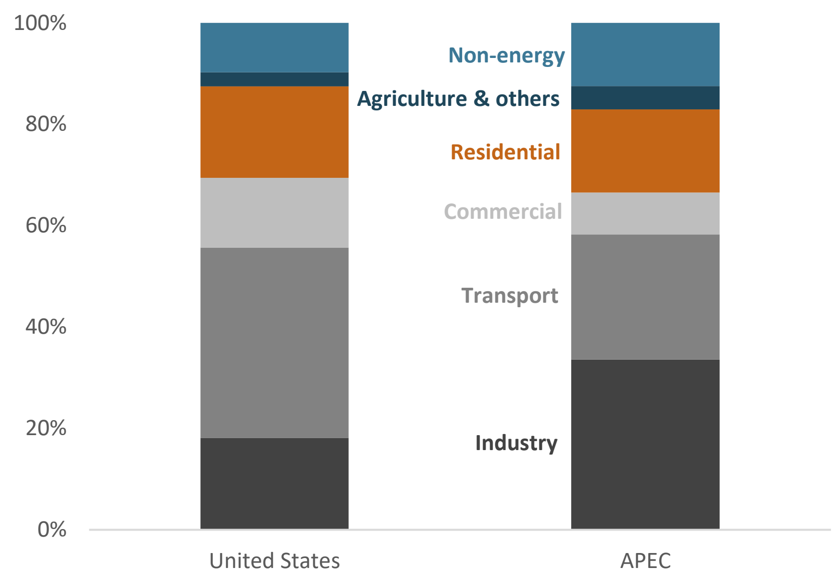


Source: EGEDA (2022)

The transport sector accounts for the largest share of TFC in the US, despite the decline in transportation fuel in 2020 due mobility restrictions associated with the pandemic. In 2020, transportation's share of TFC was 40%, followed by residential and industry (17% each), commercial (14%), non-energy (10%) and agriculture (2%). As of 2020, there had been no marked shift in the sectoral TFC patterns in the US since 2000.

The transport sector's 40% share of TFC in the US is 15 percentage points higher than the total APEC share. However, the industrial sector's share of TFC in the US is only half the aggregate share in APEC.

Figure 5: Final consumption by sector, the United States and APEC, 2020



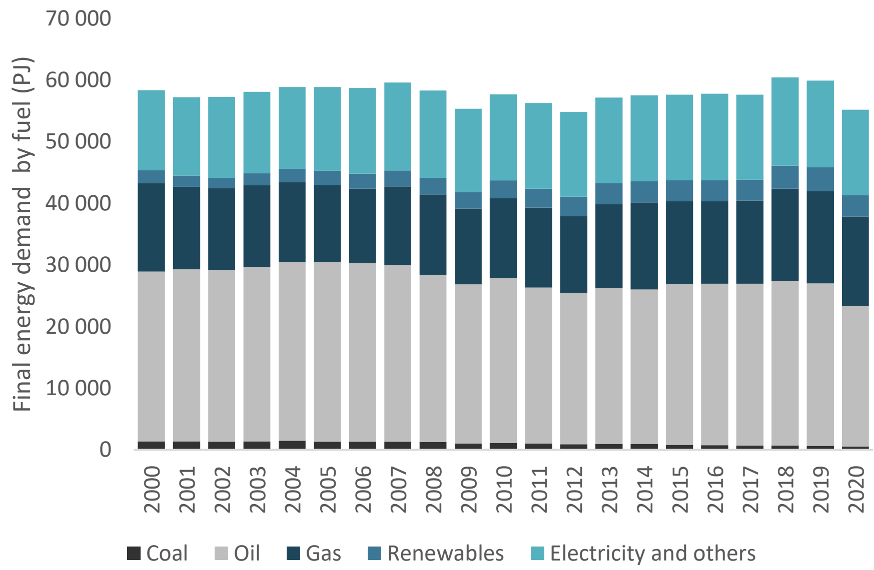
Source: EGEDA (2022)

Total final energy consumption

In 2020, US total final energy consumption (TFEC), which excludes the non-energy use of fuels, was 55 200 PJ, which was an 8% decline relative to 2019. Changes in TFEC were caused by several factors, including changes in economic activity, weather, and the degree of electrification. US TFEC trends have largely mirrored TFC trends, with variation mostly associated with significant macroeconomic shocks.

The fall associated with COVID-19 in 2020 (7.8%) was the largest decline for the two decades shown.

Figure 6: The United States' final energy consumption by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

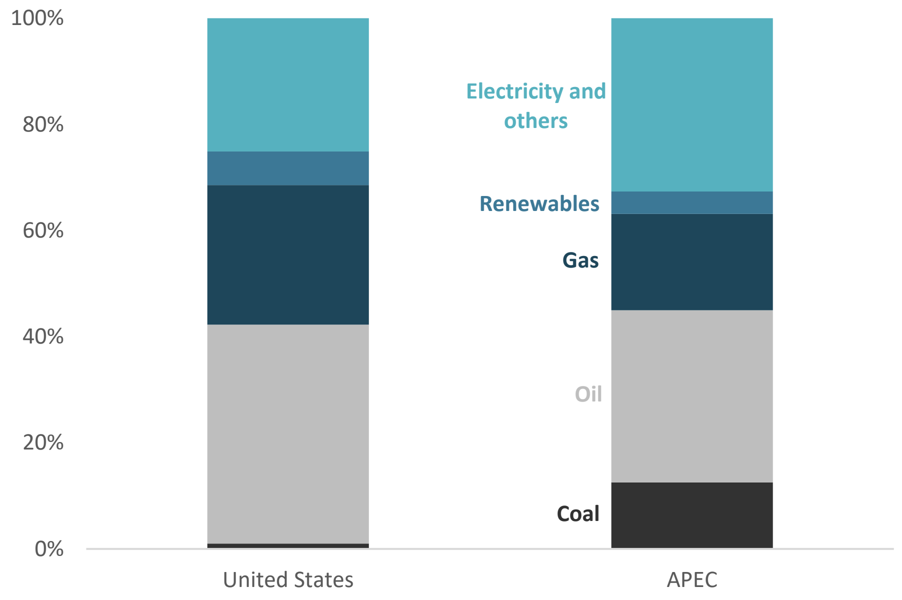
Note: does not include non-energy sector consumption of energy products

Petroleum products remained the dominant energy source in the US, accounting for 41% of TFEC in 2020 (down from 44% in 2019). Natural gas and electricity were the two other main energy carriers, accounting for 26% and 25%, respectively.

Both natural gas and electricity slowly gained market share while petroleum products and coal lost share. Since 2000, the share of electricity and natural gas gained 2.9 and 1.7 percentage points, respectively, while petroleum products and coal lost 4.7 and 1.2

percentage points. During the same period, direct use of renewables rose from a 3.6% to 6.3% market share and the renewables share of electricity generation rose from essentially zero to 4.4%.

Figure 7: Final energy demand fuel share, the United States and APEC, 2020



Source: EGEDA (2022)

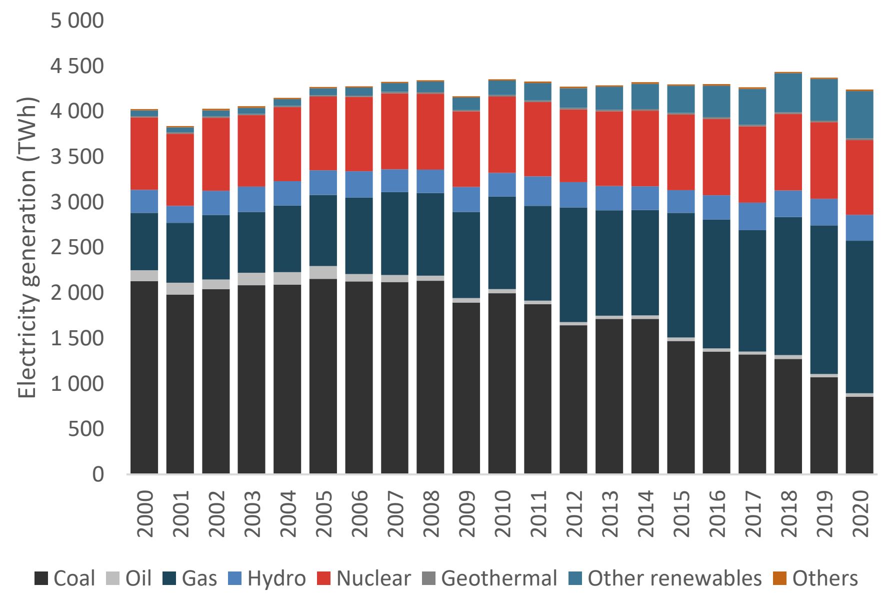
In comparison to the aggregate TFEC of APEC, the US relies much more on oil and gas and less on coal and electricity than the APEC average. The US share of oil and gas is 17 percentage points higher than the APEC average, and the US's share of coal and electricity is 11 and seven percentage points lower, respectively.

Transformation

Power sector

The US generated 4 240 TWh of electricity in 2020. This was slightly less than the power generated in 2019. US generation was mostly growing in the 2000s, though it plateaued following the Great Recession. The fall in the most recent two years of data has meant US generation has only increased by an average of 0.3% per year since 2000.

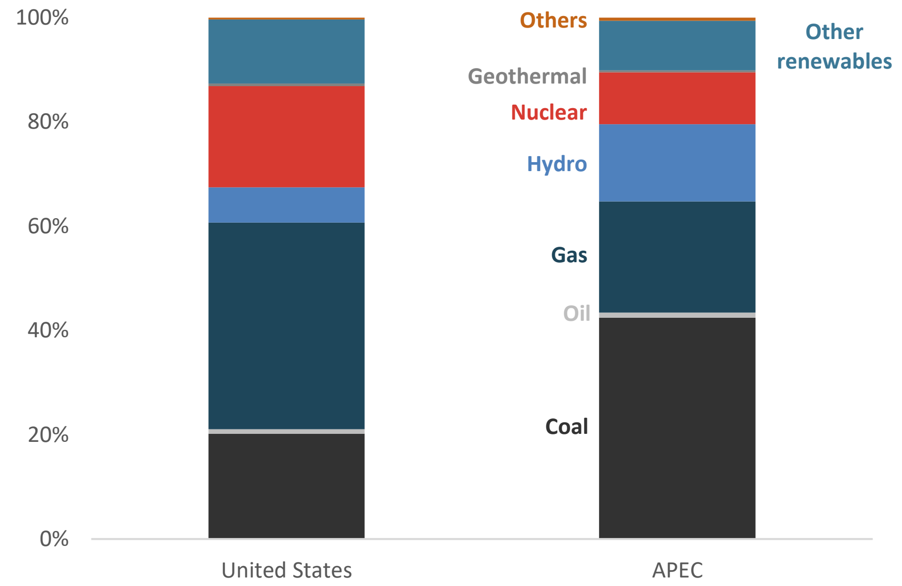
Figure 8: The United States electricity generation by fuel, 2000 to 2020



Source: EGEDA (2022)

Although the amount of generation has been relatively stable, the fuels used to generate power in the US have changed considerably over the last 20 years. From 2000 to 2006, over 50% of US electricity was generated in coal-fired plants, but this share steadily declined to 20% in 2020. Over the same period, the share of gas-fired generation increased from 16% in 2000 to 39% in 2020. The shares of other fuels and technologies remained relatively constant except for non-hydro renewables, the share of which grew from 2% in 2000 to 12% in 2020.

Figure 9: Electricity generation fuel share, The United States and APEC, 2020



Source: EGEDA (2022)

The increase in gas use and the decline in coal use have been driven by both economics and government policies. When compared to the shares of generation for APEC, natural gas, nuclear, and non-hydro renewables had larger shares in the US than the APEC average. In 2020, natural gas generated 39% of electricity in the US, but only 21% in aggregate APEC; nuclear accounted for 19% in the US, but only 15% in APEC; non-hydro renewable generation accounted for 12% in the US, but only 9.5% in APEC. The reverse is true for coal and hydroelectric. Coal generated 20% of US electricity, but 42% in APEC; hydro generated 7% in the US, but 10% in APEC.

Energy transition

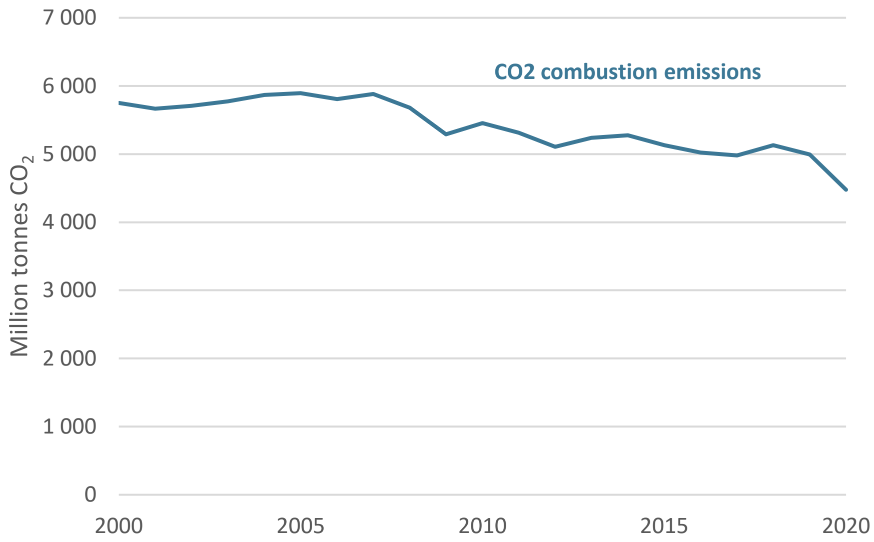
The Biden administration believes the climate crisis requires immediate and sustained investment to reduce global greenhouse gas emissions. The administration views this crisis as a transformational opportunity for the US that can be captured through investment in clean energy technologies, infrastructure, workforce, and systems of the future to improve quality of life and create a vibrant, sustainable, resilient, and equitable economy.

Emissions

The expert group on energy data and analysis (EGEDA) falls under the umbrella of APEC's Energy Working Group (EWG). In addition to energy data compiled by EGEDA, CO_2 emissions from combustion activities in the energy sector are recorded. These emissions are a subset of total greenhouse gas (GHG) emissions that are considered in the context of climate change, such as under the United Nations Framework Convention on Climate Change (UNFCCC).

US CO_2 emissions have declined steadily since 2007. Increased natural gas production from horizontal drilling and hydraulic fracturing enabled a substantial supply of cost-competitive domestic natural gas. Natural gas was increasingly consumed for electricity generation at the expense of coal.

Figure 10: The United States' CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Even though the US produces much more energy than it consumes, energy security has become an increasingly prominent issue in recent years. The recent increases in international oil, gas, and coal prices caused by reduced upstream investment during the pandemic were exacerbated by the Russian-Ukraine conflict and caused energy prices to rise substantially in the US.

In March 2022 in response to the higher prices, President Biden authorised the largest-ever release from the US Strategic Petroleum Reserve (SPR) and secured commitments from allies and partners to release crude oil from their reserves. In total, 180 million barrels of crude oil was sold from the US SPR in 2022.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective – to reduce energy intensity and double the share of modern renewables.

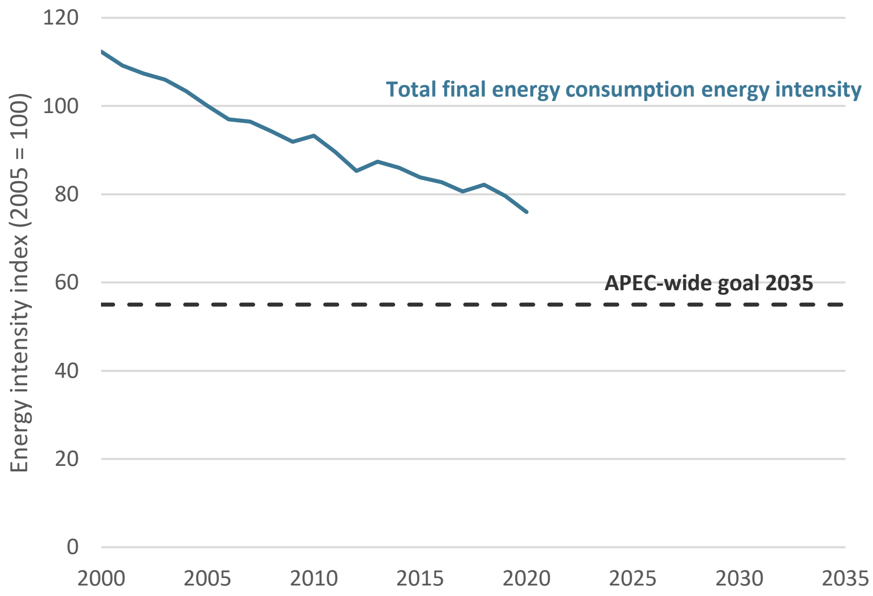
Energy intensity goal

In 2011, APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

In 2020, the energy intensity of the total final energy consumption (excluding non-energy) of the US improved by 24% relative to 2005 (Figure 11).

Figure 11: The United States' total final energy consumption intensity index, 2000 to 2020 (2005 = 100)

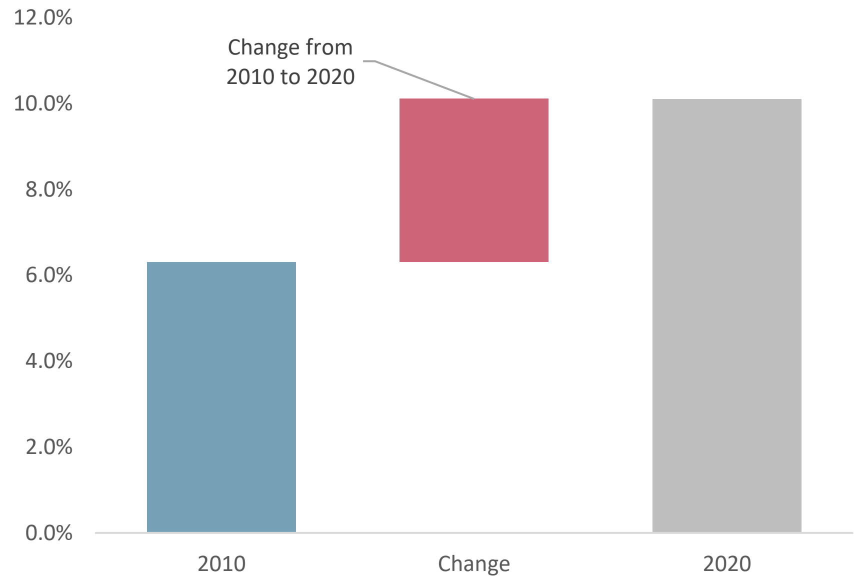


Source: EGEDA (2022)

Doubling of renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal. In the US, the share of modern renewables to final energy consumption in 2010 was 6.3%, and this increased to 10% in 2020 (Figure 12).

Figure 12: The United States' modern renewable energy share, 2010 and 2020

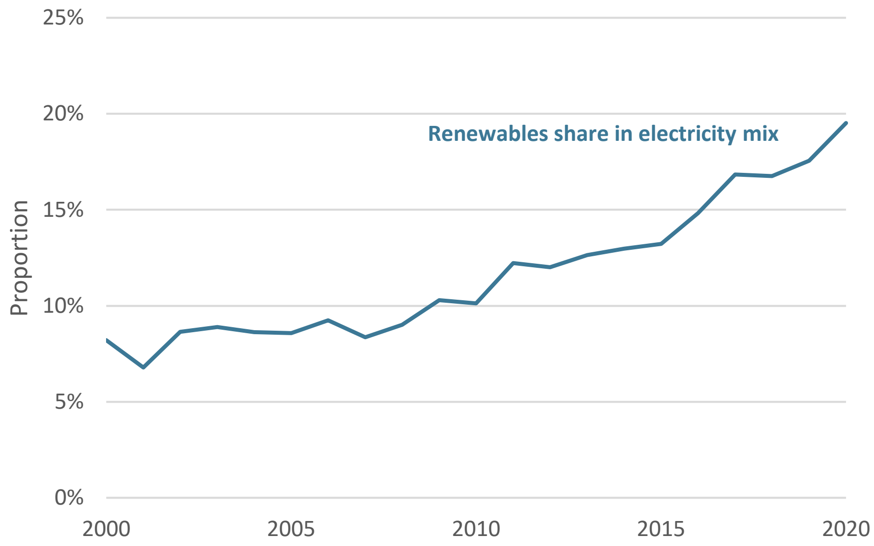


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

The share of renewable electricity generation has been steadily rising in the US since the mid-2000s. Renewables accounted for approximately one-fifth of US electricity generation in 2020 (Figure 13).

Figure 13: The United States renewable generation share, 2000 to 2020



Source: EGEDA (2022)

Energy policy

Energy policy	Details	Reference
Paris Agreement	The United States rejoined the Paris Agreement in January 2021. The updated NDC emphasises a whole-of-government approach to climate change policy with a target of reducing net GHGs by 50-52% by 2030 (relative to 2005).	US updated NDC
Global Methane Pledge	At COP 26 in November 2021 in Glasgow, President Biden and President Von der Leyen invited economies to commit to a Global Methane Pledge (GMP). Participants joining the Pledge agree to take voluntary actions to contribute to a collective effort to reduce global methane emissions by at least 30% from 2020 levels by 2030. As of November 2022, economy endorsements of the GMP have grown to 150. More than 50 economies have developed methane action plans or are in the process of doing so, and substantial new financial resources are being directed toward methane reduction.	Global Methane Pledge
Long-Term Strategy of the United States	Published in November 2021, the Long-Term Strategy envisions sustained, coordinated action along four dimensions: Federal government leadership, innovation, local government leadership, and all-of-society action. The energy transition to net-zero emissions will be based on five key transformations. - Decarbonise electricity - Electrify end uses and switch to other clean fuels - Cut energy waste - Reduce methane and other non-CO_2 emissions - Ramp up CO_2 removal	Long-Term Strategy

Notable energy developments

Notable developments	Details	Reference
Bipartisan Infrastructure Law	The Bipartisan Infrastructure Law (or Infrastructure Investment and Jobs Act) includes several important energy provisions for clean energy transmission and electric grid upgrades; hydrogen research and infrastructure; expanding rail and transit; deploying electric vehicle (EV) charging stations; and funding carbon dioxide removal (CDR), CO_2 pipelines, and large-scale carbon capture, utilization, and sequestration (CCUS) projects.	Bipartisan Infrastructure Deal
Inflation Reduction Act	The Inflation Reduction Act (IRA) of 2022 builds on the Infrastructure Investment and Jobs Act by earmarking USD 370 billion in energy investments. The IRA contains many provisions, including incentives for the production of clean energy projects; development of critical mineral supply chains; and the manufacturing of clean energy components in the United States.	Inflation Reduction Act
Energy Earthshots Initiative	Energy Earthshots are designed to drive integrated program development across the US Department of Energy's science and applied energy offices and ARPA-E, and take an 'all R and D community' approach to leading science and technology innovations to address tough technological challenges and cost hurdles. There are currently seven Energy Earthshots: - Hydrogen shot - Long Duration Storage Shot - Carbon Negative Shot - Enhanced Geothermal Shot - Floating Offshore Wind Shot - Industrial Heat Shot - Clean Fuels and Products Shot	Energy Earthshots Initiative
New Proposed Vehicle Pollution Standards	In April 2023, the US Environmental Protection Agency (EPA) proposed new pollution standards to reduce CO_2 emissions from all vehicles, including gasoline-powered cars and heavy-duty trucks. The EPA projects that the proposed standards would avoid nearly 10 billion tonnes of CO_2 emissions through 2055. If the proposed rules are adopted, the EPA estimates that by 2032 the regulation could result in EVs accounting for 67% of new light-duty vehicle sales and 46% of new medium-duty vehicle sales in 2032.	Proposed Vehicle Pollution Standards

New Proposed Carbon Pollution Standards for Coal and Gas Power Plants	In May 2023, the US EPA proposed new carbon pollution standards for coal and new natural gas-fired power plants. The EPA estimates that, if adopted, the proposal for coal and new natural gas power plants would avoid up to 617 million metric tons of CO_2 emissions through 2042. The proposed rules would: - Strengthen New Source Performance Standards (NSPS) for newly built fossil fuel-fired stationary combustion turbines (generally natural gas-fired). - Establish emission guidelines for the economy to follow to limit carbon pollution from existing fossil fuel-fired, steam generating electricity generating plants (including coal, oil and natural gas-fired units). - Establish emission guidelines for existing, large, frequently used, fossil fuel-fired stationary combustion turbines (generally natural gas-fired).	New Proposed Carbon Pollution Standards for Coal and Gas Power Plants

Useful links

US Census Bureau - https://www.census.gov

US Department of Energy — https://www.energy.gov/

US Energy Information Administration — https://www.eia.gov/

US Environmental Protection Agency — https://www.epa.gov/

The White House Presidential Actions — https://www.whitehouse.gov/briefing-room/presidential-actions/

Viet Nam

Introduction

Viet Nam announced its commitment to achieving a net-zero carbon emissions target by 2050 in October 2021 at the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow. Simultaneously, Viet Nam pledged to reduce methane emissions by 30% from 2020 levels by 2030 and joined the Global Coal to Clean Power Transition Statement.

In October 2022, Viet Nam updated its nationally determined contribution (NDC), committing to reduce greenhouse gas (GHG) emissions by 15.8% below 2005 levels by 2030 with domestic resources. It is a significant increase in ambition to the prior commitment (2020 version). With financial support from international organisations, the GHG emissions reduction target will increase to 43.5% (NDC, 2022).

In recent decades, Viet Nam has been one of the fastest-growing economies in Asia, with a gross domestic product (GDP) growth rate of 6.4% per annum in the 2000–2020 period. The population was 99 million in 2021, with an urbanisation share of 37% (GSO, 2022). In 2020, Viet Nam's GDP reached just over USD 1 000 billion (2017 USD purchasing power parity [PPP]), marking a 2.9% increase from 2019 (World Bank, 2022).

According to the General Statistics Office, GDP in 2022 was estimated to increase by 8% compared to the previous year, achieving the highest growth since 2011 as a result of the economic recovery. Industry, construction, and service are significant sectors, accounting for approximately 95% of Viet Nam's GDP in 2022.

Natural resources are diverse, including coal, oil, natural gas and renewables, which is an advantage for Viet Nam (Table 1). The proven fossil energy reserves were 4.4 billion barrels of oil, 23 trillion cubic feet of gas and 3 360 million tonnes (Mt) of coal in 2019 (BP, 2022). Viet Nam has high potential in renewable energy, including hydro, solar, wind and biomass. The renewable energy share in the total primary energy supply (TPES) was 15% in 2020 (EGEDA, 2022), and it is expected to rise to 30% by 2045 (Politburo, 2020).

Table 1: Viet Nam's macroeconomic data and energy reserves

Key data [a, b]		**Energy reserves** [c]	
Area (million km^2)	0.33	Oil (billion barrels)	4.4
Population (million)	97	Gas (trillion cubic feet)	23
GDP (2017 USD billion PPP)	1 000	Coal (million tonnes)	3 360
GDP per capita (2017 USD PPP)	10 340	Uranium (kilotonnes U < USD 130/kgU)	-

Source: [a] GSO (2022); [b] World Bank (2022); [c] BP (2022)

Over the last few years, Viet Nam's energy sector has shifted from fossil fuel-based energy to cleaner energy to pursue climate goals, particularly in power generation. For instance, installed capacity from renewable energies (solar and wind energy) increased from 7% (3.4 GW) of the total generation mix in 2018 to 27% (21 GW) in 2022.

Simultaneously, the government of Viet Nam has prioritised energy security, resilience, and affordability for economic growth amid the recent global energy crisis and volatile energy prices.

In 2022, several energy-related policies were endorsed to accommodate the net-zero target, such as the National Climate Change Strategy to 2050, the Action Plan of the Ministry of Industry and Trade to implement Viet Nam's commitments at COP26, and the Scheme on Tasks and Solutions to Implement the Results of COP26.

Energy supply and consumption

Total primary energy supply

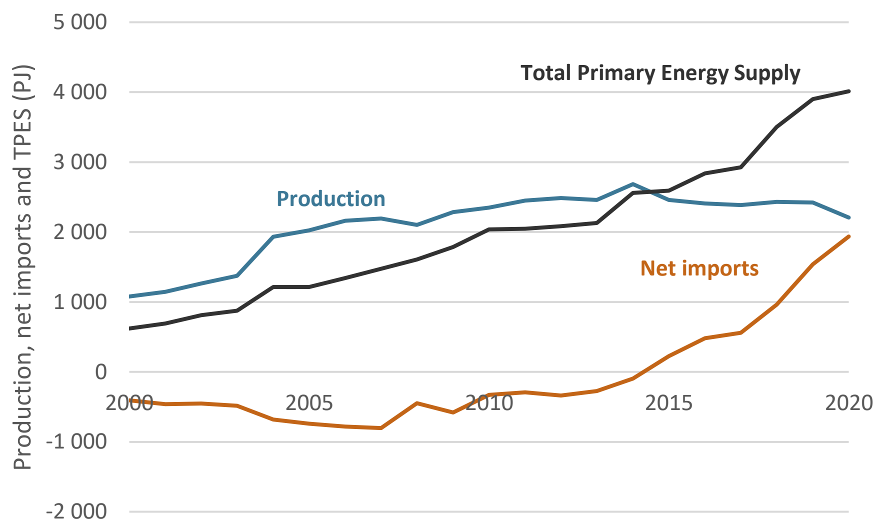
With a high economic growth target in coming years, ensuring energy sources is one of the top priorities of Viet Nam's government. Figure 1 illustrates that the TPES rose by a factor of 6.6 from 2000 to 2020, primarily driven by the high economic growth rate. In 2020, TPES rose only by 2.8% relative to the previous year due to the impacts of the COVID-19 pandemic, reaching 4 000 petajoules (PJ) (EGEDA, 2022).

Indigenous energy production declined by approximately 9% in 2020. The decline in 2020 was due to preventive measures against the spread of the COVID-19 virus, such as social distancing, quarantine, and isolation.

Energy production has fallen and plateaued recently after reaching a peak in 2014.

Viet Nam has abundant coal resources in the northern provinces, anthracite and semi-anthracite coal in Quang Ninh province, and sub-bituminous coal in the Red River Delta provinces (Thai Binh, Hai Duong, Hung Yen, Nam Dinh, Hai Phong and Ha Nam). Nevertheless, the domestic coal mining industry is constrained due to technical barriers such as complex geological conditions and deep coal seam formations. There are also economic barriers in that coal energy is uncompetitive compared to other resources. Therefore, coal has mainly been mined in the Quang Ninh coal basin. This region produces around 40 Mt of coal annually, accounting for approximately 90% of domestic coal production. Meanwhile, sub-bituminous coal in the Red River Delta area has not been mined yet due to technical and economic issues.

Figure 1: Viet Nam's energy supply, production, and net imports (PJ), 2000 to 2020



Source: EGEDA (2022)

Crude oil and natural gas are mainly extracted offshore in the south of Viet Nam. However, the crude oil production is expected to be depleted sometime before 2030. The significant recent development of natural gas is the Ca Voi Xanh project, located in the central provinces (Quang Nam and Quang Ngai). This is a joint venture project between the Exxon Mobil group and the Viet Nam National Oil and Gas Group and is expected to start commercial production in 2025 (Offshore Technology, 2021). It will supply gas-fired power and petrochemical plants in Viet Nam's central region, such as Mien Trung 1 and 2; Dung Quat 1 and 3.

Hydropower is the most important renewable energy source in Viet Nam and accounted for 29.3% of its electricity generation in 2020. Viet Nam aims to leverage hydro and other renewable sources to offset fossil energy through electrification to reach its net-zero target by 2050.

While Viet Nam was a net energy exporter for several decades, it has transitioned to a net energy importer since 2015 due to the high energy demand for economic growth. Energy imports have grown dramatically in recent years and are expected to continue to rise in the coming decades. Net imports increased by 26% from the previous year to 1 940 PJ in 2020, accounting for 48% of Viet Nam's TPES in 2020.

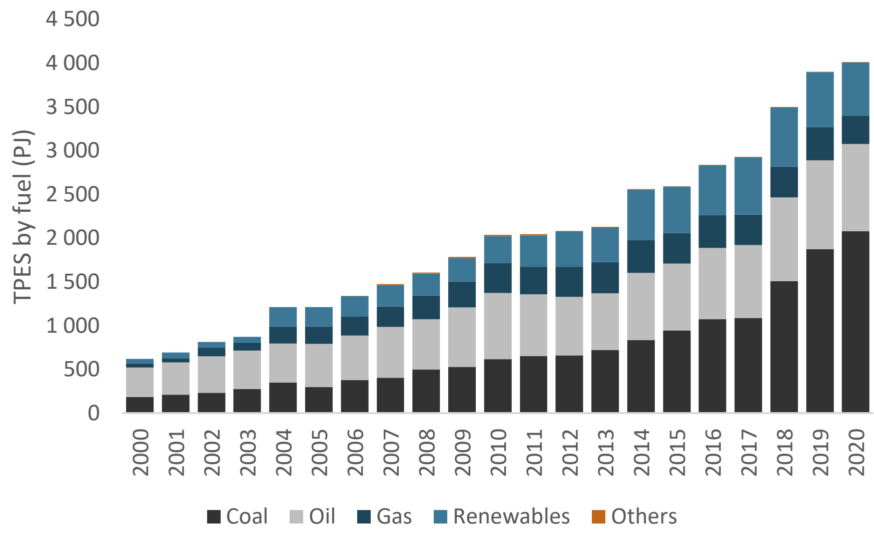
Viet Nam's TPES provided by fuel has continuously increased since 2000, surging in recent years (Figure 2). Coal supply rose approximately 11% from 1 870 PJ in 2019 to 2 080 PJ in 2020, accounting for approximately 52% of Viet Nam's TPES in 2020. However, oil and gas supply declined by 2% and 13%, respectively in 2020 compared to the previous year.

Renewables supply declined by 4.2%, from 631 PJ in 2019 to 605 PJ in 2020 (EGEDA, 2022). A surge in renewable energy projects in 2018 resulted from policies promoting renewable energy through a solar power feed-in-tariff (FiT) mechanism (Watson Farley, 2019). However, Viet Nam has faced several challenges that hinder the switching to renewable energy, such as insufficient smart grid technologies, storage systems and transmission lines capacity.

Consequently, most solar installations have been required to reduce their electricity output due to the limited capacity of the grid system in recent years.

Coal-fired power plants and energy-intensive industries (steelmaking, aluminium smelting, cement manufacturing and fertiliser production) have contributed to significant coal supply growth in recent years.

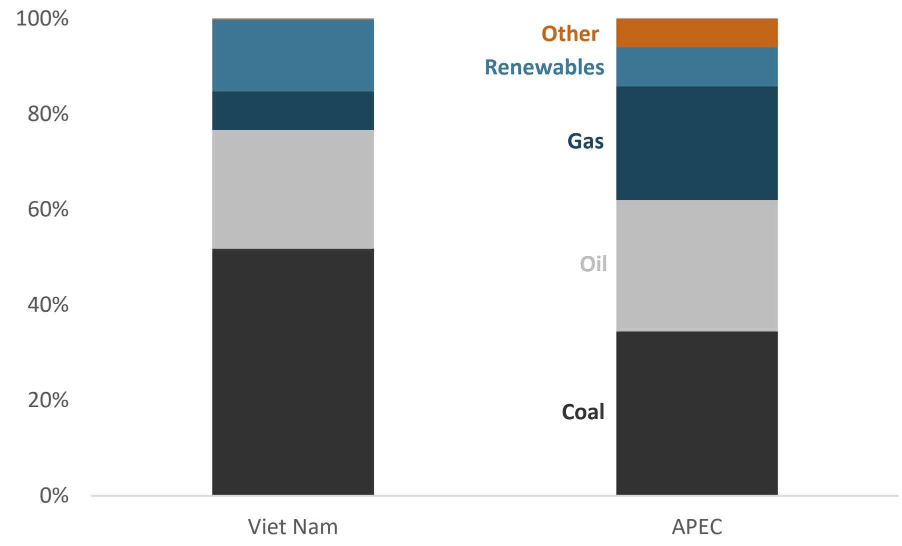
Figure 2: Viet Nam’s energy supply by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

Figure 3 shows the energy supply mix for Viet Nam and the APEC region in 2020. Coal has indeed dominated Viet Nam energy supply mix, accounting for over half of the energy supply mix (52%). This share is much more prominent than coal's share in the APEC region (35%). Oil's share in Viet Nam’s energy supply mix was approximately 25%, 2.6% lower than the APEC region's oil share. Furthermore, Viet Nam's gas share accounted for only 8.2% of the energy supply mix, much lower than the APEC gas share (24%). The renewables share accounted for 15% of Viet Nam's energy supply mix, almost double the APEC region's renewables share (8.2%).

Figure 3: Energy supply mix – Viet Nam and APEC, 2020



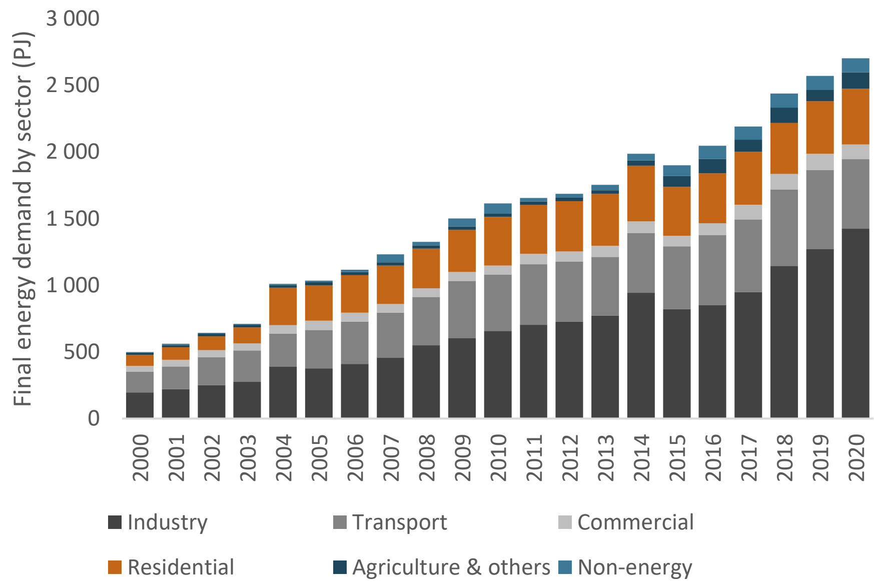
Source: EGEDA (2022)

Total final consumption

Viet Nam's total final consumption rose 5.4-fold over the 2000–2020 period (Figure 4). This large increase resulted from significant GDP and population growth. The total final consumption in 2020 was 2 700 PJ, a rise of 5.1% compared to the previous year.

The industrial sector was the dominant end-use sector, accounting for 53% of all end-use energy consumption (including non-energy) in 2020. The transport sector was the next largest, with a proportion of 19%. The commercial and residential sectors accounted for 4.1% and 15% of the total final consumption, respectively, while agriculture, forestry, fishery and others accounted for 4.5%.

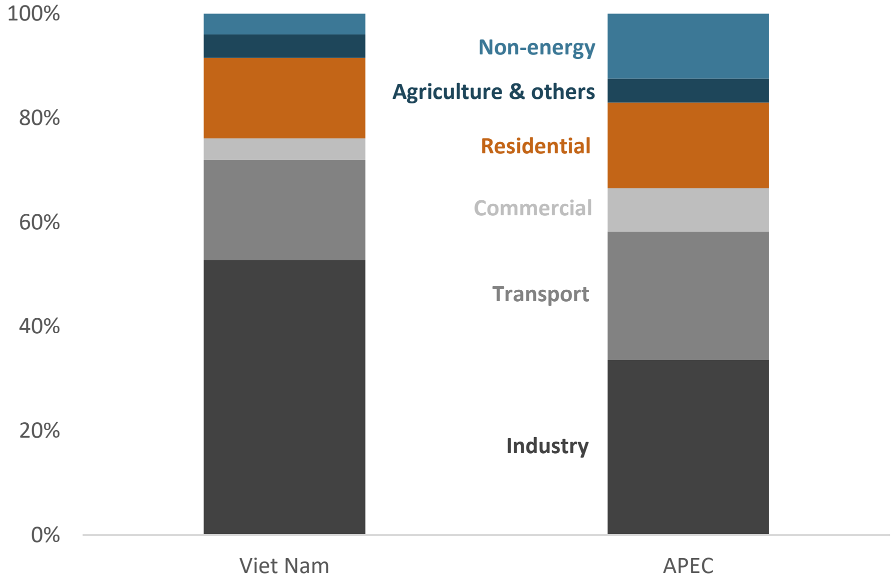
Figure 4: Viet Nam’s final consumption by sector (PJ), 2000 to 2020



Source: EGEDA (2022)

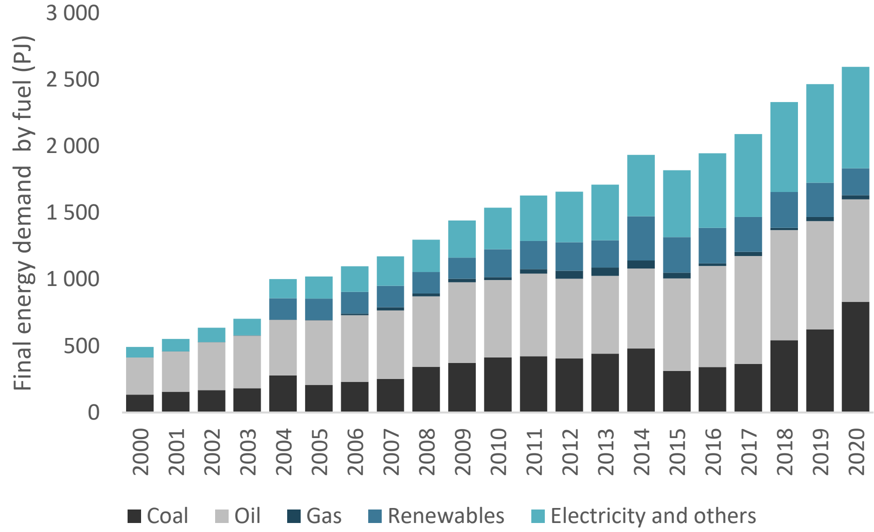
The final consumption by sector of Viet Nam and APEC in 2020 is depicted in Figure 5. Energy consumption for Viet Nam's industry accounted for over half of the total final energy consumption (53%), which was much higher than APEC's industry end-use energy consumption (34%). Viet Nam's extensive energy use in the industrial sector is driven by government policy to accelerate the industrialisation and modernisation process (Politburo, 2018). In contrast, the transport sector share of Viet Nam is lower than that of the APEC region.

Figure 5: Final consumption by sector, Viet Nam and APEC, 2020



Source: EGEDA (2022)

Figure 6: Viet Nam's final energy demand by fuel (PJ), 2000 to 2020



Source: EGEDA (2022)

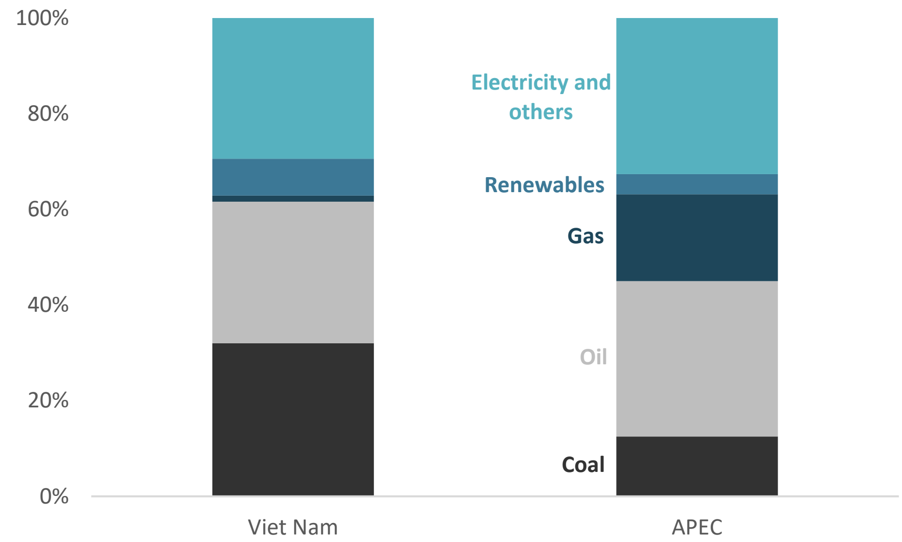
Note: does not include non-energy sector consumption of energy products

Final energy demand

In terms of final energy demand, the share of fossil fuels accounted for approximately 63% of Viet Nam's final energy demand in 2020 (Figure 6). Coal was consumed the most, accounting for almost one-third of the final energy demand (32%), followed by oil (30%). Electricity and others accounted for 29%, while gas accounted for only 1.3% of the final energy demand. Renewables' share was approximately 8% of Viet Nam's final energy demand.

While the coal share in Viet Nam's final energy demand was more than double that of APEC's coal share, its final demand share of oil was slightly lower than the APEC region's in 2020 (Figure 7). Gas demand amounted to only 1.3% of Viet Nam's final energy demand, which is much lower than its share of 18% for the entire APEC region. Viet Nam's renewables share was almost double that of the APEC region in 2020, while the share of electricity and others showed only a small difference between Viet Nam and APEC overall.

Figure 7: Final energy demand fuel share, Viet Nam and APEC, 2020



Source: EGEDA (2022)

Transformation

Power sector

Viet Nam Electricity (EVN) is an economy-owned group with significant control over power transmission and distribution systems. Viet Nam's power sector has one of the highest growth rates in electricity grids worldwide, with a power generation growth rate of approximately 10% per annum in the 2010–2020 period (EGEDA, 2022). Although the electricity grid is interconnected across the entirety of Viet Nam's geography, the different generation modalities tend to be congregated together. For instance, coal-fired power plants are mainly located in the north, while gas-fired power plants, solar and wind power plants are mostly located in the south.

In 2020, Viet Nam generated approximately 243 terawatt hours (TWh) of electricity, an increase of 2.5% from the previous year. Fossil fuel-based power generation (coal, oil and gas) accounted for nearly two-thirds of the total generation mix, followed by hydro (30%). Renewable generation and others constituted less than 5% of the total generation mix (EGEDA, 2022).

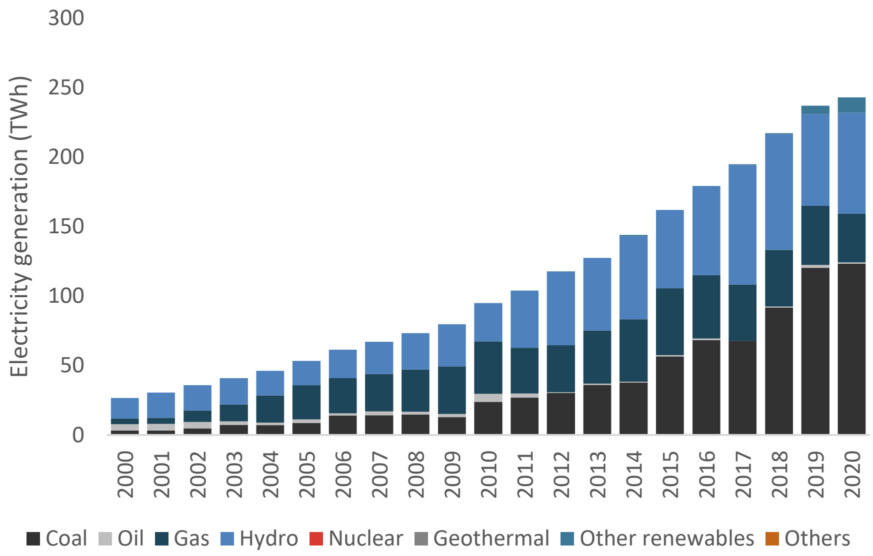
Viet Nam's power sector is increasingly reliant on coal. Over half of the electricity production (51%) was generated from coal in 2020, which represented an increase of nearly 18% per annum over the 2010-2020 period (EGEDA, 2022).

Hydropower plants are close to full utilisation, contributing 30.3% of the total electricity production in 2020. Other renewables, including small hydropower, biomass, solar, and wind power, accounted for 4.5% of the total generation mix.

Before 2018, only a small amount of solar and wind capacity was installed in Viet Nam. Thanks to the FiT mechanism, solar installed capacity increased substantially from 8 MW in 2017 to almost 16 600 MW in 2020 (EVN, 2021). Up to the end of 2021, the total solar and wind capacities together reached 20 600 MW, accounting for 27% of the total installed generation capacity.

Viet Nam is drafting the Power Development Plan for the 2021-2030 period with the vision to 2045 (PDP8), considering the 2050 net-zero carbon emission target, which was committed at COP26. According to the recent revision draft, Viet Nam plans to reduce the share of coal power generation and ramp up renewable generation, biomass, hydropower and energy storage.

Figure 8: Viet Nam's electricity generation by fuel, 2000 to 2020

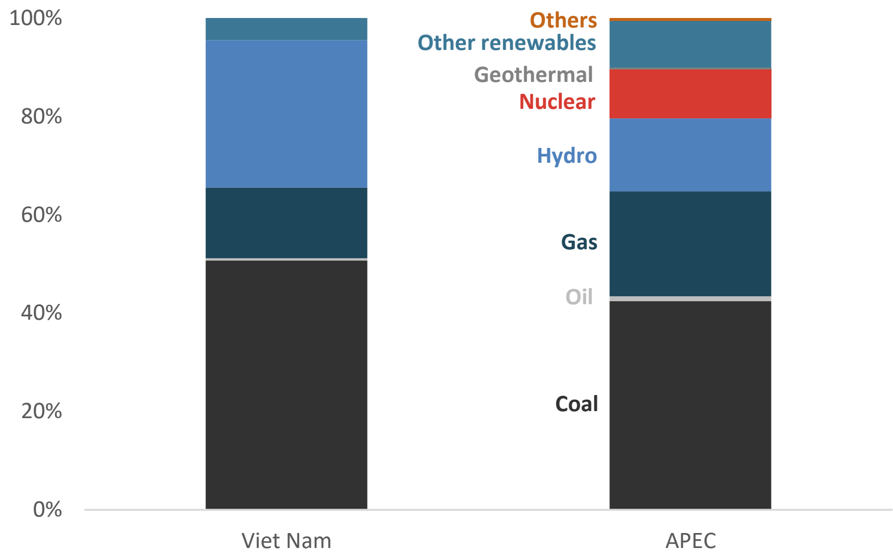


Source: EGEDA (2022)

Viet Nam's electricity share from coal in 2020 was 8.3% higher than the share for the entire APEC region (Figure 9). However, the share of gas in electricity generation for Viet Nam was much smaller than for APEC.

Hydropower accounted for the second-largest share of Viet Nam's electricity generation mix in 2020. Its share was approximately 30%, more than double that of APEC's hydropower share. Generation from other renewables in Viet Nam accounted for only half of the generation share of APEC's other renewables.

Figure 9: Electricity generation fuel share, Viet Nam and APEC, 2020



Source: EGEDA (2022)

Refining

Currently, Viet Nam has two refinery plants, namely Dung Quat and Nghi Son, with a refinery capacity of 16.5 Mtpa, meeting 70% of its oil product demand.

Dung Quat is the first refinery plant, commissioned in 2009 with a capacity of 6.5 Mtpa, and is operated by PetroVietnam, a subsidiary of the economy-owned Viet Nam Oil and Gas Group. The second one is the Nghi Son refinery plant with a capacity of 10 Mtpa, commissioned in 2018 and operated by Idemitsu Kosan (Japan).

Viet Nam is planning a schedule of expansions and new refineries to help meet rising refined product demand over the coming decades. According to the draft of the National Energy Master Plan for the

2021-2030 period with the vision to 2050, Viet Nam plans to expand its refining capacity to 15.3 Mtpa in 2026-30.

Energy transition

After announcing a net-zero carbon emissions target for 2050 at COP26 in 2021, the Viet Nam Government has updated current energy-related policies and issued several new policies related to GHG emissions and energy transitions.

These policies are: the National Climate Change Strategy to 2050 (2022); the Ministry of Foreign Affairs' Climate Diplomacy Action Plan aiming to implement Viet Nam's commitments at COP26 in the period 2022-2025 (2022); the Action Plan of the Construction Sector in Climate Change Response for the period 2022-2030, with a vision to 2050 in order to implement Viet Nam's commitments at COP26 (2022); the Action Plan of the Ministry of Industry and Trade to implement Viet Nam's commitments at COP26 (2022); the Scheme on Tasks and Solutions to Implement the Results of COP26 (2021); the Action Program on Green Energy Transition and Reduction of Carbon and Methane Emissions of the Transportation Sector (2022); and the Methane Emission Reduction Action Plan to 2030 (2022).

The above new policies focus on the potential solutions and measures for energy transitioning to cleaner energy while maintaining energy security, reliability, and affordability, particularly in the high GHG emissions sectors.

Emissions

As a developing economy that has just started a process of industrialisation and modernisation that will last a few decades, CO_2 emissions from energy-related sectors have increased six-fold over the last 20 years, reaching 273 Mt in 2020 from 45 Mt in 2000, mainly from the power, industry and transport sectors. The power sector is the most significant contributor to CO_2 emissions, accounting for over half of total energy-related CO_2 emissions. The industrial sector is the second-largest CO_2 emitter, followed by the transport sector. Although various policies related to CO_2 emissions reduction have been implemented in recent years, CO_2 emissions have continued to rise rapidly due to economic and population growth. Furthermore, being highly reliant on fossil fuels in the power and industrial sectors hinders the progress toward net-zero emissions.

In recent years, Viet Nam has implemented measures to reduce GHG in various sectors, especially the energy and industry sectors.

In the energy sector, enhancing renewable energy, energy efficiency and saving, and reducing transmission loss are major measures for GHG emission reduction, contributing to a reduction of 68 Mt CO_2eq in 2020 compared to the baseline year of 2014.

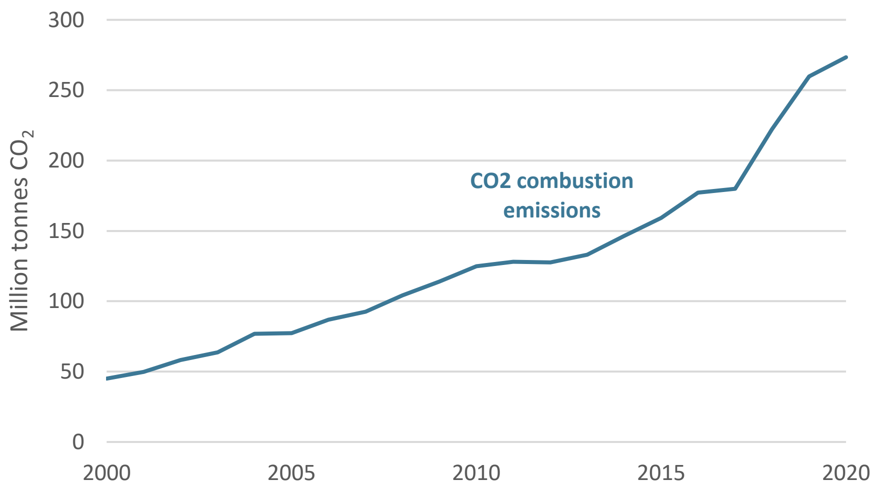
In the industrial sector, replacing clinker in cement composition and applying advanced technology in the chemical and steel industries are the key drivers to reducing carbon emissions in these sub-sectors. In 2020, a reduction of 4.06 Mt CO_2 eq was achieved in the mining, construction, and chemical industries (NDC, 2022).

Viet Nam first submitted its Intended Nationally Determined Contribution (INDC) in 2015 and signed and approved the Paris Agreement in 2016. After the Paris Agreement came into force on November 2016, the INDC became NDC. Viet Nam updated its NDC in 2020 and 2022. In the 2022 version, Viet Nam committed to reducing greenhouse gas emissions by 15.8% below 2005 levels by 2030 with domestic resources. This is a significant increase in ambition compared to the previous commitment in 2020. With financial support from international organisations, the GHG emission target will increase to 43.5%.

In December, Viet Nam and its international partners announced a NZD 16 billion package through the Just Energy Transition Partnership (JETP) program, designed to accelerate the reduction of carbon emissions and increase the uptake of renewable energy.

Using the budget package from JETP and domestic resources, Viet Nam aims to reduce CO_2 emissions from the power sector, reduce the number of existing coal-fired power plants, and develop more renewable generation capacity associated with the transmission grid, and a more effective energy infrastructure.

Figure 10: Viet Nam's CO_2 combustion emissions (million tonnes), 2000 to 2020



Source: EGEDA (2022)

Energy security

Viet Nam has become a net energy importer since 2015 and import dependency is expected to rise in the next decade, accounting for 53-60% of total primary fuels in 2030. Currently, Viet Nam is importing coal, crude oil and oil products and will import Liquefied Natural Gas (LNG) from 2023 forward. Therefore, energy security is one of the top priorities of the Viet Nam government.

A new Power Development Plan (PDP8) is currently being drafted, with substantial changes in the share of fuels for power generation. Due to the high energy prices and imported energy dependence, the Viet Nam government plans to dramatically reduce new LNG-fired and coal-fired power capacities in the latest revision (December 2022) compared to the previous revision (March 2021). This action shows that the Viet Nam government is working to ensure energy security to avoid global supply chain disruption due to geopolitical and extreme weather issues.

Energy import dependency is affected by global energy prices. By reducing the amount of imported energy, Viet Nam's energy system will face less risk due to price volatility. Therefore, diversification of domestic energy sources would also avoid the risk of global supply disruption. Viet Nam plans to expand offshore wind power generation, biomass generation, ammonia, and hydrogen production from renewable energy.

APEC energy goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective – to improve energy intensity and double the share of modern renewables.

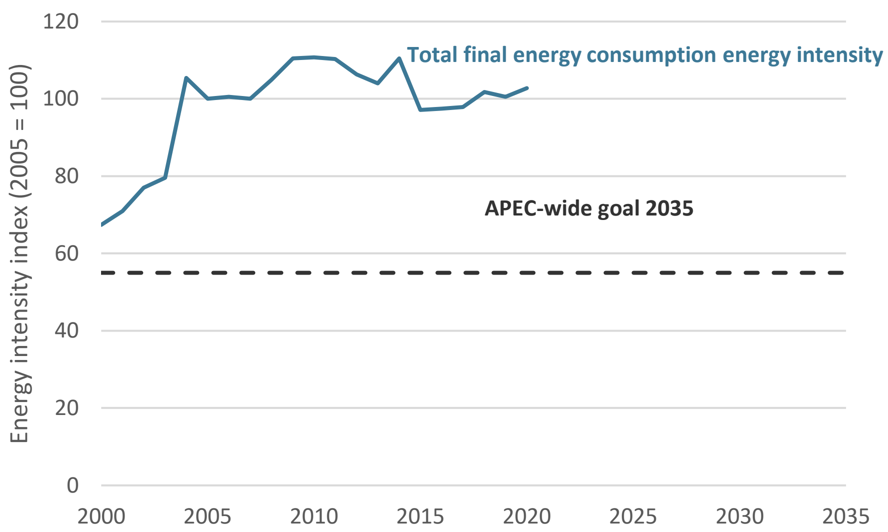
Energy intensity goal

In 2011, APEC member economies agreed to increase their target to reduce energy intensity by 45% in 2035, relative to a 2005 baseline.

The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieve this energy intensity improvement. The goal does not impose individual economy targets, but it is possible to track the progress of individual APEC economies relative to the overarching proportional improvement.

Figure 11: Viet Nam's total final energy consumption intensity index, 2000 to 2020 (2005 = 100)



Source: EGEDA (2022)

Viet Nam deployed the National Energy Efficiency Program and the Law on Energy Efficiency and Conservation in 2006 and 2010, respectively (NAVN, 2010; PMVN, 2006). However, its final energy consumption intensity is still high compared to other economies.

Viet Nam's total final energy consumption intensity improved by 7.2% between 2010 and 2020 due to the higher increase in GDP compared to energy consumption (Figure 11). In this period, Viet Nam's GDP annual growth rate was 6.2%, while there was a 5.4% growth rate in total energy consumption.

However, the energy intensity of the economy is still considerably higher than in the neighbouring economies. Viet Nam has approved the Program on Economic and Efficient Use of Energy for 2019–2030, with a target of saving 8–10% of economy-wide energy consumption and ensuring electricity loss is below 6% (PMVN, 2019). This program will partly contribute to APEC's aspirational target of reducing energy intensity.

Doubling of renewables

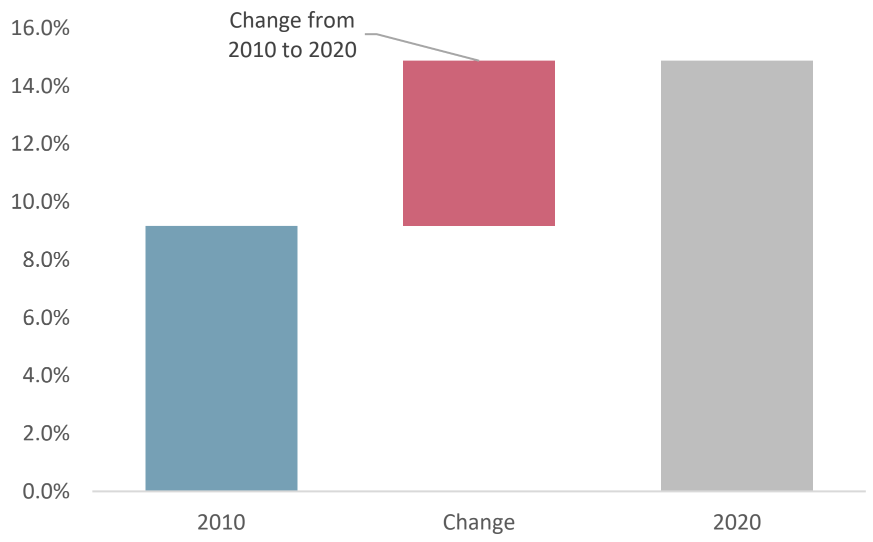
The second energy goal involves doubling the share of modern renewables in the APEC energy mix for the period 2010 to 2030. There is no economy-level goal for individual member economies, but improvements by individual economies will contribute to the doubling goal.

Viet Nam is starting from a higher renewable base than the wider APEC region, as its renewable share in 2010 was 9.2% (Figure 12), while APEC's was 6%. In 2020, the proportional share reached 15%, which is 1.6 times greater than 2010.

According to the Development Strategy of Renewable Energy of Viet Nam by 2030 with a Vision to 2050, the share of modern renewables will reach 32% by 2030 and 44% by 2050 (PMVN, 2015). This growth will contribute to APEC meeting its goal of doubling its renewables share by 2030.

With a net-zero emission target in 2050, Viet Nam aims to boost the uptake of renewable energy in the upcoming Power Development Plan (PDP8). Having a high potential for renewables, Viet Nam can achieve more than 90% penetration of domestic solar and wind power and pumped storage hydropower in its electricity mix at a competitive cost. The momentum for ramping up renewable energy uptake could be built on the economy's early success in solar and onshore wind power development, making it a leader in Southeast Asia.

Figure 12: Viet Nam modern renewable energy share, 2010 and 2020

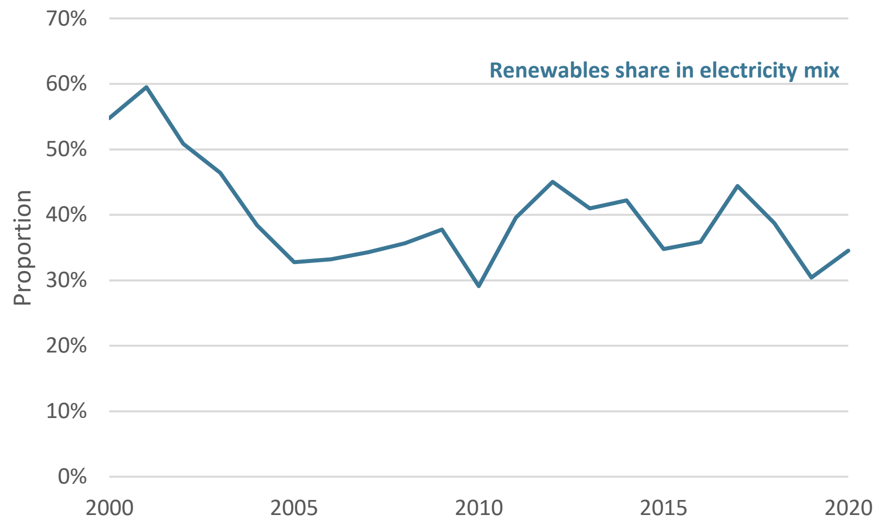


Source: EGEDA (2022)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Viet Nam has 475 GW of offshore wind power technical potential within 200 km of the coastal line, equal to about eight times Viet Nam's total installed power capacity as of 2020. According to the World Bank, by substituting coal power with 25 GW of offshore wind power by 2035, Viet Nam could reduce CO_2 emissions by about 200 Mt, approximately one-third of the total emissions in energy sectors under the business-as-usual scenario (East Asia Forum, 2021).

Figure 13: Viet Nam's renewable generation share, 2000 to 2020



Source: EGEDA (2022)

In Viet Nam, the proportion of electricity output from renewables has declined substantially from 55% in 2000 to 35% in 2020 (Figure 13). The notable reduction was due to the limited capacity of existing large-scale hydropower generation, while geographical conditions and environmental factors constrained the construction of new large-scale dams.

Although solar and wind generation in recent years has been accelerating, it has not been enough to offset the reduction from large-scale hydro generation.

Energy policy

Energy policy	Details	Reference
Politburo's Resolution No. 55 on Viet Nam's National Energy Development Strategy to 2030, with a vision to 2045	The resolution provides for the prioritisation of fast and sustainable energy development while fostering favourable conditions for all economic sectors, particularly the private sector, to participate in energy development.	Communist Party of Viet Nam
Nationally Determined Contribution (2022 version)	Viet Nam will reduce greenhouse gas emissions by 16% compared to Business as usual (BAU) by 2030 with domestic resources. However, this 16% contribution could be increased to 44% if international support is received through bilateral and multilateral cooperation.	United Nations Framework Convention on Climate Change
Law on Economical and Efficient Use of Energy	This law ensures economical and efficient use of energy; provides policies and measures to promote economical and efficient use of energy; and sets out the rights, obligations and responsibilities of organisations, households, and individuals in regard to economical and efficient use of energy.	Viet Nam Government Portal
Petroleum Law	This law prescribes activities of petroleum prospection, exploration, and exploitation within the territory, exclusive economic zone and continental shelf of the Socialist Republic of Viet Nam.	Viet Nam Government Portal
Electricity Law	This law covers electricity development planning and investment, electricity-saving, electricity markets, rights and obligations of organisations and individuals conducting electricity activities and using electricity, protection of electric equipment and facilities, electricity works and electric safety.	Viet Nam Government Portal
Law on Environmental Protection	This law provides statutory provisions on environmental protection activities, measures and resources used for the purpose of environmental protection, rights, powers, duties, and obligations of regulatory bodies, agencies, organisations, households, and individuals who are tasked with environmental protection tasks.	Ministry of Natural Resources Environment
Viet Nam's National Energy Development Strategy to 2020, with a Vision to 2045	This strategy addresses the Vietnamese government's energy development views, objectives, policies, and measures to achieve the 2050 vision.	Centre Database on Legal Normative Documents
Development Strategy of Renewable Energy (2015)	The share of produced electricity from renewable energy (including both small and large hydro) in the total economy-wide electricity production should reach about 32% by 2030 and about 43% by 2050.	Viet Nam Government Portal
National Program on Economical and Efficient Use of Energy for the Period 2019–2030	To promote the economical and efficient use of energy by means of management duties and solutions, technical assistance, scientific and technological research, product development, market transformation, human resource training and development.	Viet Nam Government Portal

National Strategy for Environmental Protection to 2020, vision to 2030	This involves controlling and limiting environmental pollution levels, reduction of natural resources and biological diversity, continuing to improve the environment and enhancing the capacity to cope with climate change towards sustainable development.	Viet Nam Government Portal
Development Plan of the Gas Industry of Viet Nam by 2025 with a Vision to 2035	This includes development of the gas industry sector in all stages, organised in a complete and uniform manner, including extraction, gathering, transport, processing, storage, distribution of gas and import and/or export of gas products across the economy. It also ensures that gas production from the blocks/gas fields of the Viet Nam Oil and Gas Group and oil and gas contractors operating in Viet Nam is fully collected.	Viet Nam Government Portal
Master Plan for Viet Nam's Coal Industry Development to 2020 and Vision towards 2030	The plan will develop Viet Nam's coal industry to make it more competitive by applying technological advances to coal exploration, mining and preparation, processing and trading. The plan will also ensure the sufficiency of coal resources to meet the domestic consumption demand, especially for the thermal power industry.	Viet Nam Government Portal
Support Mechanism for Development of Biomass Power Projects in Viet Nam	The policy provides the support mechanism for the development of projects generating power using biomass energy in Viet Nam.	Viet Nam Government Portal
Viet Nam's Industrial Development Strategy through 2025, a Vision towards 2035	This provides the overall objectives and specific targets to develop the industrial sector, including economy-owned, private, and foreign-invested sectors. Focuses on agricultural and rural industrialisation and modernisation.	Viet Nam Government Portal
National Climate Change Strategy to 2050 (2022)	The strategy sets the overall targets to minimise the effects or damage caused by climate change, reaching net-zero emissions by 2050. The greenhouse gas emissions peak is expected to be reached by 2035.	Viet Nam Plus
National Green Growth Strategy for the period 2021-2030, with a vision by 2050 (2021)	The strategy focuses on the efforts to restructure the economy in conjunction with renewing the growth model, reducing greenhouse gas emission intensity, striving towards a green and carbon neutral economy.	FAO
Viet Nam's Action Plan on Methane Emissions Reduction by 2030 (2022)	The action plan targets methane emissions in cultivation, animal husbandry, solid waste management, wastewater treatment, oil and gas exploitation, coal mining and fossil fuel consumption. Total methane emission volume should not exceed 96 million tonnes of CO_2 equivalent in 2025, down 13% from 2020.	Viet Nam Plus
Solutions to implement the Scheme on tasks and solutions to implement the results of COP26 (2022)	Decision 888/QD-TTg approved in 2022, defining the tasks and solutions to implement the results of the 26th Conference of the Parties to the Convention of the United Nations framework on climate change in Viet Nam.	Law Net

Notable energy developments

Energy development	Details	Reference
Viet Nam made a political declaration on the Fair Energy Transition Partnership (JETP) with G7 economies and partners	On 14 December 2022, representatives of Viet Nam and the G7 economies, and development partners of the European Union, Norway and Denmark approved a political declaration establishing the JETP to support Viet Nam's transition from fossil fuels to renewable energy in order to achieve net-zero emissions by 2050. The program will initially mobilise a climate finance package of about USD 16 billion from the public and private sectors during the next three to five years to support some of Viet Nam's new ambitious goals, including targets to reduce coal-fired power, and accelerate renewable energy projects, and may achieve the greenhouse gas emission reduction target five years earlier than planned.	Viet Nam Energy
Viet Nam's renewable generation output exceeds the thermal power output	The domestic output and import electricity in 2022 was 268 billion kWh, of which hydropower output increased by 21% compared to 2021 due to good water in the lakes and the mobilisation of power generation in accordance with inter-lake regulation. The stable operation of the wind and solar generation plants led to reduce the coal power. In 2022 as a result, electricity output from renewable energy plants (including hydropower plants) exceeded output from thermal power.	Viet Nam Energy
Amendment of the Petroleum Law	The amended Petroleum Law more clearly stipulates the role of management and investors (contractors), thereby upgrading PVN's proactive role in investment approval and appraisal activities, including technical and commercial approvals such as: exploration, drilling programs and field development plans (ODP/FDP), economic estimate and investment report. This is the premise for PVN to develop a series of key projects and gather all offshore fields as soon as the Petroleum Law (amended) takes effect from July 2023, as a growth lever for the entire industry.	Viet Nam Energy
Strategy for developing hydrogen and offshore wind power projects in Viet Nam	The Viet Nam Oil and Gas Group (PVN) and the Asian Development Bank signed a Memorandum of Understanding on building a strategic partnership in 2021 – 2024 to promote clean and sustainable energy development in Viet Nam, as well as to help PVN to achieve the green energy transition goal. Specifically, the two sides will cooperate in strategy; in producing a roadmap for green energy transition; in carbon capture, use and storage; and in developing the hydrogen industry and offshore wind power projects.	Viet Nam Energy
Viet Nam fosters shift to renewable energy	With an emphasis on sustainable power, the Vietnamese government has enacted several procedures and regulations to foster an equitable energy transition.	Viet Nam Investment Review

Useful links

Government of Viet Nam—http://chinhphu.vn/portal/page/portal/chinhphu/trangchu

Ministry of Industry and Trade—http://www.moit.gov.vn/

National Energy Efficiency Program (VNEEP)—http://vneec.gov.vn/

Electricity Regulatory Authority of Viet Nam (ERAV)—http://www.erav.vn/

National Load Dispatch Centre (NLDC)—https://www.nldc.evn.vn/

Viet Nam Electricity (EVN)—http://www.evn.com.vn

Energy Savings—https://tietkiemnangluong.evn.com.vn/

Viet Nam Energy—http://nangluongvietnam.vn

Viet Nam Oil and Gas Group (PVN)—http://www.pvn.com.vn

Viet Nam National Petroleum Group (Petrolimex)—https://petrolimex.com.vn/

Viet Nam National Coal and Mineral Industries Holding Corporation Ltd (Vinacomin)—http://www.vinacomin.vn/

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