



**Asia-Pacific
Economic Cooperation**



APEC ENERGY OVERVIEW 2022



APERC

Asia Pacific Energy Research Centre

DISCLAIMER

The views and opinions expressed in this publication belong solely to the authors. The expert group on energy data and analysis focal points and energy working group members of the respective economies were consulted to ensure the veracity of the information within.

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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 in showcasing the latest APEC energy data compiled by the Expert Group on Energy Data and Analysis (EGEDA) for 20 years.

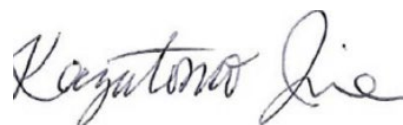
The Overview relies on APEC data to monitor progress toward the two APEC energy goals, namely:

1. To improve energy intensity by 45% by 2035 (relative to 2005)
2. To double the renewable energy share in the APEC energy mix by 2030 (relative to 2010)

By 2019, APEC-wide energy intensity had improved by 25.1%, leaving an additional 19.9% improvement needed to meet the 2035 goal. Assuming these trends on final energy consumption and GDP continue, APERC forecasts that APEC's goal of 45% energy intensity reduction will be achieved before 2035. Progress has also been made in doubling the share of modern renewables in the energy mix by 2030 from 2010. The modern renewable share of final consumption has increased from 6.14% in 2010 to 9.1% in 2019. Given the fast growth of renewables utilisation, the APEC renewable share doubling goal in final energy demand is likely to be achieved before 2030.

The economy chapters of the Overview also discuss policies, initiatives, and notable developments that are contributing to each economy's continued growth and development with respect to energy.

The basis of this report is the EGEDA data that each member economy submits on an annual basis. We thank APEC member economies for their continued support in providing us these data. We also encourage them 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 analysis.



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The *APEC Energy Overview 2022* 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 those named below who contributed to the successful completion of this publication.

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Commonly used abbreviations and terms

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

Currency codes

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

APEC ENERGY OVERVIEW

2022

Introduction

This year’s APEC Energy Overview provides a detailed summary and analysis of energy supply, transformation, and final consumption for the period 2000 to 2019, as well as an up-to-date accounting of energy policies and notable energy developments to 2022, for each APEC member economy. A summary of net-zero commitments is also provided.

Energy supply and consumption

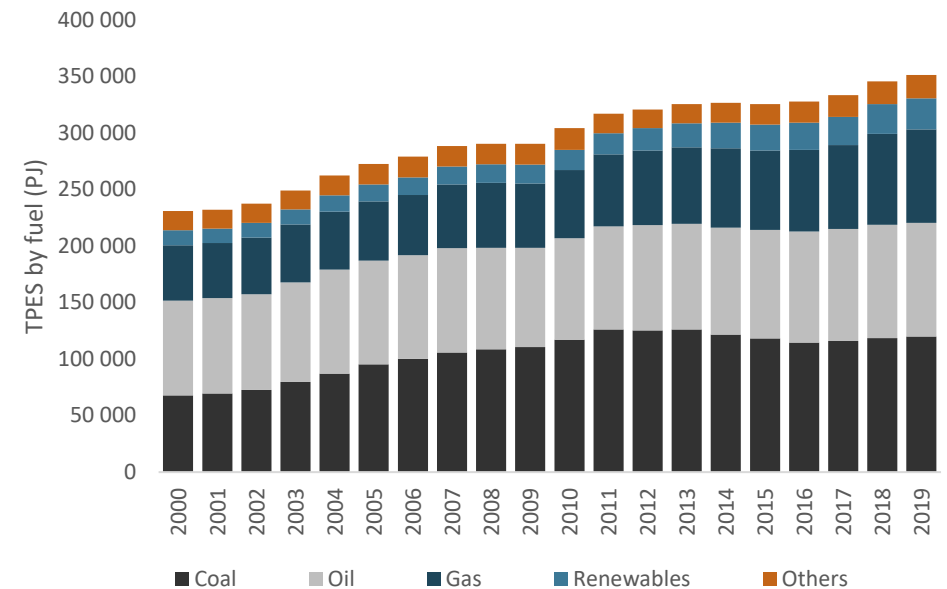
Total Primary Energy Supply

The 21 economies that comprise APEC accounted for almost 55% of global output in 2019 (PPP constant 2017 USD). Immense quantities of energy are required to support this economic activity. In 2019, APEC energy supply increased by over 5 500 PJ (1.7% annual increase) to reach more than 351 000 PJ (Figure 1).

Most of the growth in energy supply was attributable to natural gas (41% contribution), followed by coal (25%), and renewables (17%). Renewables supply remains relatively small (less than 8% share of supply), though has grown by the fastest rate (almost 5% per annum), for the previous decade.

Fossil fuels accounted for 86% of the APEC energy supply in 2019, which is only slightly lower than the 87% share in 2000. Coal surpassed oil to become the most prominent source of supply in 2005, peaking at a 40% share in 2011. Its share has since fallen to just over one-third of supply in 2019, though absolute levels of coal have increased for the three most recent years in the data.

Figure 1: APEC total primary energy supply by fuel, 2000 to 2019



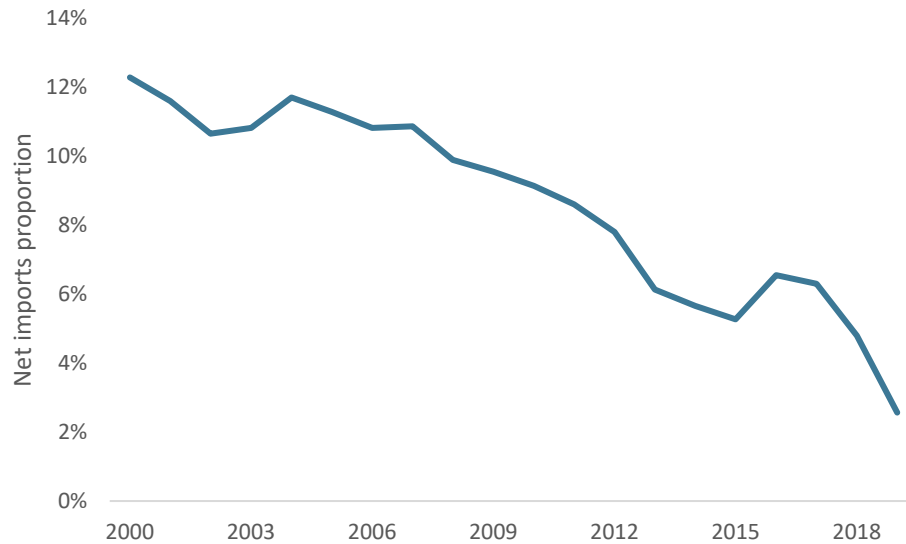
Source: EGEDA (2021)

APEC has been a consistent net importer of energy for multiple decades. However, the share of net energy imports to energy supply has been falling, from over 10% in the early 2000s to less than 3% in 2019 (Figure 2). While the APEC region at large is a net importer, the United States, and the group of southeast Asia economies, both transitioned to becoming net exporters of energy in 2019. The transition for the United States is the culmination of the very large increase in shale oil and gas production that occurred through the 2010s.

China remains the dominant counterweight to the trend in the United States, with a net energy import position that doubled from 2010 to 2019, to more than 30 000 PJ. Japan (almost 16 000 PJ) and Korea (10 000 PJ) were the next largest net energy importers in 2019. Russia was the largest net energy exporter (more than 30 000 PJ) in 2019,

followed by Australia (almost 13 000 PJ), Indonesia (over 10 000 PJ), and Canada (almost 10 000 PJ).

Figure 2: APEC net energy imports as a proportion of supply, 2000 to 2019



Source: EGEDA (2021)

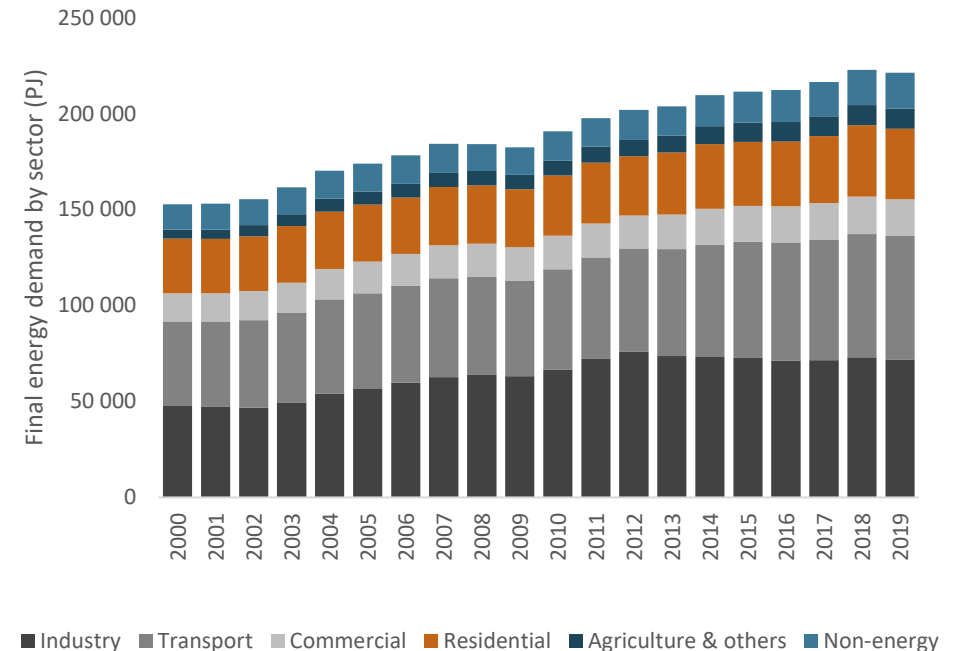
Total final consumption

Total final consumption (which includes consumption of energy commodities by the non-energy sector) fell 0.7% to 221 000 PJ in 2019. The industry sector has accounted for the largest share of APEC energy consumption for the last two decades, peaking at a 38% share in 2012. The increasing prominence of industry through the 2000s is largely associated with China’s economic development. The rapid urbanisation associated with this development has relied on very large quantities of steel, cement, and other industrial products. China’s industrial energy consumption has also increased due to its prominent

role in global manufactured goods supply chains.

Since 2012, APEC industrial energy consumption has maintained a high plateau, with China beginning to transition to a more services-based economy. Part of the fall in China’s industrial energy consumption has been offset by a rise in industrial activity from rapidly developing economies in southeast Asia. Industry accounted for 32% of APEC energy consumption in 2019 (Figure 3).

Figure 3: APEC final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

The transport sector consumes large quantities of energy to move things and people within APEC economies. The increasing consumption over the past two decades is associated with rising living

standards, and greater levels of mobility. In 2019, transport accounted for 29% of APEC energy consumption. In contrast to industry, the share of transport in energy consumption has been increasing for most of the 2010s. The buildings sector (residential and commercial sectors combined) accounted for a quarter of APEC energy consumption in 2019. Residential energy consumption is almost twice as large as commercial consumption (Figure 3).

The non-energy sector, which relies on energy commodities such as natural gas and oil products as a building block for things like fertilisers and plastics, accounted for 8% of APEC energy commodity consumption in 2019. Agriculture and other relatively small energy consuming parts of the APEC economy accounted for 5% of consumption.

Transformation

The APEC transformation sector is instrumental in converting primary energy supply into end-use energy consumption products. For example, transforming crude oil into the suite of refined petroleum products that support transport activity, or the use of blast furnaces to convert coking coal into coke, used to produce steel.

The power sector is the most prominent component of APEC energy transformation, consuming primary energy fuels (including renewable energy such as solar radiation and wind energy) and converting that embedded energy into electricity.

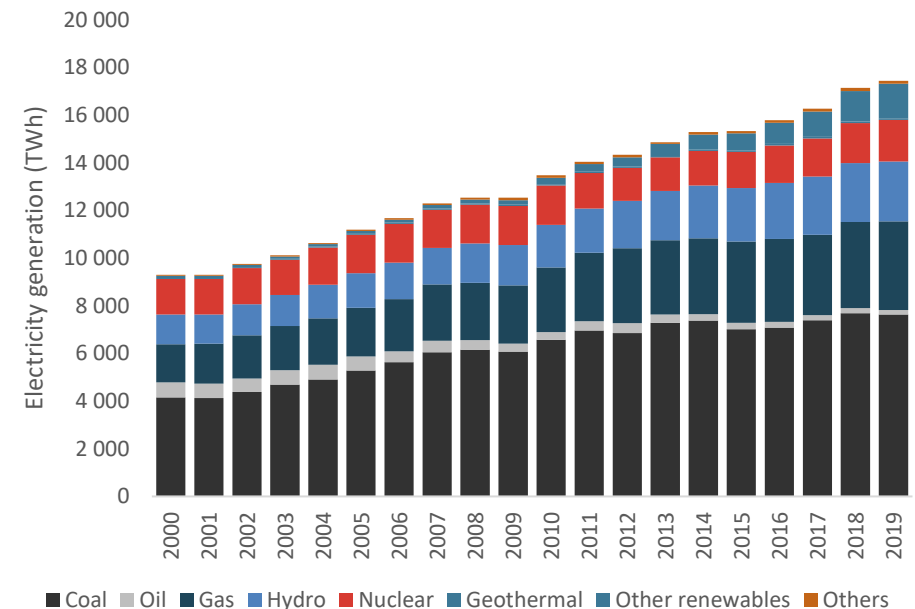
The power sector

APEC power generation increased to 17 436 TWh in 2019, which was a 1.7% annual increase. This was a significant slowdown in growth from the 5.3% annual increase that occurred in 2018. The global move to low carbon technologies is currently re-shaping the APEC generation

mix. However, fossil fuel generation remains dominant.

Coal-fired power peaked at a 50% share of APEC generation in 2011 and has since fallen to a 44% share in 2019. Natural gas is a less emissions intensive generation fuel and has increased from a 17% share of generation in 2000 to more than 21% in 2019. Fossil fuels accounted for two-thirds of the APEC generation mix in 2019, which is a decline from the peak of almost 73% in 2011 (Figure 4).

Figure 4: APEC electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

Nuclear generation fell significantly in 2011, following the Fukushima Daiichi nuclear power plant accident in Japan in 2011. There has been a subsequent policy shift away from nuclear in multiple APEC economies, though APEC nuclear has been increasing since 2013 due mostly to an increase in nuclear power in China and Russia.

Hydro power has been a prominent source of renewable generation for many decades in multiple APEC economies. Hydro generation has been increasing at a similar rate to total electricity generation, accounting for a more than 14% share of APEC generation in 2019.

Wind and solar generation technologies are being deployed rapidly throughout APEC, partially due to policy support and partially due to an increasingly competitive cost structure, so long as there is sufficient back-up capacity to account for their variable generation characteristics. Solar and wind account for most of the growth in the other renewables category (Figure 4), which has grown by over 20% per year from 2010 to 2019. Other renewables (mostly solar and wind) generated 1 453 TWh in 2019, which was an 8% share of the APEC generation mix.

The slowdown in energy demand growth, combined with a shift in the power mix away from coal and toward natural gas and renewables, has contributed to a significant reduction in emissions. APEC CO₂ emissions fell from 20 027 gigatonnes (Gt) in 2018 to 19 588 Gt in 2019, a fall of 2.2% (ESTO, 2021).

APEC energy goals

Energy intensity improvement

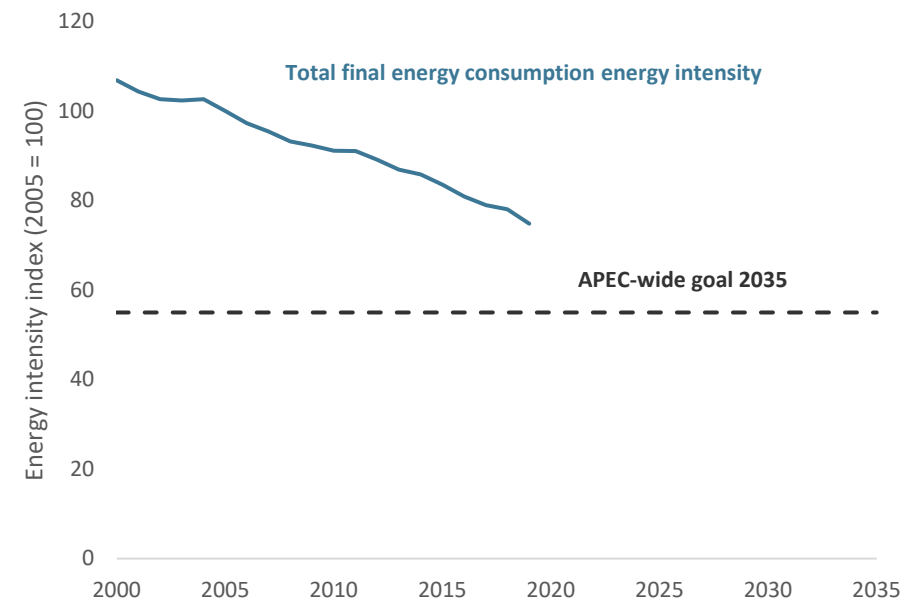
In 2011, APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

As of 2019, APEC-wide final energy intensity has improved 25.1%, leaving an additional 20% improvement needed to meet the 2035 goal. APEC is on track to achieve this energy intensity improvement (Figure 5), and this is substantiated by results from the forthcoming 8th edition

of the *APEC Energy Demand and Supply Outlook* (the Outlook). The APEC region is projected to achieve the energy intensity improvement in both the Reference and Carbon Neutrality modelled scenarios that are constructed in the Outlook.

The observed improvement in energy supply intensity (not shown here) is very close to the observed improvement in energy demand intensity (Figure 5).

Figure 5: APEC total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



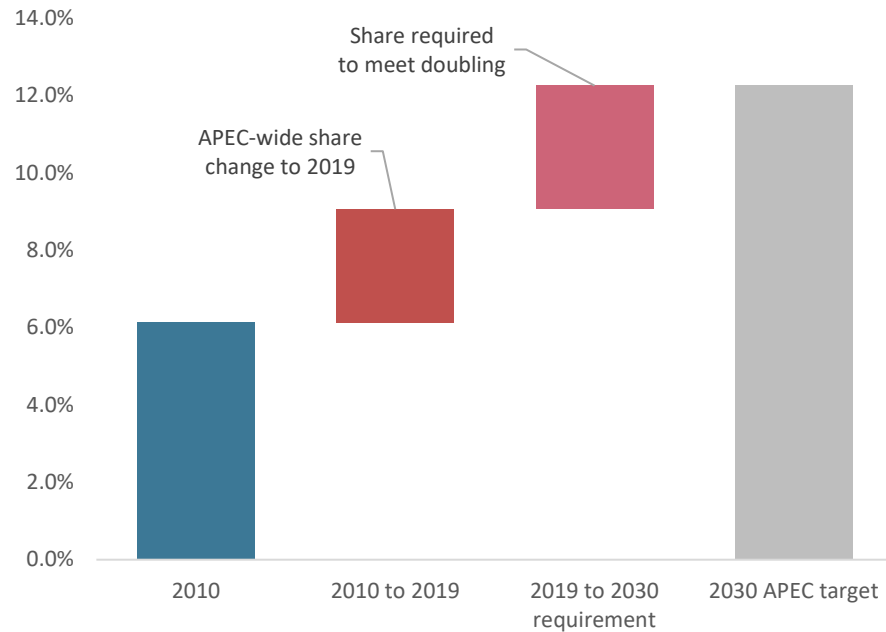
Source: EGEDA (2021)

Doubling 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 used in developing regions in the residential sector and is associated with adverse 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.

Figure 6: APEC modern renewable energy share in final energy consumption, 2010 through to 2030



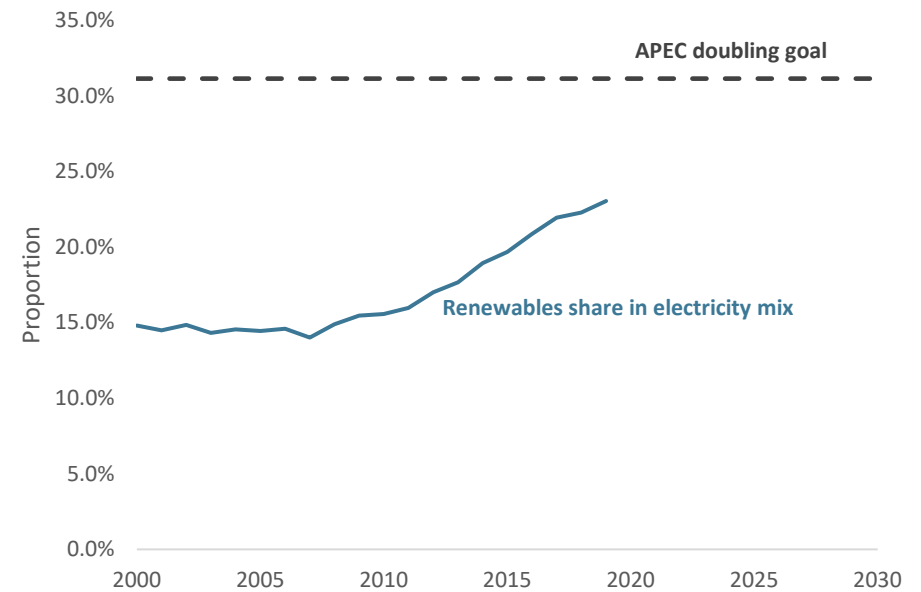
Source: EGEDA (2021)

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, biofuels, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

The modern renewables share of final consumption has increased from

6.1% in 2010 to almost 9.1% in 2019, which is a 48% improvement. This means that APEC is on track to double its share of modern renewables by 2030 (Figure 6).

Figure 7: APEC renewable energy share of the generation mix, 2000 to 2030



Source: EGEDA (2021)

The share of renewables in the APEC generation mix has increased from 15.6% in 2010 to over 23% in 2019. A significant increase has begun to compound from the late-2000s due to the advancements in solar and wind technologies, policy support for these technologies, and improving cost structures that mean they can be part of a portfolio of generating assets that deliver lowest cost electricity in many APEC economies. The share will need to increase by an additional 8% by 2030 to achieve a doubling (Figure 7).

Carbon neutrality

Many APEC economies have made net-zero/carbon neutrality commitments, with a significant amount of activity in this domain in the lead up to the October 2021 United Nations Climate Change Conference (COP26) in Glasgow.

Table 1: Net zero/carbon neutrality commitments by APEC economies, as of June 2022

Economy	Net-zero by:	Commitment
Australia	2050	In policy document
Canada	2050	In law
Chile	2050	In policy document
China	2060	In policy document
Hong Kong, China	2050	Declaration/pledge
Indonesia	2060	Proposed/in discussion
Japan	2050	In law
Korea	2050	In law
Malaysia	2050	Declaration/pledge
New Zealand	2050	In law
Papua New Guinea	2050	Proposed/in discussion
Peru	2050	Proposed/in discussion
Russia	2060	In law
Singapore	2050	In policy document
Chinese Taipei	2050	In policy document
Thailand	2050	Declaration/pledge
United States	2050	In policy document
Viet Nam	2050	Declaration/pledge

Source: Net Zero Tracker (2022)

Economy chapters

Australia

Introduction

In October 2021, Australia announced a commitment to achieving net-zero emissions by 2050 as part of the lead-up to the UN Climate Change Conference of the Parties in Glasgow (COP26). The commitment relies primarily on technological innovation supported by an investment roadmap rather than direct emissions policies.

Australia’s population growth has slowed dramatically following the COVID pandemic, with the otherwise large net overseas migration turning negative for the first time since World War II (ABS, 2021). The reduced labour supply has generated upward pressure on wages, though real pay rises remain modest. Gross domestic product (GDP) partially recovered after the initial early-2020 economic shock but the recovery faltered when Australia was subject to its first bouts of unconstrained spread of the delta strain of the virus in mid-2021. High vaccination rates and lower COVID severity associated with the omicron strain mean that it will be unlikely that Australia is subjected to additional hard lockdowns.

Australia has abundant, high-quality thermal and metallurgical coal resources that will last for many decades at the current rates of production. Natural gas reserves are also large, though the very high current production levels that feed LNG exports will see total proved reserves depleted in less than two decades (BP, 2021). Australia’s oil reserves are less plentiful, accounting for approximately one-thousandth of global reserves. Uranium reserves are the largest in the

world.

Australia is the world’s fourth largest energy exporter, with 85% of energy production destined for overseas markets. Coal and natural gas are the second and third largest export categories behind iron ore, and account for almost AUD 80 billion, or one-fifth of Australia’s total exports in 2020. Energy export volumes were only slightly down in 2020, though a large fall in energy commodity prices meant that total export revenue for coal and gas fell by 30%.

Table 1: Australia’s 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)	25.7	Gas (trillion cubic feet)	84
GDP (2017 USD billion PPP)	1 250	Coal (million tonnes)	150 227
GDP per capita (2017 USD PPP)	48 698	Uranium (kilotonnes U < USD 130/kgU)	1 693

Source: a ABS (2021); b World Bank (2021); c BP (2021); d UN (2021)

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

The energy crunch that occurred in the latter half of 2021 has meant coal and gas prices have increased significantly, with Australia’s energy export earnings having more than recovered the fall that occurred in 2020. LNG export revenues were anticipated to almost double to AUD 56 billion in the 12 months to June 2022, with coal revenues increasing by about half as much (Resources and Energy Quarterly, Industry, 2022). At the end of 2021, moderating global demand and greater

global supply were already leading to a pullback in prices, but the war in Ukraine has led to almost all energy commodity prices again moving higher.

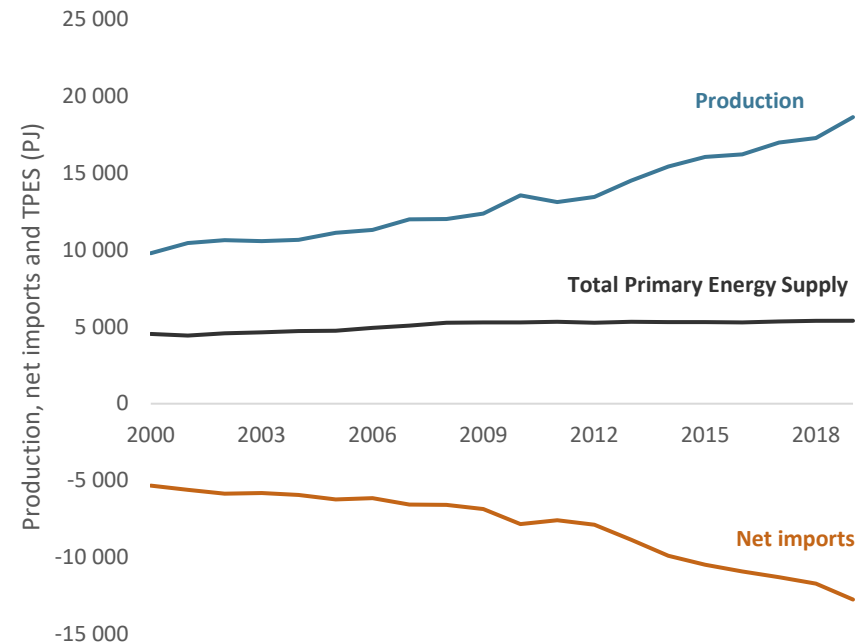
The Altona refinery in Victoria and Kwinana refinery in Western Australia wound-down operations in 2021. These closures will mean fuel security issues shift more to sources of refined products supplies instead of crude oil supplies. The federal government has announced support measures for the remaining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

Energy Supply and Consumption

Total Primary Energy Supply

Australia was the fourth largest global producer of coal and seventh largest global producer of natural gas in 2020 (BP, 2021). 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) in Asia. Metallurgical coal accounts for less than one-fifth of APEC coal consumption, though are almost half of Australia's coal exports. These exports are expected to remain robust given that virgin steel production technologies that forego metallurgical coal will not be commercially viable at scale for some time.

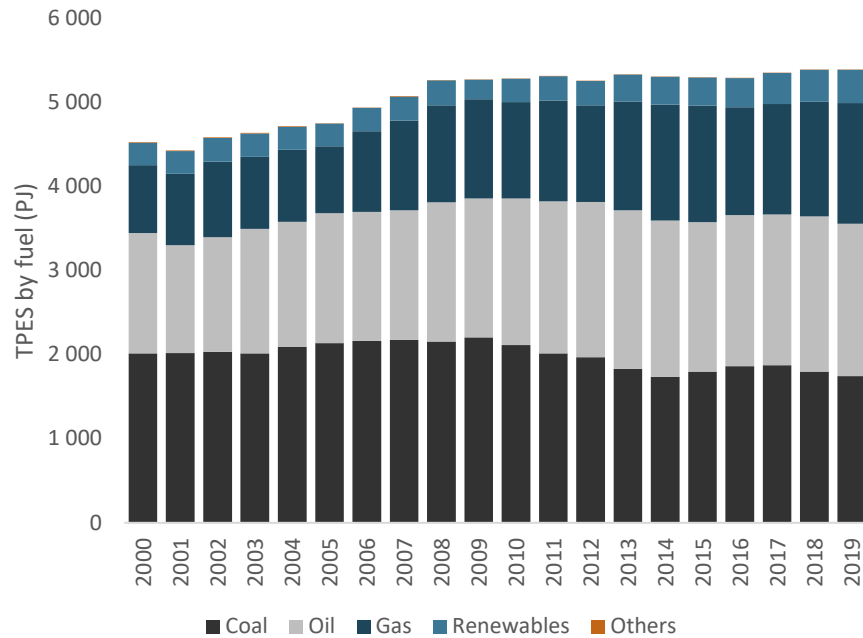
Figure 1: Australia's total primary energy supply, production, and net imports, 2000 to 2019



Source: EGEDA (2021)

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 12 700 PJ of net exports in 2019 (Figure 1).

Figure 2: Australia's total primary energy supply by fuel, 2000 to 2019



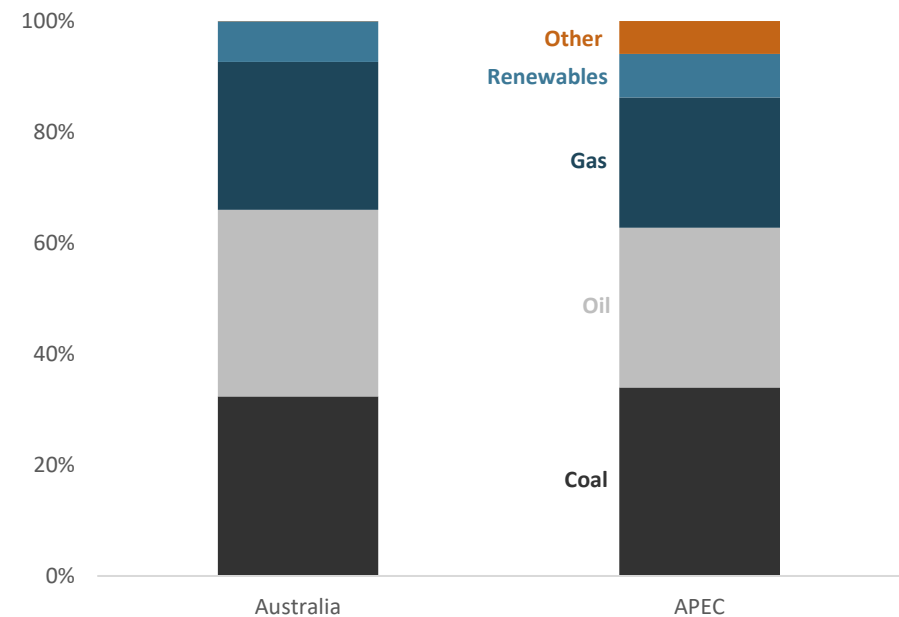
Source: EGEDA (2021)

Australia's total primary energy supply is the amount of energy consumed domestically. Australia's energy consumption 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 meant that energy supply has maintained a plateau, increasing by only 2% for the most recent decade (Figure 2). Coal's share in the supply mix has dropped to less than one-third in 2019, with oil (and refined products) being the most prominently supplied fuel since 2018.

When viewed alongside average APEC energy supply, Australia's coal supply is only slightly lower, whereas oil has a significantly larger share due to Australia's relatively large transport sector. Gas supply is also

larger due to a prominent role for gas-fired turbines in the power sector and large consumption associated with the liquefaction process for LNG exports. Hydro and solar generation combine with biomass consumption to deliver a more than 7% renewables share in Australia's energy supply in 2019.

Figure 3: Total primary energy supply relative fuel share – Australia and APEC, 2019



Source: EGEDA (2021)

Total Final Consumption

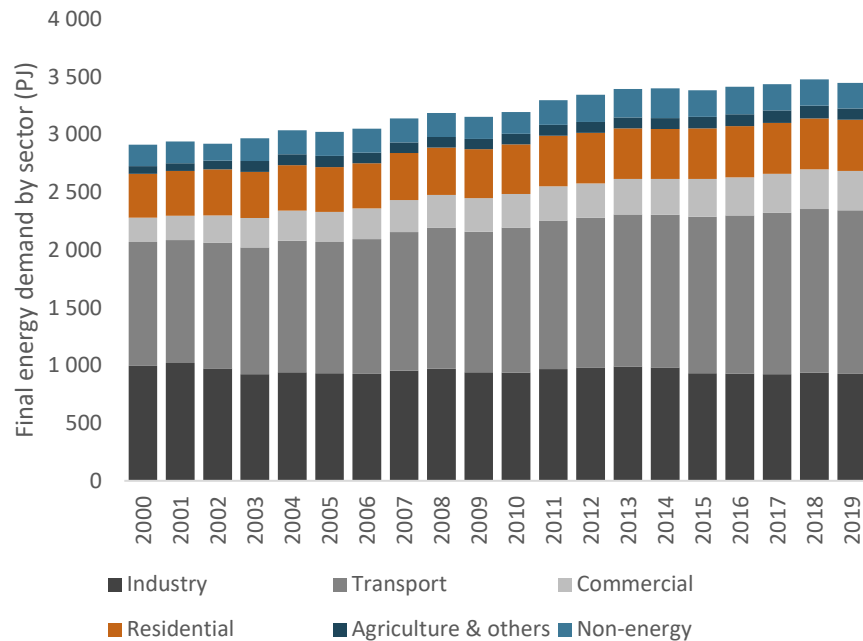
Australia's energy supply of 5 390 PJ in 2019 flows through to 3 447 PJ of end-use energy demand. This means that more than one-third is consumed in the transformation process, mainly through own-use and losses. Transport remains the largest end-use sector, accounting for

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more than two-fifths of final consumption. Transport's prominence has increased in the last two decades due to the continued slow decline in Australia's manufacturing industries.

The commodity boom of the 2000s and 2010s led to increased mining activity, but this was not enough to offset the impacts of a strong Australian dollar and the offshoring of many other industrial enterprises. While the resources boom has cooled in the last five years, the onset of higher domestic natural gas prices that coincided with the domestic natural gas market being linked to markets in Asia, has limited industrial growth.

Figure 4: Australia's final consumption by sector, 2000 to 2019

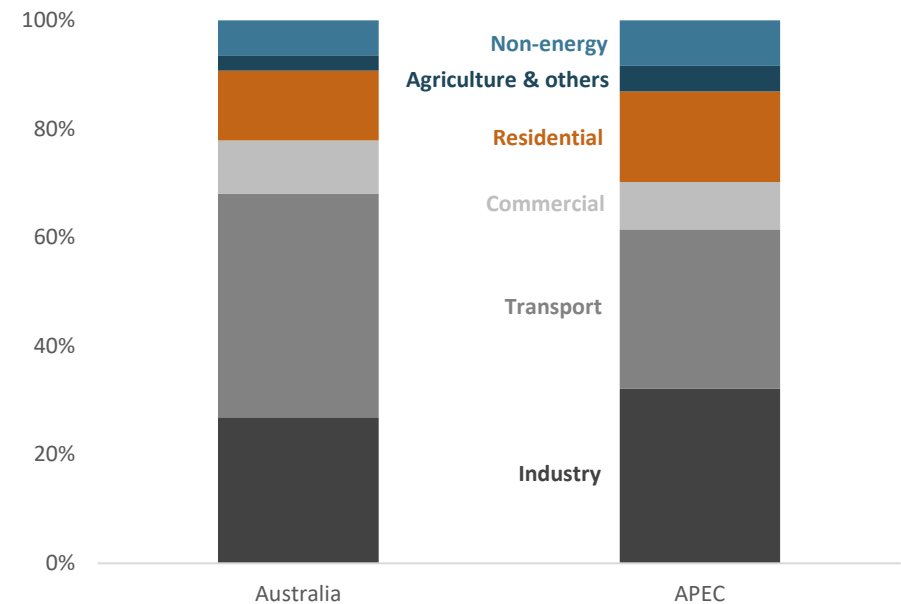


Source: EGEDA (2021)

While most people live in urban areas, the distance between cities

requires large consumption of energy to move people, goods, and resources between the different population centres. This is part of the reason why transport sector energy consumption is almost 40% larger than the average for the entire APEC region, as shown in Figure 5.

Figure 5: Final consumption sectoral share, Australia and APEC, 2019



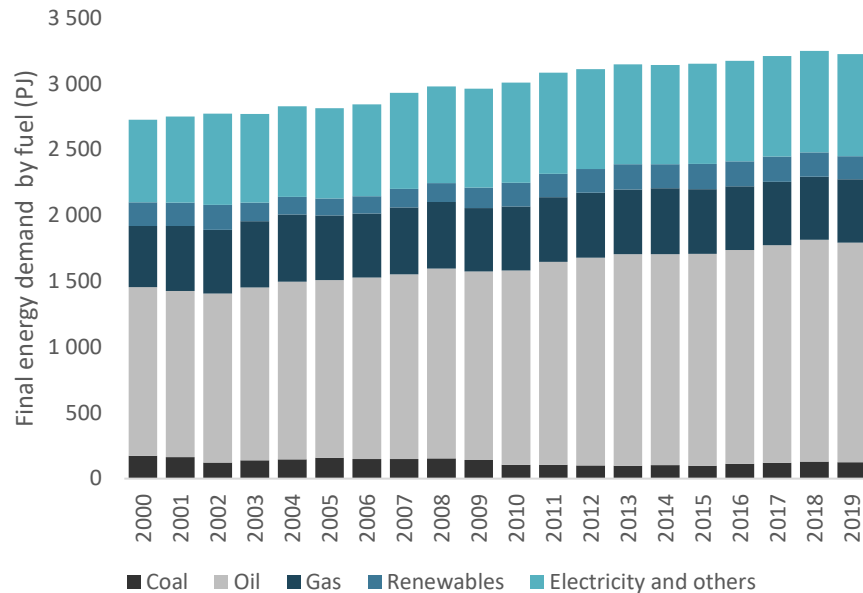
Source: EGEDA (2021)

With transport energy consumption still tied to oil across the APEC region, refined products remain dominant in Australia's end-use energy. Refined products also feature prominently in other end-use sectors, such as diesel in mining, LPG in residential buildings, and diesel generators in commercial buildings. These use cases combine to mean that oil accounts for more than half (52%) of Australia's final energy demand, which represents an increase since 2000 (47%).

Wide-scale electrification of end-use applications is still in an early stage. Electricity accounts for just under one-quarter of all end-use consumption. 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 APEC’s forthcoming *8th Energy Demand and Supply Outlook* for analysis and discussion of these trends.

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

Figure 6: Australia’s final energy demand by fuel, 2000 to 2019

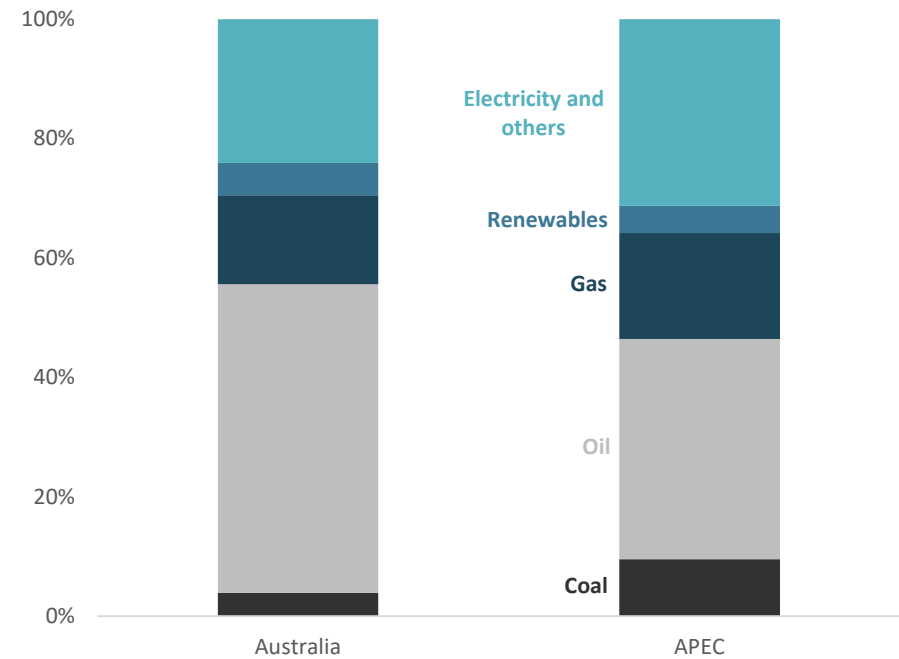


Source: EGEDA (2021)

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

Heating and cooking within the buildings sectors has been one of the most prominent sources of natural gas demand. Multiple manufacturing applications have also relied on its consistent heating properties. However, a tight market and higher prices that coincided with the linkage of Australia’s east coast gas markets to markets in Asia in the mid-2010s has constrained growth in natural gas demand. There is typically a lag of multiple years in fuel-switching fuel due to a change in market dynamics due to long-term contracts and delays in upgrading or switching equipment. Nevertheless, natural gas has recently begun to decline, dropping from 500 PJ in 2014 to 480 PJ in 2019.

Figure 7: Final energy demand fuel shares, Australia and APEC, 2019



Source: EGEDA (2021)

Almost three-quarters of Australia’s natural gas production was

exported in 2019. A large portion of this production occurs in the north and west with limited availability to domestic consumers in the main population centres in the south-east. There are also no LNG import terminals, though there are currently multiple proposals to build these facilities at locations on the east and south coasts. While natural gas production is large, Australia's domestic consumption share is likely to stay lower than that of the APEC region (Figure 7).

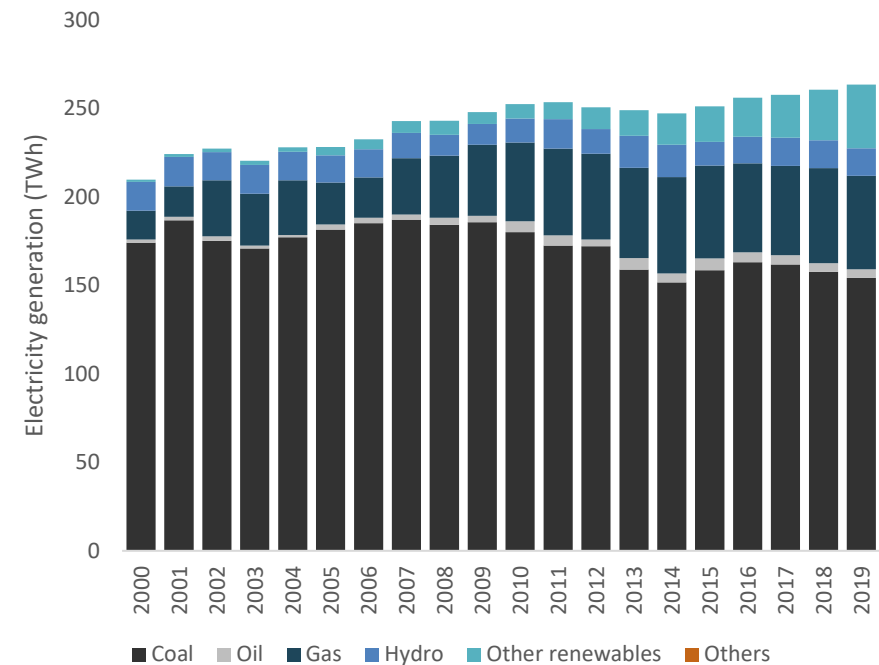
The relatively small size of Australia's industry sector goes part way to explaining the smaller proportional consumption of coal in Australia. Australia's relatively low consumption of electricity again correlates with the high relative share of the transport sector. With the rise of EVs, end-use electricity consumption is likely to grow faster in Australia than for other economies that have smaller transport sectors.

Transformation

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 under 60% in 2019. Natural gas-fired generation has increased significantly from the late-2000s to account for 20% of generation in 2020. Part of this increased role is to provide power during evening peak demand to make-up for the decline in solar generation.

Australia is home to very high levels of solar radiation. These favourable conditions combined with additional policy support have led to Australia having the highest uptake of household rooftop solar in the world. More than one in four homes have solar panels installed. Utility scale solar and wind power are continuing to ramp-up with renewables (including hydro) accounting for one-fifth of electricity generation in 2019.

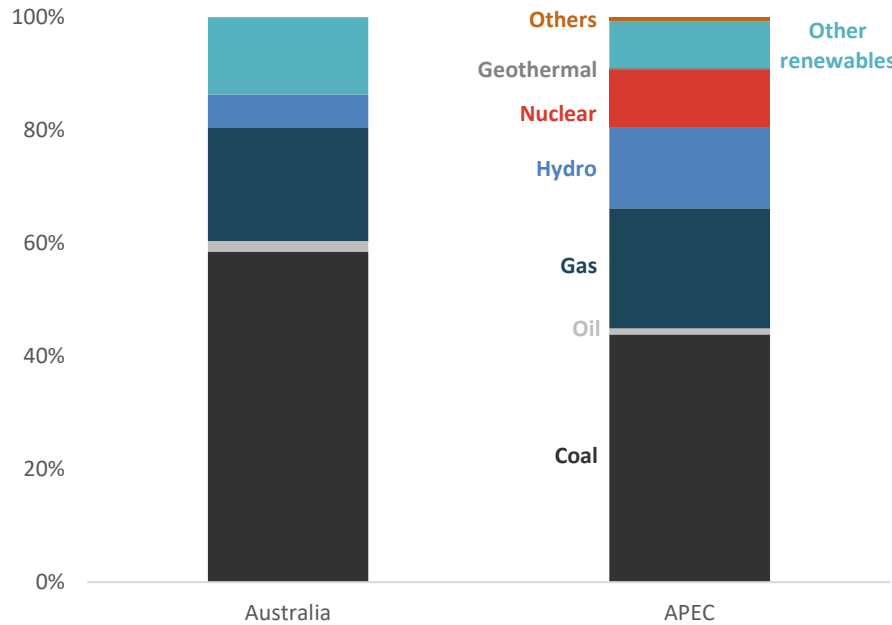
Figure 8: Australia's electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

Coal's prominence is clear when viewed alongside the APEC generation mix, with relative coal-fired generation being one-third higher in Australia than in APEC. One of the main points of difference is that hydro generation is comparatively low, though this will receive a boost with the Snowy Hydro 2.0 scheme providing an additional two gigawatts of capacity in 2025. There are also no nuclear power stations in Australia. This technology provides an important source of zero emissions baseload generation for many other APEC economies such as Canada, China, Russia, Japan, Korea and the US.

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



Source: EGEDA (2021)

APEC 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

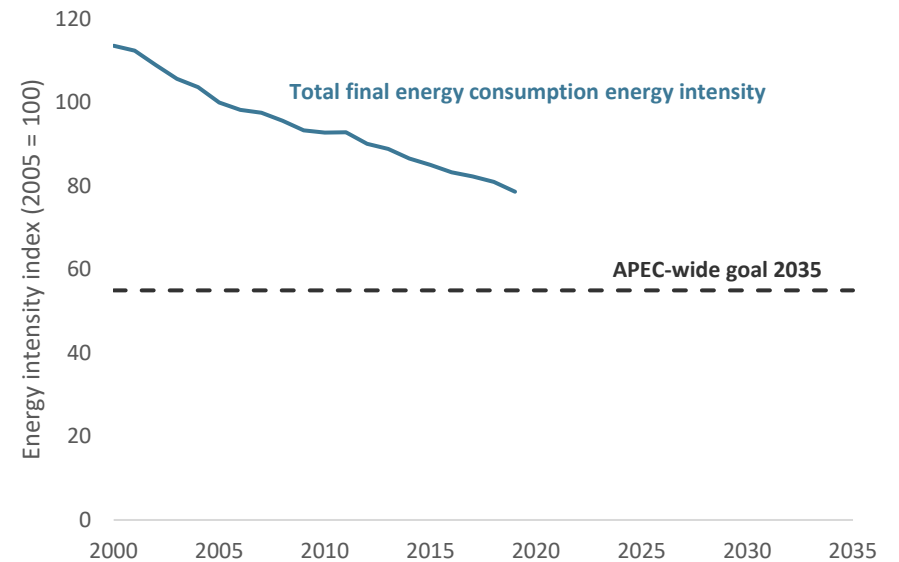
In 2011, APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline.

The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

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 2019, Australia's total final energy consumption (not including non-energy) intensity improved by more than 21% relative to the 2005 level. This confirms Australia's commitment to the 2035 energy intensity goal, as shown in Figure 10. Energy intensity relative to total primary energy supply and final consumption, which includes non-energy sector consumption of energy products, shows a similar improvement.

Figure 10: Australia's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)

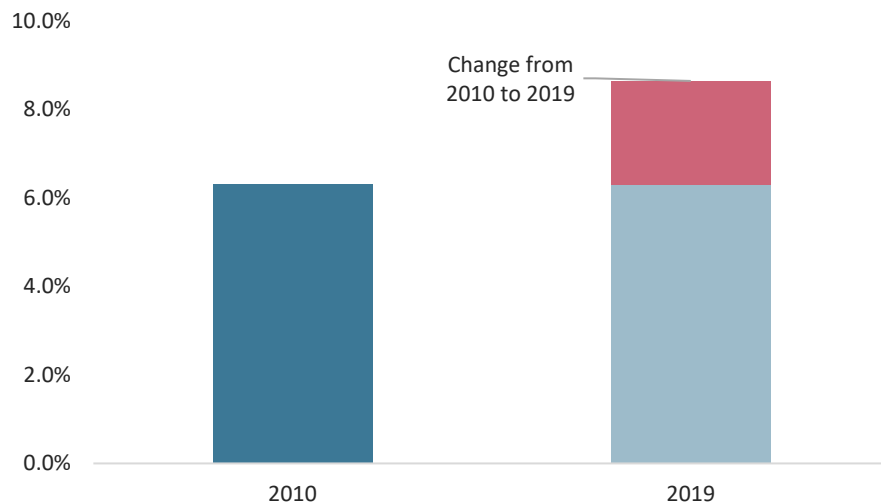


Source: EGEDA (2021)

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 11: Australia's modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

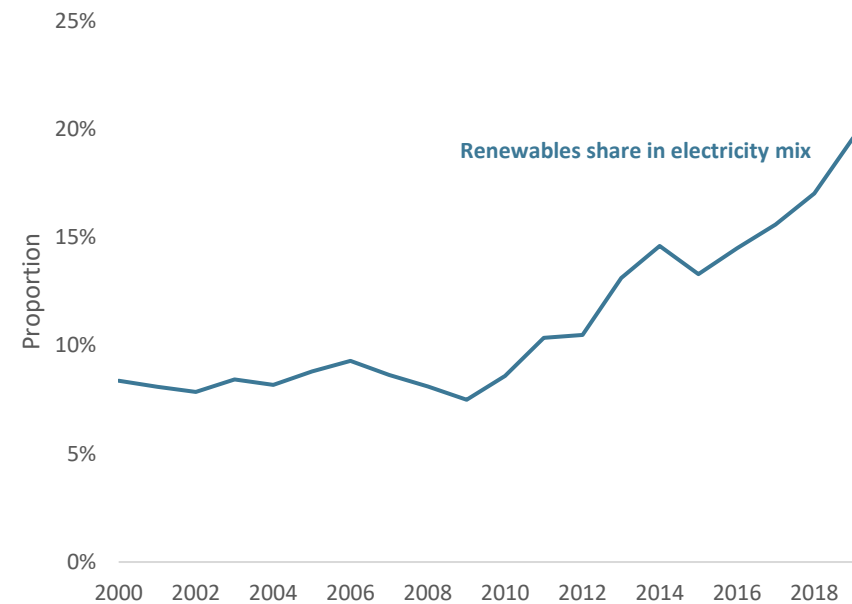
Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share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

Modern renewables do not include traditional biomass. The share of modern renewables to final energy consumption (not including non-energy sector consumption of energy products) in 2010 was 6.3%. In 2019, the proportional share was 8.6%, which represents a 37%

increase in modern renewables for Australia (Figure 11). Meeting the APEC-wide doubling goal will require APEC's modern renewables share to reach 12.3% by 2030.

Electricity generation from renewables reached almost 20% in Australia in 2019, which is more than double the 2005 level of less than 9% (Figure 12). The large pull-back in 2015 was due to the impact of drought and low hydro generation. The short-lived carbon price, from 2012 to 2014, had an impact as well. The sustained rise of the late-2010s is 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.

Figure 12: Australia's renewable generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

Energy Policy	Details	Reference
Australia's long-term emissions reduction plan	A whole-of-economy plan to achieve net zero emissions by 2050.	Department of Industry, Science, Energy and Resources
Technology Investment Roadmap	A strategy to accelerate development and commercialisation of low emissions technologies. The first low emissions technology statement 2020 prioritises clean hydrogen, electricity storage, low emissions steel and aluminium production, carbon capture and storage, soil carbon sequestration, and ultra-low cost solar.	Department of Industry, Science, Energy and Resources
Emissions Reduction Fund (ERF)	Australian Carbon Credit Units (ACCUs) are earned for each tCO ₂ e stored or avoided, and these can be sold to the government (reverse auction) or in the secondary market.	Clean Energy Regulator
Safeguard mechanism	The safeguard complements the ERF by placing a legislated obligation on Australia's largest greenhouse gas emitters to keep net emissions below their emissions limit (or baseline).	Clean Energy Regulator
Australia's National Hydrogen Strategy	Designed to establish Australia's hydrogen industry as a major global player by 2030.	Department of Industry, Science, Energy and Resources
Climate Solutions Fund	An investment of AUD 3.5 billion to deliver Australia's 2030 Paris climate commitments.	Clean Energy Regulator
Climate Active	Certification is awarded to Australian businesses that meet the requirements to achieve net zero carbon emissions.	Climate Active
The National Greenhouse and Energy Reporting scheme	A single economy-wide framework for reporting and disseminating company information about greenhouse gas emissions, energy production and energy consumption.	Clean Energy Regulator
Paris Agreement Nationally Determined Contribution	To reduce greenhouse gas emissions by 26 to 28% below 2005 levels by 2030.	Department of Industry, Science, Energy and Resources
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 Industry, Science, Energy and Resources
Energy National Cabinet Reform Committee (ENCRC) and the Energy Ministers' Meeting (EMM)	Tasked with priorities to deliver the following: <ul style="list-style-type: none"> - Immediate measures to ensure reliability and security of the electricity grid - Redesign of the National Electricity Market - Package of reforms to unlock new gas supply, improve competition and better regulate pipelines 	Department of Industry, Science, Energy and Resources

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Liddell Taskforce	Will advise government whether sufficient dispatchable capacity is built to make up for the closure of the Liddell power plant in 2023.	Department of Industry, Science, Energy and Resources
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 Industry, Science, Energy and Resources
Energy efficiency and energy productivity	Offers support for the establishment of standards, programs and innovative practices to improve energy efficiency and energy productivity. The National Energy Productivity Plan is a commitment to improve Australia's energy productivity by 40% between 2015 and 2030.	Department of Industry, Science, Energy and Resources
Australia's fuel security package	The government's long-term fuel security goal is to increase domestic storage and hold a sovereign refining capability that meets Australia's needs during an emergency.	Department of Industry, Science, Energy and Resources
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 Industry, Science, Energy and Resources
Energy infrastructure resilience	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.	Department of Industry, Science, Energy and Resources
Energy security assessments	The Australian Government undertakes energy security assessments to better understand the risks to the adequacy, reliability and affordability of energy in Australia.	Department of Industry, Science, Energy and Resources
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 Industry, Science, Energy and Resources
Subsidies for residential (and commercial) storage and/or PV	Upfront subsidy for residential storage in South Australia until 2022; residential storage in Victoria until 2021; residential PV in Victoria until 2027	Solar rebates in Australia
Large-scale Renewable Energy Target	Annual targets for renewable electricity generation will be achieved through a market for large-scale generation certificates.	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 2025 by the federal government.	Snowy Hydro
Retailer Reliability Obligation (RRO)	If there are forecast gaps between energy demand and supply, the Australian Energy Market Operator will compel energy retailers to contract additional generation.	Department of Industry, Science, Energy and Resources

APEC ENERGY OVERVIEW 2022

Underwriting new generation investments (UNGI)	UNGI will provide financial support to increase generation capacity. The program is supporting 3 818 MW of new generation.	Department of Industry, Science, Energy and Resources
Grid Reliability Fund	This is a commitment made by government in 2019, but it has yet to be established. Its intention is to ensure that sufficient reliable generation capacity is available to meet periods of high demand in the National Electricity Market.	Department of Industry, Science, Energy and Resources
Modern Manufacturing Strategy	A whole-of-government strategy to help Australian manufacturing scale-up, become more competitive and resilient. Recycling and clean energy is a priority. Investments in low emissions domestic manufacturing have been invited under the AUD 1.3 billion Modern Manufacturing Initiative, launched with the strategy.	Department of Industry, Science, Energy and Resources
National Carbon Capture Use and Storage (CCUS) Technology Emissions Abatement Strategy	Currently under development. Will guide Australian Government approach to deploying CCUS, signal government priorities and support the development of potential hubs.	Department of Industry, Science, Energy and Resources
Commercial Building Disclosure (CBD) Program	The CBD Program is a regulatory program that 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.	CBD
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

Notable Energy Developments

Energy development	Details	Reference
Clean hydrogen	The Australian Government has announced over AUD 1.5 billion for the hydrogen industry. Support includes: <ul style="list-style-type: none"> - AUD 464 million to develop up to seven Clean Hydrogen Industrial Hubs - AUD 300 million via the Clean Energy Finance Corporation (CEFC) Advancing Hydrogen Fund - Over AUD 100 million for three 10 MW hydrogen electrolyser projects through ARENA - AUD 25 million for new gas generators to be hydrogen-ready - AUD 50 million for the German-Australian Hydrogen Innovation and Technology Incubator (HyGate) under the Australia-Germany Hydrogen Accord. 	Department of Industry, Science, Energy and Resources
Reliable Affordable Clean Energy Cooperative Research Centre	Focussed on opportunities from low-cost renewable energy, network integration and smart energy management. The Australian Government has committed AUD 68.5 million over 10 years, with industry and research partners committing AUD 279 million.	RACE for 2030

APEC ENERGY OVERVIEW 2022

Future Battery Industries Cooperative Research Centre	Drives collaboration on research and development across all segments of the battery value chain. The Australian Government has committed AUD 25 million over six years, while industry and research partners have committed AUD 111 million.	Future Battery Industries
Heavy Industry Low-carbon Transition Cooperative Research Centre	Will develop material such as 'green' iron, alumina, cement and other processed minerals for the Australian heavy industry sector. The Australian Government has committed AUD 39 million over 10 years, with a further AUD 176 million from industry, research and other government partners.	Heavy Industry Low-carbon Transition
CCS and CCUS	The Australian Government has committed AUD 250 million over 10 years to the CCUS Technologies and Hubs Program, which will: <ul style="list-style-type: none">- fund CCUS projects- establish CCUS hubs- support research, development and commercialisation of CCUS technologies.	Department of Industry, Science, Energy and Resources
Low emissions cement	The Government has invested AUD 75 million, with additional contributions from industry and researchers, for: <ul style="list-style-type: none">- SmartCrete Cooperative Research Centre- Building 4.0 Cooperative Research Centre- Low Carbon Living Cooperative Research Centre.	SmartCrete CRC
LNG import terminals	Currently, there are five proposed import terminals for locations on the east coast of Australia at various stages of development. It is uncertain how many of these will be built.	Resources and Energy Quarterly

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/>

Australia's National Energy Analytics Research Program – <https://near.csiro.au/>

Australia's Nationally Determined Contribution – <https://www.industry.gov.au/news/affirming-australias-net-zero-emissions-by-2050-target>

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

Commonwealth Scientific and Industrial Research Organisation – <https://www.csiro.au/>

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

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

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

Energy.gov.au – <https://www.energy.gov.au/>

Reserve Bank of Australia – <https://www.rba.gov.au/>

The Treasury – <https://treasury.gov.au/>

Brunei Darussalam

Introduction

Brunei Darussalam (BD) is a tiny economy situated on the northwest coast of the third largest island in the world, Borneo Island. The Malaysian (MAS) state of Sarawak surrounds BD on three sides. The remaining border is a 168 km-long coastline along the South China Sea. The coastal areas are generally low-lying, as low as 12 meters below sea level. Elevation progressively increases to the south, reaching a peak of 300 meters above sea level. Climate-wise, BD has tropical weather the whole year round, with daily temperatures ranging between 23°C and 32°C and an average humidity above 85%.

The capital, Bandar Seri Begawan, is fondly known as "Bandar" by locals. BD comprises four districts: Belait, Tutong, Brunei-Muara and Temburong. Brunei-Muara houses the capital and is the most densely populated, but also smallest, district. Population of the economy in 2019 was 0.43 million people (World Bank, 2021), which represented a 1% annual increase. Malays comprise close to 70% of the total population, followed by Ethnic Chinese and all other groups at 11% and 25%, respectively (MOFE, 2021).

Table 1: Brunei Darussalam's Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^b	
Area (km ²)	5 765	Oil (billion barrels)	1.1
Population (million)	0.43	Gas (trillion cubic feet)	7.9
GDP (2017 USD billion PPP)	26.91	Coal (million tonnes)	-
GDP per capita (2017 USD PPP)	62 098	Uranium (kilotonnes U7< USD 130/kgU)	-

Source: ^a World Bank (2021), ^b BP (2021)

In 2019, BD GDP was valued at almost USD 27 billion (2017 USD billion PPP), an increase of 3.9% from 2018. GDP per capita increased by 2.8% in 2019, amounting to over USD 62 000. This growth was driven by an increase of 15.2% in crude oil and NGL exports and a 1.9% increase in liquefied natural gas (LNG) exports (EGEDA, 2021). The operation of the first phase of Hengyi Industries refinery and petrochemical complex on the island of Pulau Muara Besar has seen significant exports of petroleum products (motor gasoline, diesel, jet fuel and other products), accounting for over half of the economy's total trade volume in 2020.

Following the launch of BD's first National Climate Change Policy (BNCCP) in July 2020, BD recently pledged to achieve net-zero emissions by 2050 mainly through energy transition and forests preservation. This pledge was announced during the 26th United Nations Climate Change Conference in Glasgow, United Kingdom, in November 2021 (COP26).

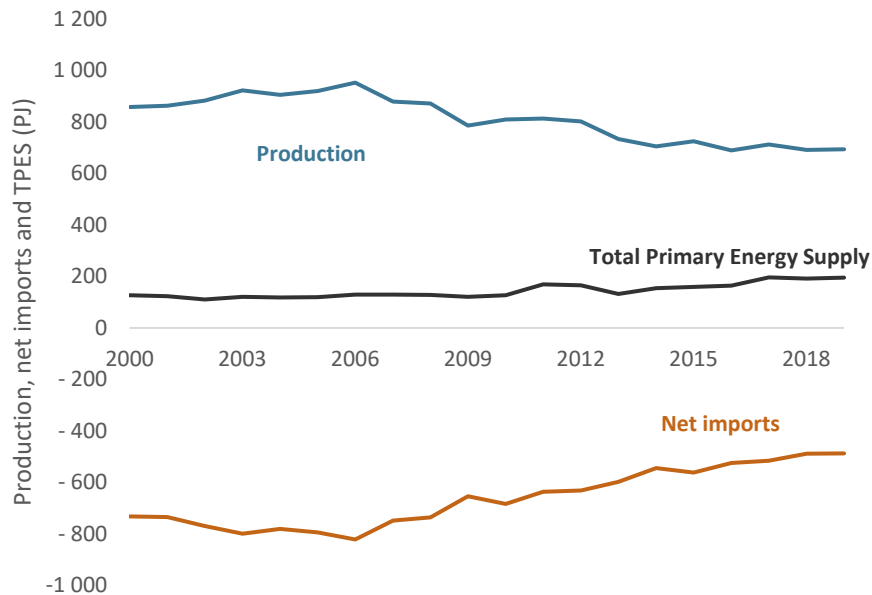
Energy Supply and Consumption

Total Primary Energy Supply

Relative to 2018 levels, the overall energy supply in BD increased by 1.6% in 2019, primarily driven by the increase in supply from oil and coal. Gas supply significantly declined by 14%, due to decreased demand in the non-energy sector, particularly for methanol production. The share of renewables remained negligible.

Production increased 0.36% in 2019, which contrasts with a downward trend since 2000. The figure below on net imports reflects BD's continued strong energy self-sufficiency.

Figure 1: Brunei Darussalam's total primary energy supply, production, and net imports, 2000 to 2019

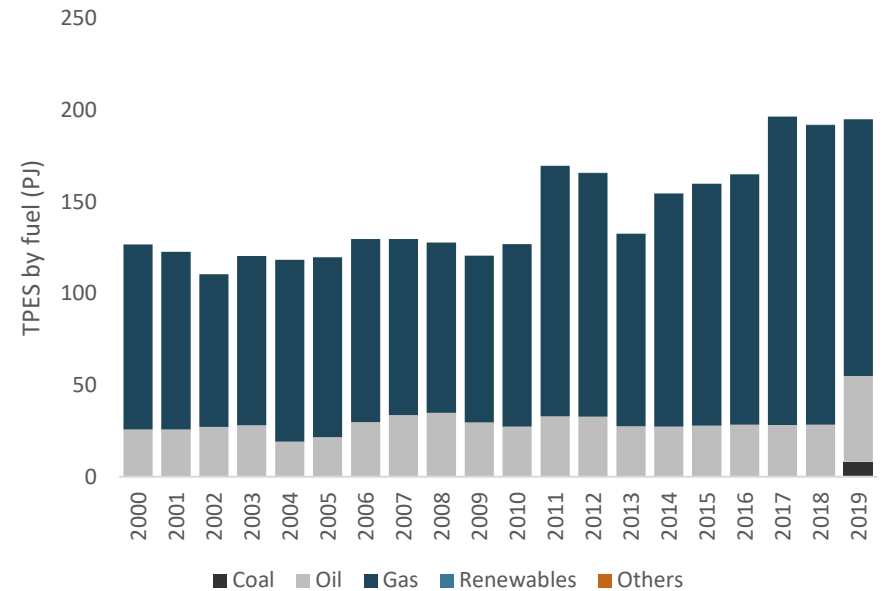


Source: EGEDA (2021)

Oil and gas remain the two most dominant fuels in BD's overall energy supply, registering shares of 24% and 72%, respectively, in 2019. The development of a coal-fired power plant to power the Hengyi complex means that coal accounted for 4.1% of the economy's energy supply.

Oil and gas remain the two most dominant fuels in BD's overall energy supply, registering shares of 24% and 72%, respectively, in 2019. The development of a coal-fired power plant to power the Hengyi complex means that coal accounted for 4.1% of the economy's energy supply.

Figure 2: Brunei Darussalam's total primary energy supply by fuel, 2000 to 2019

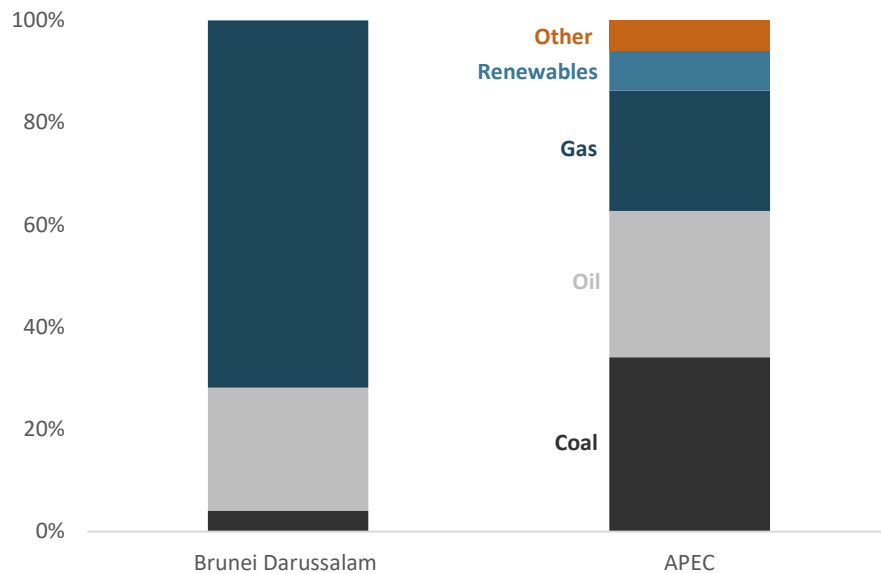


Source: EGEDA (2021)

Brunei Darussalam's domestic gas dominance places the economy above APEC in terms of gas shares in 2019, as shown in Figure 3. The share of oil, however, is on par with APEC's share. In addition, the tiny

share of 4.1% of coal in BD is well below the APEC average share. Although BD is well endowed with energy supply and self-sufficient, the economy's fuel diversification is still in its infancy, as shown in Figure 3.

Figure 3: Total primary energy supply relative fuel share – BD and APEC, 2019



Source: EGEDA (2021)

Total Final Consumption

Figure 4 illustrates that BD's final consumption stood at almost 83 PJ in 2019, a decline of 6.3% from 2018 levels. This decline is primarily driven by a more than 12% reduction in the uptake of natural gas – sourced from Brunei Shell Petroleum (BSP) – as a feedstock in the non-energy sector, particularly to produce methanol at Brunei Methanol Company (BMC). In addition, a significant reduction in the use of lubricants and bitumen was noticed. Nonetheless, non-energy remained the largest end-user sector in 2019 with a 52% share.

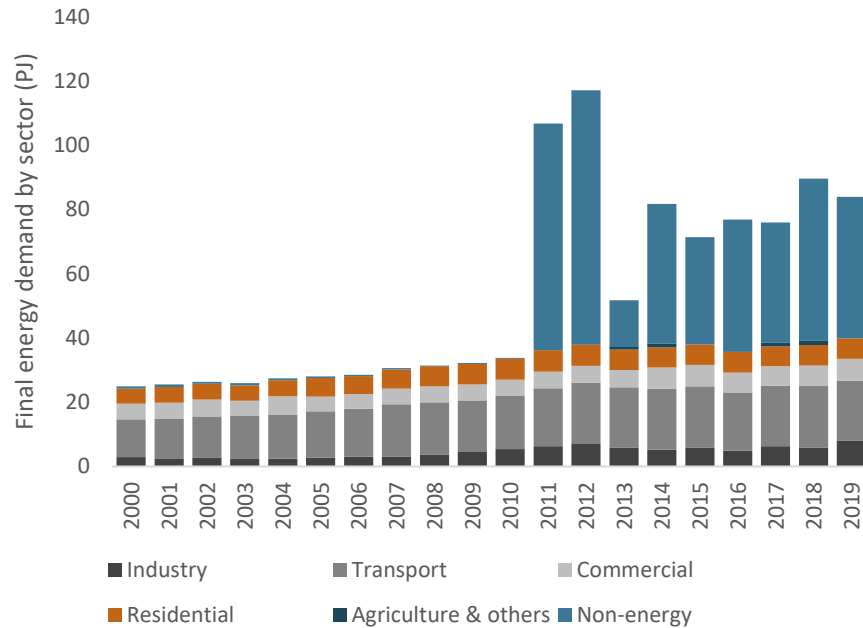
Transport continued to be the next largest sector, accounting for 22% of all end-use consumption (including non-energy), despite seeing a slight decrease in its consumption in 2019. This decrease is attributed to the decline in diesel consumption, while consumption of motor gasoline remained unchanged.

Coinciding with the maiden operation of the first phase of Hengyi Industries' complex, the industry sector's energy demand is notably higher in 2019. This increase is to the extent that the consumption in that year is the highest ever recorded in the last 20 years. Its sectoral share, however, remained below both non-energy and transport sectors, accounting for 10% of the end-use energy mix, marginally above both commercial and residential sectors.

Commercial and residential sectors' shares stood at 8.0% and 7.6% respectively in 2019, with the former registering a higher yearly growth than the latter. This can be attributed to the growth in new business enterprises, with the number of large enterprises increasing by 3.1% in 2019 (MOFE, 2020).

APEC ENERGY OVERVIEW 2022

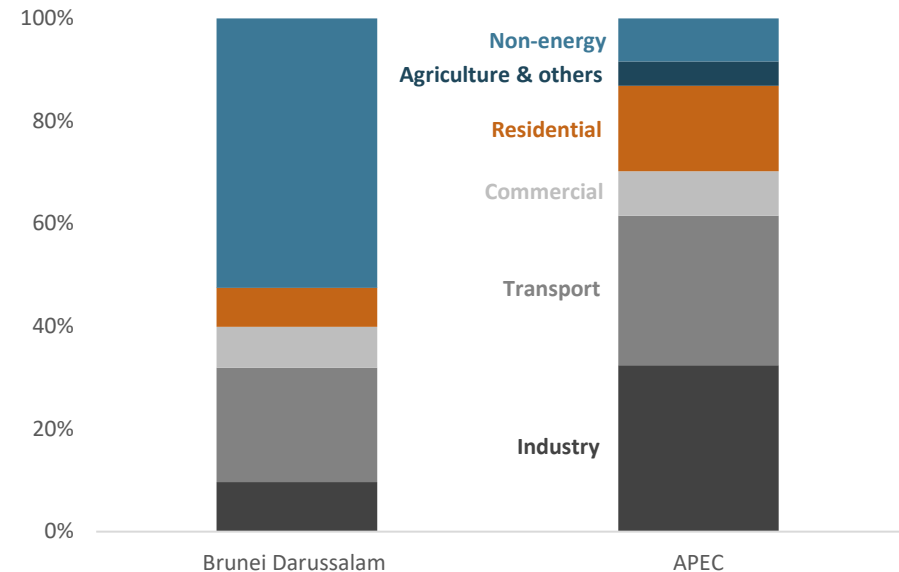
Figure 4: Brunei Darussalam's final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

With respect to APEC's sectoral energy demands in Figure 5, BD's industry sector is less prominent than the APEC region, as the economy's industry development is still in its early stages. On the other hand, BD's transport sector share is nearly identical to APEC's, owing to its high vehicles per capita and limited public transport system. The share of non-energy use in BD is also significantly higher than in APEC, driven by a large supply of natural gas for domestic methanol production. Naturally, with a non-energy sector that is smaller, the other sectors have grown in prominence, and are more similar to the APEC region's disaggregation.

Figure 5: Final consumption sectoral share, BD and APEC, 2019

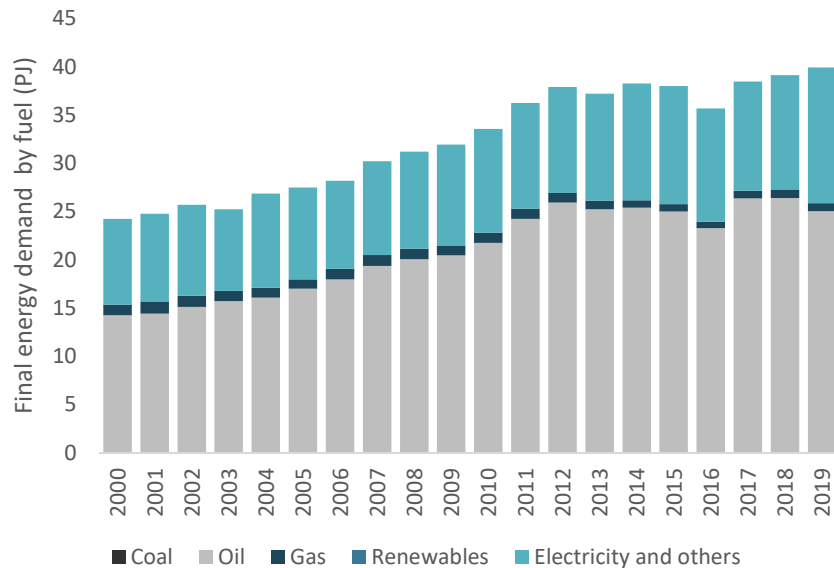


Source: EGEDA (2021)

As shown in Figure 6, oil (which captures petroleum products) continues to dominate, accounting for 63% of the overall fuel share in 2019. The majority of oil was used by the road transport subsector in the form of gasoline and diesel, which are currently supplied locally by Brunei Shell Marketing (BSM). Besides diesel, BSM currently offers various forms of gasoline fuel according to their octane ratings, with Shell Premium Unleaded having the best octane rating of 97. Most vehicles in BD use this type of fuel, which yields high performance and is less polluting than lower octane gasoline. The industry sector was the second-highest consumer of oil, particularly in the form of diesel to support the operations of various industry subsectors.

Electricity is the next dominant fuel, constituting a share of 35%. Close to half of the electricity was consumed by commercial and public services establishments, followed by residential households and industry.

Figure 6: Brunei Darussalam's final energy demand by fuel, 2000 to 2019

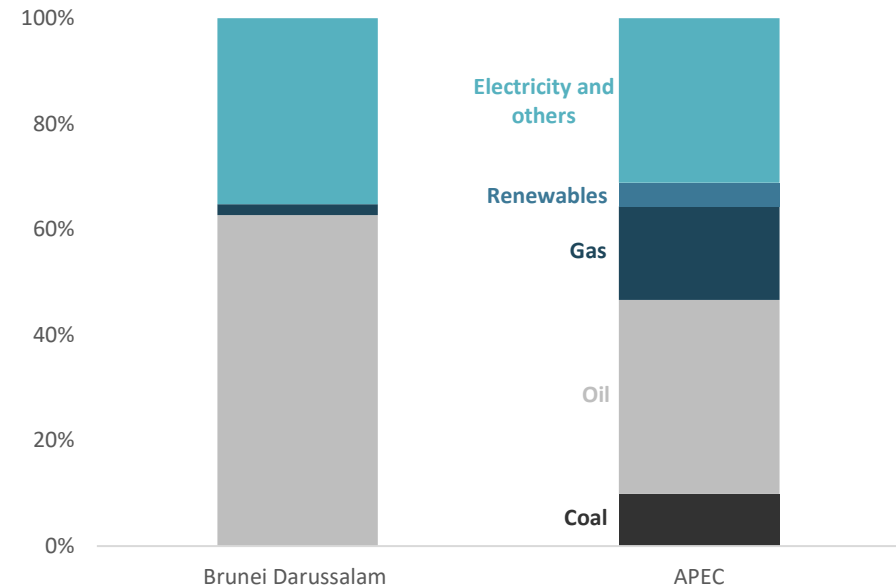


Source: EGEDA (2021)

Note: does not include non-energy sector consumption.

BD's relatively large electricity share (Figure 7) is partly due to its residential electricity usage per capita being more than twice APEC's in 2019. Electricity prices are also highly subsidised, which contribute to consumption levels that are higher than would be the case without the subsidies. BD's significantly higher share of oil was due to the dominance of conventional vehicles in addition to inexpensive fuel prices.

Figure 7: Final energy demand fuel shares, BD and APEC, 2019



Source: EGEDA (2021)

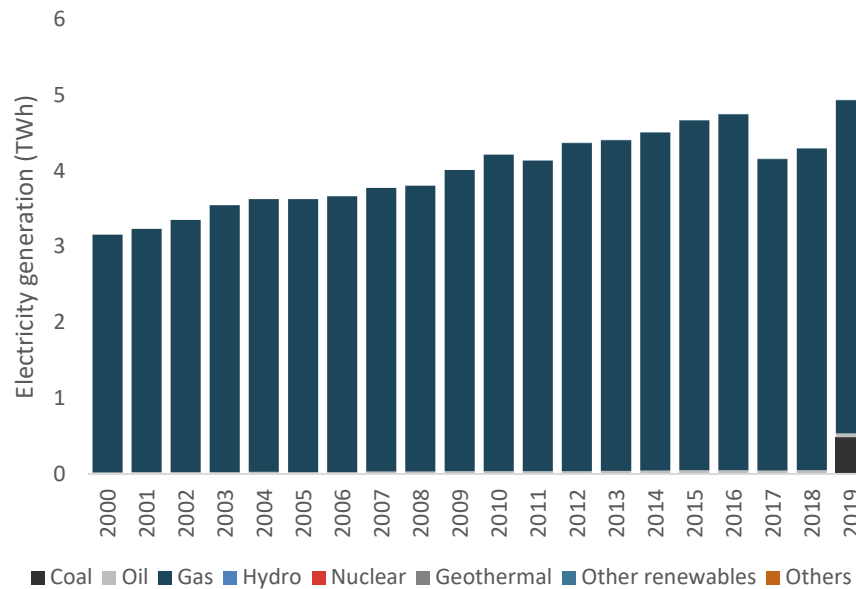
Transformation

Gas fuels all the publicly available electricity generated in BD, which is managed by two main utilities: (i) the Department of Electrical Services (DES) of the Prime Minister's Office and (ii) Berakas Power Company Sdn Bhd (BPC). DES accounts for 58% of the overall electricity demand in BD, while BPC covers 42% of the demand, including strategic and critical loads in the Brunei-Muara district (BPC, 2021).

More than half (55%) of the electricity generated is via open-cycle gas turbines located in DES-owned power stations (Gadong 1A and Gadong 2) and BPC stations (Gadong 3, Berakas and Jerudong). DES also inherited a combined-cycle gas power plant in Bukit Panggal and a co-generation power plant in Lumut, whose waste heat generated is

supplied to Brunei LNG Sdn Bhd for their own use. BPC has also upgraded part of their Berakas gas turbine into an ORegen plant from which the waste heat from the gas turbines is used to generate power in an organic Rankine cycle (ORC) using a turbo expander.

Figure 8: Brunei Darussalam's electricity generation by fuel, 2000 to 2019

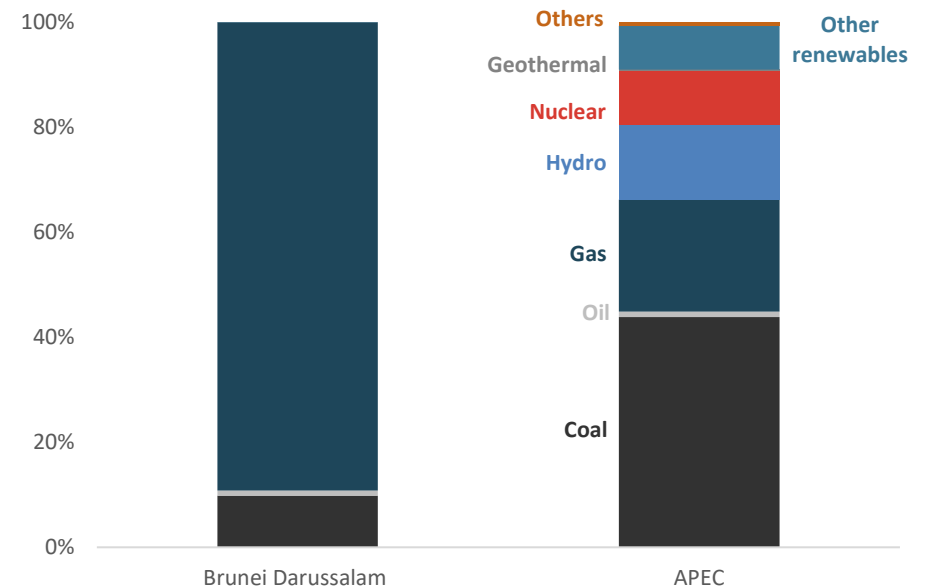


Source: EGEDA (2021)

Electricity generation increased by almost 15% in 2019, driven mainly by the operation of the new coal-fired power plant in the Hengyi Industries refinery and petrochemical complex (first phase). The entrance of coal into the electricity mix in 2019 is significant, but gas still provides all publicly available electricity generation.

Gas-fired electricity generation increased by 3.7%, driven by increased activities within industry, commercial and residential sectors.

Figure 9: Electricity generation by fuel share, BD and APEC, 2019



Source: EGEDA (2021)

BD's low fuel diversity in its electricity mix is clear in Figure 9. Diversity in the mix has increased with the Hengyi coal-fired power plant beginning to provide power in 2019. Nevertheless, the share of coal in BD is far below that of APEC's. All the economy's coal is imported and consumed solely within the industry sector.

APEC Goals

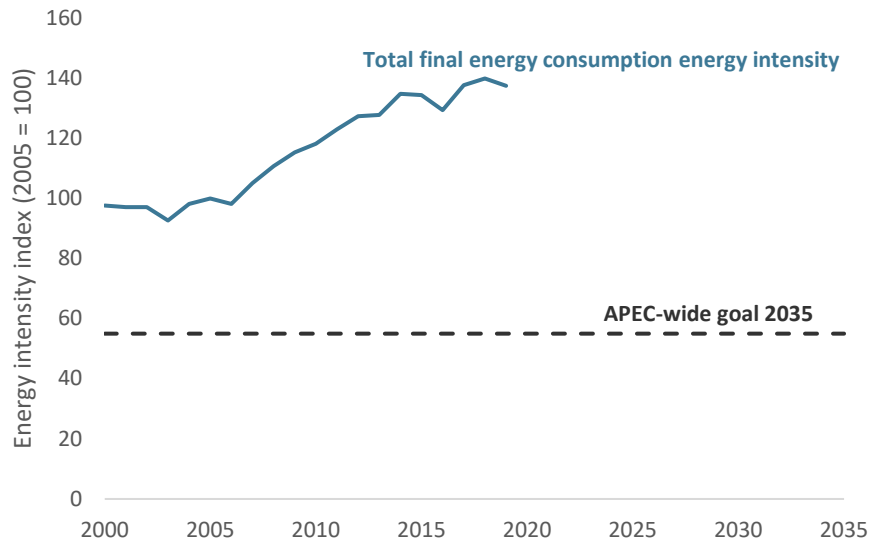
Energy Intensity Goal

APEC member economies have agreed to achieve a collective reduction of 45% in APEC energy intensity by 2035, relative to a 2005 baseline. APEC is on track to meet this intensity improvement. Although the goal

is not being imposed on each of the APEC member economies, it is possible to track their individual progress relative to that overarching proportional improvement.

Although there was a small dip of 1.7% in 2019 relative to 2018 levels, BD's energy intensity has generally seen an increasing trend since 2005.

Figure 10: Brunei Darussalam's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



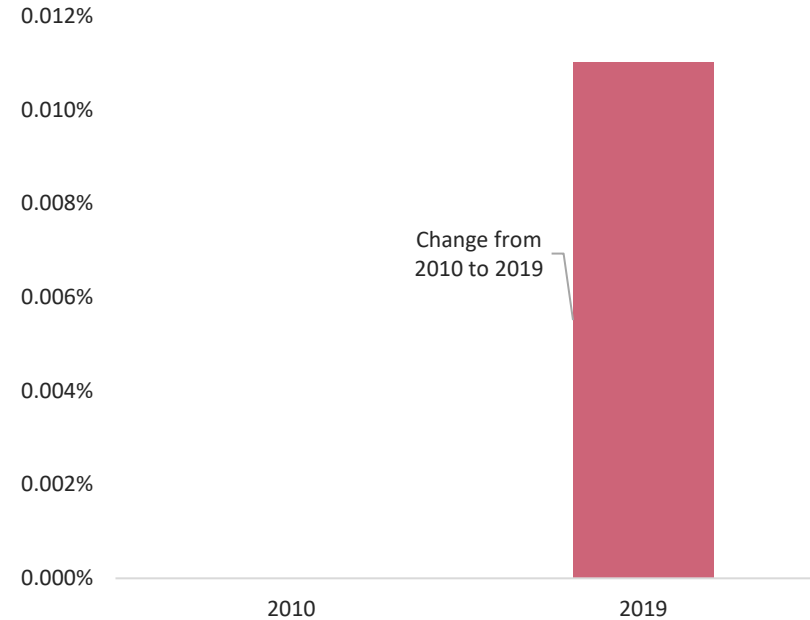
Source: EGEDA (2021)

Doubling of Renewables

Currently, the share of modern renewables in BD is still in infancy due to the predominance of natural gas in its electricity mix. Relative to 2010

levels, its collective share rose to 0.01% in 2019. BD plans to intensify its renewables share by aiming to achieve at least 30% of its total installed electricity capacity by 2035.

Figure 11: Brunei Darussalam's modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

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 generated from renewable sources.

Energy Policies

Energy Policy	Details	Reference
NDC target	20% reduction of GHG emission relative to Business-as-Usual levels by 2030. This NDC effectively supersedes the previous INDC.	UNFCCC (2020)
Brunei Darussalam National Climate Change Policy	The policy was established to pave for Brunei's low-carbon and climate-resilient pathways for a sustainable nation, 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)
Climate Ambition	Brunei is moving towards net-zero emissions by 2050, announced during the recent UNFCCC COP26 in Glasgow, Scotland, United Kingdom	UNFCCC (2021)
Energy Efficiency and Conservation	The Ministry of Energy announced the implementation of Standards and Labelling Order 2021 in July 2021. The Order, now in a grace period until June 13, 2022, will be enforced in phases, initially with air-conditioning system. Other appliances will follow.	ME (2021)

Notable Energy Developments

Energy development	Details	Reference
Renewable Energy	A 30 megawatts (MW) solar PV plant is planned to be developed by the Department of Energy in Belimbing Subok in the Brunei-Muara district.	Department of Energy, Prime Minister's Office (2020) (in Malay)
Renewable Energy	Brunei LNG Sdn Bhd aims to shift 10% of its overall power generation mix from conventional fuel gas to renewable energy by 2025 as part of its strategy on sustainability.	BSP (2021)

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Canada

Introduction

Canada has the second-largest land mass in both APEC and the world, after Russia. The Canadian–US border is the world’s longest international border, and it extends from the Pacific Ocean in the west across the Atlantic Ocean to the east. There are 10 provinces and three territories in Canada, with a population nearing 38 million in 2019 (EGEDA, 2021). In 2019, Canada’s gross domestic product (GDP) grew by 1.9% to USD 1 842 billion (2017 USD purchasing power parity [PPP]), and GDP per capita grew by 0.4% to USD 49 007 (EGEDA, 2021).

The economy has extensive conventional and unconventional oil, natural gas and coal reserves as well as significant uranium deposits. It has the world’s third-largest number of proven oil reserves. At the end of 2020, the reserves were estimated at 168 billion barrels, of which oil sands constitute 97% (BP, 2021) (NRCan, 2021a). Canada has proven gas reserves of 72 trillion cubic feet (tcf). Canada currently holds 6 582 million tonnes of proven resources of coal, and its 462 kilotonnes of uranium resources is the world’s second largest (NEA, 2020)¹. Further, Canada’s rivers discharge about 7% of global renewable water, which provides a large resource for hydroelectricity.

¹ Uranium resources measure reasonably assured resources at USD 130 per

Table 1: Canada’s Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^c	
Area (million km ²)	10	Oil (billion barrels)	168
Population (million)	38	Gas (trillion cubic feet)	72
GDP (2017 USD billion PPP)	1 842	Coal (million tonnes)	6 582
GDP per capita (2017 USD PPP)	49 007	Uranium (kilotonnes U < USD 130/kgU)	462

Source: ^a World Bank (2020) ^b StatCan (2016) ^c StatCan (2022); BP (2021); NEA (2020)

Energy Supply and Consumption

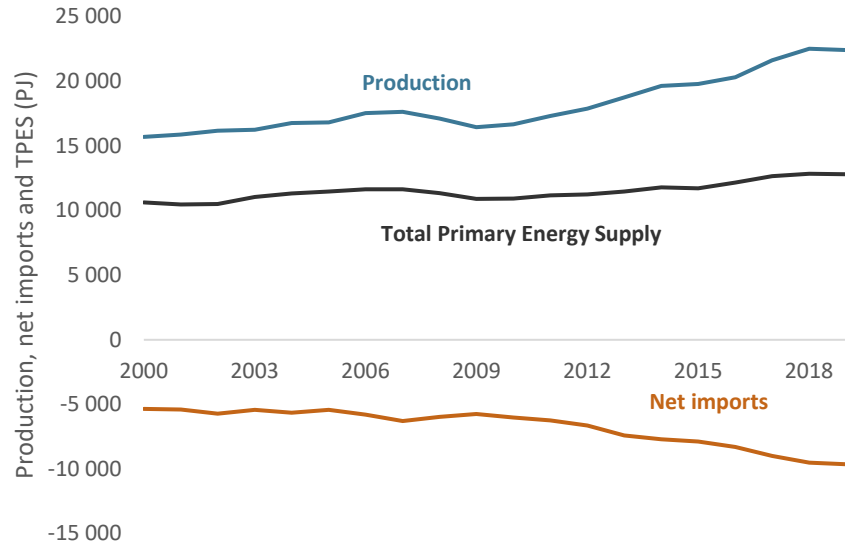
Total Primary Energy Supply

Canada is the fourth-largest energy producer in the APEC region, after China, the US and Russia, and the sixth largest in the world (NRCan, 2021a). Figure 1 illustrates that this production exceeds the domestic supply requirements. Therefore, much of Canadian production is for export markets. Canada is one of the world’s top-six exporters of crude oil, natural gas, uranium, and electricity. The energy sector is an important contributor to Canada’s economy, directly accounting for 7.2% of GDP in 2019 and indirectly (through purchases of goods and services from non-energy industries) for an additional 3.0%. In 2019, Canada exported CAD 134 billion worth of energy products and

kilogram of uranium (kgU).

imported CAD 48 billion. The main export market for Canadian energy continues to be the US, which makes up 90% of its export value.

Figure 1: Canada's total primary energy supply, production, and net imports, 2000 to 2019



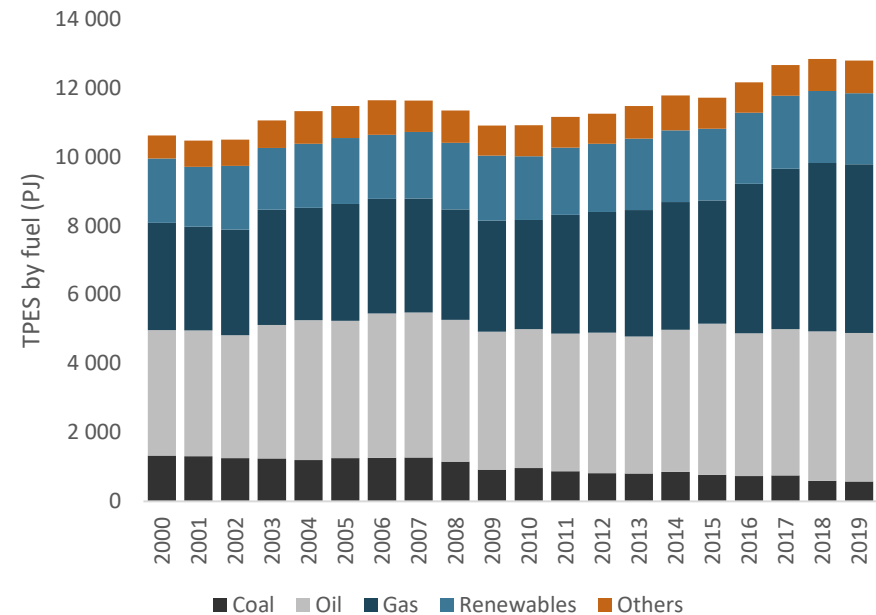
Source: EGEDA (2021)

Canada is a leading global producer of energy, as evident from its global production ranks for gas (fourth), crude oil (fourth), hydro (third) and uranium (fourth) (NRCAN, 2021a). Canada's domestic energy production fell by 0.4% to 22 424 petajoules (PJ) in 2019 (EGEDA, 2021). Fossil fuels dominated this production with a share of 86%. Oil, including natural gas liquids (NGLs), constituted the largest share (11 405 PJ, 51%), followed by gas (6 627 PJ, 30%) and coal (1 208 PJ, 5.3%). The share of nuclear energy production was 4.9% (1 104 PJ), leaving a share of approximately 9.2% for renewables (2 070 PJ).

Although Canada's crude oil source varies geographically, it

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 32%; offshore methods make up the remaining 5.5%. Production hit 4.9 million barrels per day (MMb/d) in 2019 but fell to 4.7 MMb/d in 2020 due to the COVID-19 pandemic (CER, 2021a).

Figure 2: Canada's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

Almost 99% of natural gas production occurs in the Western Canadian Sedimentary Basin (WCSB) (CER, 2021a). 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

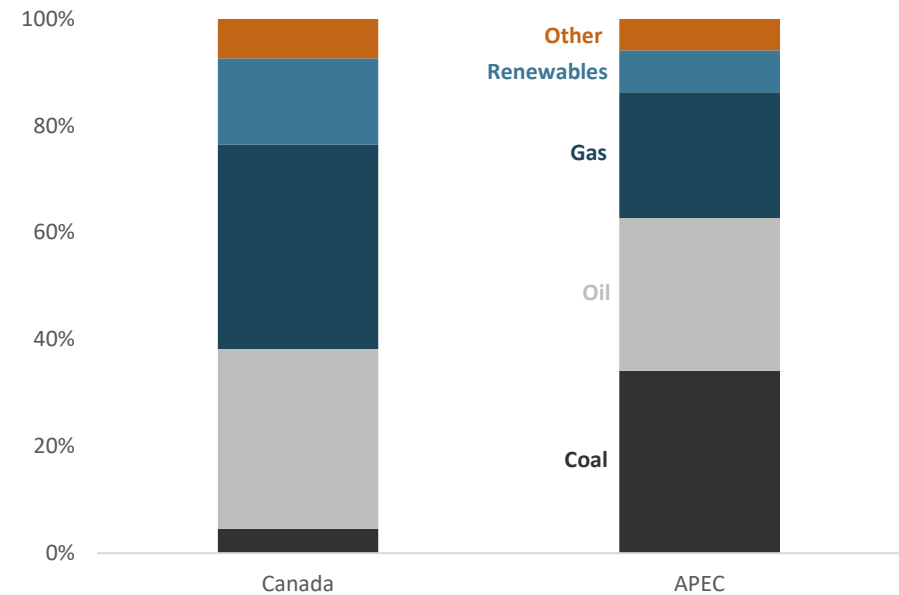
expected to dominate future production growth and allow for significant LNG exports later this decade.

Hydro is the most important source of renewable energy in Canada, supplying 62% 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 the 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.

Canada is a net exporter of oil, gas, coal, uranium and electricity, and the economy's energy exports go mainly to the US. From 2000 to 2019, energy exports grew 60%; exports increased by 2.4% in 2018 to 13 352 PJ (excluding uranium exports) (EGEDA, 2021).

Figures 2 and 3 illustrate how predominant fossil fuels continue to be in Canada's energy mix. However, Canada has significant renewable potential in addition to hydroelectricity. There are large and diverse biomass resources for energy production, owing to its large land mass and active forests. Moreover, Canada continues to tap into its variable renewable potential.

Figure 3: Total primary energy supply fuel share, Canada and APEC, 2019

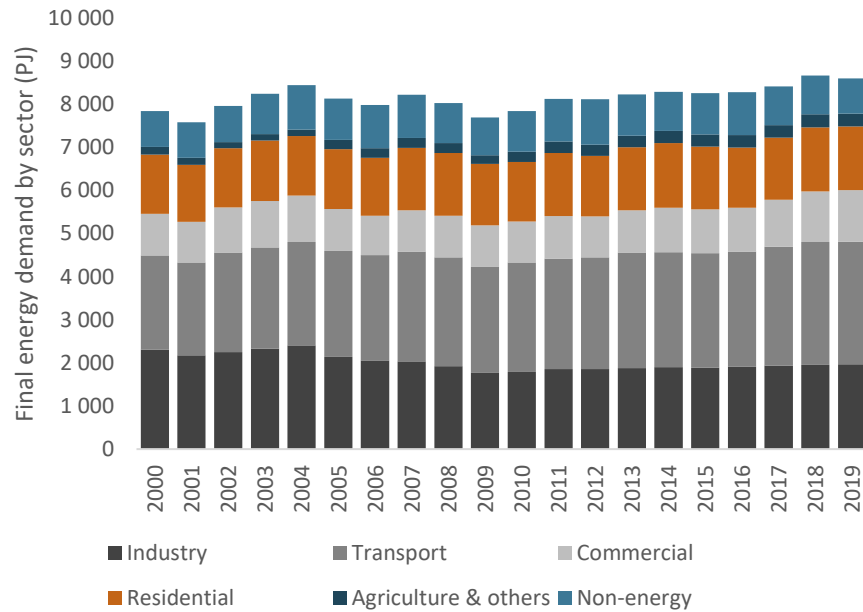


Source: EGEDA (2021)

Total Final Consumption

Canada's total final consumption in 2019 decreased by 0.78% to reach 8 605 PJ, making Canada the fifth-largest energy consumer in APEC, after China, the US, Russia, and Japan (EGEDA, 2021).

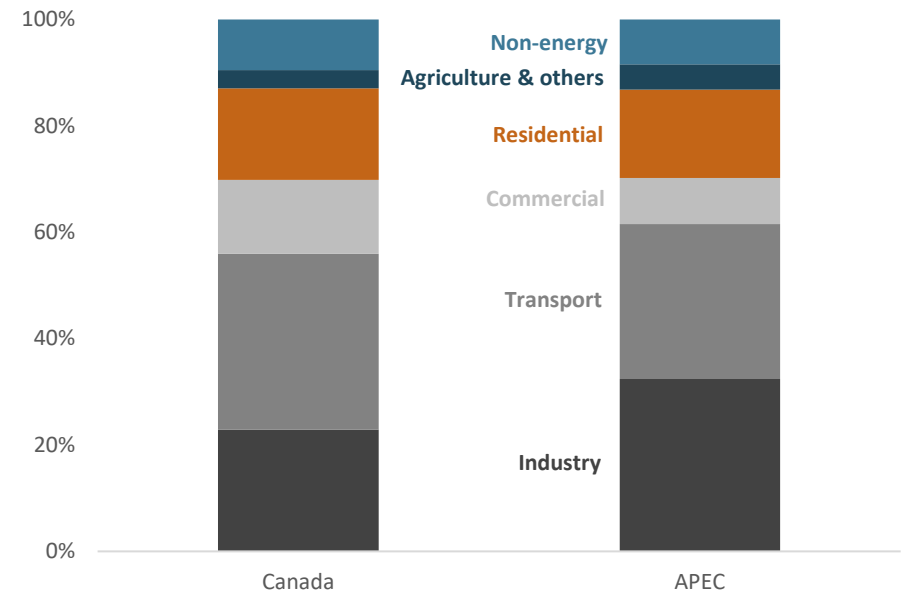
Figure 4: Canada's final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

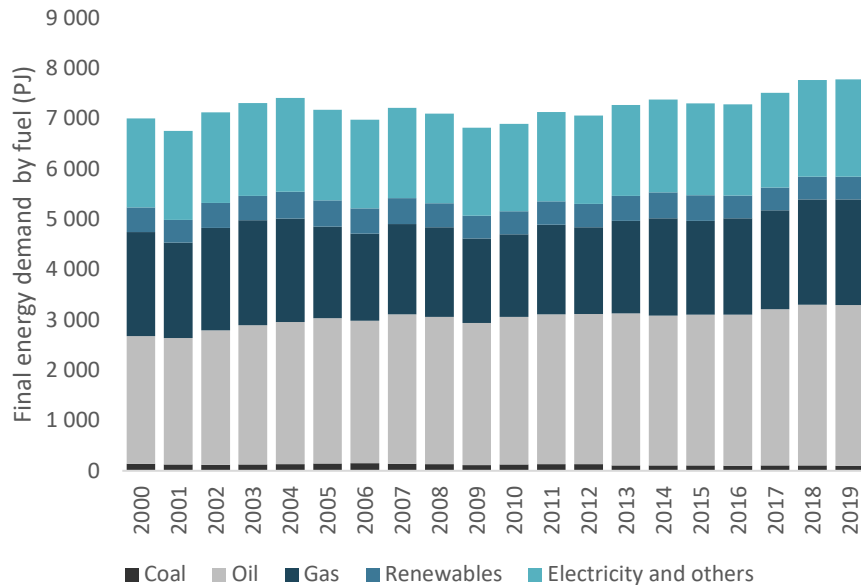
The transport sector accounted for the largest share of final energy consumption (2 847 PJ, 33%), followed by the industrial sector (1 969 PJ, 23%) (EGEDA, 2020). Non-energy use made up 9.5% (820 PJ), and buildings along with agriculture and non-specified others made up the remainder (2 970 PJ, 35%).

Figure 5: Final consumption sectoral share, Canada and APEC, 2019



Source: EGEDA (2021)

Figure 6: Canada's final energy demand by fuel, 2000 to 2019



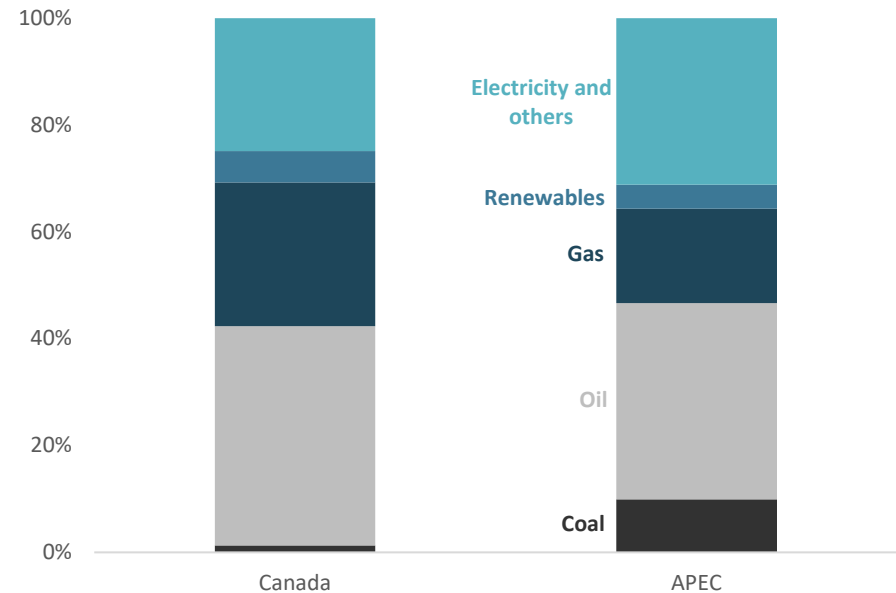
Source: EGEDA (2021)

Note: Does not include non-energy consumption.

Fossil fuels accounted for 69% of the final energy consumption² in 2019, comprising oil (3 195 PJ, 41%), gas (2 097 PJ, 27%), and coal (102 PJ, 1.3%). The remainder was formed by the share of renewables (454 PJ, 5.8%) and electricity and others (1 937 PJ, 25%), 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 average, the economy does rely more on fossil fuels than other economies in the region.

² Note that the demands in the EGEDA energy balance differ than those in the Report on Energy Supply and Demand (RES-D) energy balances due to

Figure 7: Final energy demand fuel shares, Canada and APEC, 2019



Source: EGEDA (2021)

Transformation

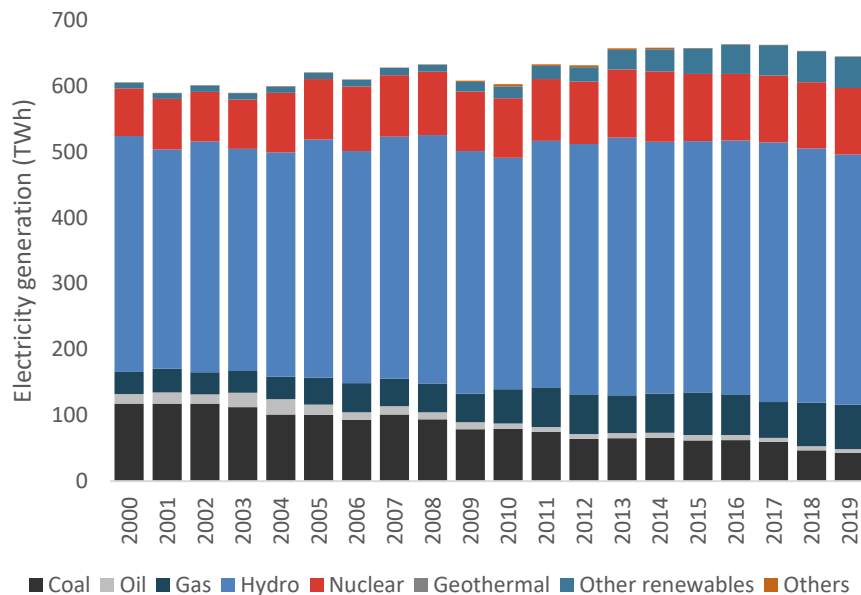
Canada generated 645 terawatt-hours (TWh) of electricity in 2019, a decrease of 1.3% from the previous year. Renewables constituted the largest share of this generation (66%), with hydro as the major contributor (59%) and solar, wind, geothermal and tidal at 7.0% combined. The share of nuclear energy was 16%, which increased the combined share of non-emitting power generation to 82%. Fossil generation made up 18%, with natural gas-fired generation climbing to 11% and coal falling to 6.7%. A combination of biomass (wood and spent pulping liquor) and other fossil fuels such as diesel, light fuel oil

differences in energy accounting frameworks (StatCan, 2021).

and heavy fuel oil accounted for under 1%.

Canada has been increasing the share of renewables, including hydroelectricity, for electricity generation since 2000. Low natural gas prices, the rapidly decreasing cost of renewable energy, the introduction of emission pricing on electricity, and new regulations that limit the use of coal have all decreased the greenhouse gas (GHG) intensity of Canada's electricity sector. 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.

Figure 8: Canada's electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

In 2016, the federal government announced its plan to phase-out coal-fired electricity generation in Canada by 2030. An acceleration of this phase-out started in 2018 – low natural gas prices and higher carbon

prices increased the relative operating cost of coal-fired generation in Alberta, prompting utilities to co-fire natural gas at existing coal units. Since then, economics and investor pressure culminated in utilities announcing a complete coal phase-out in Alberta by 2023. The remaining coal-fired generation in Canada will be equipped with carbon capture and storage (CCS) or covered by an equivalency agreement to reduce power emissions.

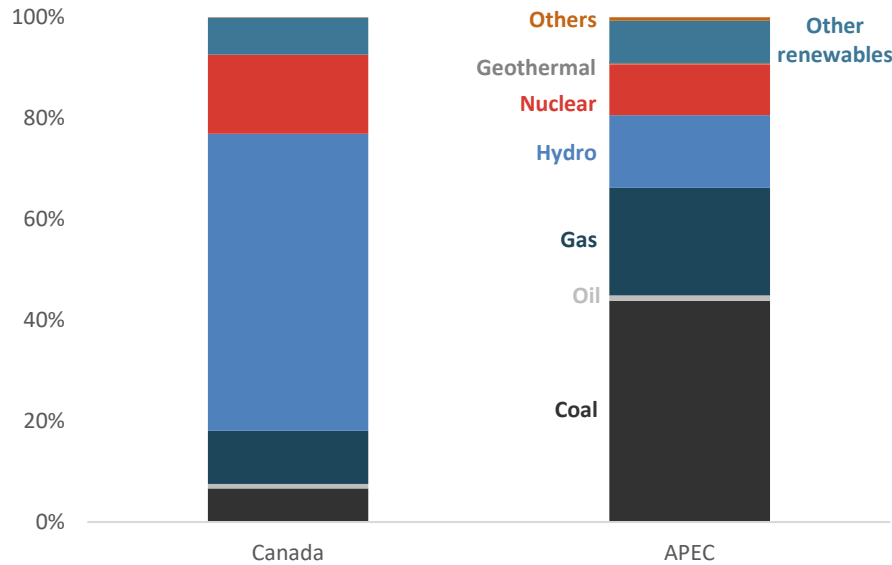
Canada also committed to phasing out inefficient fossil fuel subsidies that cause wasteful consumption by 2023, two years ahead of its G7 and G20 partners.

Despite a series of renewable contract cancellations in Alberta and Ontario, declining costs are prompting renewable bids that are competitive with other sources of generation. Therefore, in the absence of guaranteed contracts, it is reasonable to expect expansions of wind and solar resources to continue throughout Canada.

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 electricity networks of Canada and the US are highly integrated. In 2018, Canada exported 217 PJ of electricity to the US and imported 48 PJ (EGEDA, 2021). The bulk of Canada's electricity trade with the US occurs between Quebec, Ontario, Manitoba and British Columbia provinces and their neighbouring American states. Going forward, several new international power lines could increase electricity trade between the two economies (CER, 2021b). However, opposition to the construction of new transmission lines, such as the recent citizen rejection of the NECEC project to move Quebec hydroelectricity into New England through Maine, is challenging electricity trade growth (NECEC, 2021).

Figure 9: Electricity generation by fuel share, Canada and APEC, 2019



Source: EGEDA (2021)

APEC Goals

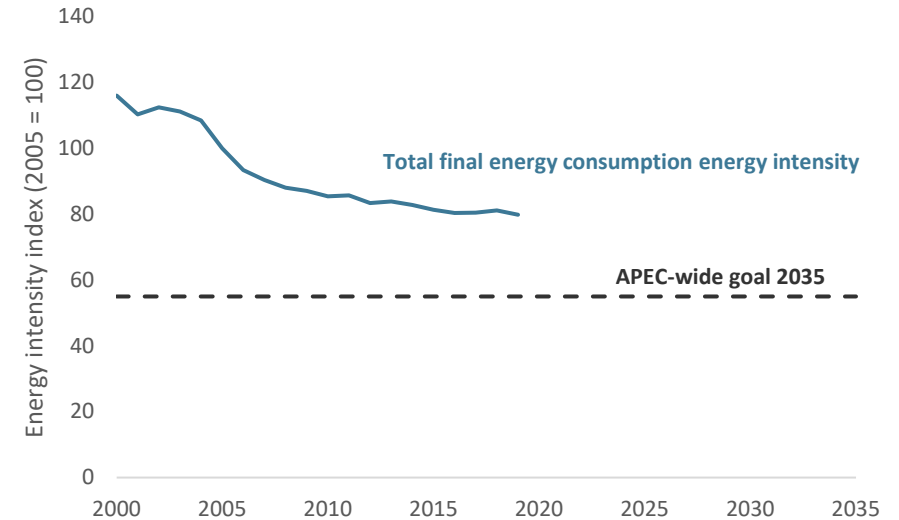
APEC has two aspirational goals. The first is to reduce energy intensity by 45% between 2005 and 2035, and the second is to double the share of renewables in the fuel mix, including the electricity mix, as compared to 2010 levels. However, it is important to articulate that APEC does not specify any economy-specific targets. Thus, while Canada need not achieve such targets, improving energy intensity and renewable shares can help APEC achieve its aspirational goals.

Energy Intensity Goal

Canada's energy efficiency policies, commitment to reducing GHG emissions and other targeted regulations have historically reduced

energy intensity. Figure 8 illustrates this, showing a 20% reduction in energy intensity since 2005.

Figure 10: Canada's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



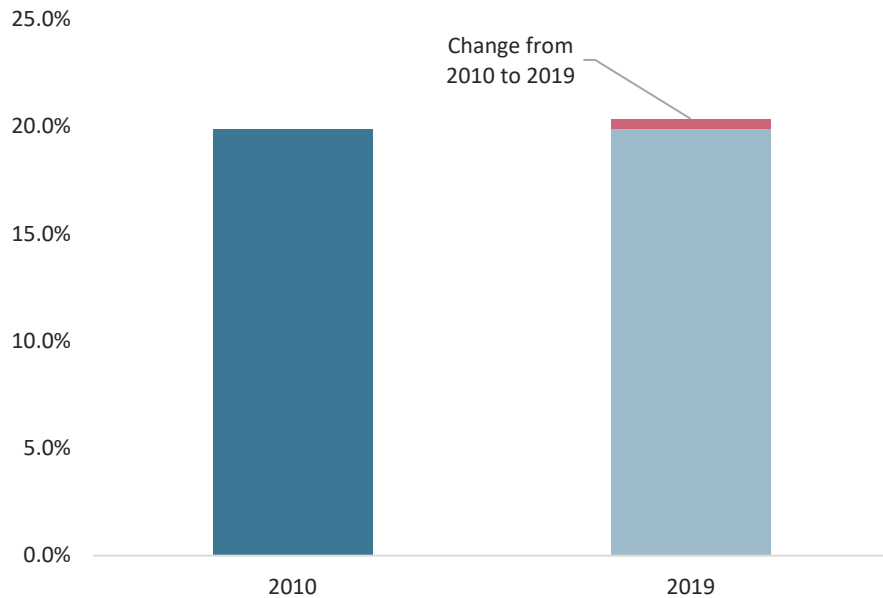
Source: EGEDA (2021)

This reduction is plateauing; energy intensity in 2019 is the same as it was in 2016. While it is difficult to determine the cause, one contributor is the rising role of trucks and SUVs in the vehicle mix, which is dampening fuel economy and reducing Canadian energy efficiency efforts in the transport sector (CER, 2019a; IEA, 2019). The implementation of economy-wide carbon prices and the adoption of energy-efficient technologies and climate policies (see below) could prompt accelerated efficiency improvements once again.

Doubling of Renewables

Due to the prevalence of hydroelectricity in its electricity mix, Canada is starting from a much higher renewable base than the APEC region. While Canada's renewable share in 2010 was 20% (Figure 9), APEC's was 6%.

Figure 11: Canada's modern renewable energy share, 2010 and 2019

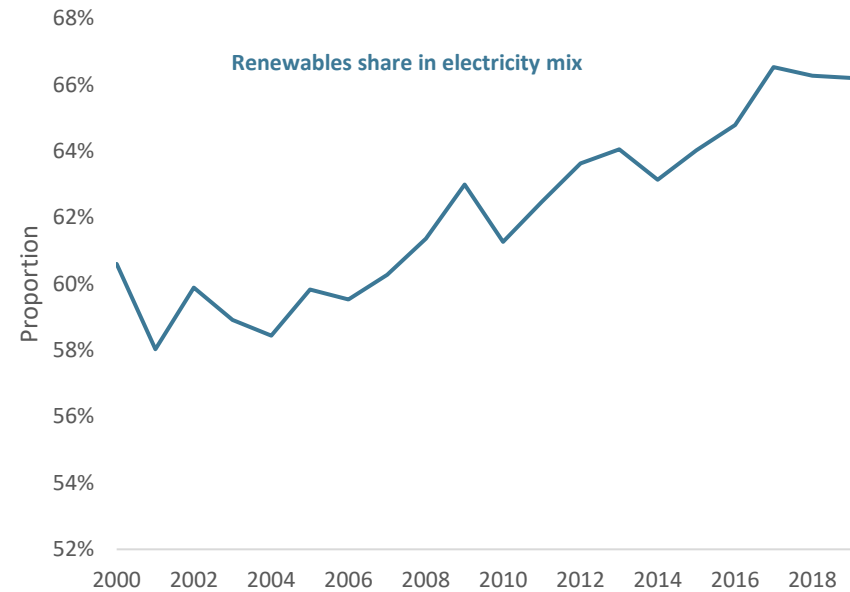


Source: EGEDA (2021)

Note: The 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 includes 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 12). However, Canada can still contribute to APEC achieving its aspirational goals. Several of Canada's climate policy announcements, including an Clean Fuel Standard, an upcoming Clean Electricity Regulation, a target of 100% net-zero power system by 2035 and higher carbon prices, will continue to increase the share of renewables in the Canadian and APEC fuel mix.

Figure 12: Canada's renewable generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

This table is not an exhaustive list of energy and climate policies in Canada or its provinces or territories. However, it is a list of material 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.
- A Healthy Environment and a Healthy Economy (ECCC, 2020d): Canada’s strengthened climate plan comprised of 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.
- Budget 2021 (Department of Finance, 2021): The Government of Canada provided an additional CAD 17.6 billion towards a green recovery to create jobs, build a clean economy, and fight and protect against climate change.
- The 2030 Emissions Reduction Plan (ECCC, 2022) is an ambitious and achievable roadmap that outlines a sector-by-sector path for Canada to reach its emissions reduction target of 40 percent below 2005 levels by 2030 and net-zero emissions by 2050. Several of the policies outlined in this plan are included in the policy table below.

2021 was a dynamic year for Canadian energy policy, particularly on the climate front. Ahead of the 2021 United Nations Climate Change Conference (COP26), Canada updated its GHG emissions reduction target and legislated its 2050 net-zero into law. The table below includes these developments.

Pan-Canadian approach to pricing carbon pollution	Carbon price on small emitters in Canada. Applies to residential, commercial and transport sectors. Price increases from CAD 50 per tonne in 2022 by 15 CAD per year, reaching 170 CAD per tonne in 2030. Canada is exploring methods to guarantee this price schedule with carbon contracts de-risk emission-reducing investments from political cycles.	Environment and Climate Change Canada
Green Municipal Fund	Invest \$950 million to increase energy efficiency in residential, commercial, and multi-unit buildings.	Environment and Climate Change Canada
Greening Government Strategy	Introduced in 2017, the Greening Government Strategy sets a target to reduce greenhouse gas emissions from federal operations by 40% by 2030.	Environment and Climate Change Canada
Amendment 14 - Energy Efficiency Regulations - Air Conditioners	Regulations for small AC units (residential and small commercial). Room AC unit efficiency standard update - details in the link	Canada Gazette

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Amendment 15 - Energy Efficiency Regulations - furnaces, boilers, fireplaces, HRV, tankless water heaters	Efficiency standards for residential and commercial electric furnaces, gas boilers, gas fireplaces, gas furnaces, HRV, oil boilers, tankless water heaters, oil water heaters.	Canada Gazette
Amendment 16 - Energy Efficiency Regulations - heat pumps, AC units, vending machines, freezers, etc.	Efficiency standards for residential and commercial AC and heat pumps, ceiling fans, portable AC units, chillers, coolers, vendors, vertical AC units, and other cooling devices	Canada Gazette
CMHC Green Home: Mortgage Financing of energy efficiency investments and retrofits	A partial refund of up to 25% of the premium for eligible home investments that improve energy efficiency.	Canadian Mortgage Housing Corporation Green Home
Energy Efficiency Regulations - Large AC units, Heat Pumps, condensing Units	Specifics regulations for commercial and industrial usage of large-scale cooling, condensing and space heating technologies.	Natural Resources Canada
NRCC National Energy Code of Canada for Buildings 2017	2017 NRRC Building Codes	National Research Council Canada
Output-based Pricing System (OBPS) for large emitters in industry and power sectors	Provide output-based allocations to large emitters to offset the effect of carbon leakage on carbon-intensive, trade exposed industries.	Justice Laws Canada
Federal Coal phase-out by 2030	Coal will be phased-out in Canada by 2030, with exceptions for coal power equipped with CCS units and Nova Scotia permitting its total electricity emissions decrease an equivalent to a phase-out.	Justice Laws Canada
Boiler standards for natural gas power units	Prohibits the operation of facilities exceed the standards: 420 tCO ₂ e/GWh for natural gas boilers; declining standard for coal-to-gas conversions; 550 tCO ₂ e/GWh if facility under 150 MW.	Environment and Climate Change 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.	Environment and Climate Change Canada
Methane Emissions	Reduce upstream methane emissions by 40 - 45% below 2012 levels by 2025 and 75% by 2030; supports the Global Methane pledge to reduce methane emissions 30% below 2020 levels by 2030.	Environment and Climate Change Canada
100 MtCO ₂ eq oil sand emission cap	Total emissions by the oil sands, less some allowances, cannot exceed 100MtCO ₂ eq	Alberta Government
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

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Short-term, capped ZEV subsidy	CAD 300 million between 2020-2023 on eligible ZEVs; CAD 5000 for long-range; CAD 2500 for short-range.	Transport Canada
Clean Fuel Standard: liquid fuels	Reduce the lifecycle carbon intensity of liquid fuels by 13% below 2016 levels by 2030. Compliance can be achieved via refining efficiency increases, EV adoption and increases in biofuel content.	Environment and Climate Change Canada
Pricing Carbon Pollution Phase II: 2023-2030	Increase carbon pricing in Canada by 15 CAD per tonne annually from CAD 50 per tonne in 2023 to CAD 170 per tonne in 2030	Environment and Climate Change Canada
Updated sales targets for zero emission vehicles	Light-duty zero emission vehicle (ZEV) sales target update: 20% by 2026, 60% by 2030, 100% by 2035. Medium and heavy-duty vehicle target for 45% ZEV by 2030 and 100% by 2040	Environment and Climate Change Canada
Canada Launches Just Transition Engagement	Consulting Canadians on the development of just transition legislation will help workers and communities thrive in the transition to a net-zero economy.	Natural Resources Canada
Canada's Updated Climate Plan (A Healthy Environment and a Healthy Economy)	Suite of emissions reduction measures across all sectors of the economy, including a schedule for increasing the carbon price rate by 15 CAD annually until it reaches 170 CAD per tCO ₂ in 2030.	Environment and Climate Change Canada
Canada 2021 Update to NDC Under the Paris Agreement	Canada updates its GHG reduction commitment to 40 to 45% below 2005 levels by 2050 and commits to by net-zero by 2050.	UNFCCC
Canadian Net-Zero Emissions Accountability Act	Legislates emissions reductions accountability to address climate change, by setting legal requirements on the current government and future governments to plan, report, and course correct on the path to net-zero emissions by or before 2050.	Environment and Climate Change Canada
Canada Green Buildings Strategy	Build off existing initiatives and set out new policy, programs, incentives, and standards needed to drive a massive retrofit of the existing building stock, and construction to the highest zero-carbon standards. This will help reduce emissions and heating and cooling costs.	Environment and Climate Change Canada
Low Carbon Economy Fund	Funds to empower communities to take climate action. Targets government, businesses and Indigenous communities.	Environment and Climate Change Canada
Lower carbon oil and gas	In addition to methane reduction, targetting a reduction of oil and gas sector emissions by 31% below 2005 levels by 2030 and working to implement an overall cap to the sector's emissions.	Environment and Climate Change Canada
Net-zero electricity by 2035	The Government of Canada has committed to achieve a net-zero electricity system by 2035.	Environment and Climate Change Canada
Carbon capture, utilisation and storage (CCUS)	Develop a CCUS strategy and introduce a CCUS investment tax credit.	Environment and Climate Change Canada

Notable Energy Developments

The table below details the recent developments that will shape Canada's energy future. This includes sanctioned infrastructure projects, such as LNG Canada and the TMX crude oil export pipeline, which will grant Canada increased access to energy markets, projects facing challenges, such as the NECEC transmission project, and roadmaps to develop emerging energy carriers and technologies, such as hydrogen and SMRs.

Hydrogen Strategy for Canada	Vision and Roadmap for hydrogen development in Canada.	Natural Resources Canada
Air Liquide Bécancour Electrolyser	The commissioning of the world's largest low-carbon proton exchange membrane (PEM) electrolyser increases production capacity by 50%.	Air Liquide
Smart Renewables and Electrification Pathways Program (SREPS)	SREPS provides over a billion (CAD) for smart renewable energy and grid modernisation projects over four years, incentivising the replacement of fossil-fuel generation with renewables that can provide essential grid services while supporting an equitable transition to an electrified economy.	Natural Resources Canada
Canada Greener Homes Grant	This will help homeowners make their homes more energy efficient. Participants are eligible for up to CAD 5 000 for eligible home retrofits and CAD 600 for EnerGuide evaluations to target retrofit planning. The program will also fund the recruitment and training of EnerGuide energy advisors.	Natural Resources Canada
SMR Action Plan	Action plan to commercialise SMR technology for the Canadian power sector by the end of the 2020s.	SMR Action Plan
LNG Canada	Two 14 Mtpa facilities, the first coming on H2 2025, the second H2 2031.	LNG Canada
NRCan Mandate Letter	NRCan is given the mandate to achieve a 100% net-zero electricity system by 2035. Future policies will likely be crafted to this end.	PMO Canada
ECCC Mandate Letter	ECCC is given the mandate to craft a Clean Electricity Standard to help achieve a 100% net-zero electricity system by 2035 and develop a regulated sales mandate for ZEVs. Future policies will likely be crafted to this end.	PMO Canada
Maine citizen initiative vote to block the NECEC transmission project	Maine citizens vote against the New England Clean Energy Connect (NECEC) transmission project to transport electricity from Quebec to New England through Maine.	Public Power
Thermal coal export ban	Announced an intention to ban thermal coal exports from Canada by 2030; includes re-exports.	Environment and Climate Change Canada
Federal Greenhouse Gas Offset System	The Federal Greenhouse Gas (GHG) Offset System is under development, to encourage cost-effective domestic GHG emissions reductions and removals from activities that are not covered by carbon pollution pricing and that go beyond legal requirements.	Environment and Climate Change Canada
Trans Mountain Pipeline voluntary shutdown for three weeks following B.C. flooding	Significant flooding in interior B.C. led to the voluntary shutdown of the Transmountain pipeline for three weeks, which cut off a significant source of oil product supply to the province.	Trans Mountain

Zero Emissions Vehicle Infrastructure Program	Several funding programs aimed at achieving the government goal of adding 50 000 ZEV chargers to Canada's network.	Natural Resources Canada
Clean Energy for Rural and Remote Communities Program	Provides funding for renewable energy and capacity building projects and related energy efficiency measures in Indigenous, rural and remote communities across Canada.	Natural Resources Canada

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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

Chile

Introduction

Chile is one of the longest and narrowest economies on the planet, occupying a stretch of land in the southwest of Latin America. It extends from the Antarctic in the south to the Atacama Desert in the north. Chile spans three continents, with its sovereign territory mainly on the South American continent, its westernmost border on Easter Island in Oceania, and its southernmost region in Antarctica. Peru is to its north, Bolivia and Argentina to its east, Antarctica to its south, and the Pacific Ocean to its west. Chile has a land area of 756 092 square kilometres (km²), with an average width of 175 km and a coastline of 6 435 km.

Chile is the fifth-largest energy consumer of the Americas, but unlike most other large economies in the region, it is only a small fossil fuel producer. Despite the availability of vast solar and wind energy resources and the rapid shift towards cleaner energy over the past decade, Chile is dependent on energy imports. Recent exploratory drilling in the Magallanes Basin, a shale formation, may increase Chile's domestic oil supply. There are an estimated 2.4 billion barrels of shale oil in the basin (EIA, 2019).

Chile's conventional uranium resources are estimated at 1.45 kilotonnes (NEA, 2018). These resources are recoverable at a price of USD 260 per kilogram at a recovery factor of 75%. No new uranium resources have been identified since 2011 (IAEA, 2020).

Chile has 16 regions headed by president-appointed regional governors. In 2020, the population reached 19.1 million.

Table 1: Chile Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^{b, c}	
Area (km ²)	756 092	Oil (billion barrels)	150
Population (million)	19.1	Gas (trillion cubic feet)	98
GDP (2017 USD billion PPP)	445.9	Coal (million tonnes)	171
GDP per capita (2017 USD PPP)	23 325	Uranium (kilotonnes U < USD 130/kgU)	1.45

Source: ^a World Bank (2021), ^b BP (2019), ^c NEA (2018)

Chile is one of the fastest-growing economies in South America, with an average annual growth rate of 3.2% between 2000 and 2020. In 2020, Chile's gross domestic product (GDP) reached USD 445.9 billion (constant 2017 USD PPP), a decrease of 5.8% from 2019, and the GDP per capita fell by 6.6% to USD 23 325 (World Bank, 2019). This decrease is largely due to the COVID-19 pandemic.

In recent decades, Chile's economy has benefited from exports of copper, wood pulp, fish and wine. Additionally, Chile has begun to capitalise on its domestic energy resources, namely the gusty coastal winds, intense desert sun and plate tectonics for geothermal power generation.

China has substantially increased its investments in electricity, renewable energy, agribusiness, and mining in Chile. For example, in 2018, China-based Tianqi Lithium Corp acquired a 24% stake in the Chilean lithium mining company SQM for USD 4 billion.

In 2019, foreign direct investment (FDI) flows in Chile increased for the second consecutive year, with inflows reaching USD 11 billion (an

increase of 63% from 2018) according to the World Investment Report 2020. These investments mostly flowed to utilities, mining and services, with a considerable contribution from China.

While the FDI inflows were a positive sign, 2019 was characterised by an increase in uncertainty following the announcement that the government would redraft the constitution. The overall stock of FDIs fell 0.7% to USD 267 billion (UNCTAD, 2020). The constitutional uncertainty was only exacerbated by the COVID-19 pandemic in 2020, with many mining companies announcing the suspension of their activities and delays in their expansion projects.

Energy Supply and Consumption

Chile's primary fuel mix has historically been dominated by oil, mostly consumed by the industry and transport sectors. Industry oil use rose in the past decade in response to the severe energy crisis that occurred when natural gas imports from Argentina suddenly dropped in 2004 (Chávez-Rodríguez et al., 2017).

Transport remains the largest oil consumer and has the second-highest overall energy consumption after the industry sector. Moreover, the number of private vehicles has increased with the rise in GDP and living standards.

Hydropower has long been an essential component of Chile's electricity generation mix. When the Argentinian government curtailed the supply of gas in 2008, hydropower's importance increased significantly.

Chile's energy transformation over the past 20 years has involved power generators switching from natural gas to diesel, then to coal and most recently to renewable energy.

At the beginning of 2010, only 3% of the power generation capacity used modern renewable energy resources: 183 MW in onshore wind farms alongside small amounts of solar PV, small hydro, and biomass and biogas plants.

As of 31 December 2020, 6 445 MW of modern renewable energy capacity has been installed in Chile, representing 25.9% of the total installed power capacity.

The breakdown of renewables is as follows: 39.2% for onshore wind farms, 55.6% for solar photovoltaic (PV) and 7.4% for biomass, with small hydro, geothermal and biogas plants constituting the rest (CNE, 2021). A 20% target for modern renewables by 2025, combined with declining capital costs and outstanding renewable resources, is currently transforming the market.

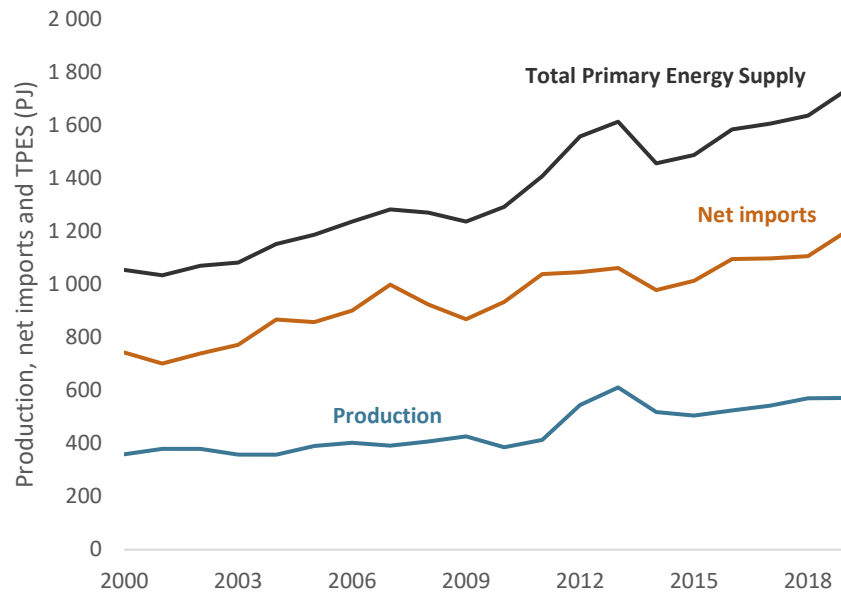
Total Primary Energy Supply

In 2019, Chile's total primary energy supply (TPES) was 1 732 PJ, an increase of 5.9% compared to the 1 636 PJ supply in 2018.

Chile is dependent on imported fossil fuels (oil, gas and coal). Fossil fuel imports represented 70.6% of TPES in 2019, an increase of 6.1% from 2018 (Expert Group Energy Data Analysis [EGEDA], 2021).

In 2019, the two largest source economies for Chile's imported crude oils were Brazil (36.0%) and Ecuador (36.0%). Natural gas mainly came from Argentina (47.3%) and the US (36.0%), while coal mostly came from Colombia (79.6%), the US (9.0%) and Australia (9.0%) (CNE, 2020).

Figure 1: Chile's total primary energy supply, production and net imports, 2000 to 2019



Source: EGEDA (2021)

In terms of fuel type, oil contributed the largest share (41.7%), followed by coal (20.4%), biofuels (16.9%), natural gas (13.7%), hydro (4.5%) and modern renewables (2.9%). In 2019, Chile's net import of energy sources constituted 72.3% of the TPES, growing by 3.0% annually from 2010 to reach 1 221 PJ in 2019 (EGEDA, 2021; IEA, 2020).

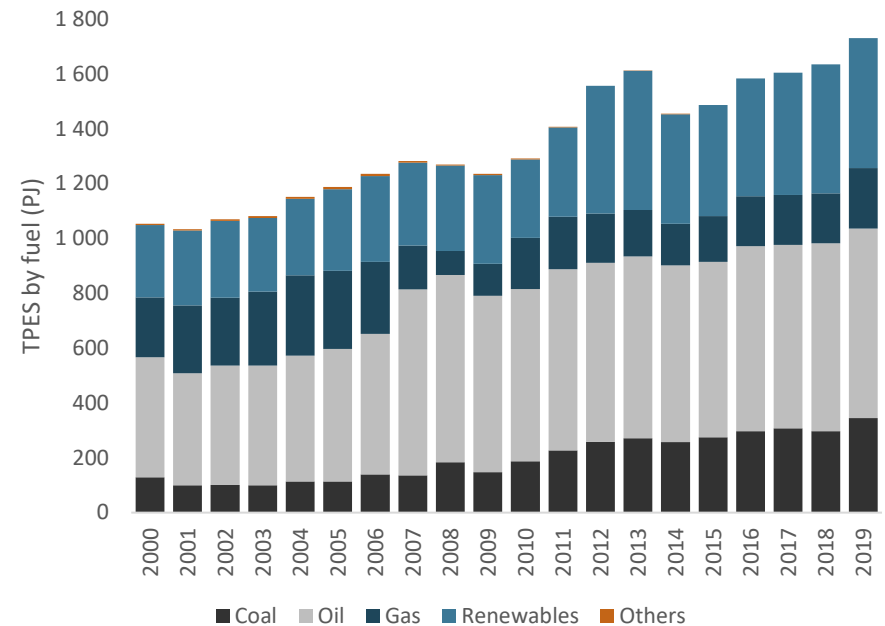
Coal's primary role is in the transformation sector, where it is used almost entirely in coal-fired power stations and coke ovens.

In 2019, the total renewable energy production in Chile was 474 PJ or 27.4% of the TPES. Production decreased by 0.6 % from the previous

year (EGEDA, 2021). Further, the primary forms of renewable energy production were biomass (71.3%) and hydro (17.1%).

Figures 2 and 3 illustrate how fossil fuels continue to be predominant in Chile's energy mix. However, Chile has significant renewable potential in addition to hydroelectricity.

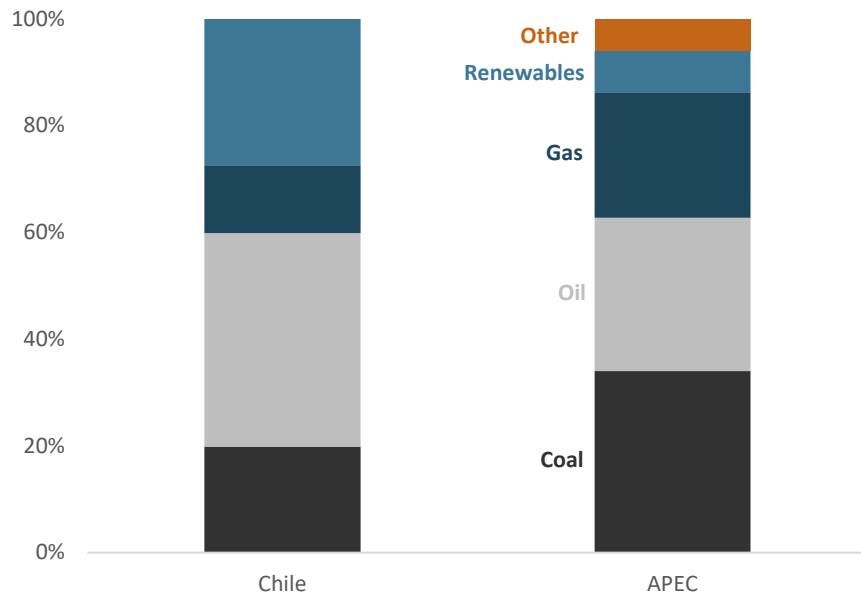
Figure 2: Chile's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

The Atacama Desert in the north boasts a direct normal irradiance of more than 9 kilowatt-hours (kWh) per square metre (m²) per day, the highest in the world. In its extreme south, together with Argentina, Chile has the best onshore wind resources globally.

Figure 3: Total primary energy supply relative fuel share, Chile and APEC, 2019



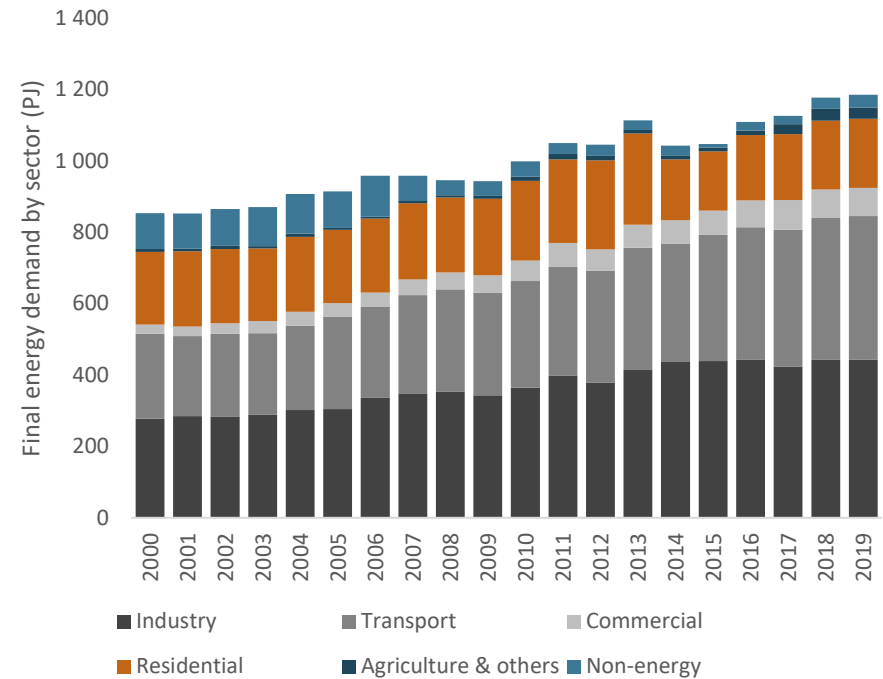
Source: EGEDA (2021)

Studies by the National Oil Company (ENAP), endorsed by the United States Geological Survey (USGS), estimated the non-conventional shale gas potential in Magallanes to be 8.3 trillion cubic feet (tcf), which is twice the volume of gas that the ENAP has extracted from the Magallanes Basin over the last 70 years (4.2 tcf).

Total Final Consumption

In 2019, Chile's final energy consumption was 1 185 PJ, representing an annual increase of 0.7%. By sector, industry accounted for 37.3% of final consumption, followed by transport (34.0%), residential (16.3%), and the commercial sectors (6.7%).

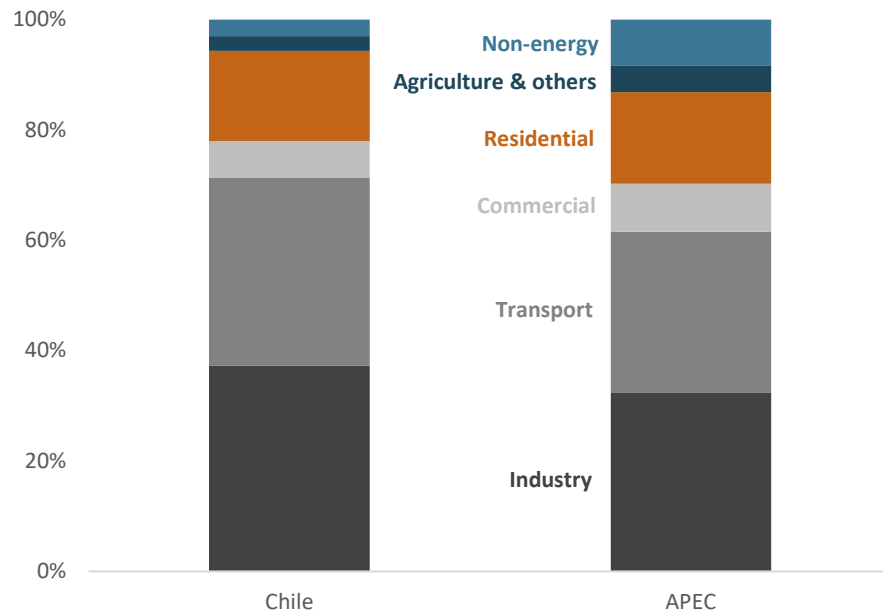
Figure 4: Chile's final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

Agriculture and others accounted for 2.7% of this final consumption in 2019. The remaining 3.0% was accounted for by non-energy use.

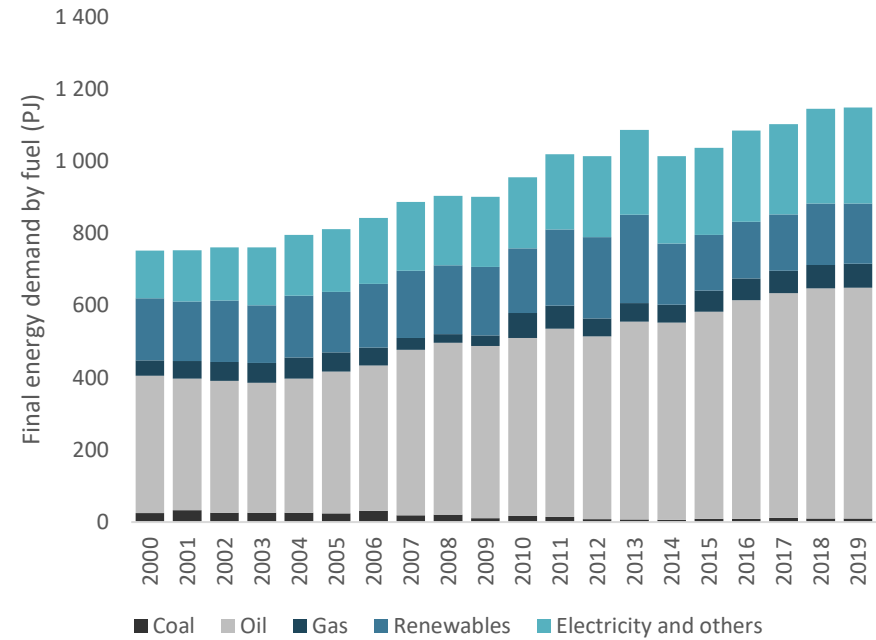
Figure 5: Final consumption sectoral share, Chile and APEC, 2019



Source: EGEDA (2021)

Chile's final energy demand sectoral share resembles APEC's. However, the main difference is that the transport share is bigger in Chile because its geography demands high transport activity to move people and products through its long territory. The Chilean commercial sector is slightly smaller than APEC's.

Figure 6: Chile's final energy demand by fuel, 2000 to 2019

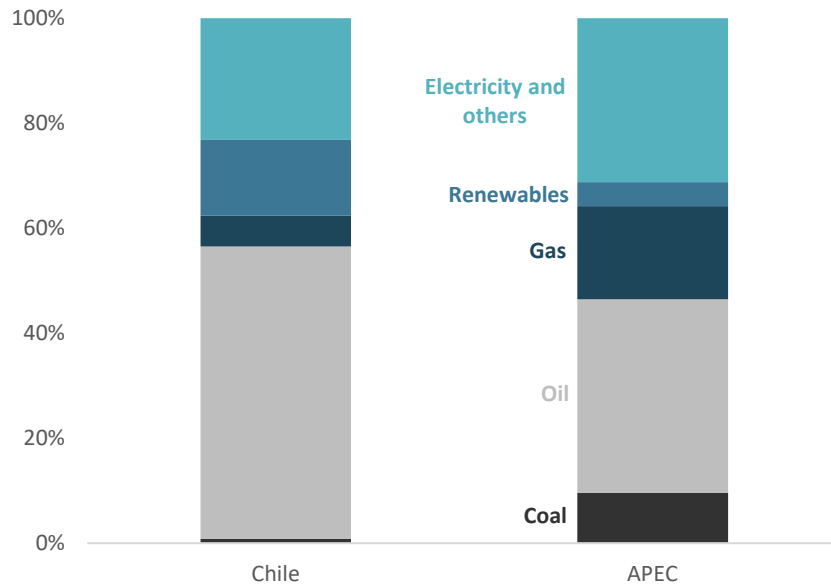


Source: EGEDA (2021)

Note: Does not include non-energy consumption.

Oil (in the form of petroleum products) accounted for 55.6% of Chile's final energy consumption, primarily consumed by the transport and industrial sectors. Electricity and other sources (23.2%), natural gas (5.9%) and coal (0.9%) comprised the remainder. Oil consumption increased by 0.2% from 2018, and electricity and other use increased by 1.5% (EGEDA, 2021).

Figure 7: Final energy demand fuel shares, Chile and APEC, 2019



Source: EGEDA (2021)

Fossil fuels accounted for 62.2% of final energy consumption in 2018, comprising oil (640 PJ, 55.6%), gas (67 PJ, 5.9%) and coal (10 PJ, 0.9%). The remainder consisted of renewables (166 PJ, 14.5%) and electricity and others (267 PJ, 23.2%), of which the share of renewable electricity and others was 122 PJ.

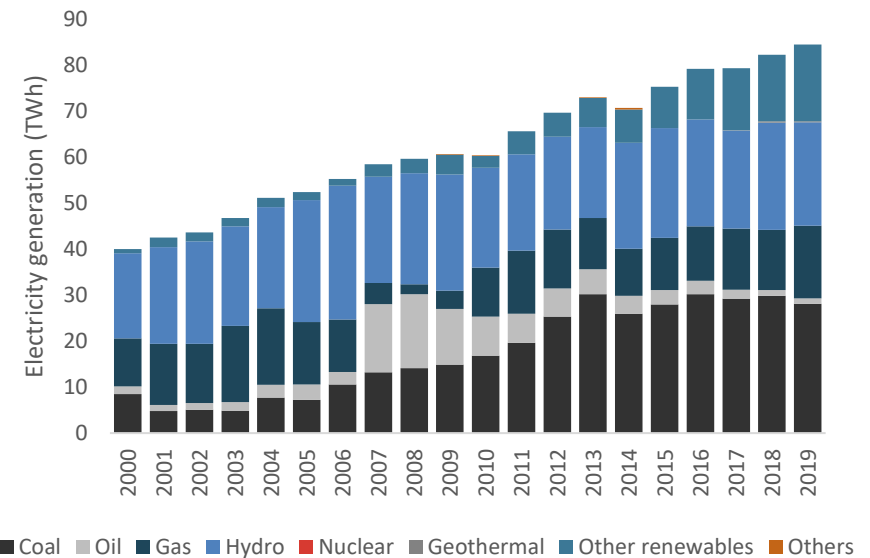
Coal makes up much less of Chile's final energy demand mix than the APEC average. However, even with a much larger share of oil, Chile relies slightly less on fossil fuels than the aggregate of all economies in the APEC region.

Transformation

Generation represents the production phase of the electricity supply chain. This segment is a competitive market in Chile, where generator companies offer energy at marginal production costs. The system operator (CEN) must ensure balance in the market, aiming to meet the electricity demand at minimum costs while preserving system security levels.

Electricity generation grew at an average annual rate of 4.0% between 2000 and 2019, reaching 84.6 TWh in 2019. Of this, 53% came from fossil fuel plants, 27% from hydro, 8.2% from solar PV and 6.2% from wind. Chile remains an electricity island, with only one intermittent cross-border connection with Argentina.

Figure 8: Chile's electricity generation by fuel, 2000 to 2019

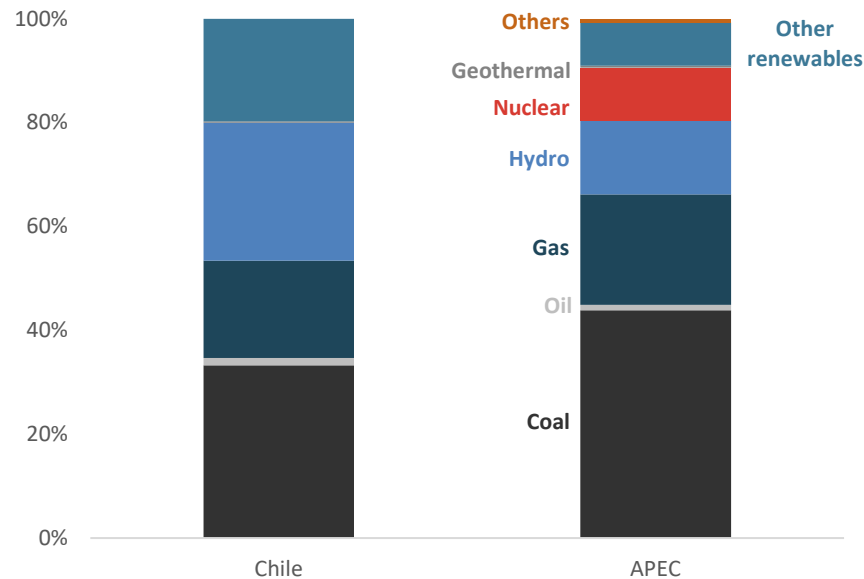


Source: EGEDA (2021)

Over the past two decades, the energy mix for Chile's power generation has changed remarkably with the introduction of low-carbon technologies, mostly renewables. Between 2004 and 2007, Argentina, which was then the sole natural gas supplier to Chile, faced an energy crisis and restricted its gas exports. Consequently, the natural gas supply in Chile decreased significantly in 2007, and its contribution to electricity generation dropped by 60% (IEA, 2018).

During this time, diesel units were replaced with a combination of coal- and gas-fired generation. The commissioning of two liquefied natural gas regasification plants allowed gas-fired power plants to further contribute to this replacement. Since 2010, the increased use of renewables has started to shape a new energy matrix.

Figure 9: Electricity generation by fuel share, Chile and APEC, 2019



Source: EGEDA (2021)

Even with an evolving electricity generation mix, the share of coal is still large, at around 33% in 2019. Chile's reliance on coal is influenced by the 10 years of consecutive drought in the central-south region, which reduced hydropower supply from 44% in 2008 to 26% in 2019 (EGEDA, 2021; IEA, 2020).

APEC Goals

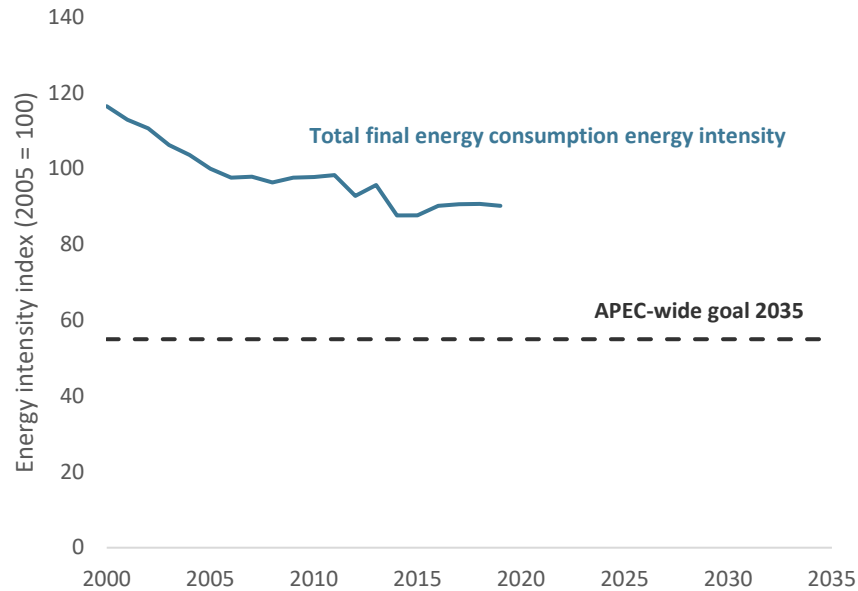
APEC has two aspirational goals: the first is to reduce energy intensity by 45% between 2005 and 2035, and the second is to double the share of renewables in the fuel mix by 2030, including the electricity mix, compared to the 2010 levels. However, it is essential to articulate that APEC does not specify any economy-specific targets. Thus, while Chile need not achieve such targets, improving energy intensity and renewable shares would help APEC achieve its aspirational goals.

Energy Intensity Goal

Chile's energy efficiency policies, commitment to reducing green houses gases emissions (GHG) and other targeted regulations have historically reduced energy intensity.

Figure 10 illustrates a 10% reduction in energy intensity since 2005. However, energy intensity improvements are slowing down. In 2019, energy intensity improved 0.6% with respect to 2018.

Figure 10: Chile's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



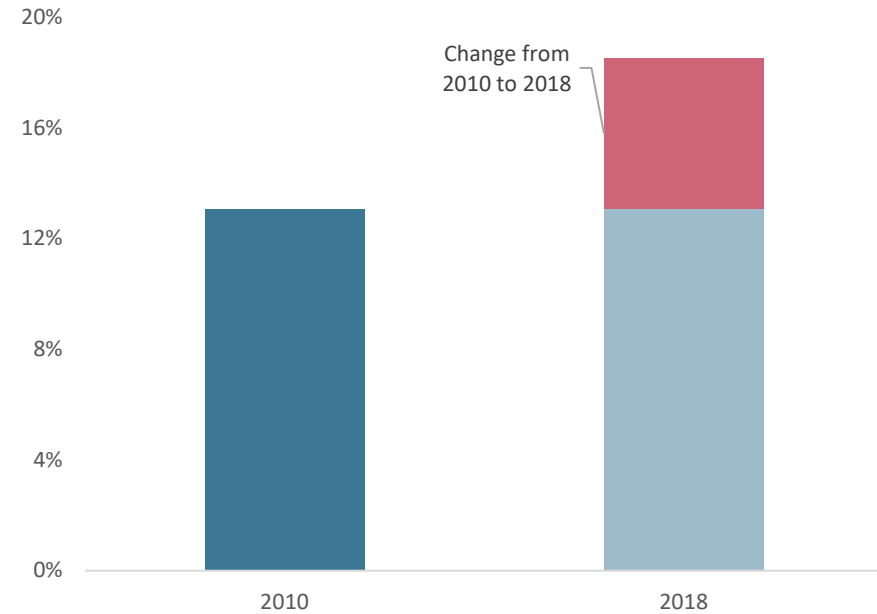
Source: EGEDA (2021)

Doubling of Renewables

Due to the prevalence of hydroelectricity in its electricity mix, Chile is starting from a higher renewable base than the APEC region. Chile's renewable share in 2010 was 13.1% (Figure 11), while APEC's was 6%.

Chile is likely to significantly increase its share of renewables over the next decade, contributing to APEC's aspirational goals. In 2019, Chile's modern renewable energy share was 18.4%. Several of Chile's climate policy announcements, including the National Hydrogen Strategy, electromobility strategy and potential updates to carbon prices, will help increase the share of renewables in the APEC fuel mix.

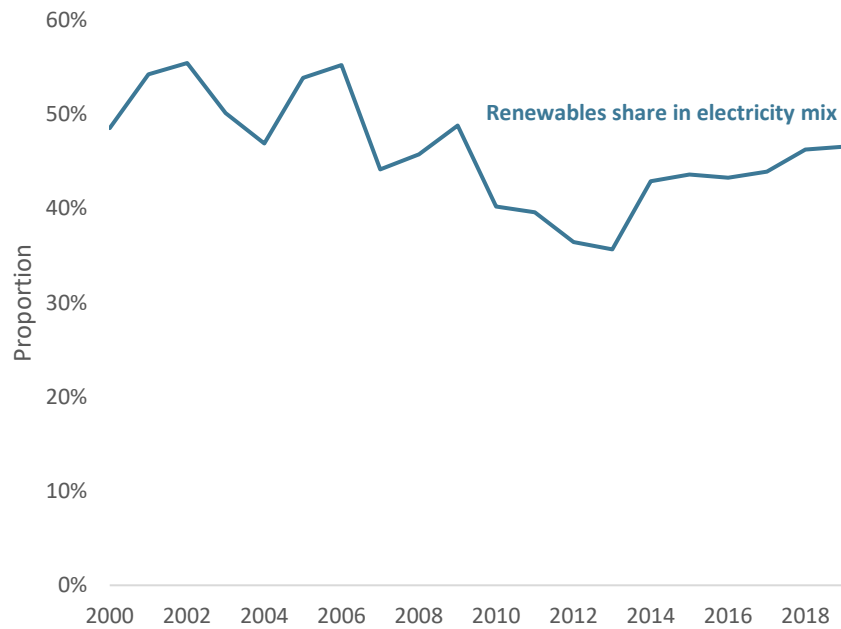
Figure 11: Chile's modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

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 generated from renewable sources

Figure 12: Chile renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Renewables share in electricity has seen a declining trend from 2006 to 2014. This decline is because increases in electricity demand were largely satisfied by an increase in coal-fired power plant generation. This generation took place due to restrictions on imports of natural gas from Argentina, as mentioned above. Since 2014, the addition of capacity of solar, wind and geothermal energy has led to an increasing share of renewable energy in electricity generation.

Energy policy

Energy Policy	Details	Reference
Carbon neutrality pledge	The Chilean government announced in June 2019 its aim to reach 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-term to meet the government's goal of having 40% of the private vehicle and 100% of the public transport fleets powered by electricity in 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 be 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

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 LULUCF) in 2030 has been announced. A GHG emission budget of 1 110 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 Energy
Energy Efficiency Bill	The law outlines a long-term energy efficiency plan, to be updated every five years. The new law promotes 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 industries sectors.	Ministry of Energy

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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 Energy Commission (CNE) – www.cne.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 Power Utilities – www.electricas.cl

Chilean Association of Solar Energy – www.acesol.cl

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

China

Introduction

China is in Northeast Asia. Its population of 1.4 billion is approximately one-fifth of the world’s population. China has a land area of approximately 9.6 million km² with diverse landscapes consisting of mountains, plateaus, plains, deserts, and river basins.

In 2019, China’s gross domestic product (GDP) reached USD 21 492 billion (2017 USD purchasing power parity [PPP]), which was a 5.9% increase from 2018 (World Bank, 2021). The primary, secondary and tertiary industries accounted for 7.1%, 39% and 54%, respectively (NBS, 2021).

China is relatively rich in energy resources, particularly coal. According to the BP statistics published in 2021, China’s proven coal reserves were over 143 billion tonnes, proven oil reserves were 26 billion barrels, and proven natural gas reserves were 8.4 trillion cubic metres (tcm) (BP, 2021). In addition, China has 400 gigawatts (GW) of economic hydropower potential, more than any other economy (IRENA, 2014).-

From 2000 to 2019, the compound annual growth rate (CAGR) of final energy consumption (excluding non-energy use of energy products) was 6.3% and the CAGR of GDP was 9.0% (EGEDA, 2021; World Bank, 2021).

Table 1: China’s Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	9.6	Oil (billion barrels)	26
Population (million)	1 397	Gas (trillion cubic feet)	8.4
GDP (2017 USD billion PPP)	22 492	Coal (million tonnes)	143 197
GDP per capita (2017 USD PPP)	16 092	Uranium (kilotonnes U < USD 130/kgU) ^d	119

Source: ^a United Nations (2022); ^b World Bank (2020); ^c BP (2021); ^d OECD (2020).

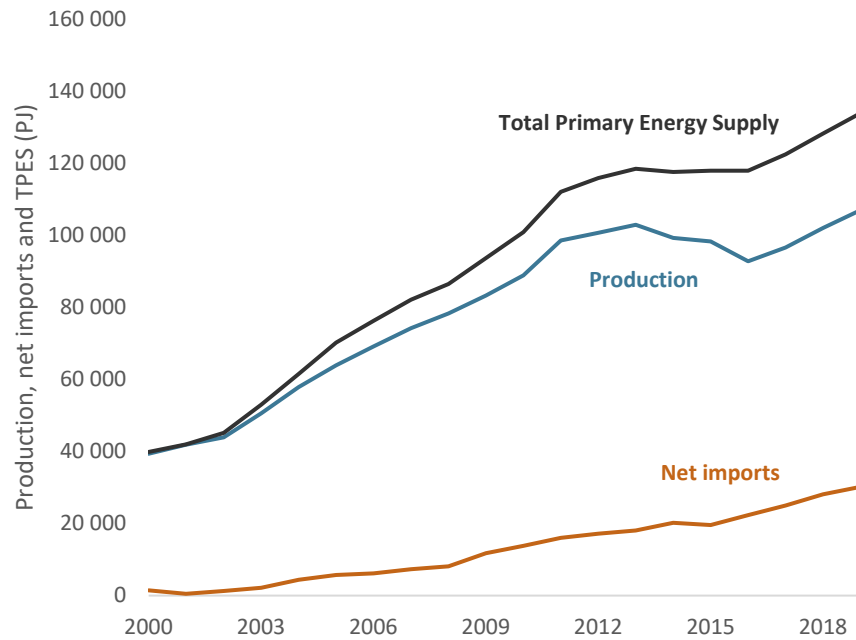
Energy Supply and Consumption

After a long period of development, China 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 2019, China’s total primary energy supply (TPES) increased by 4.4%, reaching 133 886 PJ. The supply of natural gas increased by 9.3% and that of renewable energy increased by 6.8%. Energy production increased by 4.8%: coal was the dominant source, accounting for 61%, followed by oil (20%), gas (8.7%), renewables (6.9%) and others (3.3%) (EGEDA, 2021). Coal production began to decline in 2014, reached its lowest level in 2016 and resumed growth in 2017. Energy production in 2019 increased 4.0% above 2018 levels (NBS, 2022). Increases in domestic demand led to net imports increasing to 30 177 PJ in 2019, a 7.5% annual increase (Figure 1).

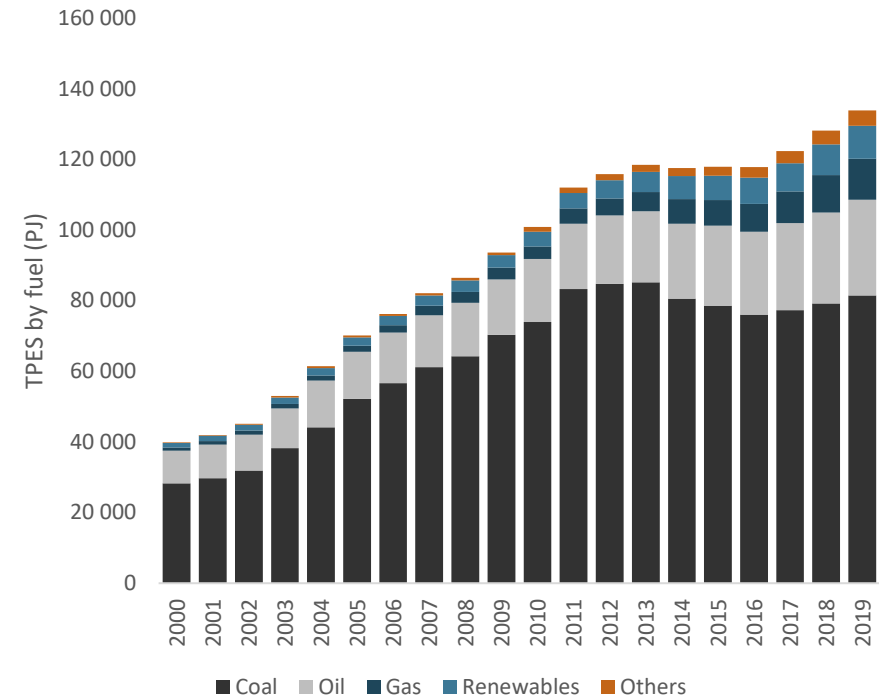
Figure 1: China's total primary energy supply, production and net imports, 2000 to 2019



Source: EGEDA (2021)

Since 2000, the different energy types that constitute TPES in China have shown varying trends, though all fuel types have grown significantly. Coal's share of TPES declined to 61% in 2019, down 10% from 71% in 2000. The share of oil decreased from 23% to 20%. The shares of gas and renewables increased to 8.7% and 6.9% from 2.2% and 3.2%, respectively (Figure 2).

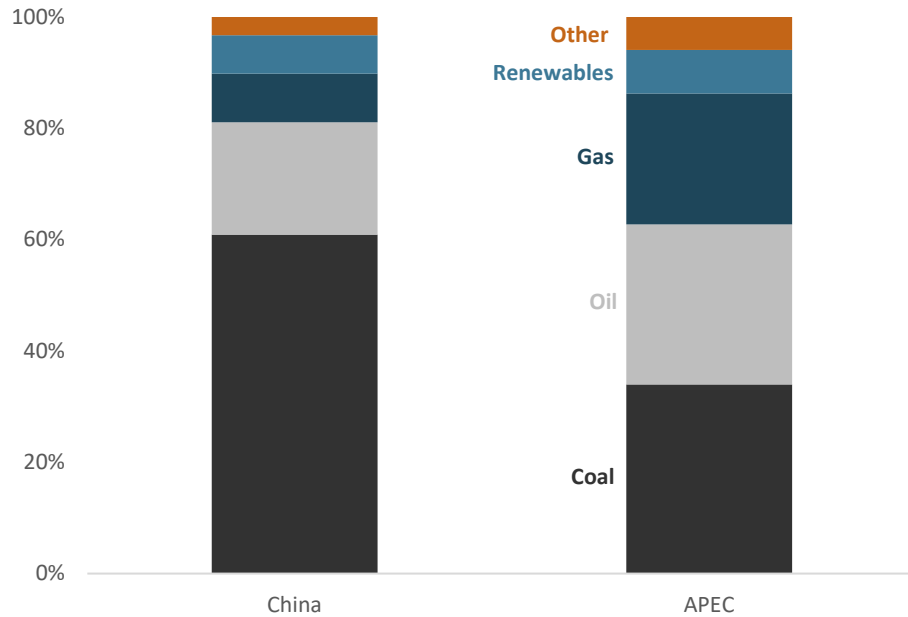
Figure 2: China's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

China's large coal reserves and coal's favourable economic situation in China mean that the share of coal in China's energy supply is much higher than that of APEC. However, as mentioned, 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 meant that China's share of renewables was comparable to the APEC region in 2019 (Figure 3).

Figure 3: Total primary energy supply relative fuel share – China and APEC, 2019



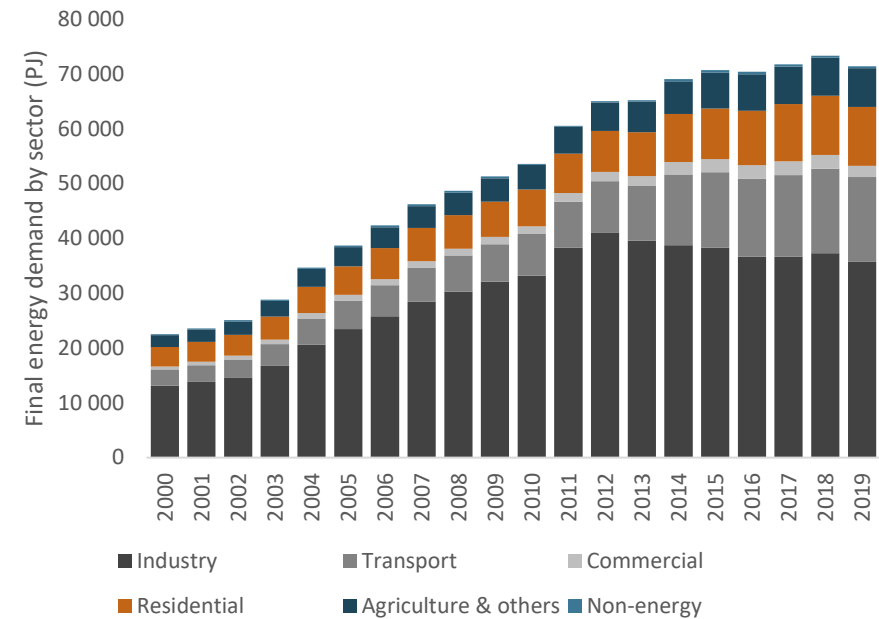
Source: EGEDA (2021)

Total Final Consumption

Total final consumption is a representation of end-use energy, including non-energy consumption. China's final consumption fell by 2.6% in 2019, which was the first annual fall since 2016. Industry's share of total final consumption in China is relatively large. However, despite its large share in 2019, industry's share has been declining, falling from 58% in 2000 to 50% in 2019. China's transport sector has the next largest share, accounting for 22% of all end-use energy sectors (Figure 4).

The Chinese government acknowledges that the industry sector must contribute to an acceleration of the low-carbon transition. Industry energy consumption peaked in 2012 (Figure 4), and policies are in place to encourage the economy to reach a peak in carbon dioxide emissions as soon as is practical.

Figure 4: China's final consumption by sector, 2000 to 2019

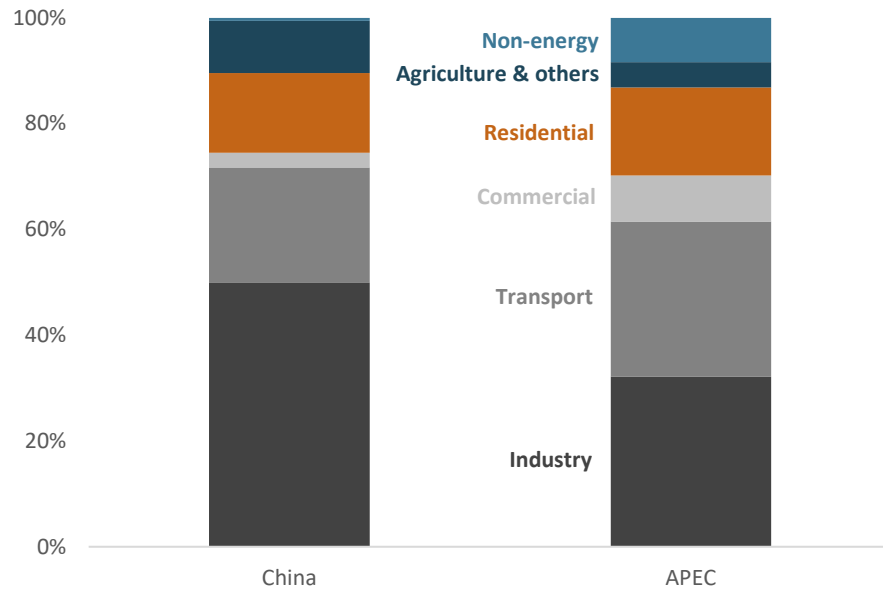


Source: EGEDA (2021)

China's industrial energy consumption accounts for almost one-sixth of final consumption for the entire APEC region. A continued transition to a more service-based economy will be important for China to reduce 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 of industrial activity in other economies.

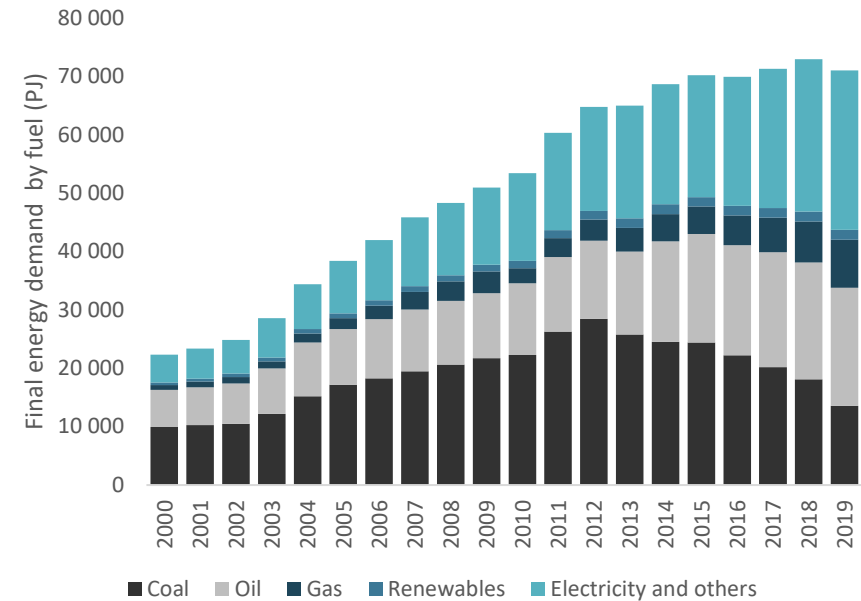
Figure 5: Final consumption sectoral share, China and APEC, 2019



Source: EGEDA (2021)

From 2000 to 2019, the fuel composition of final energy demand changed significantly. The most prominent change is that of coal, which increased from just under 10 000 PJ in 2000 to a peak of over 28 000 PJ in 2012. Since 2012, coal consumption has more than halved (13 597 PJ), and its share in final energy consumption was 19% in 2019, down from 44% when it peaked at absolute levels in 2012. In contrast, the share of electricity and others, gas and renewables had all increased by 2019, reaching 38%, 12% and 2.4% respectively. The share of oil maintained a similar share over the last two decades and was 28% in 2019 (Figure 6).

Figure 6: China's final energy demand by fuel, 2000 to 2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy products.

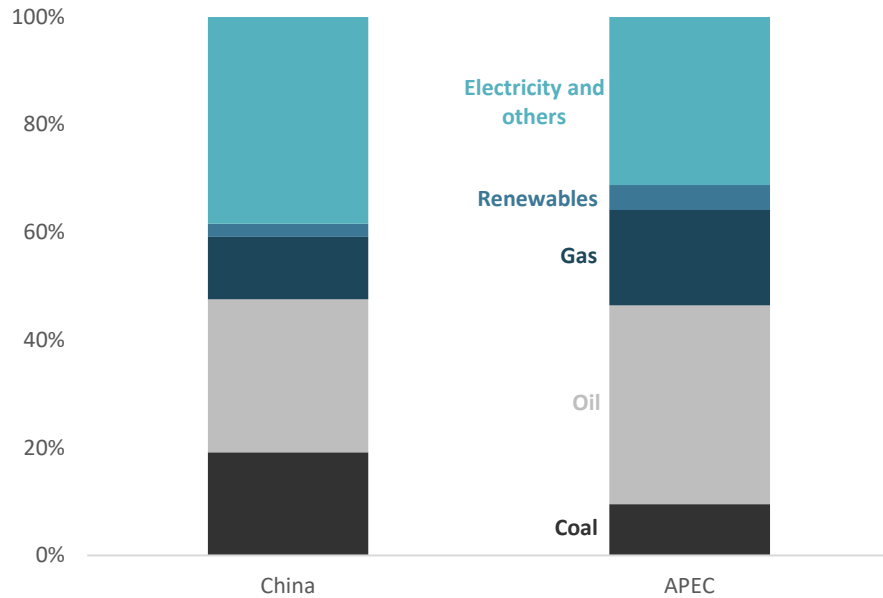
According to the updated Nationally Determined Commitment (NDC) submitted in October 2021, China will strictly limit the increase in coal consumption over the 14th Five-Year Plan (FYP) period (2021 to 2025) and phase coal consumption down in the 15th FYP period (2026 to 2030).

Updated NDC goals include increasing the share of non-fossil fuels in primary energy consumption to around 20% (UNFCCC, 2021).

Although demand for coal and its share has decreased from the high recorded in 2012, China's share of coal in 2019 (19%) was still relatively high (Figure 7). For the entire APEC region, coal's share of

final energy consumption was less than 10% in 2019.

Figure 7: Final energy demand fuel shares, China and APEC, 2019



Source: EGEDA (2021)

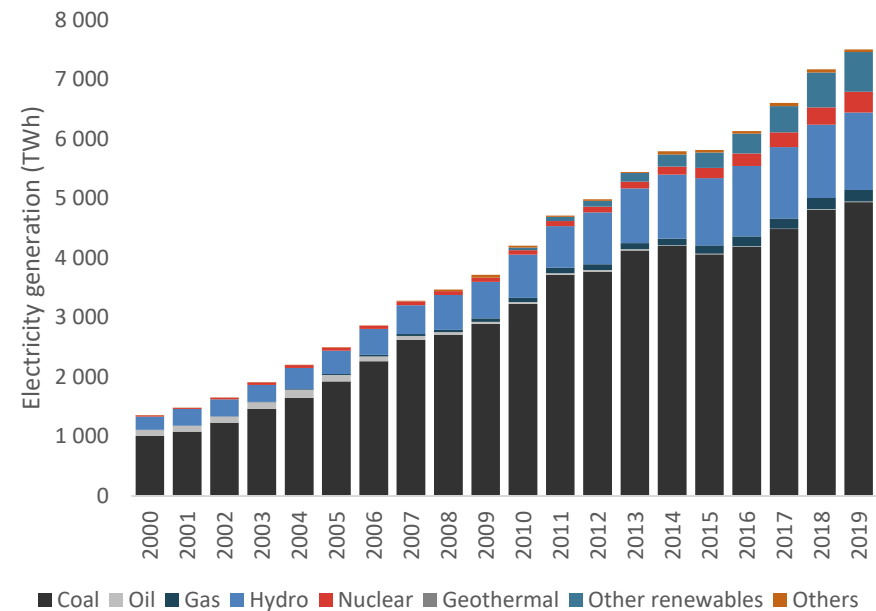
Transformation

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 68% of China's electricity generated from coal-fired power plants in 2019. However, this share represents a decline from 82% in 2000 (EGEDA, 2021). From 2000, the proportion of non-fossil energy in electricity generation has increased by more than three-quarters, and the absolute level of generation from non-fossil fuels has increased by a factor of 10. Within that increase, nuclear generation is now 20 times greater (Figure 8).

China is stringently curbing coal-powered projects and has committed to no longer building new coal-fired power projects abroad. At the same time, China has committed to the acceleration of the large-scale development of wind and solar power. Hydro power will also be developed, in accordance with local conditions.

As for nuclear power, it will be advanced in an ordered manner with the premise of ensured safety (UNFCCC, 2021).

Figure 8: China's electricity generation by fuel, 2000 to 2019



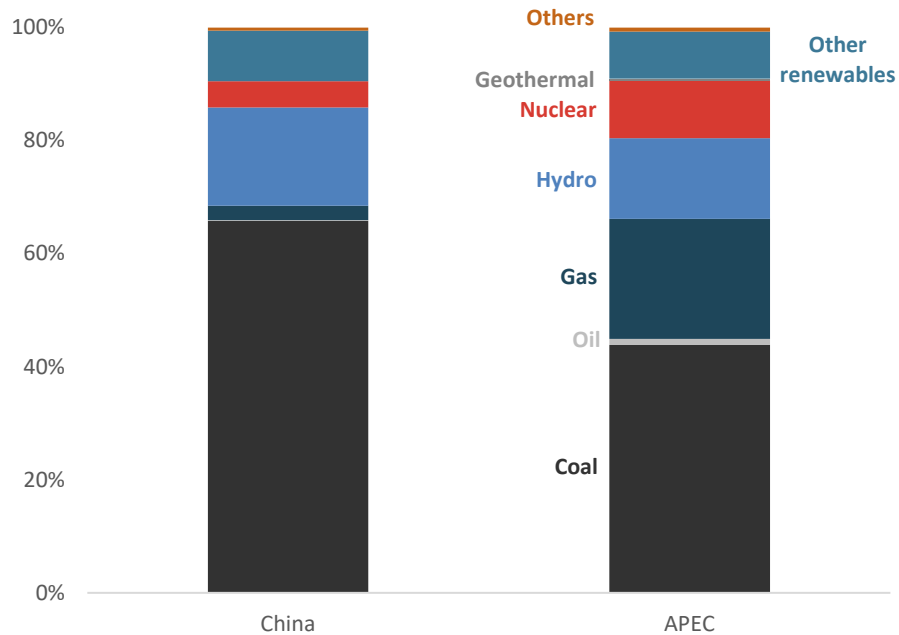
Source: EGEDA (2021)

Resource endowment combined with favourable economics 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 2019, China's power generation reached 7 503 TWh. Thermal power

and hydropower reached 5 140 TWh and 1 304 TWh, respectively (EGEDA, 2021), ranking each as first in the world. Nuclear power generation reached 348 TWh, ranking third (EGEDA, 2021; BP, 2021).

Figure 9: Electricity generation by fuel share, China and APEC, 2019



Source: EGEDA (2021)

APEC Goals

APEC goals include reducing energy intensity by 45% by 2035 (from the 2005 level) and doubling the share of renewable energy by 2030 with 2010 as the base year.

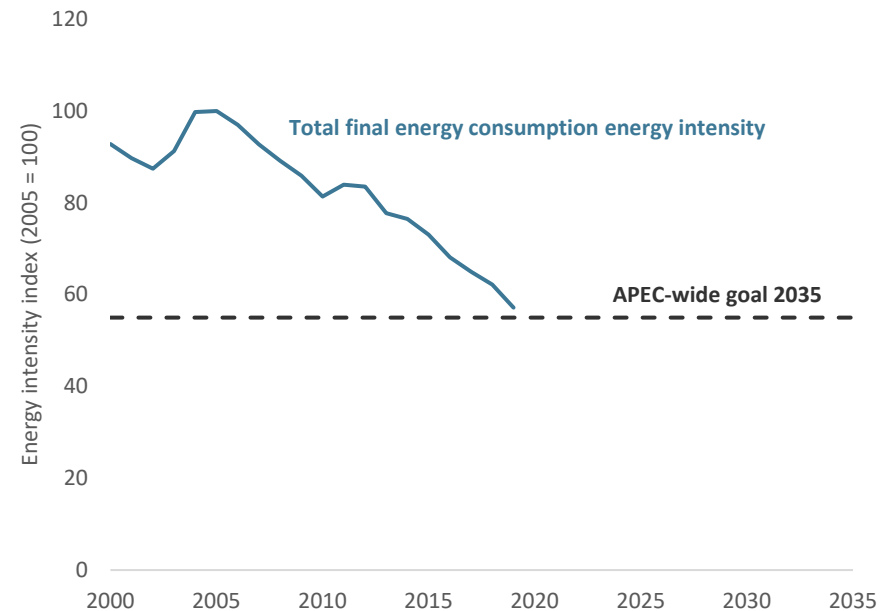
Energy Intensity Goal

Energy intensity in the APEC region has been continuously improving.

China is contributing to APEC’s aspirational goal of a 45% energy intensity reduction by 2035 from the 2005 level. 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% (The State Council, 2021).

In 2019, China’s total final energy consumption (excluding non-energy sources) energy intensity improved by 43% relative to 2005 (Figure 10).

Figure 10: China’s total final energy consumption intensity index, 2000 to 2019 (2005 = 100)

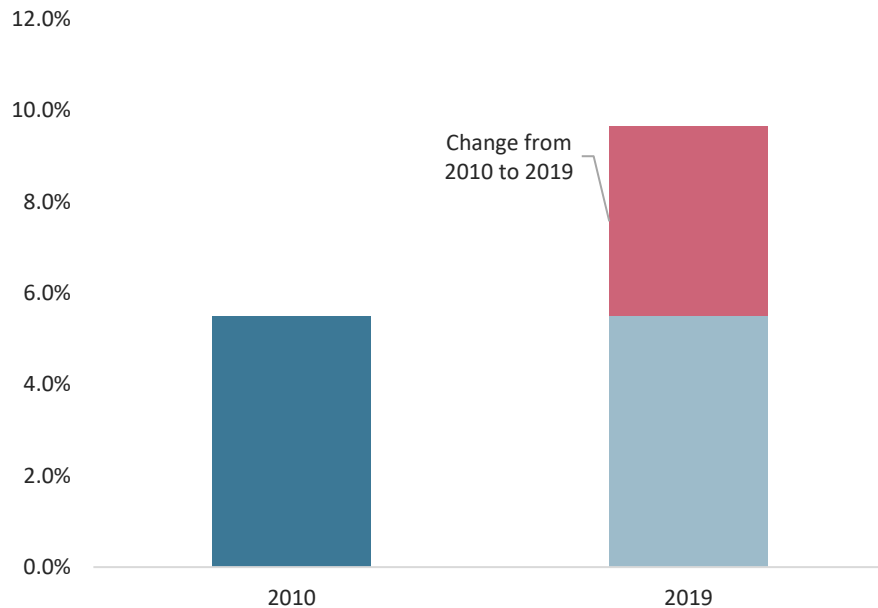


Source: EGEDA (2021)

Doubling of Renewables

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

Figure 11: China’s modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

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

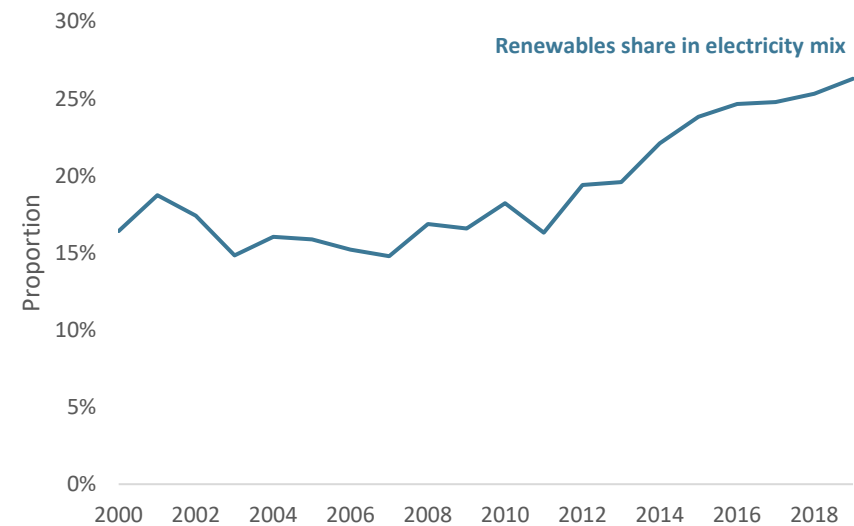
There is no economy-level goal for individual member economies; however, it is possible to calculate the relative improvement of

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 5.5%. In 2019, this proportional share was 9.7%, which represents a 4.2 percentage point increase (Figure 11).

The renewables share in China’s electricity mix increased from 16% in 2000 to 26% in 2019 (Figure 12). The increase was mainly driven by wind and solar. The capacity of wind and solar are expected to increase more as NDC goals include bringing China’s total installed capacity of wind and solar power to over 1 200 GW by 2030 (UNFCCC, 2021).

Figure 12: China’s renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

Energy Policy	Details	Reference
Fair and open supervision of oil and gas pipeline network facilities	Encouraging and supporting various types of capital to participate in the investment and construction of oil and gas pipeline network facilities that are included in the unified plan to improve guaranteed oil and gas supply capacity.	The State Council
Support the reform and development of private enterprises	Support private enterprises in entering the fields of oil and gas exploration and development, refining and marketing, building infrastructure, construction in the fields of storage and transportation of crude oil, natural gas and refined oil products, and pipeline transportation.	The State Council
Accelerate the development of distribution to promote commercial consumption	Cancel the qualification for the wholesale distribution of refined oil products and delegate to lower-level governments the examination and approval of the qualification for retail sales.	The State Council
Industrialisation of the development of biogas	Annual production of biogas will exceed 10 billion cubic metres by 2025 and 20 billion cubic metres by 2030.	National Development and Reform Commission (NDRC)
Wind power construction management	Changing the benchmark feed-in tariff for wind power to a guided tariff and the feed-in tariff for newly approved centralised onshore and offshore wind power projects to be allocated and determined through competition	NEA
Improve the feed-in tariff mechanism for photovoltaic (PV) power generation	Changing the benchmark feed-in tariff for centralised PV power stations to a guided tariff and reducing the intensity of subsidies for distributed PV projects	NDRC
Establish and improve the guarantee mechanism of renewable energy power consumption	Determine the target proportion of renewable energy power in electricity consumption in each provincial administrative region.	NEA
Government work report for 2021	Promote the clean use of coal, develop new energy sources and develop under the premise of safety.	Report on the work of the government
Renewable power subsidy for 2022	China set the renewable power subsidy at 3.87 billion Yuan for 2022.	Reuters

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Green production and consumption	Study and formulate standards, norms and supporting policies for the development of hydrogen energy, marine energy and other new sources of energy.	NDRC
Management of power business licenses	Reduce items subject to administrative examination and approval, simplify the scope and optimise procedures.	NEA
Reform the oil and gas system	Established an independent pipeline network company. It is an important measure to thoroughly implement a new energy security strategy of "Four revolution, one cooperation"	The State Council
Peak carbon emissions by 2030 and achieve carbon neutrality before 2060	In 2020, President Xi announced that China aims to peak CO2 emissions before 2030 and achieve carbon neutrality before 2060	Xinhua
Energy Law of the PRC (Draft for Solicitation of Comments)	The to-be-announced Energy Law gives all energy policies a clear legal basis to ensure the direction of energy development and the stability of energy regimes.	NEA
Updated Nationally Determined Commitment (NDC)	Updated NDC was submitted, which includes new NDC goals: <ul style="list-style-type: none"> · Aims to have CO2 emissions peak before 2030 and achieve carbon neutrality before 2060 · Lower CO2 emissions per unit of GDP by over 65% from the 2005 level · Increase the share of non-fossil fuels in primary energy consumption to around 25% · Increase the forest stock volume by 6 billion cubic metres from the 2005 level · Bring total installed capacity of wind and solar power to over 1.2 billion kilowatts by 2030 	UNFCCC

Notable Energy Developments

Energy Development	Details	Reference
1+N policy framework	"1" refers to the long-term approach to combatting climate change and "N" refers to solutions to achieve peak carbon emissions by 2030. "Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy" was released as the comprehensive document of 1+N policy framework for carbon peaking and neutrality together with an "Action Plan for Carbon Dioxide Peaking before 2030".	Xinhua Embassy of the People's Republic of China in the United States

Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy

Principles to follow to achieve carbon dioxide peaking and carbon neutrality. The guidance gives first priority to the conservation of energy and resources. It also includes industrial restructuring, development of a low-carbon, safe and efficient energy system, and construction of a low-carbon transportation system, etc.

[NDRC](#)

Action Plan for Carbon Dioxide Peaking before 2030

Ten major actions for peaking carbon dioxide emissions, including low-carbon energy transition, energy saving, carbon emission mitigation and energy efficiency improvement, peaking carbon dioxide emissions in the industry sector, etc.

[NDRC](#)

Steady growth in renewable capacity

By the end of 2021, China's installed capacity totalled 1.06 billion kilowatts, accounting for 44.8% of the total installed power generation capacity.

[The State Council](#)

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United Nations (2022), <https://data.un.org/en/iso/cn.html>

World Bank (2021), <https://data.worldbank.org/cn/country/china?view=chart>

Useful Links

China Electricity Council (CEC) – <https://cec.org.cn/>

Ministry of Ecology and Environment (MEE) – <https://www.mee.gov.cn/>

Ministry of Finance (MOF) – <http://www.mof.gov.cn/>

Ministry of Industry and Information Technology (MIIT) – www.miit.gov.cn

Ministry of Housing and Urban-Rural Development – <http://www.mohurd.gov.cn/>

Ministry of Science and Technology – <http://www.most.gov.cn/index.html>

National Bureau of Statistics (NBS) – <http://www.stats.gov.cn/>

National Development and Reform Commission (NDRC) – <https://www.ndrc.gov.cn/>

National Energy Administration (NEA) – <http://www.nea.gov.cn/>

National Nuclear Safety Administration (NNSA) – <nnsa.mee.gov.cn>

Standardization Administration – <http://www.sac.gov.cn/hdjl/>

The State Council, the People's Republic of China – <http://www.gov.cn/>

World Nuclear Association (WNA) – <https://www.world-nuclear.org/>

Hong Kong, China

Introduction

Hong Kong, China (HKC), is an autonomous Special Administrative Region of the People's Republic of China, except in defence and foreign affairs¹. It is located at the south-eastern tip of China, with about 1 110 square kilometres of total land area and a population of 7.39 million as of mid-2021².

HKC is categorised as a highly developed free-market economy and provides a world-class financial, trading and business centre. HKC has become the world's 6th largest trading economy in 2020³, with the mainland of China as its most significant trading partner.

HKC's gross domestic product (GDP) rose 24% from USD 242 billion in 2000 to USD 447 billion in 2019 (2017 USD purchasing power parity [PPP]), and its recorded GDP per capita was at USD 59 586 (2017 USD PPP) in 2019, which is the third-highest among APEC economies. The service sector is the dominant driving force of economic growth, contributing 93.4% to the HKC's GDP in 2019⁴.

HKC does not have indigenous energy resources and derives its energy supplies almost entirely from other economies, either directly imported (as in the case of oil products and coal products) or produced through intermediate transformation processes that use imported fuel

inputs (as in the case of electricity and gas)⁵. HKC has been continuously promoting the development of renewables technology, especially solar and wind energy technology for electricity generation. HKC also has utilised landfill gas as a fuel for gas production since 2007 and produced biodiesel from waste oil since 2010⁶.

Table 1: Hong Kong, China's Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves	
Area (km ²)	1 106	Oil (billion barrels)	–
Population (million)	7.51	Gas (trillion cubic feet)	–
GDP (2017 USD billion PPP)	447	Coal (million tonnes)	–
GDP per capita (2017 USD PPP)	59 586	Uranium (kilotonnes U < USD 130/kgU)	–

Source: a – World Bank (2021); Government HKC (2021)

Energy Supply and Consumption

Total Primary Energy Supply

HKC has been importing almost all fuels required to meet its primary energy. A substantial share of imported energy is transformed into secondary energy for final consumption, such as electricity and gas.

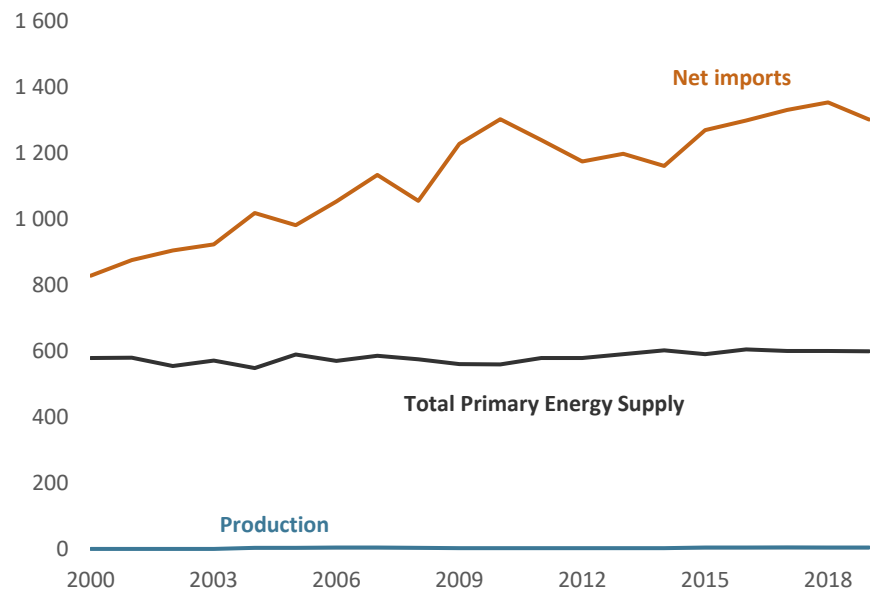
HKC's total primary energy supply was 599 petajoules (PJ) in 2019, a slight decrease of 0.2% or 1 PJ from the previous year (Figure 1). Total primary energy supply and production were stable at around 600 PJ

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and 5 PJ, respectively, from 2016 to 2019. Net imports fell by 3.09% in 2019 after increasing for five consecutive years as a result of HKC's policy to reduce coal consumption in electricity generation⁷.

In 2019, HKC mostly imported oil products, particularly LPG and gas from China, while they imported coal from Indonesia.

Figure 1: Hong Kong, China's total primary energy supply, production and net imports, 2000 to 2019 (PJ)

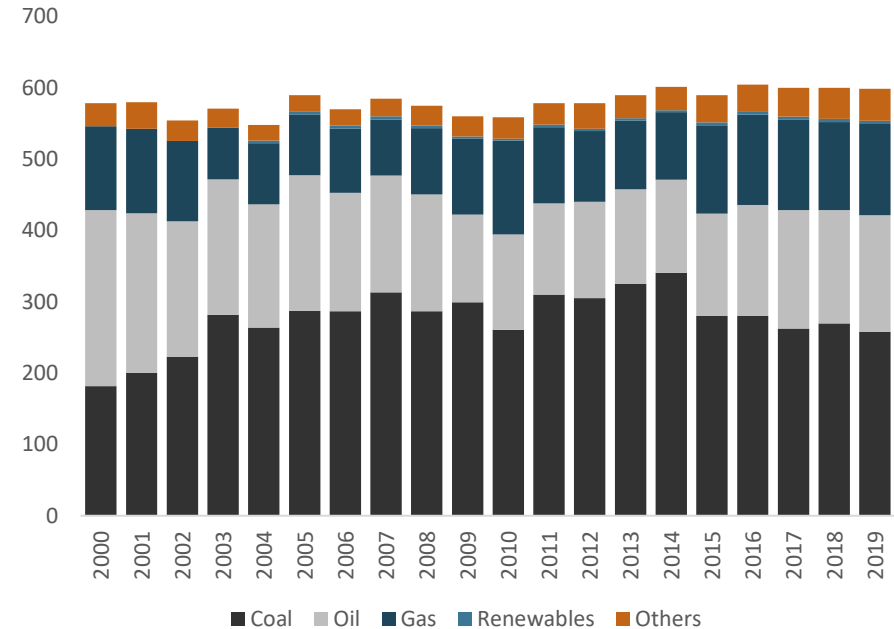


Source: EGEDA (2021)

HKC's total primary energy supply fluctuated marginally from 2000 to 2019 (Figure 2). Fossil fuels dominated the supply with changes in structure over the period. Oil's share declined from 43% to 27%. In contrast, coal's share increased from 31% to 43%, while gas's share accounted for a modest increase from 20% to 21% over the same period.

Renewables and other sources grew slightly from 6% of the total primary energy supply in 2000 to 8% in 2019.

Figure 2: Hong Kong, China's total primary energy supply by fuel, 2000 to 2019 (PJ)

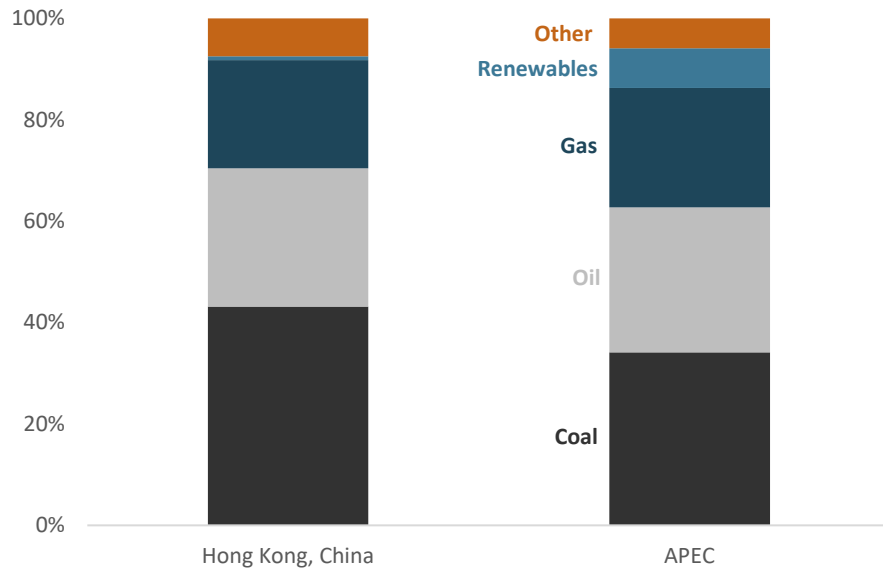


Source: EGEDA (2021)

HKC's total primary energy supply structure shows about 5% higher reliance on fossil fuels than the entire APEC region in 2019, contributed by a larger share of coal (Figure 3). Oil and gas shares were almost similar, while renewables share was significantly lower than the APEC region.

Figure 3: Total primary energy supply relative fuel share – Hong Kong, China and APEC, 2019

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Source: EGEDA (2021)

Total Final Consumption

Total final consumption is a representation of end-use energy, including non-energy consumption. For HKC, the commercial and transport sectors are the main end-use sectors, accounting for 44% and 31% of all end-use energy consumption in 2019 (Figure 4).

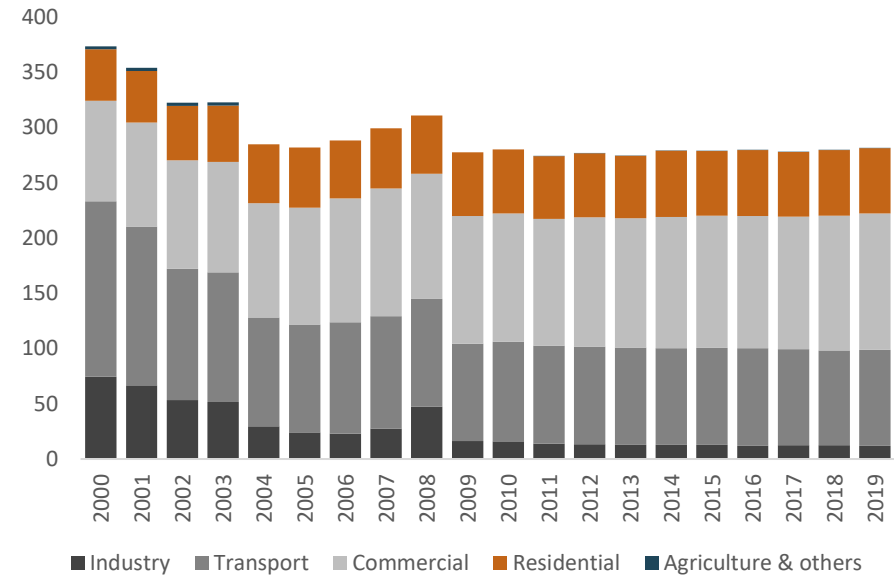
The commercial sector has experienced steady energy growth since 2000, while the transport sector has slowly declined in energy consumption. In 2004, the former surpassed the latter for the first time and became the largest consumption sector and has been rising gradually since then. The restaurant segment consumed the most energy in the commercial sector, followed by retail, office, and accommodation.

The declining trend in the transport sector is due to a significant

decrease in the freight segment's energy consumption than the increase in the passenger segment over the 2000 to 2019 period.

Energy consumption by residential, industry, and the agriculture and others sectors has been stable since 2009.

Figure 4: Hong Kong, China's final consumption by sector, 2000 to 2019 (PJ)

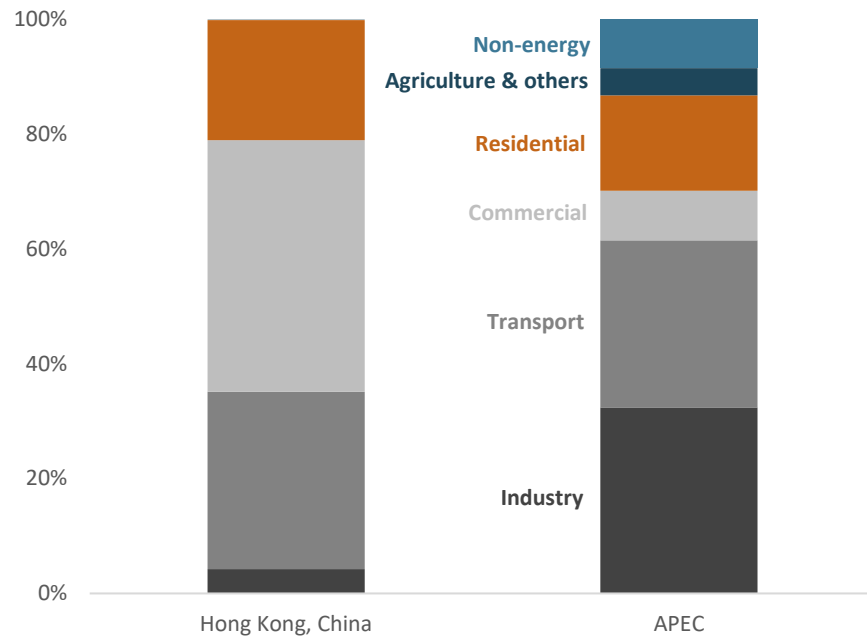


Source: EGEDA (2021)

HKC's commercial sector energy consumption share was five times larger than the APEC region in 2019. Services have accounted for the largest share of economic output since the early 2000s (Figure 5). The transport sector's share was almost similar to the APEC region, while industry and agriculture and other sectors' shares were much smaller.

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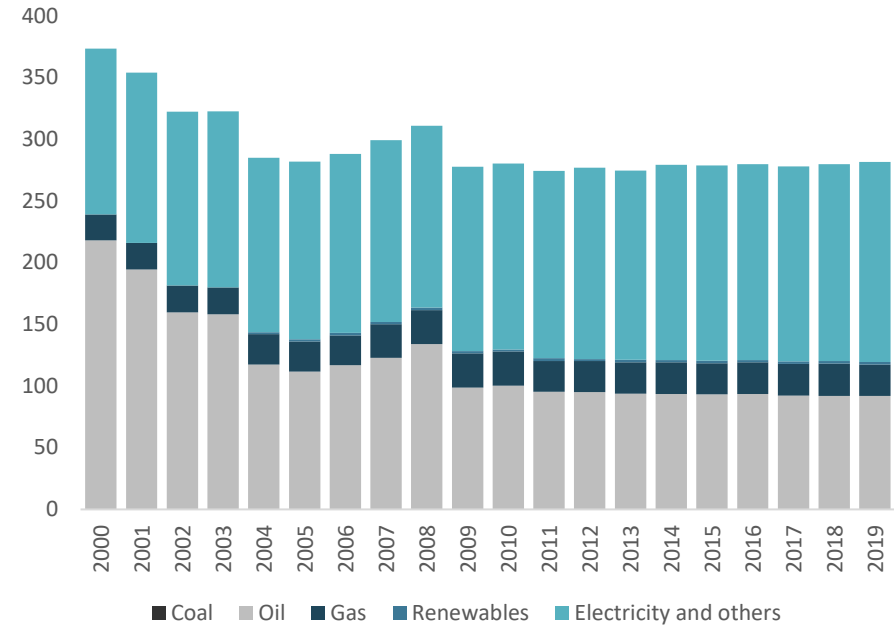
Figure 5: Final consumption sectoral share, Hong Kong, China and APEC, 2019



Source: EGEDA (2021)

HKC's final energy demand was stable at around 280 PJ from 2009 to 2019, dominated by the electricity and others category (Figure 6). Demand for electricity and others increased marginally from 159 PJ in 2018 to 162 PJ in 2019, accounting for 57% of the final energy consumption in 2019, followed by oil at 33%, gas at 9% and coal at 1%.

Figure 6: Hong Kong, China's final energy demand by fuel, 2000 to 2019 (PJ)

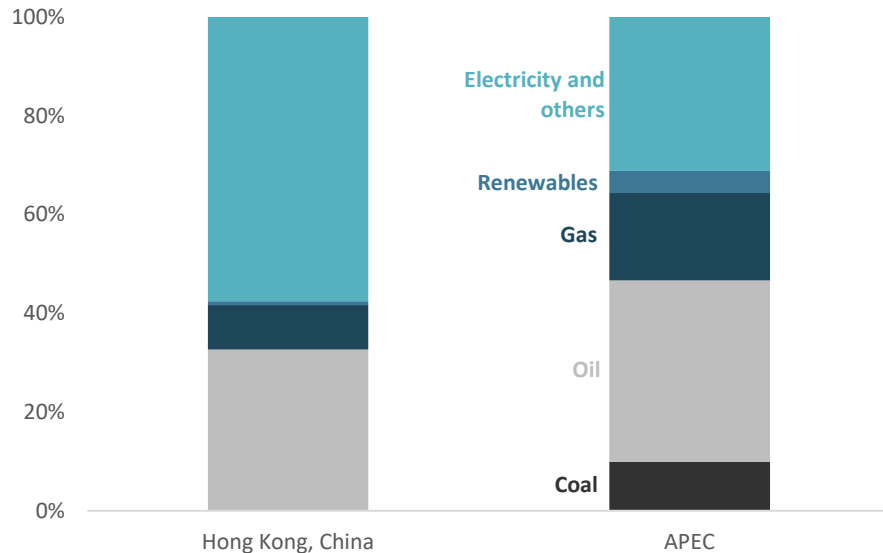


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

HKC's electricity and others share was almost double compared to the APEC region in 2019 (Figure 7), mostly consumed by commercial and residential sectors. Coal, oil, and gas shares were smaller than the APEC region.

Figure 7: Final energy demand fuel shares, Hong Kong, China and APEC, 2019



Source: EGEDA (2021)

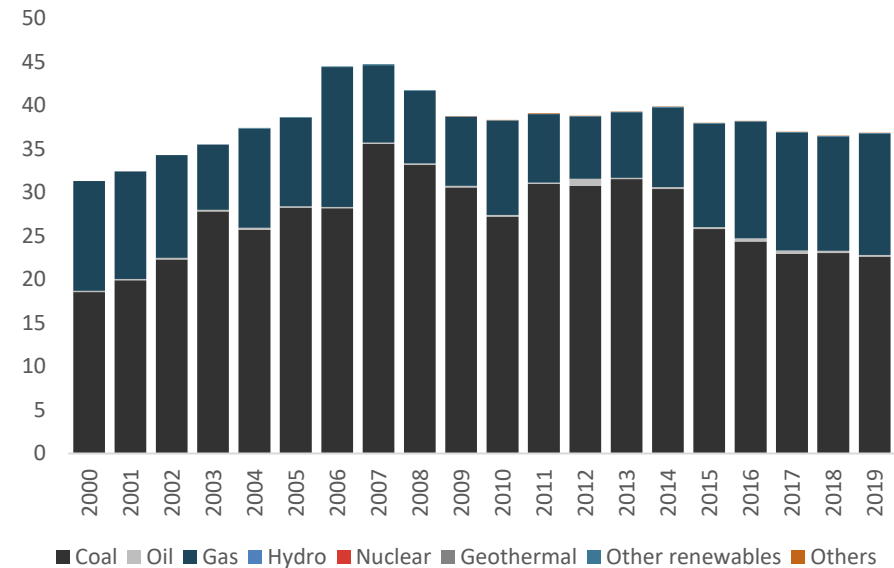
Transformation

HKC's electricity generation relies heavily on fossil fuels, specifically coal and gas. Following the commitment to the Paris Agreement, HKC released Climate Action Plan 2030+ (CAP 2030) in 2017, which comprises a target and mitigations to reduce carbon emissions by 2030. One of the mitigations is reducing coal consumption gradually in electricity generation.

As a result of CAP 2030, the share of electricity generation from coal declined from 62% in 2017 to 61% in 2019 (Figure 8). The share of electricity generation from gas increased from 37% in 2017 to 38% in 2019. This shows that there is a small coal-to-gas trend occurring in HKC.

All other fuels aside from coal and gas accounted for less than 1% of the fuel mix in 2019. Hydro and other renewables showed a slight increase from 0.054 TWh in 2018 to 0.067 TWh in 2019. The increase was driven by the implementation of Feed-in Tariff (FiT) Schemes from October 2018 and January 2019 by CLP Power Hong Kong Ltd and HK Electric Company as well as the introduction of Renewable Energy (RE) Certificates in January 2019.

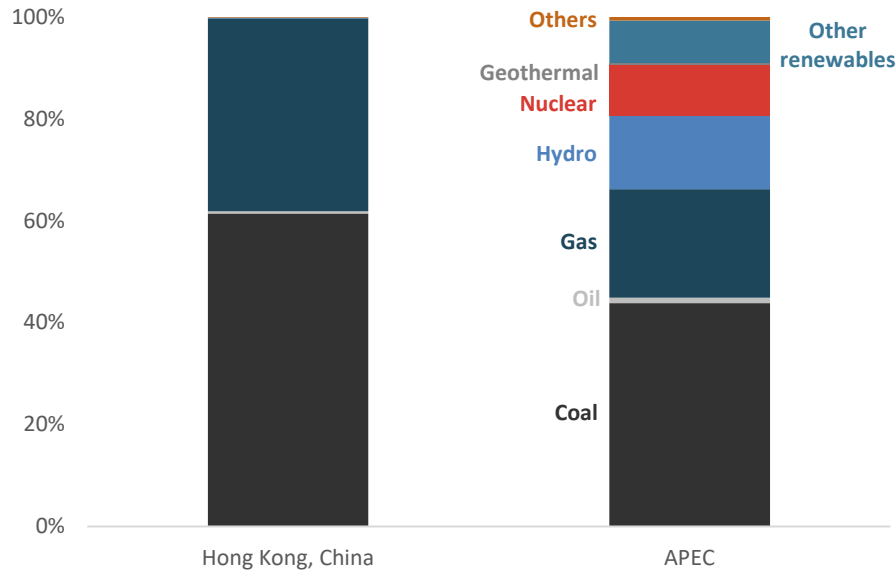
Figure 8: Hong Kong, China's electricity generation by fuel, 2000 to 2019 (TWh)



Source: EGEDA (2021)

HKC imports almost all fuels to generate electricity and meet demands. Most of HKC's imported coal and gas in 2019 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 2019 (Figure 9).

Figure 9: Electricity generation by fuel share, Hong Kong, China and APEC, 2019



Source: EGEDA (2021)

APEC Goals

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

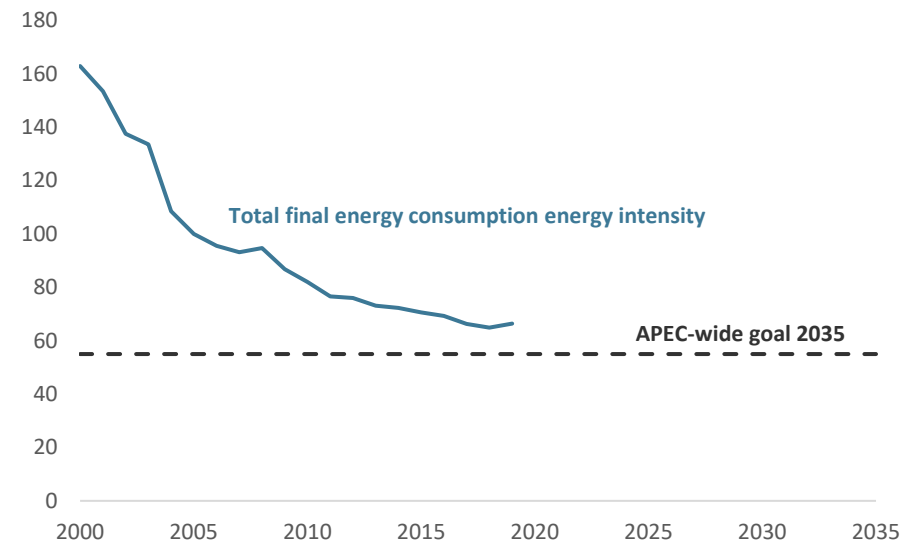
Energy Intensity Goal

In 2011, the APEC member economies agreed to reduce energy intensity by 45% in 2035, 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's possible to track the progress of

respective APEC economies relative to that overarching proportional improvement.

In 2019, HKC's total final energy consumption intensity reduced by 34% relative to a 2005 baseline or decreased at an average annual rate of 3% (Figure 10). HKC's total final energy consumption intensity slightly increased by 1% in 2019 compared to the previous year due to an increase in total energy consumption by 0.6%, specifically in the commercial sector and a drop in GDP of 2.4%.

Figure 10: Hong Kong, China's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

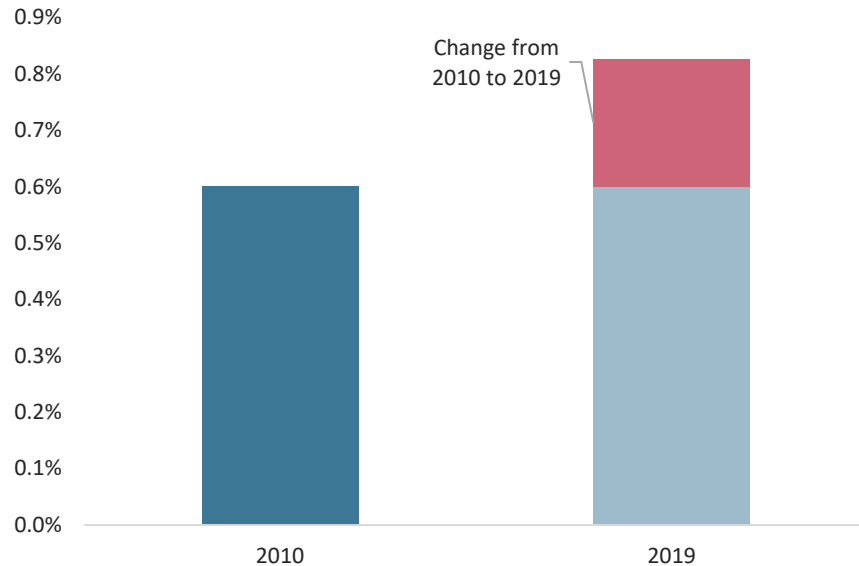
Doubling of Renewables

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

renewables do not include traditional biomass, and the share is relative to the final energy consumption.

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

Figure 11: Hong Kong, China's modern renewable energy share, 2010 and 2019

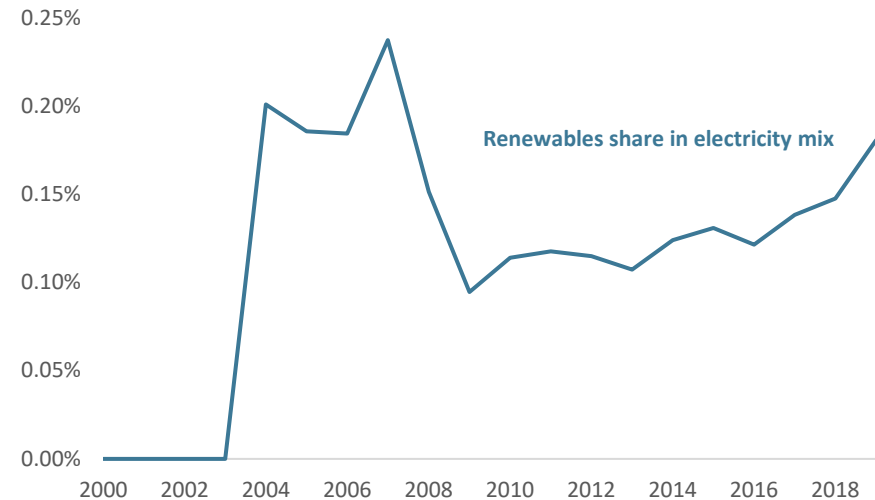


Source: EGEDA (2021)

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's share of modern renewables to final energy consumption in 2010 was 0.6% (Figure 11). In 2019, this proportional share was 0.8%, representing a 38% improvement. HKC's share of renewables in electricity generation is relatively low at less than 0.2% for most of the last decade (Figure 12). A small landmass limits the options for installing renewable generation technologies.

Figure 12: Hong Kong, China's renewable generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

HKC's energy supply policy objectives are to provide reliable supplies of energy at reasonable prices, promote its economic and safe use, and, at the same time, minimise the environmental impact in the production and use of energy⁸. From the demand perspective, HKC's energy efficiency and conservation policy aim to increase and sustain the conservation of energy to reduce the growing trend of energy use⁹.

In keeping with the free-market economic policy of Hong Kong, China, the government intervenes only when necessary to safeguard the interests of consumers, ensure public safety and protect the environment.

Energy Policy	Details	Reference
Green Tech Fund (GTF)	HKD 200 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 RE Certificate, Installing RE System in Various Government Schools and Welfare NGOs, Waste-to-energy Infrastructures	GOVHK, HKRENet
Scheme of Control Agreements (SCAs)	Promotes the development of quality service of power companies and improves energy efficiency and energy conservation	Environment Bureau
A memorandum of understanding (MOU) between National Energy Administration (NEA) and HKC	PRC provides HKC with a stable supply of natural gas and nuclear electricity	Agreement between NEA and HKC
Energy Saving Plan for Built Environment 2015-2025+	Comprises energy-saving policy and strategies to achieve energy intensity reduction by 40% from the 2005 level by 2025	Environment Bureau, Development 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.	Environment Bureau
Climate Action Plan 2050	Comprehensive plans and measures across sectors to achieve carbon neutrality before 2050	Environment Bureau
Deepening Energy Saving in Existing Buildings in HKC through '4Ts' Partnership	A five-year plan through a partnership between the government and building sector to save electricity by 5% from 2015 to 2020 and in the range of 1–30% in 1–12 years.	Environment Bureau
HKC Roadmap on Popularisation of Electrical Vehicles	Measures related with electric vehicles to achieve zero vehicular emissions before 2050	Environment Bureau

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Clean Air Plan 2035	Comprehensive policies, measures and long-term decarbonisation strategies to improve the air quality	Environment Bureau, Transport and Housing Bureau, Food and Health Bureau, Development Bureau
Building a Liveable City	Striving towards Carbon Neutrality before 2050	Policy Address 2021

Notable Energy Developments

Energy development	Details	Reference
The first round of Green Tech Fund applications in 2021	14 R&D projects on green technology have been approved, with a total grant of HK\$70 million	GTF
CLP Community Energy Saving Fund	CLP is allocating HK\$220 million to boost the economy and promote low-carbon living	CLP
First carbon neutral LNG in HKC	China's CNOOC supplied the first carbon-neutral LNG of 65 thousand tonnes to HKC.	SPG Global

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C&SD (Census and Statistics Department, The Government of the Hong Kong Special Administrative Region) (2020), *Hong Kong Energy Statistics: 2019 Annual Report*, https://www.censtatd.gov.hk/en/data/stat_report/product/B1100002/att/B11000022019AN19B0100.pdf⁵

ENB (Environment Bureau, The Government of the Hong Kong Special Administrative Region) (2022), *Energy*, <https://www.enb.gov.hk/en/energy/index.html>⁸

ENB (Environment Bureau, The Government of the Hong Kong Special Administrative Region) (2022), *Energy Efficiency and Conservation Policy*, https://www.enb.gov.hk/en/about_us/policy_responsibilities/energy_efficiency.html⁹

ENB (Environment Bureau, The Government of the Hong Kong Special Administrative Region) (2017), *Climate Action Plan 2030+*,

<https://www.enb.gov.hk/sites/default/files/pdf/ClimateActionPlanEng.pdf>⁷

EMSD (Electrical and Mechanical Services Department, The Government of the Hong Kong Special Administrative Region) (2021), *Hong Kong Energy End-use Data 2021*, https://www.emsd.gov.hk/filemanager/en/content_762/HKEEUD2021.pdf

GHK (Government HKC) (2022), *Government Structure*, <https://www.gov.hk/en/about/govdirectory/govstructure.htm>¹

GHK (Government HKC) (2021), *Mid-year population for 2021*, <https://www.info.gov.hk/gia/general/202108/12/P2021081200387.htm>²

GHK (Government HKC) (2019), *LCQ12: Promoting use of biodiesel*, <https://www.info.gov.hk/gia/general/201906/05/P2019060500435.htm>⁶

GHK (Government HKC) (2019), *LCQ21: Renewable energy*, <https://www.info.gov.hk/gia/general/201910/23/P2019102300390.htm>

TID (Trade and Industry Department, The Government of the Hong Kong Special Administrative Region) (2021), *Hong Kong and Mainland of China: Some Important Facts*, <https://www.tid.gov.hk/english/aboutus/publications/factsheet/china.html#1>³

Useful links

The HKC Government – www.gov.hk/en

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

Environment Bureau – www.enb.gov.hk

Environmental Protection Department – www.epd.gov.hk

Council for Sustainable Development – www.enb.gov.hk/en/susdev/council/index.htm

Climate Ready – www.climateready.gov.hk

Low Carbon Living Calculator – www.carboncalculator.gov.hk

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. Indonesia’s territory encompasses 16 056 large and small islands and large water bodies at the equator, covering a territorial area of 8.3 million square kilometres (km²), constituting Indonesia’s exclusive economic zone. The economy’s total land area (25% of its territory) is approximately 1.9 million km², and the population was around 272.7 million in 2021 (Badan Pusat Statistik [BPS], 2022).

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, 2021a), 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).

The economy is projected to grow by 5.2% in 2022 and 5.1% in 2023, assuming no new and severe COVID-19 waves (World Bank, 2021b). The National Economic Recovery program is intended to reduce the impact of the COVID-19 pandemic on the economy (MOE, 2022). This economic program will support the return of final energy consumption to its prior growth trajectory following a 10.8% fall in 2020 (Ministry of Energy and Mineral Resources [MEMR], 2021a).

In July 2021, Indonesia submitted its updated Nationally Determined Contribution (NDC) with its Long-Term Strategy on Low Carbon and Climate Resilient Development (LTS-LCCR) 2050 documents, containing Indonesia’s intentions towards net-zero emissions by 2060 (Government of Indonesia [GOI], 2021). Additional intentions towards net-zero were announced at the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow in 2021 (MEMR, 2021b).

The LTS-LCCR foresees Indonesia reaching peak greenhouse gas (GHG) emissions by 2030, with emissions declining to 540 million tonnes of CO₂ emissions by 2050 and opportunities towards net-zero emissions by 2060 or sooner (GOI, 2021). Assumptions for Indonesia’s emissions projections include a net sink in the forestry and land-use sectors. As part of the energy transition strategy, Indonesia has formulated a roadmap to 2060, which includes a plan to boost renewable energy development, a moratorium on new coal power generation and the early retirement of current coal power generation (MEMR, 2021b).

Table 1: Indonesia’s Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	1.9	Oil (billion barrels)	4.17
Population (2021 million)	272.7	Gas (trillion cubic feet)	62.4
GDP (2017 USD billion PPP)	3 130	Coal (million tonnes)	38 805
GDP per capita (2017 USD PPP)	11 445	Uranium (kilotonnes U < USD 130/kgU)	8.4

Source: ^a (BPS, 2022); ^b (World Bank, 2021a); ^c (MEMR, 2021a); ^d (OECD, 2020)

Indonesia has substantial and diverse energy resources of oil, natural gas, coal and renewables. In 2020, the oil reserves were estimated at 4.17 billion barrels, consisting of proven reserves of 2.44 billion barrels and potential reserves of 1.73 billion barrels (Table 1). In the same year, Indonesia's natural gas reserves amounted to over 62 trillion cubic feet (tcf), comprising 43.6 tcf of proven and 18.8 tcf of potential reserves. Indonesia's coal reserve in 2020 was estimated at almost 39 billion tonnes, with more than 60% of the reserve in Kalimantan, and the rest mainly in Sumatra (MEMR, 2021a).

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 (MEMR, 2017).

Energy Supply and Consumption

Total Primary Energy Supply

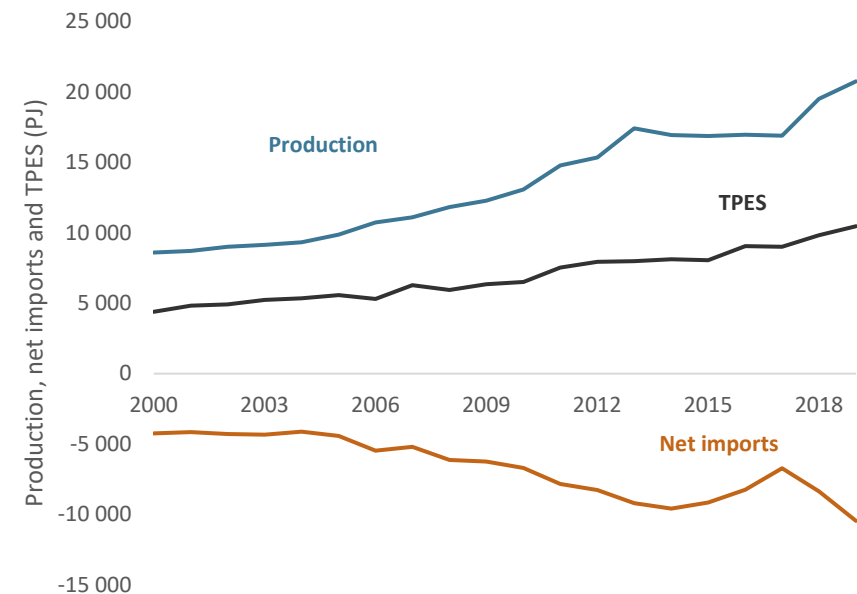
In 2019, Indonesia's total primary energy supply (TPES) grew by an annual 6.5% to reach 10 470 petajoules (PJ). Annual energy production increased by 6.4% and reached 20 760 PJ, continuing the historic rise since 2017 (Figure 1; Expert Group on Energy Data Analysis [EGEDA], 2021). A large proportion of this additional production was exported in 2019, with net exports increasing by 25% to 10 457 PJ (EGEDA, 2021). Indonesia is a net exporter of energy and exports crude oil, natural gas, , petroleum products, biodiesel and coal.

Indonesia is one of the world's biggest thermal coal exporters. Coal production in 2019 was the highest in the previous decade, reaching 616 million tonnes, with more than 70% being exported (MEMR, 2021a). In 2020, coal production was 8.5% lower than in 2019 due to decreasing coal demand caused by the COVID-19 pandemic. Nonetheless, in 2020, coal production was still high, amounting to 564 million tonnes, with an

export of 405 million tonnes. The two most prominent export destinations in 2020 were China and India (MEMR, 2021a).

Indonesia's natural gas production is decreasing. In the past decade, gas production fell from 3 million MMSCF in 2010 to 2.1 million MMSCF in 2020 (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, 2021a).

Figure 1: Indonesia's total primary energy supply (TPES), production and net imports, 2000 to 2019



Source: EGEDA (2021)

Like natural gas, Indonesia's crude oil production is also declining. In 2019, crude oil production was 272 million barrels (bbl), which was more than 20% lower than in 2010 (MEMR, 2021a). Indonesia's declining oil and gas production is due to increasingly mature oil and gas fields. In

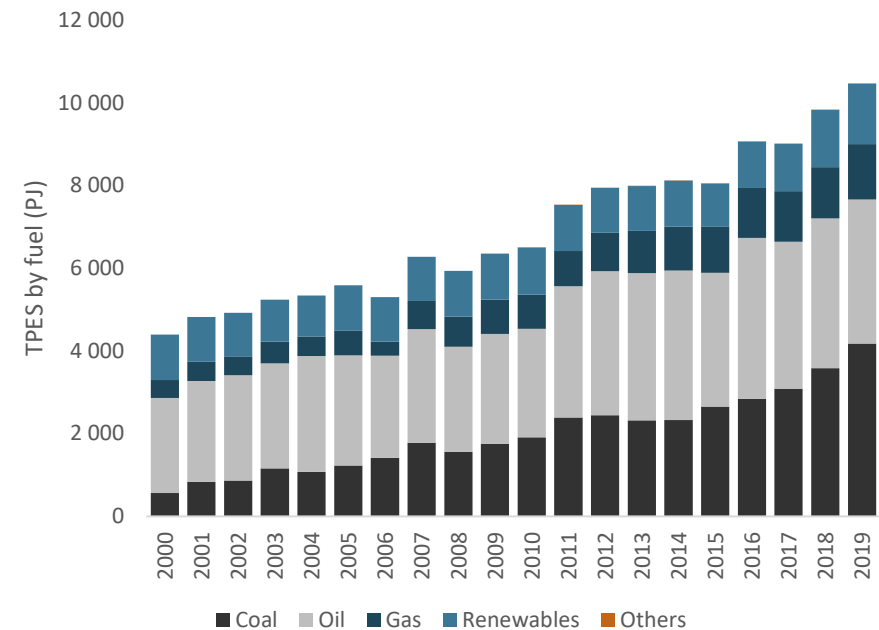
2019, oil and gas production fell by 3.5% and 6.8%, respectively, and continued to decline in 2020 (SKK Migas, 2020). Several projects expected to increase oil and gas production are currently being developed, such as the Jambaran Tiung Biru Field, Train 3 Tangguh, Merakes Field and Masela Field (SKK Migas, 2020).

Indonesia's TPES in 2019 increased slightly from the year before (Figure 2), with fossil fuels remaining prominent in the economy's energy mix. Oil supply decreased slightly in 2019, partly explained by Indonesia's blending policy, which promotes biodiesel in the transport, industry and power sectors to reduce Indonesia's reliance on oil.

Coal experienced the most significant supply growth in 2019 (17%) to become the most prominent fuel in Indonesia's energy mix in 2019 at 40% of its TPES. Coal in Indonesia is mainly used for power generation, and in 2019, coal-firing generation capacity increased by 3 GW, which explains the large growth in coal supply (MEMR, 2021a). Natural gas demand (as captured by TPES) increased by 8.7% in 2019, due to Indonesia's ongoing efforts to build city gas networks and to promote policies prioritising gas for domestic demand.

Renewable energy also increased in 2019, although its share in TPES decreased due to the much larger growth in both coal and natural gas (EGEDA, 2021).

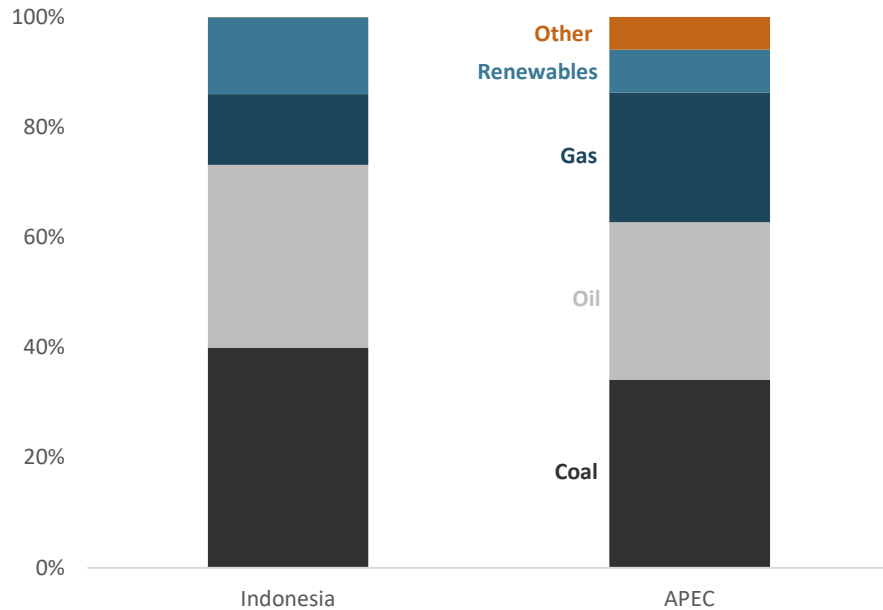
Figure 2: Indonesia's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

The energy supply in Indonesia and the APEC region at large was dominated by fossil fuels in 2019, with shares of more than 85% (Figure 3). Coal's share in Indonesia's fuel mix was slightly higher than APEC. Oil was proportionally larger at 33% in Indonesia, as opposed to 29% in the APEC region, driven by high demand from the transport sector. Renewable energy in Indonesia (14%) was almost double that of APEC (8%). Whereas, the share of gas in Indonesia was smaller than APEC, at 13% versus 24%.

Figure 3: Total primary energy supply relative fuel share, Indonesia and APEC, 2019



Source: EGEDA (2021)

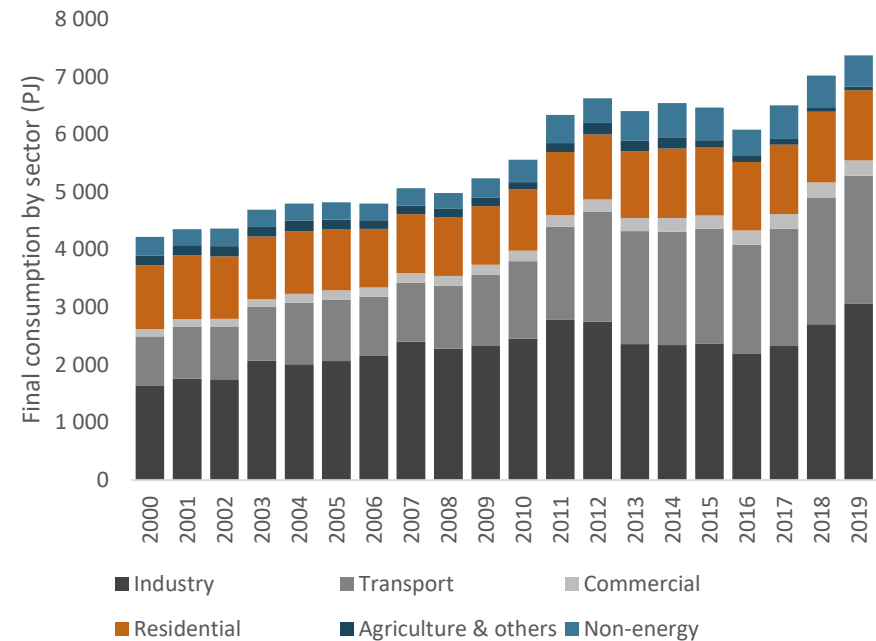
Total Final Consumption

Indonesia's final energy demand increased by almost 75% in 2019 compared to 2000 (Figure 4). Total final consumption was 7 372 PJ in 2019, representing a 5% increase from the previous year. The industry sector's energy consumption increased by more than 10% in 2019, and it has consistently been the largest energy consuming sector for multiple decades. For the two decades shown in Figure 4, the residential sector has had an increasingly less prominent sectoral share of Indonesia's final energy demand (EGEDA, 2021).

In contrast to the low growth in the residential sector, final energy demand for transport grew immensely, by 65% for the period of 2010 to 2019. This growth meant transport's share of final consumption was 30% of total final consumption in 2019, an increase from 24% in 2010. The residential sector's share of total final consumption declined from 19% in 2010 to 16% in 2019.

In 2019, the commercial, agricultural, forestry and fishing, and other sectors consumed 877 PJ, representing a slight annual decrease. Figure 4 shows that these sectors only accounted for a small proportion of all end-use consumption.

Figure 4: Indonesia's final consumption by sector, 2000 to 2019



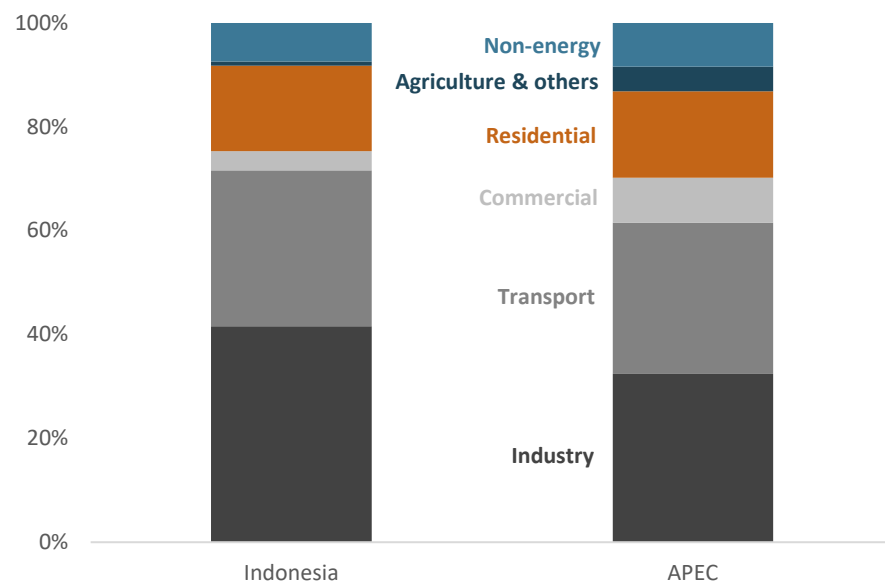
Source: EGEDA (2021)

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The transport, industry and residential sectors accounted for the largest proportion of final energy demand in Indonesia and the APEC region in 2019 (Figure 5). Industry energy consumption was the most prominent, followed by transport and residential, in both Indonesia and APEC.

The industry share was around 40% of total consumption in Indonesia, while in APEC, the share was around 30%. The transport sector's share was almost the same for both Indonesia and APEC, at around 30%. The residential sector's final energy demand share was almost the same for both regions, at about 17% in 2019.

Figure 5: Final consumption sectoral share, Indonesia and APEC, 2019



Source: EGEDA (2021)

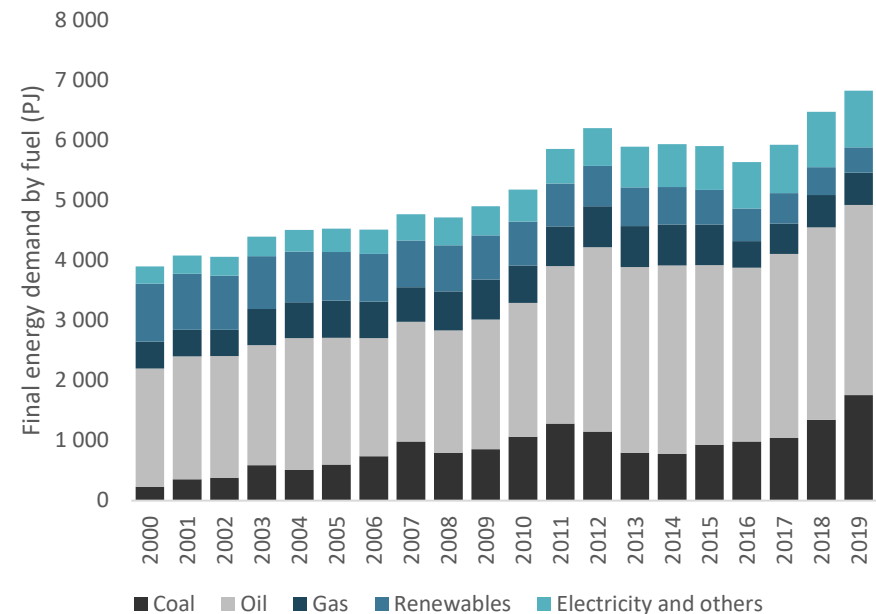
Indonesia's final energy demand has been dominated by oil for multiple decades, making oil a particularly important fuel for both the transport and industry sectors (Figure 6). Oil demand decreased slightly in 2019,

and its share in the final energy demand fell to 46% due to the rapid increase in coal consumption.

End-use consumption of coal increased by almost 31% in 2019, mostly due to industry sector applications. The large increase led to coal's share of final energy demand increasing by 5% to 26%. Natural gas consumption fell by a small amount in 2019, with its share falling only marginally to 8% of Indonesia's final energy demand (EGEDA, 2021).

Renewables consumption also fell in 2019, reducing its share in the final energy demand to 6%. Electricity and other sectors' demand slightly increased in 2019, though its share reduced due to huge growth in end-use coal consumption (EGEDA, 2021).

Figure 6: Indonesia's final energy demand by fuel, 2000 to 2019

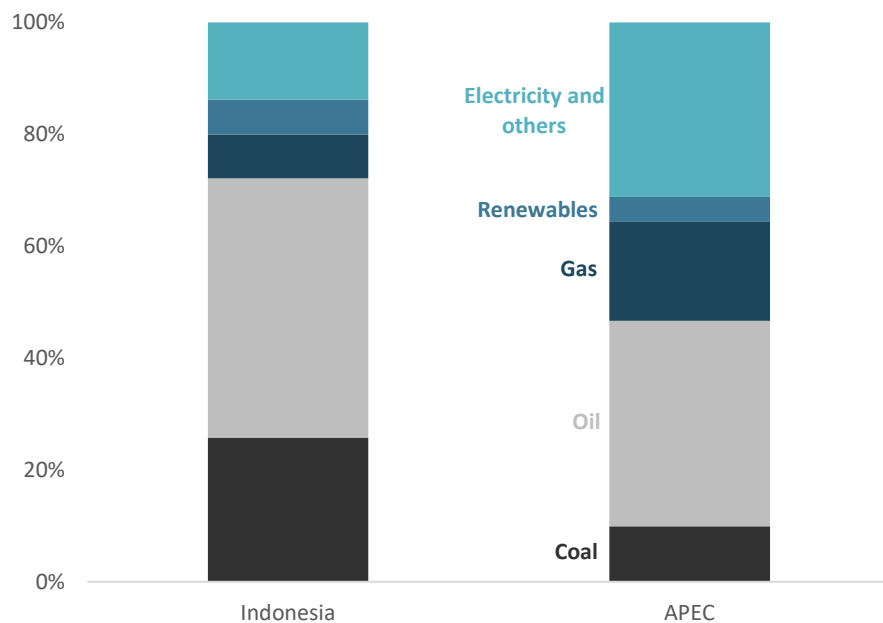


Source: EGEDA (2021)

Even with the large increase in coal, oil (or rather, petroleum products) dominated final energy demand in Indonesia in 2019 (Figure 7). Indonesia's oil share of 46% was much higher than the APEC region's share (37%). In contrast, Indonesia's share of gas in final energy demand was much lower, at less than half of APEC's gas share in 2019.

Renewables share was slightly higher in Indonesia than in APEC in 2019. Electricity and other sectors in APEC accounted for a 31% share of final energy demand, while in Indonesia, they accounted for roughly 14% (EGEDA, 2021).

Figure 7: Final energy demand fuel shares, Indonesia and APEC, 2019

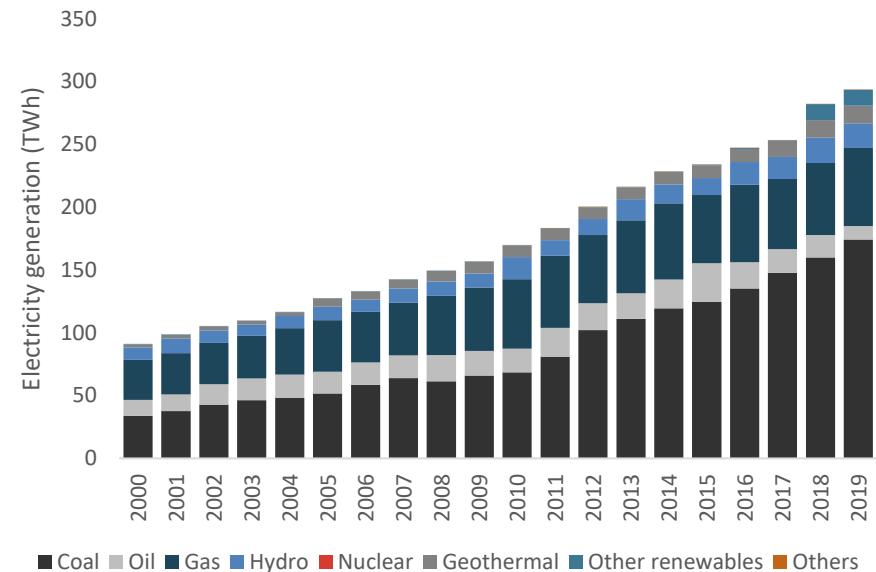


Source: EGEDA (2021)

Transformation

Indonesia's installed electricity generation capacity in 2019 was nearly 70 GW, which comprised both on- and off-grid generation (MEMR, 2021a). This capacity increased by 4.7 GW in 2019, dominated by coal capacity additions (MEMR, 2021a), which corresponded to an increasing electricity generation as well (Figure 8).

Figure 8: Indonesia's electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

In 2019, 294 terawatt-hours (TWh) of electricity was generated, a 4% annual increase. In the past two decades, the generation grew with steady pace. Since 2000, the generation has sustained 6.4% annual growth (EGEDA, 2021). 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 60% in 2019 (EGEDA, 2021). Coal

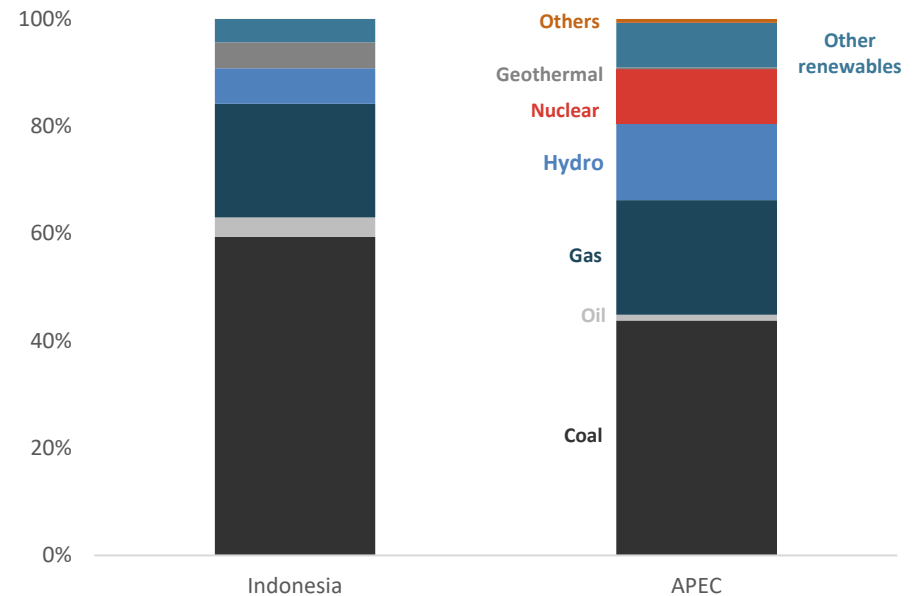
supply for power generation is mainly produced domestically. In 2019, domestic coal for power generation amounted to 98.5 million tonnes, which was an annual increase of 7 million tonnes (MEMR, 2021a).

Electricity generation from gas increased by 8.5% in 2019, with gas accounting for 21% of Indonesia's electricity generation in 2019. Policies to replace diesel generators with gas, or transition to renewables, have resulted in a continuing decline in diesel generation in Indonesia since 2016 (EGEDA, 2021).

Hydro, geothermal and other renewables produced almost the same electricity in 2019 as the previous year. Large renewable power generation sites, such as hydro and geothermal, were still under construction in 2019. For example, the 515 MW Poso hydropower generation plant only began commercial operation in February 2022.

Coal's dominance in Indonesia's power sector is evident when viewed alongside the generation mix for APEC in 2019 (Figure 9). Coal generation was 60% in Indonesia compared to 44% in APEC. Gas was the same, at around 21% in Indonesia and APEC. Indonesia also generated proportionally less hydropower than APEC (7% compared to 14%). Indonesia's geothermal generation was 5%, which was large compared to the negligible share for the wider APEC region. Indonesia's geographic location in the ring of fire means that the economy has large geothermal potential. Other renewables' generation is expected to grow due to abundant renewable potential and increasingly cost-competitive technologies.

Figure 9: Electricity generation by fuel share, Indonesia and APEC, 2019



Source: EGEDA (2021)

APEC 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.

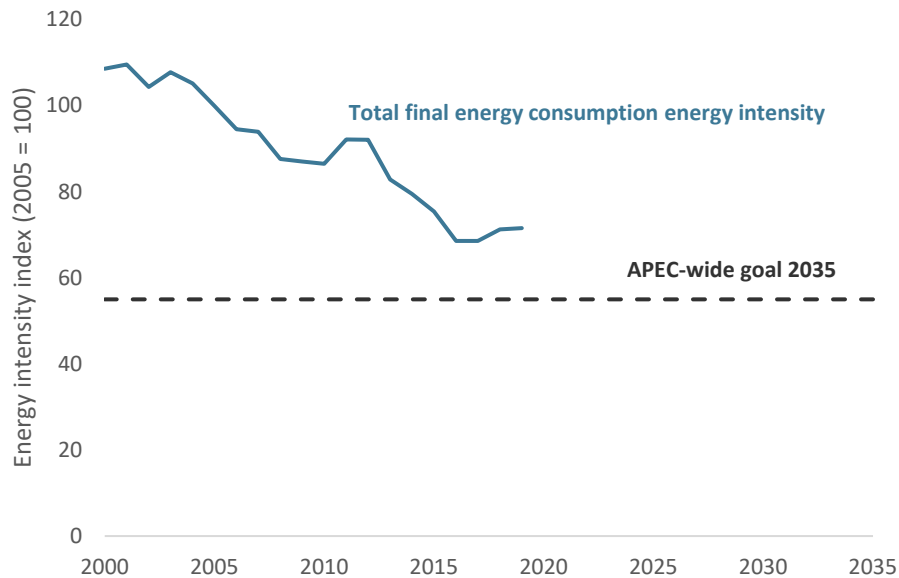
Energy Intensity Goal

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 2019, Indonesia's total final energy consumption intensity (not including non-energy) improved by more than 28% relative to 2005. This has contributed to APEC's overall commitment to improve energy intensity by 45% by 2035, as shown in Figure 10.

Figure 10: Indonesia's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

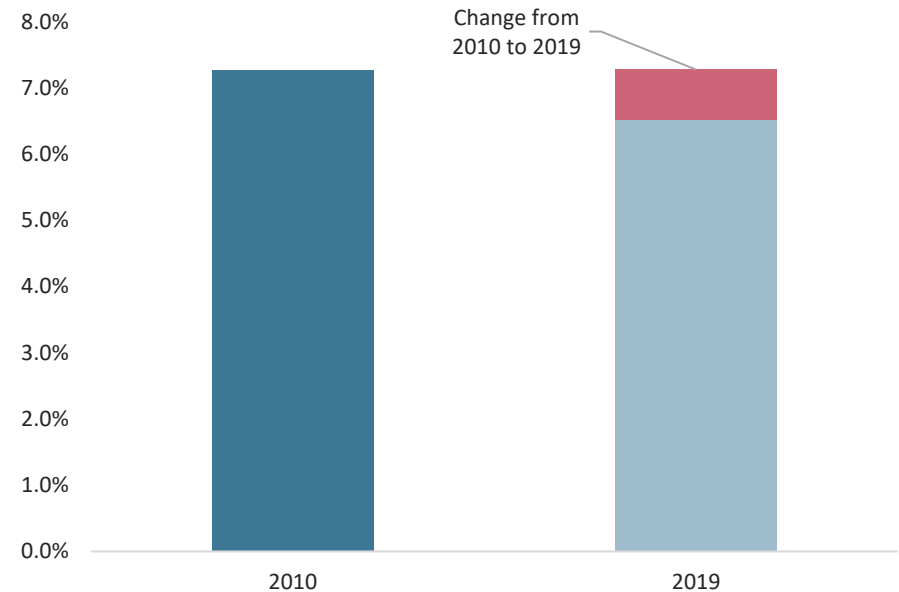
Doubling of Renewables

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 11: Indonesia's modern renewable energy share, 2010 and 2019

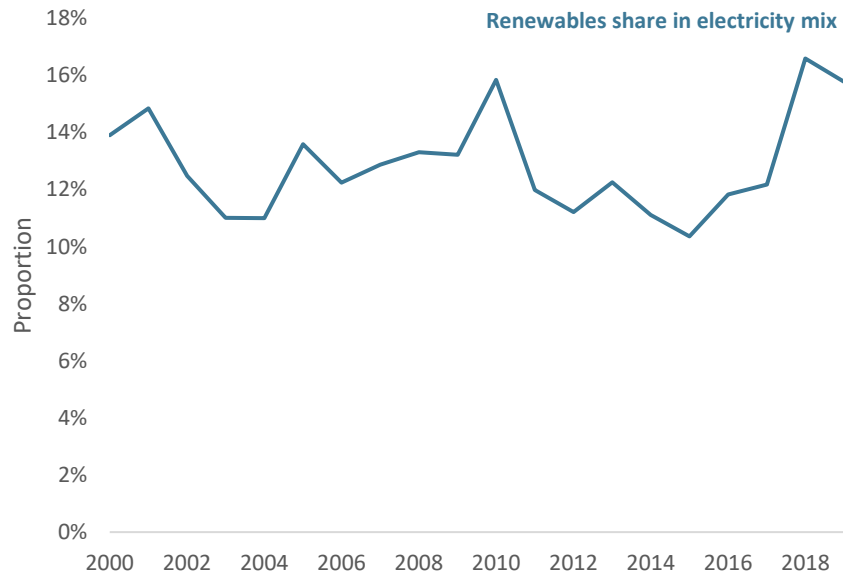


Source: EGEDA (2021)

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 2019, that proportional share was 6.5% (Figure 11). In the past decade, use of fossil fuels, especially coal and oil, has increased in Indonesia to meet the fast-growing energy demand (EGEDA, 2021). Indonesia's recent policy towards achieving net-zero emissions by 2060 or sooner will likely increase the share of renewables in the economy.

Figure 12: Indonesia's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Electricity generation from renewables reached almost 16% in Indonesia in 2019, which comprised both on- and off-grid renewable power generation (Figure 12; EGEDA, 2021).

Indonesia's renewables share in electricity generation consisted mainly of hydro and geothermal generation. Indonesia has recently announced its intention to achieve net-zero emissions, and the extensive deployment of renewable power generation coming from solar and wind will likely increase Indonesia's renewable share in its electricity mix.

Energy Policy

Energy Policy	Details	Reference
General Plan of National Energy	Indonesia has renewable energy targets of 23% by 2025 and 31% by 2050 for its energy mix.	Ministry of Energy and Mineral Resources
General Plan of National Electricity	Electricity generation targets are 23% renewables, 22% natural gas, 55% coal and 0.4% oil by 2025. For 2038, targets are 28% renewables, 25% natural gas, 47% coal and 0.1% oil.	Ministry of Energy and Mineral Resources
Updated Nationally Determined Contribution of Indonesia 2021	Reduction target is 29% and conditional reduction target is up to 41% of the business-as-usual scenario by 2030, with reduction targets of 11–14% for the energy sector and 17.2–23% for the forestry sector.	UNFCC
Long-Term Strategy on Low Carbon and Climate Resilient Development (LTS-LCCR) 2050	This strategy provides long-term policy direction for emission reduction and net-zero emission by 2060 or sooner.	UNFCC
Grand Strategy of Energy	The Indonesian government is currently formulating a Grand Strategy for the energy sector to ensure sufficient, good quality, affordable and environmentally friendly energy supply and reduced energy imports.	Ministry of Energy and Mineral Resources
Indonesia's gas transition policy	Indonesia's gas transition policy includes energy supply transformation from oil to gas.	Ministry of Energy and Mineral Resources
Production of 1 million barrels of oil	Indonesia has launched a program to increase domestic oil production through investment in new oil fields and use of enhanced oil recovery. Through this approach, oil production is expected to increase from the current 705 000 barrels per day (bpd) to 1 million bpd and increase gas production to 12 billion standard cubic feet per day (BSCFD) by 2030.	Ministry of Energy and Mineral Resources
Cost Recovery Contract	It ensures the flexibility of oil and gas contracts (cost recovery, gross split and others).	Directorate General of Oil and Gas
Refinery Development Master Plan	This plan improves Indonesian energy security by mandating domestic processing of oil products, targeted to increase to 1.3 million bpd by 2025.	Pertamina
Green Refinery Project	The state oil company produces 100% diesel from palm oil by converting the existing Cilacap refinery, producing 6 000 bpd since 2021.	Pertamina
Gas pricing policy for industry	The gas price for industrial sector was lowered to or close to USD 6/MMBTU for 2021–2024.	Ministry of Energy and Mineral Resources
Gas pricing policy for electricity generation	The gas price for electricity generation was lowered to or close to USD 6/MMBTU for 2021–2024.	Ministry of Energy and Mineral Resources

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City gas expansion program	This program increases the share of gas supply to buildings, mostly residential. The city gas network expansion will increase the number of gas connections from 325 852 in 2018 to almost eight million by 2030.	Ministry of Energy and Mineral Resources
Fuel switching from oil to gas for truck and bus	Indonesia's government pushes the fuel-switching program and increases the utilisation of gas for trucks and buses to reduce oil imports and minimise emissions.	Ministry of Energy and Mineral Resources
Biodiesel blending rate program	A mandatory biodiesel blending program implemented blending rates starting from 10% in 2016 to 20% in 2019 and 30% from 2020 onward.	Ministry of Energy and Mineral Resources
Biodiesel, bioavtur and biogasoline	After successfully blending palm oil with solar/diesel and jet fuel (avtur), the Indonesian government is conducting trials to produce gasoline from palm oil, known locally as 'bensa'.	Ministry of Energy and Mineral Resources
Bioavtur development program	This program aims to ensure an economy-wide mixing rate of biofuel with avtur jet fuel of 5% by 2025.	Ministry of Energy and Mineral Resources
Mining Law	Indonesia's parliament passed a new revision on the Indonesia Mining Law on 12 May 2020. The revision provides greater business certainty for private investment in the coal and mineral mining industries.	Ministry of Energy and Mineral Resources
Coal domestic market obligation	It obliges business entities to implement coal domestic market obligation rate at 25% of each coal mining company's production, with a selling price of USD 70 per tonne for power generation.	Ministry of Energy and Mineral Resources
Coal-gasification program	Indonesia is prioritising coal gasification as a key energy security program. The first pilot program will develop dimethyl ether (DME) from coal in Muara Enim, South Sumatra. The plant is designed to produce 1.4 tonnes of DME per year.	Ministry of Energy and Mineral Resources
Coal tax	Coal mining products are now be subject to value-added tax (VAT).	Directorate General of Mineral and Coal
Biomass cofiring in coal power generation	It requires implementation of cofiring for coal-fired power plants using biomass to increase renewable energy utilisation.	Ministry of Energy and Mineral Resources
Moratorium of coal-fired power plant development	The Indonesian government will stop developing new coal-fired power plants, except for projects that are already contracted or under construction.	Ministry of Energy and Mineral Resources
Coal power generation early retirement	Indonesia plans to retire its coal power generation early as part of its energy transition strategy. Currently, a coal power generations with total capacity of 5.5 GW in Jawa and Sumatera are ready to be retired early.	Ministry of State Secretariat
Carbon tax policy in electricity subsector	The Indonesian government has started the trial on the implementation of the carbon tax in accordance with Law Number 7 of the 2021 Harmonization of Tax Regulations.	Ministry of Energy and Mineral Resources
Refinement of renewable energy electricity purchasing regulations	Under the MEMR Regulation No. 04 of 2020, the renewable procurement and contract have been changed.	Ministry of Energy and Mineral Resources

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Updated solar rooftop program	To encourage the utilisation of solar energy, the MEMR has updated its regulations regarding solar photovoltaic (PV) rooftop development and net metering.	Ministry of Energy and Mineral Resources
Renewable energy certificate (REC)	Indonesian state-owned electricity utility company Perusahaan Listrik Negara (PLN) has been issued RECs to support the government program to promote clean energy usage.	PT PLN
Electric vehicle (EV) development program	The program targets for light-duty EVs to reach 2 million units and electric motorcycles to reach 13 million units by 2030.	Ministry of Energy and Mineral Resources
Charging station regulation	The MEMR-issued Regulation No. 13 of 2020 regulates charging infrastructure business models, electricity tariff for EV and charging stations, and technical and safety regulations.	Ministry of Energy and Mineral Resources
Electric stoves for cooking	The government continues to encourage the use of electric induction stoves to promote clean energy usage. The conversion of 1 million LPG stoves to induction stoves can reduce gas subsidies by IDR 4.8 trillion within five years.	Ministry of Energy and Mineral Resources

Notable Energy Developments

Energy development	Details	Reference
Abadi LNG Project	The development of the Abadi LNG project has been approved by the Indonesian government. The project will start producing 9.5 million tonnes per year (mtpa) of LNG and 35 000 barrels of condensate in 2027.	INPEX
Pertamina Enhanced Oil Recovery Program	Pertamina, the state-owned oil and gas company, undertook a full-scale enhanced oil recovery starting from 2020 to improve oil production from eight mature oil fields, increasing oil production by 40–60% from the 2019 rate of 922 000 bpd.	Pertamina
BP Tangguh LNG Train 3	The BP Tangguh Train 3 LNG project was expected to begin commercial operation in 2021, adding a capacity of 3.8 mtpa LNG production to an existing capacity of 11.4 mtpa.	BP
Jawa 1 Power Plant Floaring Storage Regasification Unit (FSRU)	From 2021 onward, the FSRU LNG regasification terminal (2.4 mtpa) is targeted to bring gas to the Jawa power plant.	Ministry of Energy and Mineral Resources
Coal-to-DME Conversion Program	The Coal-to-DME Conversion Program aims to reduce LPG imports required by the infrastructure sector. DME production is expected to be 1.4 mtpa, with a total investment of around USD 2.1 billion.	PT Bukit ASAM

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B30	Indonesia has implemented the B30 mandatory program in January 2020. Through this program, 9.2 million kilolitres of domestic biodiesel was projected to be utilised by the end of 2021.	Ministry of Energy and Mineral Resources
Management transfer of the Rokan block to Pertamina	Pertamina has committed to maintaining the existing scale of production after the management transfer from Chevron. It has set an investment budget until 2025 – of more than USD 2 billion. This strategic oil block is Indonesia’s second largest, with a 2021 oil production target of about 165 000 bpd or around 24% of the economy’s total.	Pertamina
Municipal waste-based power plants	Municipal waste-based power plants in Solo, Central Java, will start operating in April 2022.	Ministry of Energy and Mineral Resources
Smart grid	In increasing the electric power system’s reliability, a smart grid is a solution to escalate efficiency and transmission flexibility to receive more variable renewable energy (VRE). By 2025, 25 new smart grid systems will be developed.	Ministry of Energy and Mineral Resources
Cirata floating solar PV	The Cirata floating solar PV achieved financial closure in 2021. The project’s total capacity is 145 MW, with investments of about USD 129 million. It will be online in 2022.	Ministry of Energy and Mineral Resources
Indonesia’s electrification ratio goal	Electrification ratio in Indonesia reached 99.4% in 2021; it is targeted to reach 100% in 2022.	Ministry of Energy and Mineral Resources
Diesel power plant gasification	New regulation has revised the gasification target from around 1.7 GW to 1.2 GW of PLN’s power plants in 33 locations that previously had diesel fuel will be converted into natural gas-based plants..	Ministry of Energy and Mineral Resources
Hydropower generation in Poso and Malea	Hydropower generation in plants in Poso (515 MW) and Malea (90 MW), Central Sulawesi, started commercial operation in February 2022. The operation of these hydropower plants will increase the share of renewable energy in the energy mix.	Ministry of Energy and Mineral Resources

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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

Japan

Introduction

Japan, located in northeast Asia, comprises several thousand islands, the largest being Honshu, Hokkaido, Kyushu and Shikoku. Most of its land area is mountainous and thickly forested. It is the third-largest economy in the world after fellow APEC economies the United States and China. In 2019, Japan’s real gross domestic product (GDP) was approximately USD 5 225 billion (2017 USD purchasing power parity [PPP]) (World Bank, 2021). The population of 126 million people enjoyed a per capita income of more than USD 41 000, which accounted for a 0.3% growth in 2019, compared to 2018.

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 couple of 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 stable 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], 2021a).

Another important update for 2021 is “Asia Energy Transition Initiative

(AETI)”, AETI is an initiative led by the Japanese government which includes a variety of support realising energy transitions in Asia. The initiative consist of the following five pillars: (1) Support drawing roadmaps for energy transitions, (2) Asian version of transition finance, (3) US\$10 billion finance support (e.g., renewable energy, energy efficiency, LNG etc.), (4) Technology development and deployment, utilising the achievement of 2 trillion yen fund (e.g., offshore wind power generation, fuel-ammonia, hydrogen etc.), (5) Capacity building of decarbonisation technologies, and knowledge sharing through Asia CCUS network (METI, 2021b).

Table 1: Japan’s macroeconomic data and energy reserves

Key data ^{a, b}	Energy reserves ^{c, d, e}		
Area (thousand km ²) ^a	378	Oil (million barrels) ^c	44
Population (million) ^b	126	Gas (bcf) ^c	738
GDP (2017 USD billion PPP) ^b	5 225	Coal (Mt) ^d	350
GDP per capita (2017 USD PPP) ^b	41 380	Uranium (kilotonnes U < USD 130/kgU) ^e	6.6

Source: ^a GIS (2021); ^b World Bank (2021); ^c Xu and Bell (2021); ^d BP (2021); ^e OECD (2020)

Energy Supply and Consumption

Total Primary Energy Supply

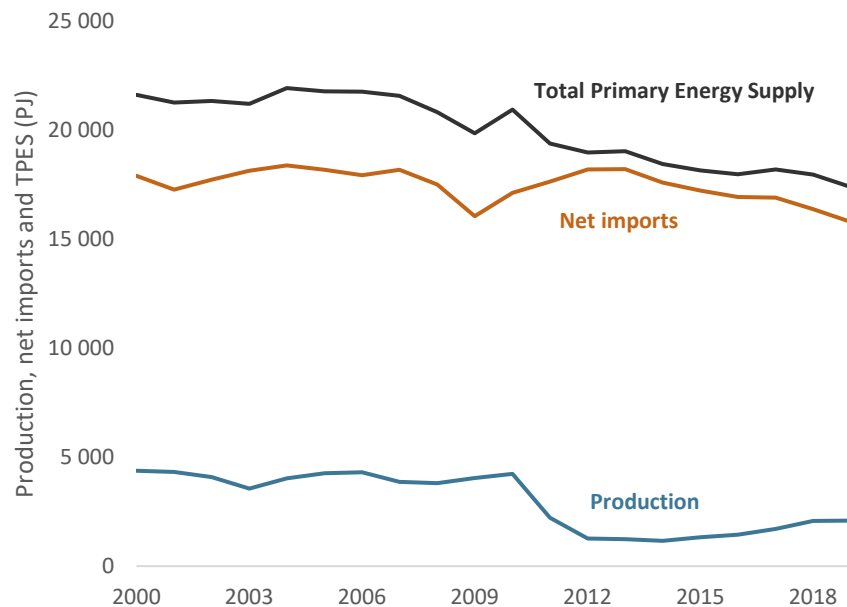
Japan’s total primary energy supply was 17 388 petajoules (PJ) in 2019, which represents an annual decrease of 3.1% (Figure 1). After the Great East Japan Earthquake, energy conservation gained

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prominence, which partly explains the continuous decline in final energy demand. In its fiscal year (FY, starting from April 1st and ending in March 31st) 2019, a declining GDP demand for cooling and heating due to the cold summer and warm winter contributed to the decline in Japan's final energy consumption (METI, 2021c).

In 2019, oil contributed the most (38%) to Japan's energy supply, followed by coal (28%) and natural gas (22%). Japan's energy supply is highly dependent on imports. The net energy imports made up 91% of the total primary energy supply (Expert Group on Energy Data Analysis [EGEDA], 2021).

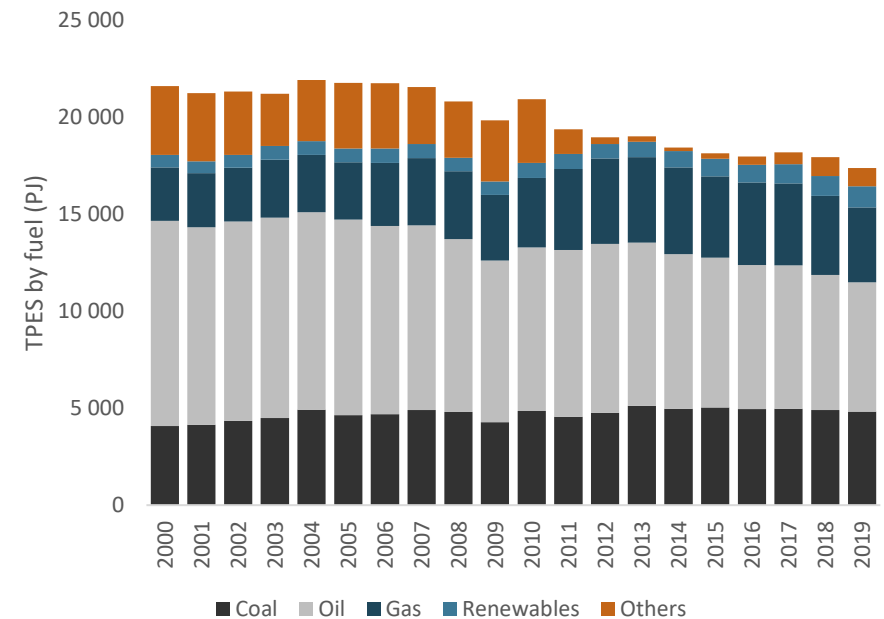
Figure 1: Japan's total primary energy supply, production, and net imports (2000 to 2019)



Source: EGEDA (2021)

Japan was the fifth-largest oil consumer in the world following the United States, China, India and Saudi Arabia (BP, 2021) and the third among APEC economies in 2020. 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, making Japan's dependency on the Middle East bounce back to 90% in FY2019.

Figure 2: Japan's total primary energy supply by fuel, 2000–2019



Source: EGEDA (2021)

Saudi Arabia, the United Arab Emirates and Qatar were the three largest suppliers of oil to Japan in FY2019 (METI, 2021c). In 2019, the

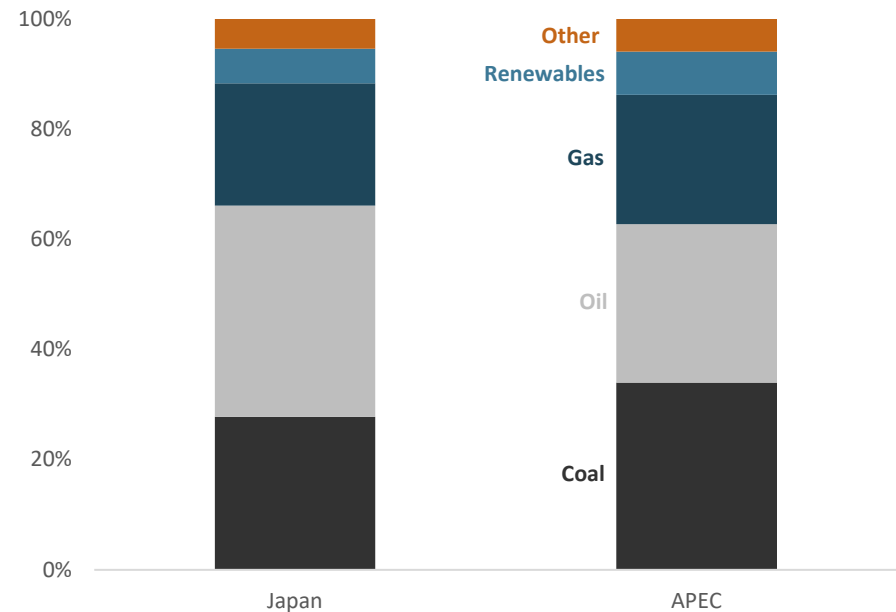
primary oil supply was 6 671 PJ, a decrease of 4.3% from the previous year (Figure 2). In 2019, the primary coal supply was 4 830 PJ, a decrease of 1.5% from the previous year (EGEDA, 2021).

Almost all of its coal was imported, making Japan 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%), Indonesia (12%) and Russia (12%), as of FY2019 (METI, 2021c). The top suppliers for coking coal are Australia (45%), Indonesia (23%) and the United States (12%) (METI, 2021c).

Like coal and oil, natural gas resources are scarce in Japan. Its domestic production stands at 2.5 billion cubic metres (bcm) and is mainly located in the Niigata, Chiba and Hokkaido prefectures (METI, 2021c).

In FY2018, liquefied natural gas (LNG) imports met almost the entirety of Japan's domestic demands. These imports were from Australia (39%), Malaysia (13%), Qatar (11%) and Russia (8.3%) (METI, 2021c). The LNG imports to Japan accounted for 21% of the total global LNG trade in 2019 (BP, 2021). Electricity generation and city gas are the main use cases for natural gas in Japan (METI, 2021c). The primary natural gas supply was 3 855 PJ in 2019, a decrease of 5.4% from the previous year (EGEDA, 2021). Japan has a larger share of oil (+10%) and smaller share of coal (-6%), gas (-2%) and renewables (-1%), when compared to the entire APEC region (Figure 3).

Figure 3: Total primary energy supply relative fuel share – Japan and APEC, 2019

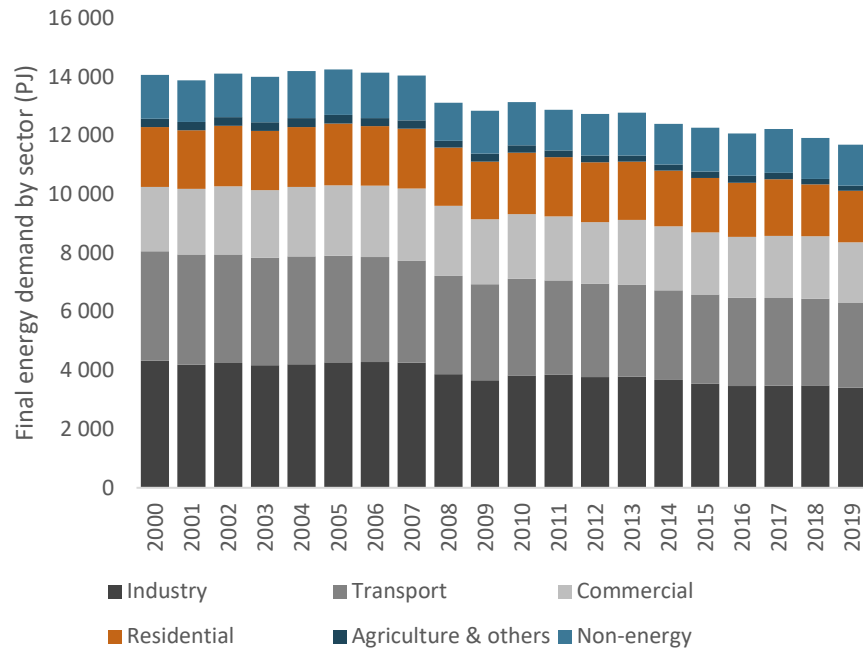


Source: EGEDA (2021)

Total Final Consumption

Japan's final energy consumption (excluding non-energy uses) decreased by 2.1% to 10 299 PJ in 2019 from the previous year (Figure 4). The non-energy uses amounted to an additional 1 386 PJ of final consumption with a decrease of 0.8% in 2019 from 2018. Including non-energy would place the final consumption at 11 686 PJ. This consumption has been declining after peaking in 2005.

Figure 4: Japan's final consumption by sector, 2000–2019



Source: EGEDA (2021)

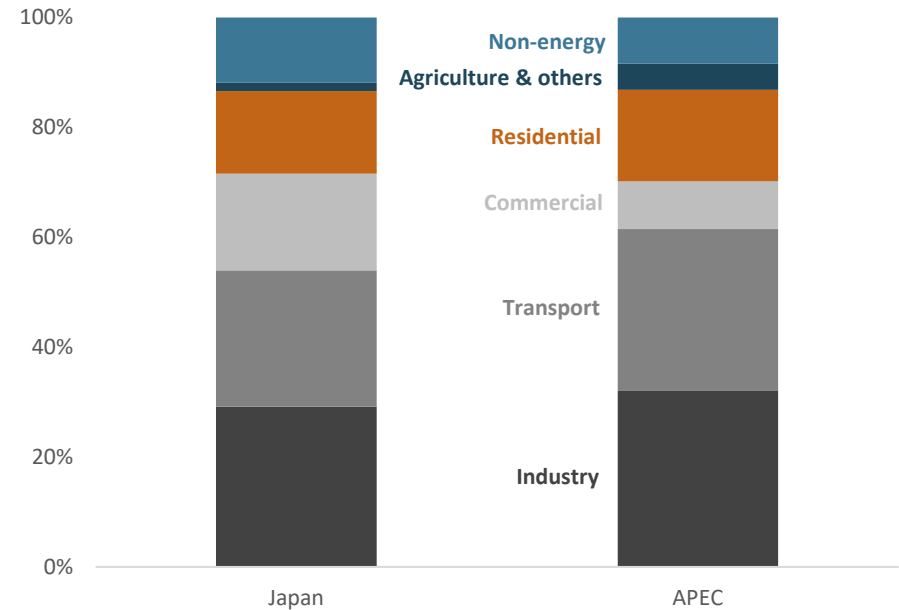
In 2019, the industry sector accounted for 29% of Japan's final consumption, followed by the transport sector (25%), the commercial sector (18%) and the residential sector (15%) (EGEDA, 2021) (Figure 5).

In the industry sector, energy efficiency improvement significantly minimised Japan's final energy consumption (METI 2021c).

In the transport sector, the decreased transport volume and enhanced transport efficiency led to a decline in energy consumption after the 2000s. In the commercial sector, energy-efficient air conditioners, improved insulation and energy-saving policies contributed to the

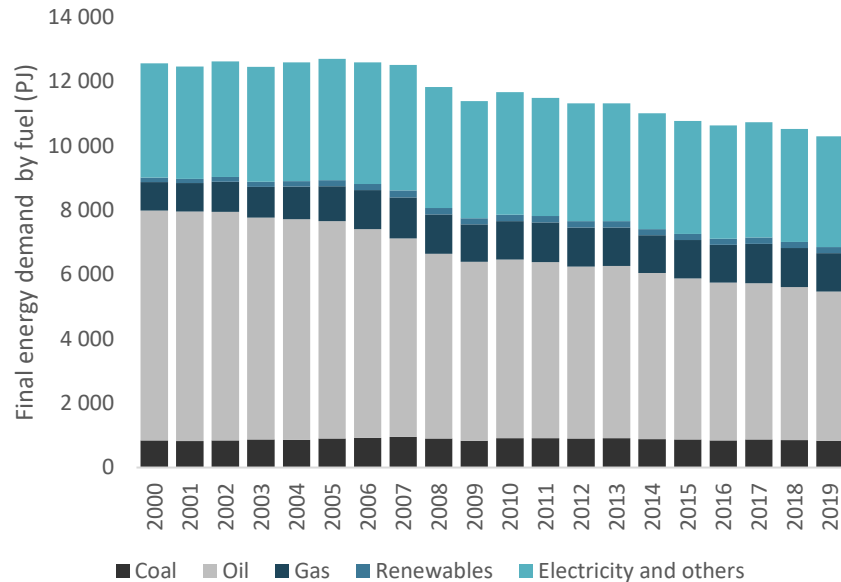
energy demand decline. Finally, in the residential sector, as people became more aware of energy use, energy consumption decreased (especially after the Great East Japan Earthquake in 2011) even though the personal expenditure and the number of households increased (METI, 2021c).

Figure 5: Final consumption sectoral share – Japan and APEC, 2019



Source: EGEDA (2021)

Figure 6: Japan's final energy consumption by fuel, 2000 to 2019

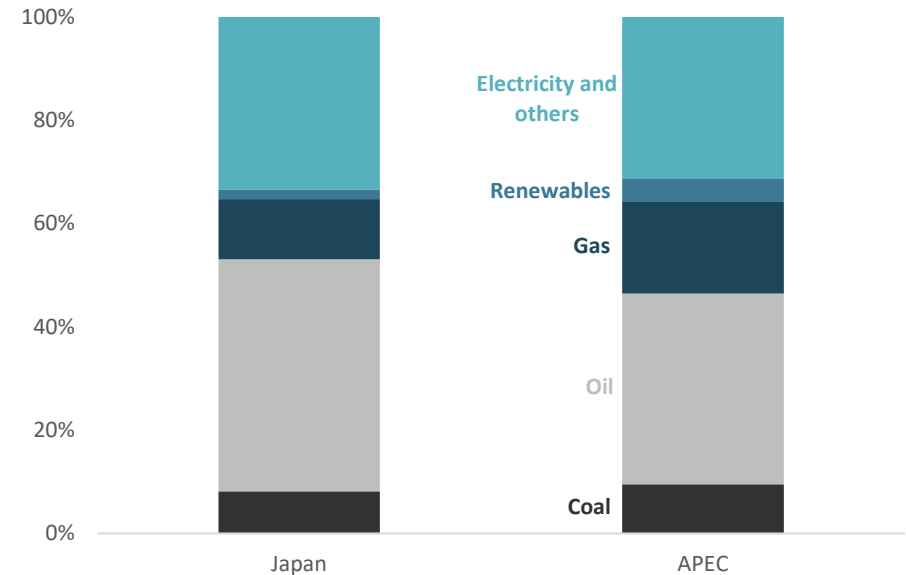


Source: EGEDA (2021)

Note: Final energy consumption excludes the non-energy sector.

Regarding Japan's final energy demand, oil constituted the largest share at 45%, electricity and others accounted for 33%, gas constituted 12%, and coal constituted 8.1%. The renewables share in this was still low at 1.9% (Figure 7). Compared to the entire APEC region, Japan has a large share of oil (+8%), electricity and others, and a smaller share of coal (-2%), gas (-6%) and renewables (-3%) (Figure 7).

Figure 7: Final energy consumption fuel shares, Japan's and APEC, 2019



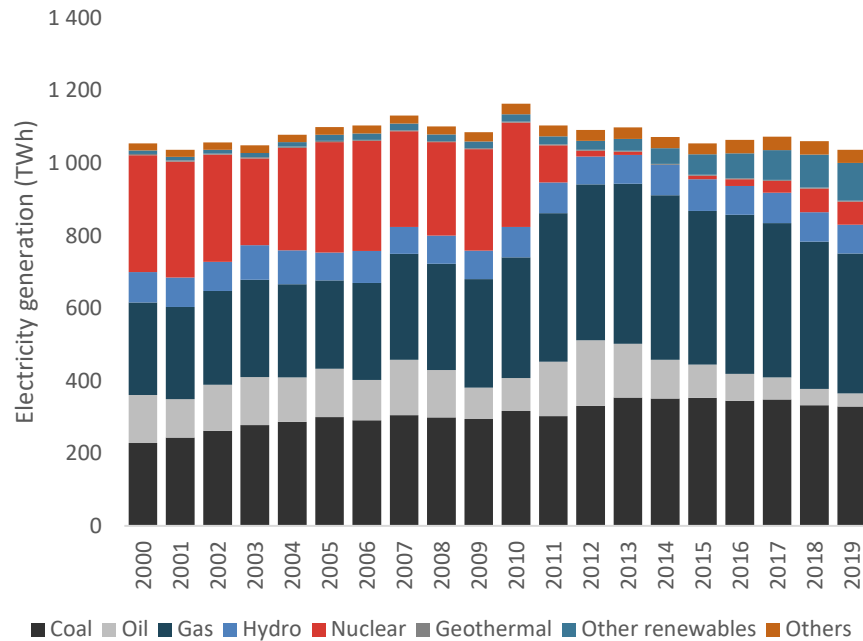
Source: EGEDA (2021)

Note: Final energy consumption excludes the non-energy sector.

Transformation

Japan had 271 gigawatts (GW) of installed generating capacity by electricity utilities as of September 2021 (METI, 2022a). In fact, it generated 1 037 terawatt-hours (TWh) of electricity in 2019 (EGEDA, 2021). Fossil fuels – coal, oil and gas – constituted 72% of the generated electricity. Renewables, including hydro, solar, wind and geothermal, accounted for 18% of the generation. The remaining share was accounted for by nuclear energy (6.1%) (EGEDA, 2021) (Figure 8).

Figure 8: Japan's electricity generation by fuel, 2000–2019



Source: EGEDA (2021)

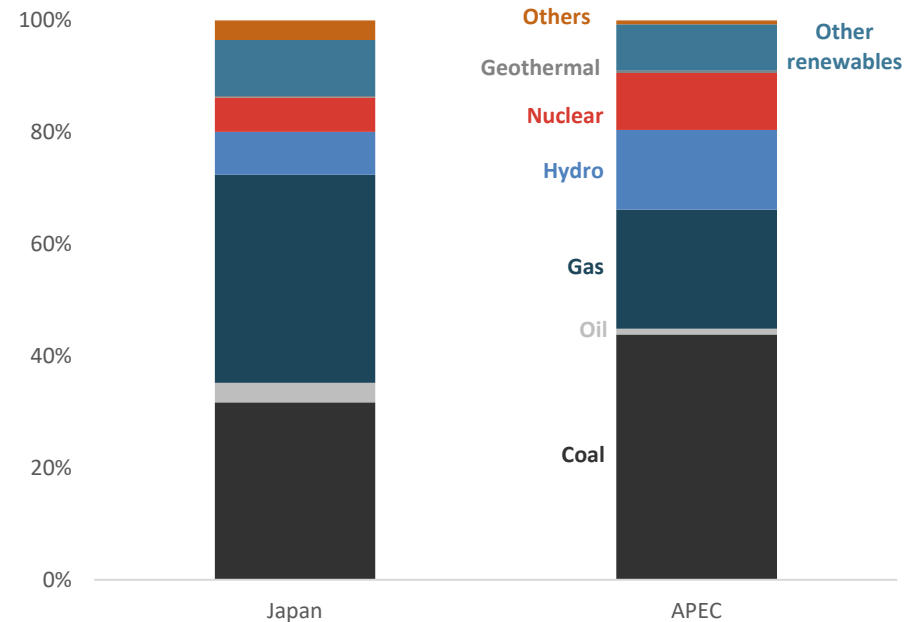
Compared to the entire APEC region, Japan has a larger share of fossil fuels (+6%), especially more gas (+16%), and a smaller share of renewables (-5%), especially less hydro (-7%) (Figure 9).

In 2018, the Ohi Units 3 and 4 and Genkai Units 3 and 4 nuclear power plants resumed operations (METI, 2021c). 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 January 2022, 10 commercial reactors had begun operating again (METI, 2022b).

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). Finally, in 2016, the retail electricity market was fully liberalised.

Figure 9: Electricity generation by fuel share – Japan and APEC, 2019



Source: EGEDA (2021)

As of January 2021, the sales share of PPS reached around 20% (METI, 2021c). After the earthquake and nuclear power accident,

Japan's electricity sector faced mounting pressure to deregulate even more to create a more competitive and transparent system. In this regard, the Electricity Business Act was amended in 2013, 2014 and 2015 to reform the market accordingly. The 2015 amendment included the legal unbundling of the power transmission/distribution sector, which began in 2020, to ensure neutrality. It also included the elimination of electricity rate regulation (METI, 2020), regarding which transitional measures are still in place to protect consumers (METI, 2021c).

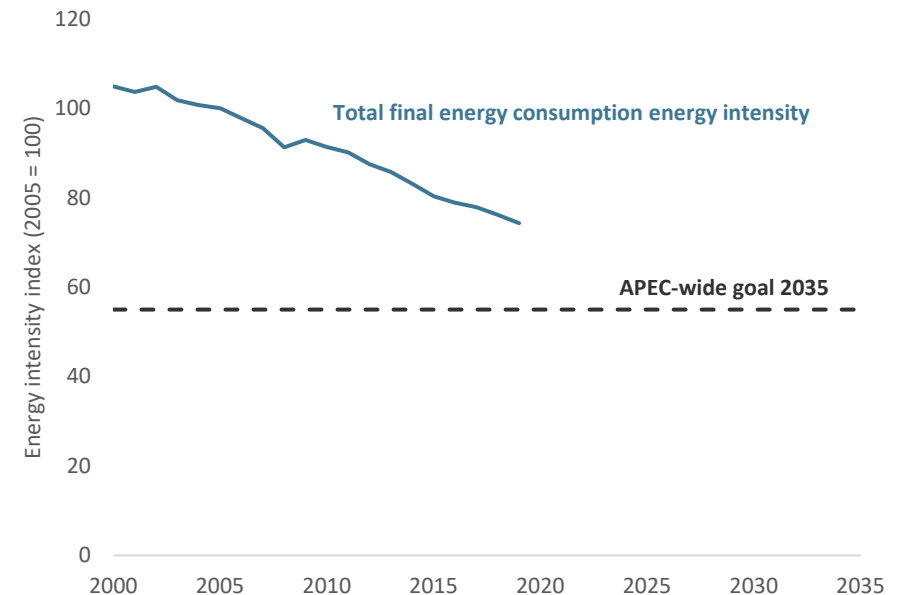
APEC Goals

The APEC economies have agreed on achieving the following two goals: (1) improving energy intensity (the total final energy consumption basis) by 45% by 2035 compared to 2005 and (2) doubling the share of renewables by 2030 compared to 2010.

Energy Intensity Goal

Japan's energy intensity has improved remarkably in the last few decades. The total final energy consumption (excluding non-energy uses) intensity improved by 2.4% in 2019 from 2018 (EGEDA, 2021). 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, 2017). Due to this, the economy achieved a 26% improvement in energy intensity from 2005 to 2019 (EGEDA, 2021) (Figure 10).

Figure 10: Japan's total final energy consumption intensity index, 2000–2019 (2005 = 100)

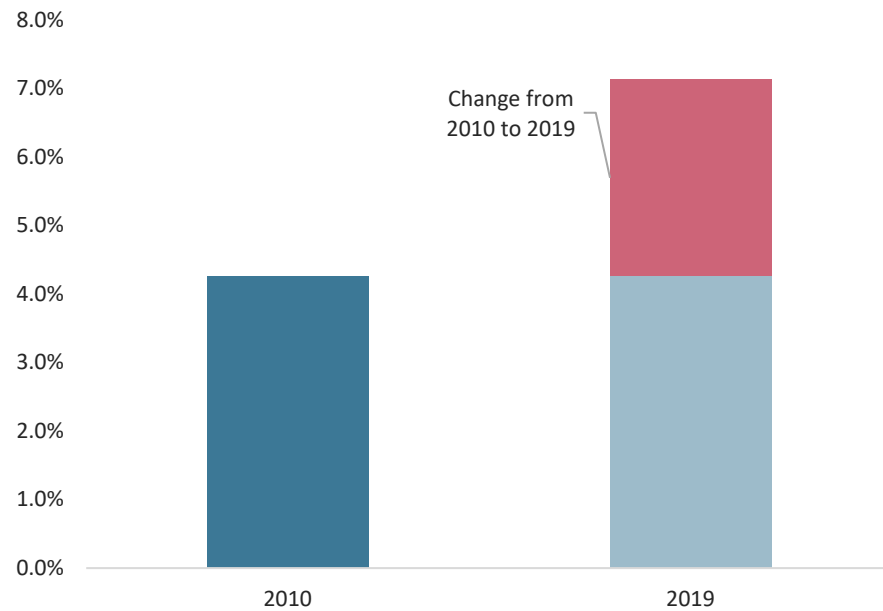


Source: EGEDA (2021)

Doubling of Renewables

In 2010, the share of modern renewables in the total final energy consumption was 4.3%, with this proportion further increasing to 7.1% in 2019 (EGEDA, 2021) (Figure 11).

Figure 11: Japan's modern renewable energy share, 2010–2019



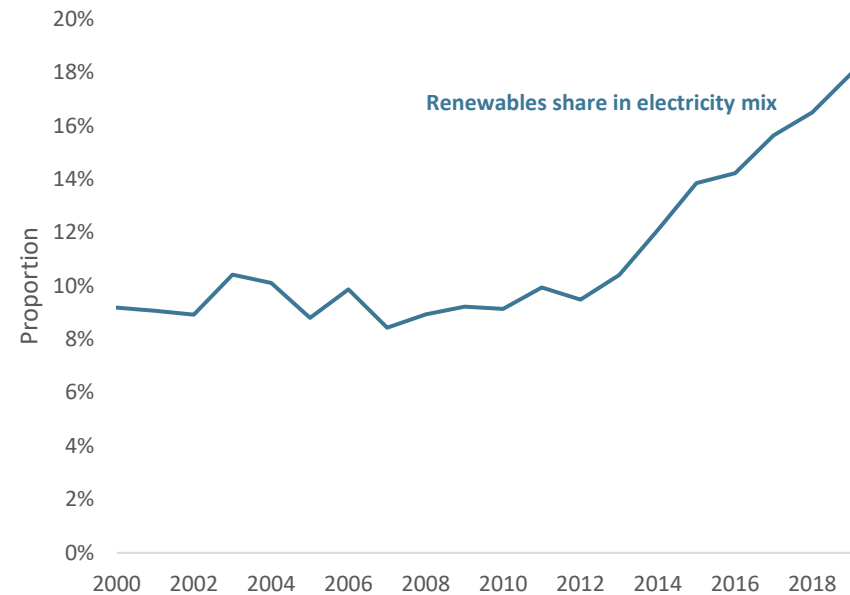
Source: EGEDA (2021)

Note: The 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 the other renewables (biomass used by the industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share of electricity that is generated from renewable sources.

Following the introduction of the feed-in tariff (FIT) system in 2012, the growth of renewable electricity installations has contributed to an

increasing share of renewables in Japan's electricity mix in recent years (METI, 2021c) (Figure 12). In 2019, the renewables share in Japan's electricity mix reached 18%. For solar, in particular, the total electricity generation increased from 0.4% in FY2011 to 6.8% in FY2019 (METI, 2022d).

Figure 12: Japan's renewable generation share, 2000–2019



Source: EGEDA (2021)

Energy Policy

Energy Policy	Details	Reference
Japan's Nationally Determined Contribution (NDC)	In 2021, at the Leaders' Meeting on Climate, the Economic Leader declared a new target of 46% GHG emission reduction by FY2030, compared to FY2013.	MOE
The Plan for Global Warming Countermeasures	It provides measures that businesses, citizens, and multiple levels of governments should implement to achieve the target of a 46% reduction in GHG emissions by FY2050.	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 (TCFD) 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	It includes various measures to reduce and absorb GHG and to adapt to climate change. It was revised in October 2021 for ensuring carbon neutrality by 2050.	MAFF
Climate Change Adaptation Plan of the Ministry of Agriculture, Forestry and Fisheries	It prompts leading production fields to disseminate adaptative techniques to evade and 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 (CSR) 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 to convert them into electricity, heat, ethanol, etc.	MAFF
Act on the Rational Use of Energy	It 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.	MOJ

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FIT Law and its revision	It creates new authorisation system, a revised method of setting purchase prices, a revision of businesses that purchase renewable energy (and other regulations) and a revision of the arrangement for reducing surcharges on electricity rates.	METI
Introduction of Feed-in Premium (FIP)	Introduction of FIP will be starting from April 2022.	METI
Electricity System Reform	It aims to expand nationwide coordination of transmission operators, achieve full liberalisation of electricity retail business and generation, and secure neutrality of power transmission and distribution sectors.	METI
Baseload Market	It 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	It aims to secure sustainable electricity supply systems by implementing 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	It encompasses multiple projects with equity capital and liability guarantees.	JOGMEC
Japan Bank for International Cooperation (JBIC) Support	It 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 about the 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

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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 2021	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 towards furthering the cause of using hydrogen globally in the future.	METI

Notable Energy Developments

Energy development	Details	Reference
The Sixth Strategic Energy Plan	<ul style="list-style-type: none"> • Carbon neutrality by 2050 • Leading international role in decarbonising technology and innovation • Energy security and energy efficiency as points of paramount focus • Tokyo Electric Power Company (TEPCO)'s decade response to the 3/11 incident • Carbon neutrality challenges 	METI
Tokyo 'Beyond-Zero' Week 2021	<ul style="list-style-type: none"> • Discussion on individual and collective challenges to moving the economies beyond the challenge of net-zero emissions. 	METI

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World Bank (2021), *Open Data*, <https://data.worldbank.org>

Useful Links

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

Institute of Energy Economics, Japan – <https://eneken.iej.or.jp/>

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>

Republic of Korea

Introduction

Over the last few decades, the Republic of Korea (Korea) has become one of Asia's fastest-growing and most dynamic economies. The gross domestic product (GDP) reached USD 2 209 billion (2017 USD purchasing power parity [PPP]) in 2019. The GDP per capita (2017 USD PPP) in 2019 was USD 42 719, approximately three times higher than in 1990. Although Korea's energy policy mainly focused on securing stable energy along with continued economic growth in the past, the energy transition policy for carbon neutrality is currently being pursued in line with global efforts to respond to climate change.

Korea is located in northeast Asia, situated between China and Japan. It has an area of 100 284 square kilometres and a population of 51.7 million as of 2019. Korea's population density is very high, with an average of more than 515 people per square kilometre. Approximately 20% of the population lives in Seoul, Korea's largest city and capital. 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. However, air conditioning is necessary during the tropical hot summers, whereas heating is required during the excessively cold winters.

Korea's major industries include semiconductors, shipbuilding, cars, petrochemicals, digital electronics, steel, and machinery parts and materials. The economic activity is driven by an export-oriented manufacturing sector. In 2019, manufacturing industry accounted for about 28% of GDP. However, the share of the manufacturing industry is expected to decrease slightly in the future as the service industry

grows faster.

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 (TCF) of natural gas. For this reason, Korea imports large quantities of energy products to sustain its high level of economic growth.

Table 1: Korea's Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^{b, c}	
Area (million km ²)	0.1	Oil (billion barrels)	-
Population (million)	51.7	Gas (trillion cubic feet)	0.3
GDP (2017 USD billion PPP)	2 209	Coal (million tonnes)	359
GDP per capita (2017 USD PPP)	42 719	Uranium (kilotonnes U < USD 130/kgU)	-

Source: ^a UN (2021); ^b EGEDA (2021); ^c EIA (2021)

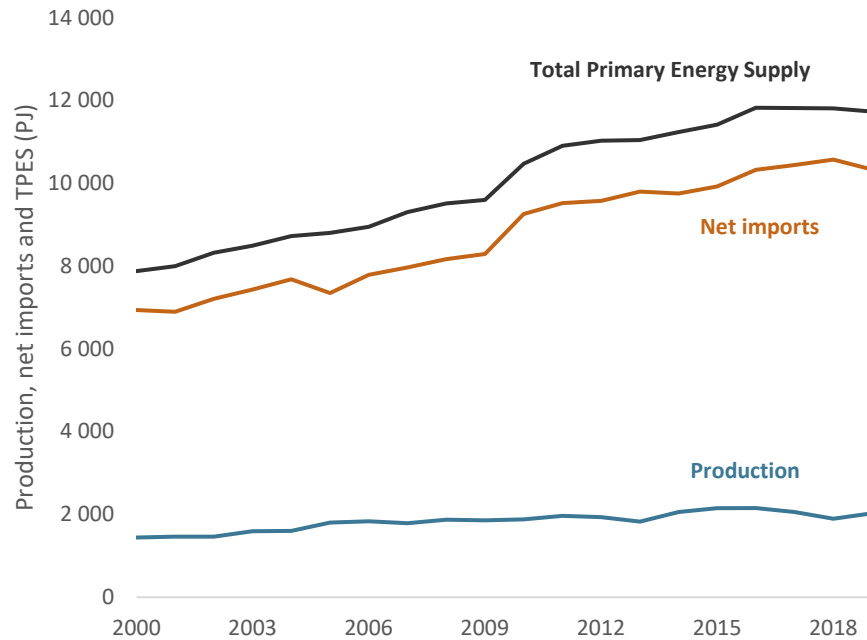
Energy Supply and Consumption

Total Primary Energy Supply

Between 1990 and 2019, Korea's total primary energy supply (TPES) more than tripled from 3 890 PJ to 11 731 PJ. From 1990 to 2000, the energy supply increased at an average annual growth rate of 7.3%, exceeding the economic growth rate of 7.1% for the same period. Energy supply increased by 49%, from 7 878 PJ in 2000 to 11 731 PJ in 2019. In the five years from 2015 to 2019, the rate of increase in Korea's energy supply has levelled off (Figure 1). Korea's energy

supply decreased slightly in 2019 (EGEDA, 2021).

Figure 1: Korea's total primary energy supply, production and net imports, 2000 to 2019



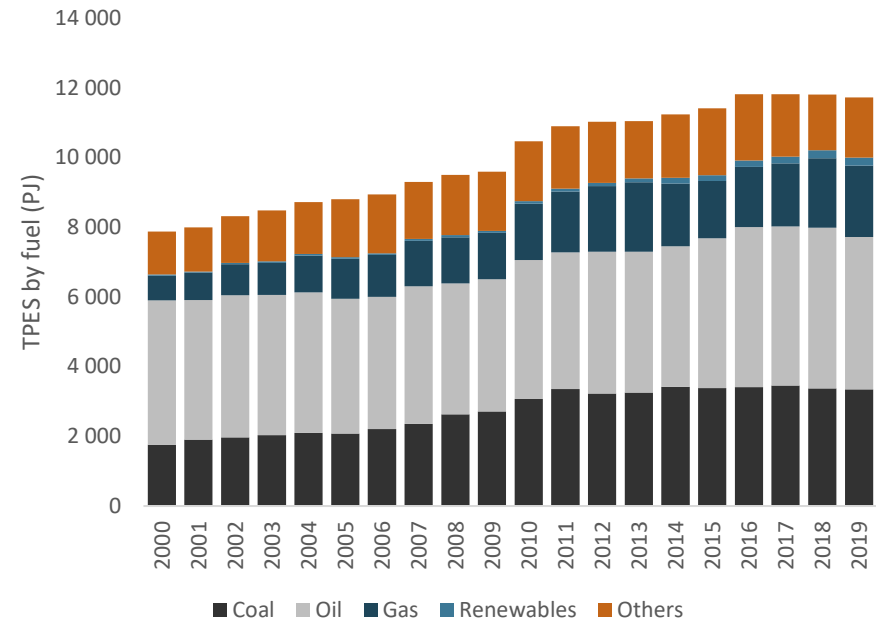
Source: EGEDA (2021)

Since Korea has limited domestic energy resources, a significant portion of Korea's TPES is imported. In 2019, Korea imported approximately 88% of its energy supply. 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, 2021).

Korea's energy supply has not experienced a drastic change in terms of fuel share though there has been an expansion of renewable energy from 2000 to 2019 (Figure 2). Coal's relative share of total primary energy supply increased from 22% to 29% for the period, while oil's

share decreased from 53% to 37%. Natural gas expanded from 9% in 2000 to 17% in 2019. Renewables showed the fastest growth, having gradually increased from a small relative amount of 0.4% to 2.0% during the same period (EGEDA, 2021).

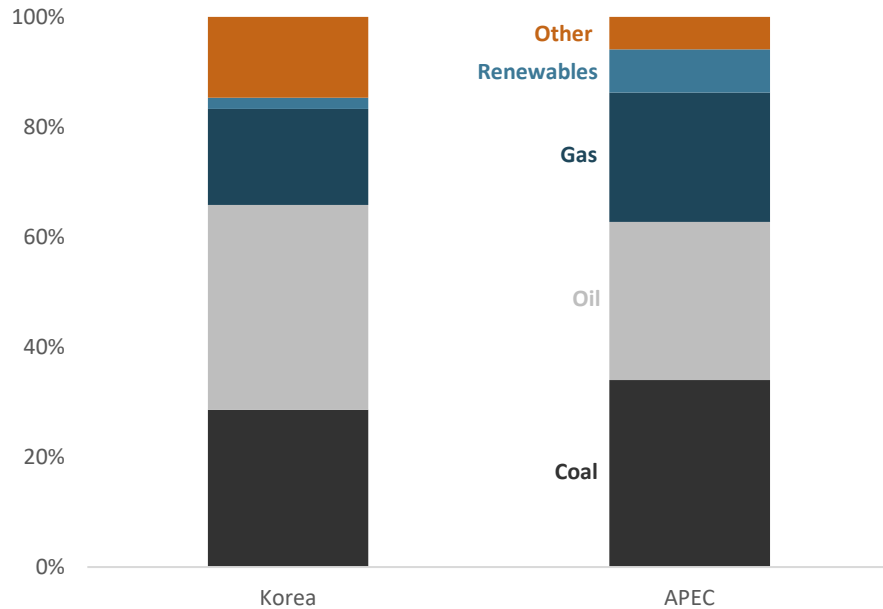
Figure 2: Korea's total primary energy supply by fuel from 2000 to 2019



Source: EGEDA (2021)

As of 2019, Korea's TPES fuel mix had some differences in the share of energy sources compared to that of the entire APEC region (Figure 3). Oil supply was proportionally higher, whereas the supply of all other fuel categories was relatively lower. Korea's oil share of TPES was 37%. Meanwhile, the portion of renewables in APEC was about four times that of Korea. The share of renewable energy supply in APEC is 7.8%, whereas the share of renewables in Korea is only 2.0%.

Figure 3: Total primary energy supply relative fuel share – Korea and APEC, 2019



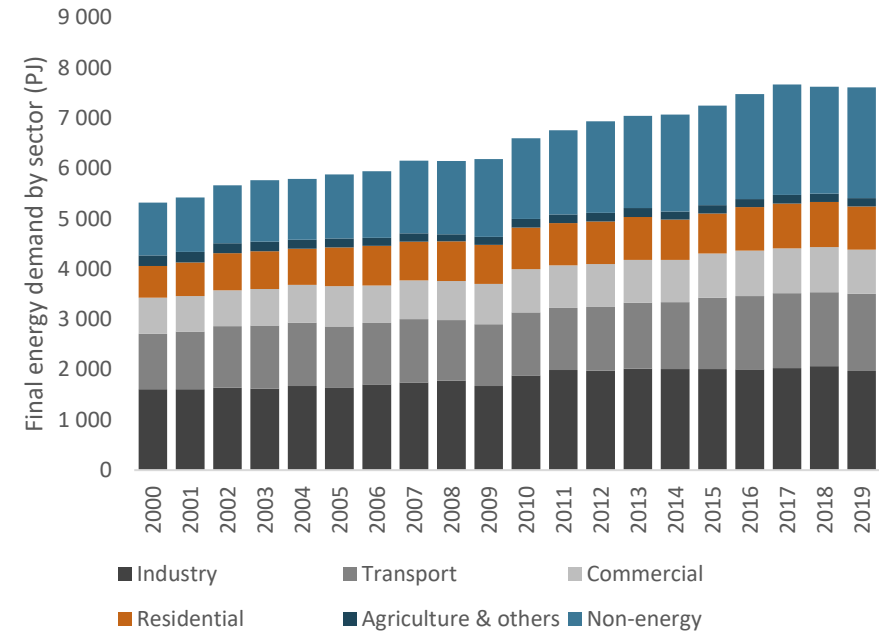
Source: EGEDA (2021)

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 2019 was 7 617 PJ, which was a 0.2% decrease from the previous year. The non-energy and industrial sectors accounted for the largest shares at 29% and 26%, respectively, while the transport sector accounted for 20%. The remainder (25%) was associated with the other sectors (combined commercial, residential, agriculture and other sectors). In general, consumption in the agriculture sector has weakened since the late 1990s, and

consumption in the transport and commercial sectors has gradually increased.

Figure 4: Korea's final consumption by sector from 2000 to 2019



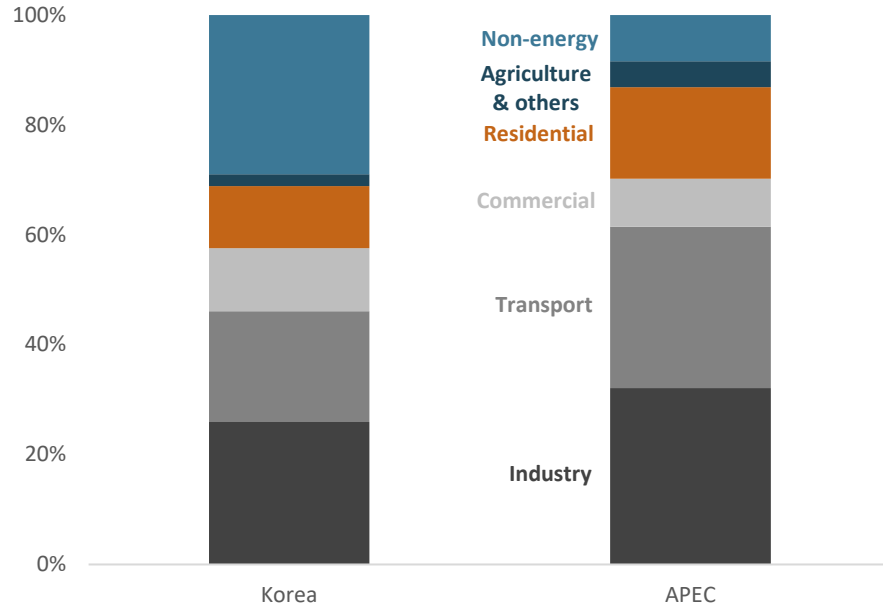
Source: EGEDA (2021)

Relative to APEC, Korea's industry and transport sectors constitute a lower portion of the final consumption, whereas the non-energy sector accounts for comparatively more use (Figure 5). APEC's final consumption share in the industry and transport sectors was 32% and 29%, respectively, in 2019, whereas Korea's respective consumption accounted for 26% and 20% of the consumption in the industry and transport sectors 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.

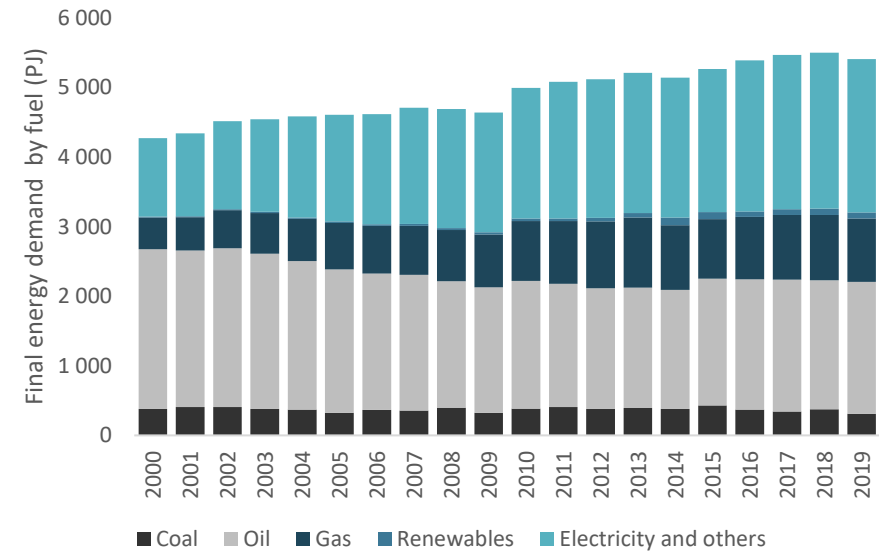
Figure 5: Final consumption sectoral share, Korea and APEC, 2019



Source: EGEDA (2021)

Korea's final energy demand increased gradually from 2000 to 2017 and then decreased slightly after 2017 (Figure 6). Although it is not shown in Figure 6, the decline was even greater in 2020 due to the unexpected COVID-19 pandemic. When examined by sector, the share of demand in 2019 compared to that of the 2000 data revealed that the industrial sector's proportion in the total share of the year has been declining; it reportedly reduced to 26% in 2019 from 30% in 2000. On the other hand, the non-energy sector's proportion in the total share of the year showed an increasing trend from 20% in 2000 to 29% in 2019.

Figure 6: Korea's final energy demand by fuel from 2000 to 2019



Source: EGEDA (2021)

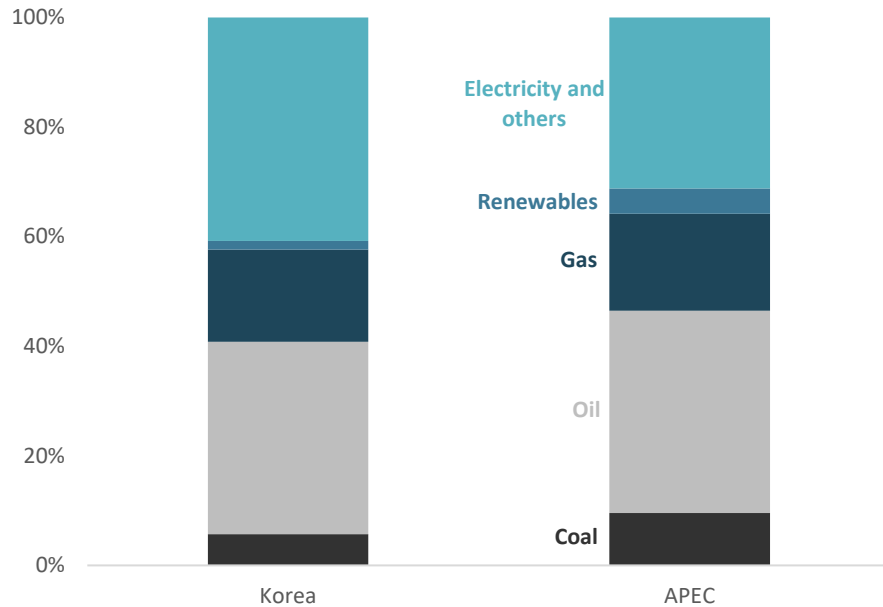
Note: Does not include non-energy consumption of energy commodities.

Relative to APEC, Korea's electricity demand is relatively large. Korea's electricity and others share of final energy consumption is 40.8%, while APEC's share is 31.2% (Figure 7). Korea's economic growth has significantly increased electricity demand over the past few decades. The Ninth Basic Plan for Long-term Electricity Demand and Supply (2020–34), finalised by Ministry of Trade, Industry and Energy (MOTIE) in December 2020, projects that electricity consumption will grow by 1.6% per year from 2020 to 2034 (MOTIE, 2020a).

Meanwhile, as of 2019, the proportion of coal and oil in Korea is relatively lower than that of APEC. This is partly due to Korea introducing city gas (natural gas) into the residential sector in the 1980s to reduce dependence on imported oil. Power-based appliances have

also continuously increased, contributing to electricity's higher share in the final energy demand.

Figure 7: Final energy consumption fuel shares, Korea and APEC, 2019



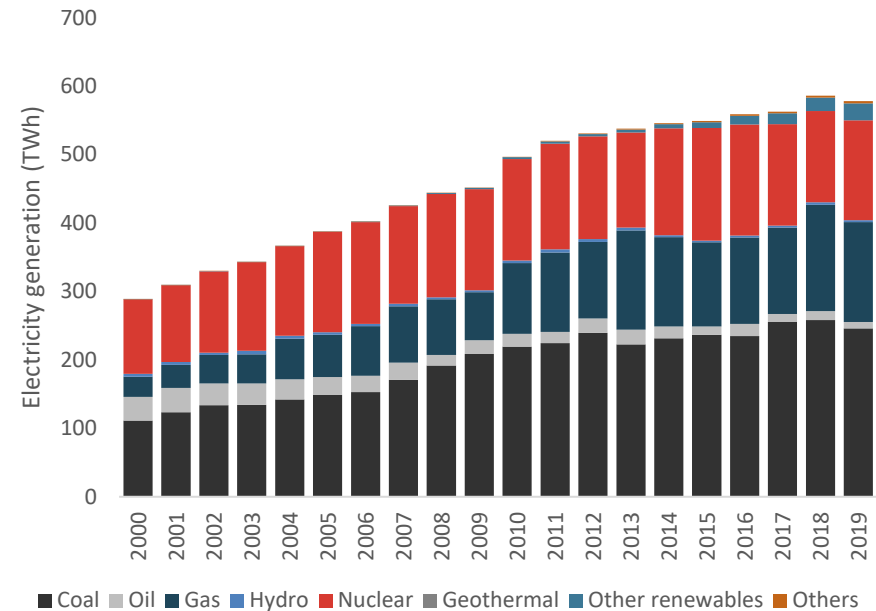
Source: EGEDA (2021)

Transformation

Energy use in Korea's transformation sectors has grown rapidly since 2000, driven by a steady expansion of refinery and electricity generation capacities. Between 2000 and 2019, the total power generation increased two-fold, from 289 terawatt-hours (TWh) in 2000 to 578TWh in 2018 (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, 43% of Korea's electricity was generated by coal in 2019, marking a 3% increase from 40% in 2000. Gas and renewables also expanded their shares in the generation mix between 2000 and 2019, whereas the portion of the oil was reduced for the same period. With the rise of carbon neutrality ambitions, the share of coal power generation is expected to considerably decrease in the future.

Figure 8: Korea's electricity generation by fuel from 2000 to 2019

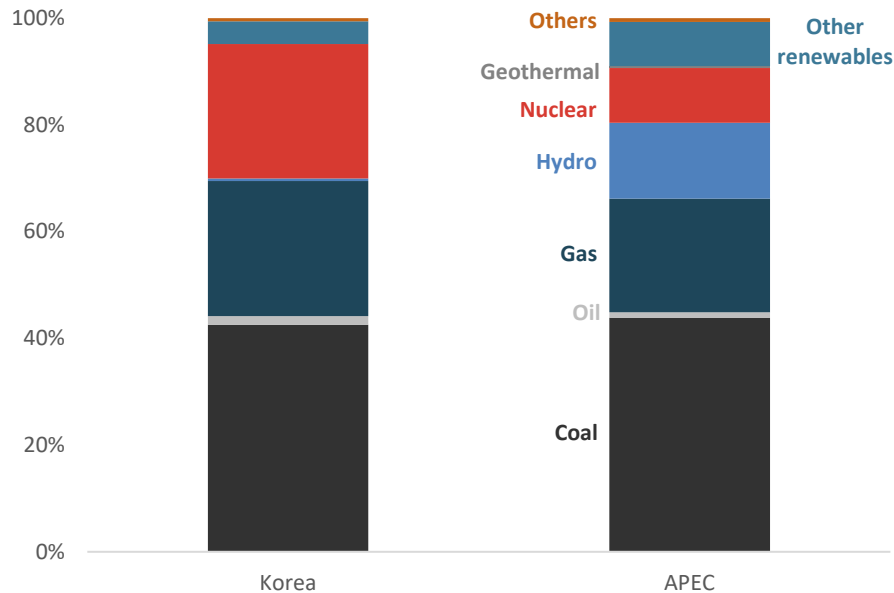


Source: EGEDA (2021)

In Korea's electricity generation mix, coal and oil had similar proportions when compared to the generation mix for APEC in 2018 (Figure 7). Meanwhile, the comparison between the two sides has revealed that other fuel sources for power generation showed some difference. The proportion of gas in Korea's power sector was relatively

higher than that of APEC. The Korean share of nuclear was 25%, more than double that of APEC, which was at 10%. In contrast to gas and nuclear, the share of renewables was higher for APEC than for Korea. Particularly, the proportion of hydro accounted for 1% in Korea and 14% in APEC.

Figure 9: Electricity generation by fuel share, Korea and APEC, 2019



Source: EGEDA (2021)

APEC Goals

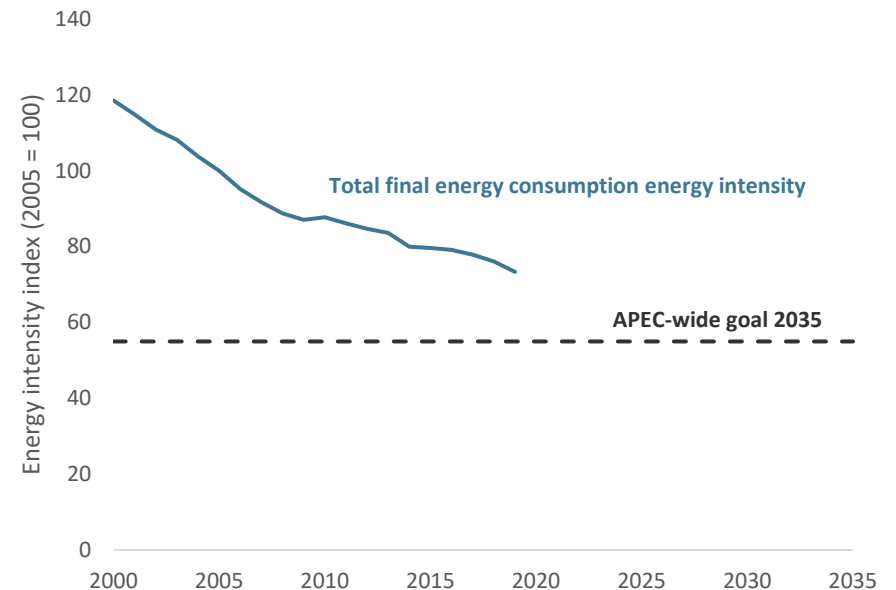
APEC has two aspirational goals: to achieve sustainable and resilient energy development within the Asia-Pacific region. These goals are to improve energy intensity by 45% by 2035 relative to 2005 as well as double the share of renewables in the overall energy mix by 2030 relative to 2010.

Energy Intensity Goal

The APEC goal of improving energy intensity by 45% does not involve individual economic targets. However, member economies' efforts are contributing to the overarching improvement of the APEC region (Figure 10).

Since 2005, Korea's total final energy consumption (not including non-energy) intensity has continued to improve. In 2019, this improvement was 27% relative to the 2005 baseline.

Figure 10: Korea's total final energy consumption intensity index from 2000 to 2019 (2005 = 100)



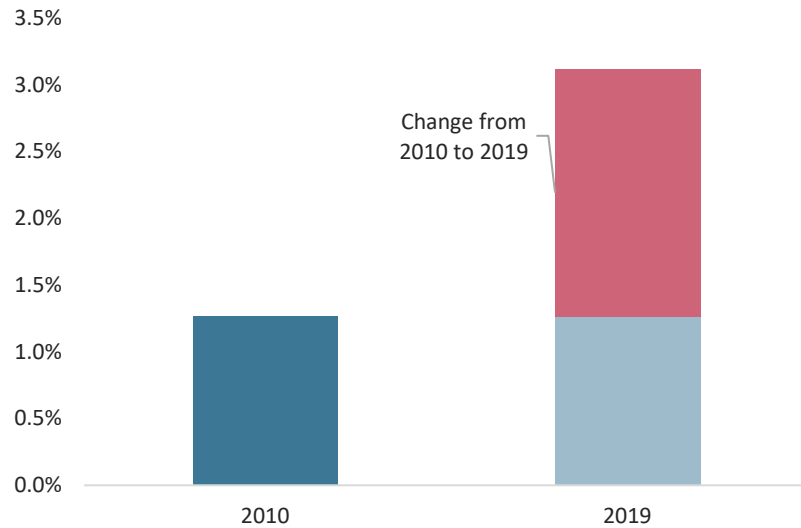
Source: EGEDA (2021)

Doubling of Renewables

Doubling the renewable energy share in the APEC region is another important aim. This goal refers to the share of modern renewables,

which does not include traditional biomass, and is doubling the share in the APEC energy mix by 2030 relative to 2010. This goal is expected to gain momentum with NDCs in the Paris Agreement for achieving reduced emissions.

Figure 11: Korea's modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

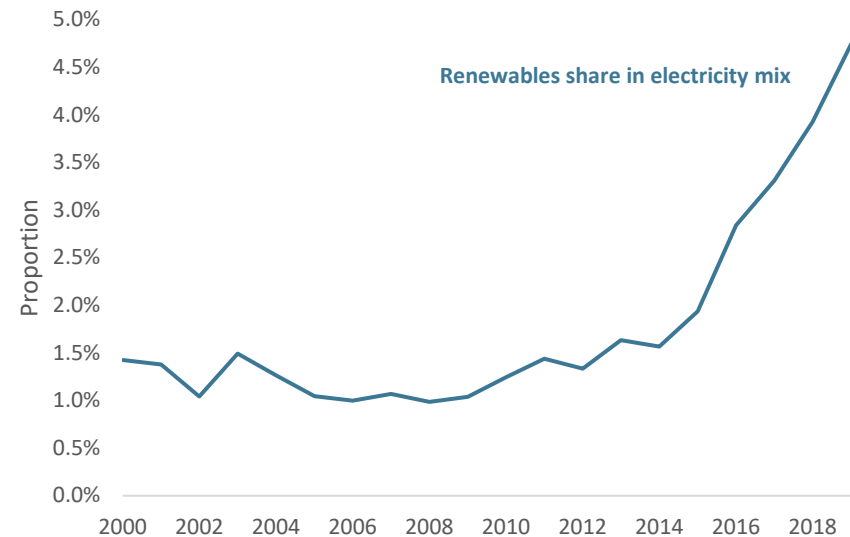
Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share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

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 through

the provision of 49GW in new generating capacity. In 2019, the government announced the 3rd National Energy Master Plan, and it is expected that the share of renewables in the power generation mix will increase to 30–35% by 2040. In 2021, the Committee on 2050 Carbon Neutrality in Korea announced its upgraded roadmaps in two scenarios to fulfill the 2050 carbon neutrality goal by expanding the use of renewable energy and strengthening its acceptability.

The 2030 Renewable Energy Initiative Implementation Plan has already led to significant increases in the share of the generation of renewables, increasing from under 2% for most of the 2000s and early 2010s to 5% in 2019.

Figure 12: Korea's renewable electricity generation share from 2000 to 2019



Source: EGEDA (2021)

Energy policy

Energy Policy	Details	Reference
3rd Energy Master Plan	The plan was announced in June 2019 to provide a mid- to long-term (2019–2040) framework for coordinating energy policy throughout the economy while identifying several problem areas affecting Korea’s energy system.	MOTIE (2019)
Renewable energy competitive incentive program	This program was designed in April 2019 to prepare an industrial strategy for the domestic renewable energy industry to make a new leap forward by taking the opportunity to change the energy paradigm.	MOTIE (2019)
9th Basic Plan on Electricity Demand and Supply	The plan for 2017–2031 was released in December 2020 to provide a mid- to long-term power demand forecast and for the expansion of power facilities, reflecting the increased demand for additional reductions in coal power generation due to the fine dust and greenhouse gases.	MOTIE (2020)
Hydrogen Economy Roadmap	The government announced this roadmap that aims to create an ecosystem of hydrogen industry, including energy production, storage, transportation and safety.	MOTIE (2019)
Resources Development Plan	MOTIE released this plan in May 2020 to increase the government’s investment in private sector companies’ resource exploration projects and proposes a new policy goal covering resource security.	MOTIE (2020)
Energy efficiency innovation strategy	This strategy aims to achieve the target demand (175.3 million TOE) in line with the 3rd Energy Master Plan by reducing 29.6 million TOE of final energy consumption in 2030 compared to the baseline demand (204.9 million TOE).	MOTIE (2019)
Enforcement decree of the electric utility act	This enforcement decree aims to diversify energy sources through the promotion of technology development, the use and distribution of new and renewable energy, and the conversion of energy systems into an environment-friendly structure by reducing greenhouse gas emissions.	National law information center
14th Plan for Long-term Natural Gas Demand and Supply	MOTIE released this plan in April 2021 to maintain a stable gas demand and supply as well as support the energy transition policy by including a long-term natural gas demand forecast from 2021 to 2034.	MOTIE (2021)

Notable Energy Developments

Korean new deal 2.0

The Korean new deal plan was created in 2020 to expand investment in a digital and green society. Korean new deal 2.0 is the upgraded version of the Korean New Deal plan, and it was introduced in July 2021, one year after the introduction of the original plan.

[MOEF \(2021\)](#)

2050 carbon neutrality roadmaps

These roadmaps have been created to achieve the goal of carbon neutrality by 2050. They were proposed to the government by the Committee on 2050 Carbon Neutrality in October 2021.

[Committee on 2050
Carbon Neutrality \(2021\)](#)

Malaysia

Introduction

Malaysia covers an area of 330 241 square kilometres and lies entirely in the equatorial zone. It comprises 13 states and three federal territories¹. In 2019, Malaysia's population stood at 32.0 million, with an increase of 1.3% from 2018², and was estimated to reach 32.7 million by December 2021³.

Malaysia's gross domestic product (GDP) reached USD 906.24 billion (2017 USD purchasing power parity [PPP]) in 2019, with an increase of 4.3% from 2018, while GDP per capita increased by 2.9% to USD 28 364 in 2019. The largest contributor to Malaysia's GDP in 2019 was services activity at 58.3%, followed by manufacturing at 22.5%, mining and quarrying at 7.3%, agriculture at 7.2% and construction at 4.7%. The main export products at the time were manufactured goods at 84.5%, minerals at 8.2% and agriculture at 6.6%¹.

After months of a nationwide strict movement control order, Malaysia's economy is slowly recovering from the COVID-19 pandemic. In the fourth quarter of 2021, Malaysia's GDP growth rebounded to 3.6% from the previous quarter, in which the GDP was at -3.6%, with annual GDP growth of around 3.1% compared to a decline of 5.6% in 2020⁴.

Malaysia's energy resources are modest compared to other APEC economies, with around two-thirds of its energy reserves located in East Malaysia and the rest in Peninsular Malaysia. As of 1 January 2019, oil (including condensates), associated and non-associated gas, and coal reserves were respectively about 4.7 billion barrels, 79.2

trillion cubic feet and 1.9 billion tonnes⁵.

Table 1: Malaysia Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	330 241	Oil (billion barrels)	2.7
Population (million)	32.0	Gas (trillion cubic feet)	32.1
GDP (2017 USD billion PPP)	906	Coal (million tonnes)	1 918
GDP per capita (2017 USD PPP)	28 364	Uranium (kilotonnes U < USD 130/kgU)	-

Source: a – EPU (2021); b – EGEDA (2021); c – BP (2021); d – EC (2021)

Note: Reserves are total proved reserves, which are measured, indicated and inferred resources for coal.

In 2021, Malaysia announced several energy-related plans and programs as a step forward in achieving its targets and commitment to becoming a low-carbon economy. The Low Carbon Mobility Blueprint 2021–2030, which was released in April 2021, focuses on the following: improving vehicle fuel economy and emission; adopting electric vehicles (EVs), low-emission vehicles and alternative fuels; and reducing greenhouse gas (GHG) emission and energy via mode shifts. Later, the National Low Carbon Cities Masterplan 2021 was released in July 2021, focusing on implementing low-carbon developments and initiatives by utilising sustainable green technology and green practices and emitting relatively low carbon or GHG at the city level in Malaysia.

In addition to drawing up comprehensive plans and programs, Malaysia revised its Intended Nationally Determined Contribution (INDC) targets in July 2021 to unconditionally achieve a 45% carbon intensity reduction in 2030, compared to the 2005 level. Malaysia also

announced a goal to achieve a carbon-neutral economy by 2050 in September 2021 alongside the zero new coal-fired plants commitment prior to the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow.

Apart from the existing green incentives, a Green Energy Tariff program was launched in November 2021 for renewable energy (RE) subscription, replacing myGreen+, while the Malaysia Renewable Energy Roadmap was released at the end of 2021 to support and accelerate renewables deployment in Malaysia, especially in the power sector⁷.

Energy Supply and Consumption

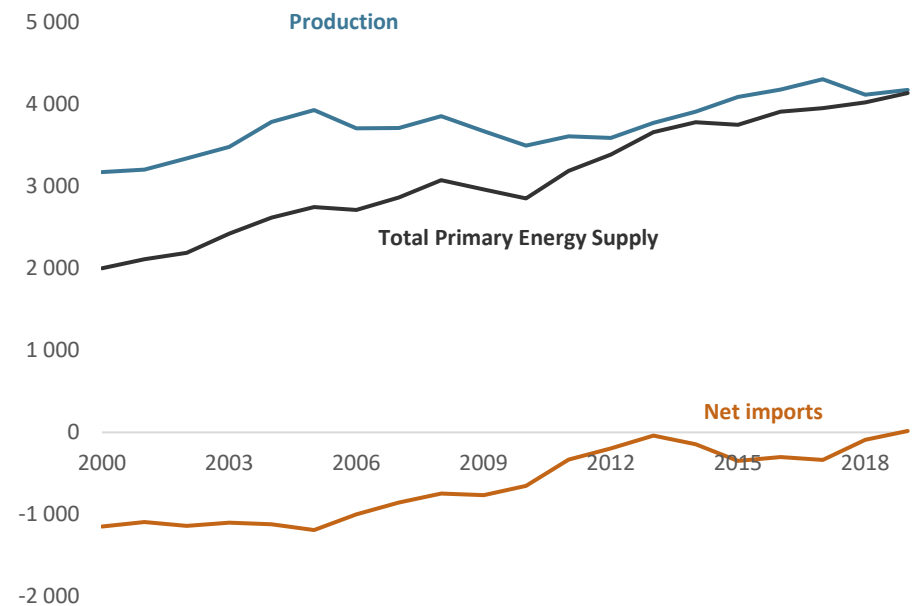
Total Primary Energy Supply

Malaysia's total primary energy supply increased slightly by 2.8% in 2019, reaching 4 133 PJ, driven by the increase in oil supply. The total energy supply grew higher than the total energy production, about double the increase in energy production in 2019. The growth of crude oil and petroleum products imports made Malaysia a net energy importer in 2019, as net energy imports reached 17 PJ (Figure 1).

However, Malaysia was still the fifth-largest global LNG exporter in 2019⁵. Malaysia's LNG exports and imports rose by 6.6% and 46.0% year-on-year, respectively, with increasing gas demand from international and domestic markets.

Oil imports increased in 2019 to meet the growing domestic oil and petroleum products demand. Malaysia also continued to rely on imported coal for power sector consumption.

Figure 1: Malaysia's total primary energy supply, production and net imports, 2000 to 2019 (PJ)

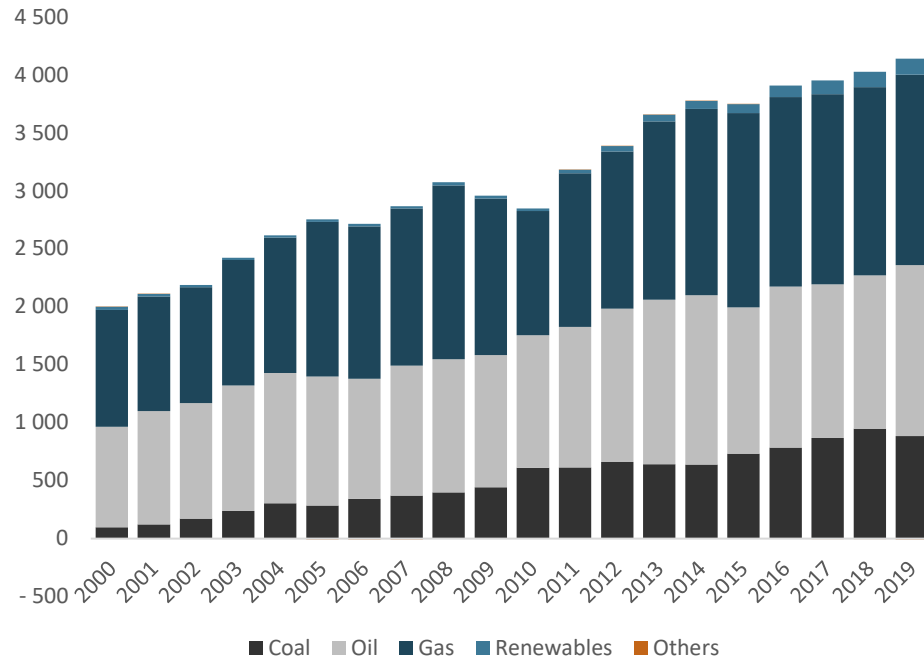


Source: EGEDA (2021)

Fossil fuels remained dominant in Malaysia's total primary energy supply in 2019. Gas contributed 39.7% of the total supply share, followed by oil at 35.6% and coal at 21.4%. Oil supply has grown 11.3% from 2018, while gas supply growth has been almost flat for the past five years, rising a mere 0.4% annually from 2014. Further, coal supply had risen steadily since 2000 as a result of fuel diversification in electricity generation. However, it declined for the first time in 2019 due to a few forced shutdowns of coal-fired power plants.

Solar energy development, especially in the power sector, increased the share of renewables in total supply from 3.0% in 2018 to 3.4% in 2019 (Figure 2).

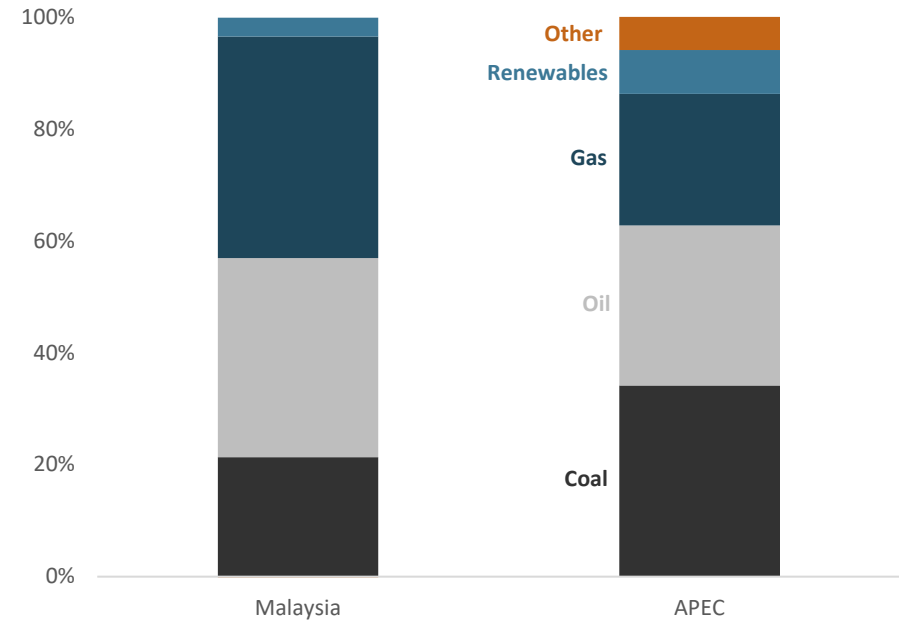
Figure 2: Malaysia's total primary energy supply by fuel, 2000 to 2019 (PJ)



Source: EGEDA (2021)

Malaysia's energy supply structure points to a higher reliance on fossil fuels than the APEC region (Figure 3), as Malaysia has a reasonable amount of indigenous oil and gas resources. Oil and gas shares were higher than in the APEC region, while coal, renewables and others were lower.

Figure 3: Total primary energy supply relative fuel share – Malaysia and APEC, 2019



Source: EGEDA (2021)

Total Final Consumption

Malaysia's total final consumption increased by 2.9% from 3 145 PJ in 2018 to 3 236 PJ in 2019, exhibiting a continuous stable increment for four years in a row (Figure 4).

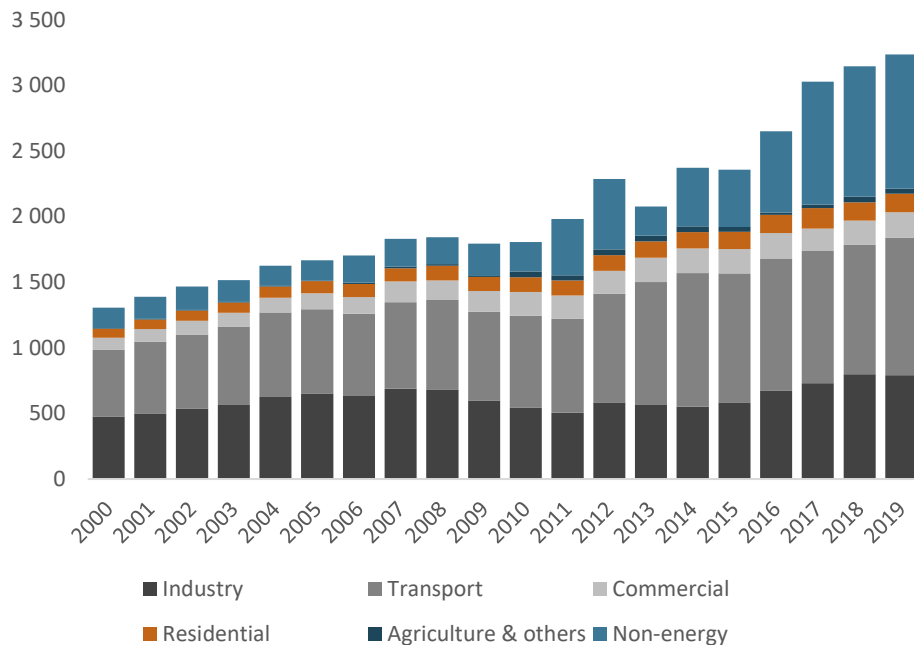
The transport sector was the largest energy consumer, constituting 32.3% of the total final consumption in 2019. The transport sector's consumption bounced back to an increasing trend in 2019 after a decrease of 2.0% in 2018, partly contributed by a 3.2% increase in passenger vehicles in 2019⁶. The non-energy sector followed with a

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31.6% share of the total final consumption in 2019, the industry sector behind that with a 24.5% share, and other sectors – including residential, commercial and agriculture sectors – had a combined share of 11.5%.

The industrial sector's consumption has been almost stable, ranging between 900 PJ to 1 000 PJ since 2013, as the services sector has become Malaysia's main economic activity.

Figure 4: Malaysia's final consumption by sector, 2000 to 2019 (PJ)

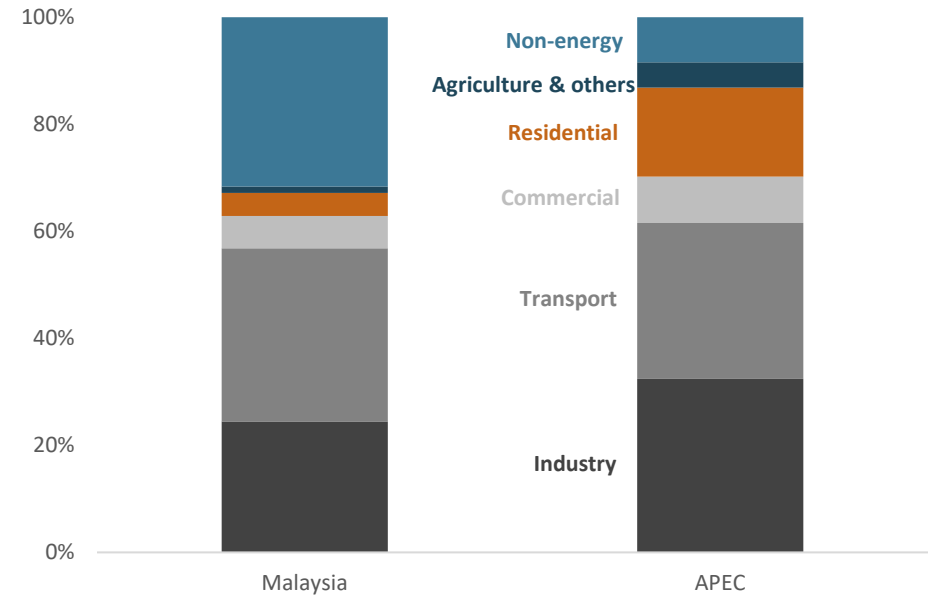


Source: EGEDA (2021)

Similar to the APEC region, the transport and industry sectors consumed the most significant portion of Malaysia's final consumption (Figure 5). The non-energy consumption share was larger in Malaysia than in the entire APEC region in 2019, as petrochemical plants,

including fertiliser plants, consumed a large amount of natural gas to produce a wide range of petrochemical products.

Figure 5: Final consumption sectoral share, Malaysia and APEC, 2019



Source: EGEDA (2021)

Malaysia's final energy demand grew by 2.8%, from 2 152 PJ in 2018 to 2 213 PJ in 2019 (Figure 6). Fossil fuels accounted for 73.0% of the fuel share consumed by end-users, in which oil dominated three-quarters of the fossil fuel share. In 2019, about 71.1% of the oil was consumed by the transport sector in the form of gasoline (RON 95 and RON 97), diesel and jet fuel, followed by the non-energy sector at 9.9%, industrial sector at 8.2% and other sectors at 10.8%.

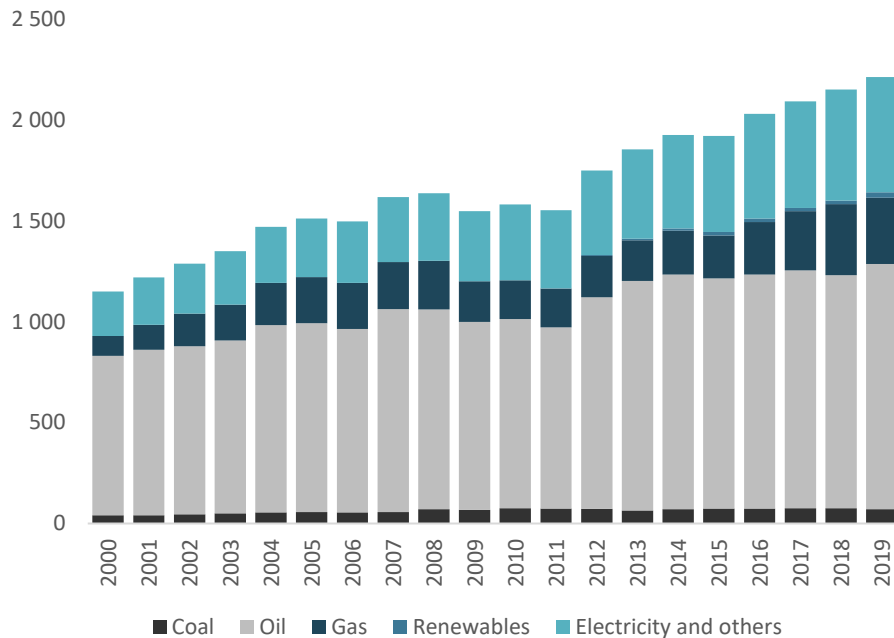
Electricity was the second dominant fuel, with slightly more than a quarter of the end-user fuel share in 2019. In general, electricity demand has shown positive growth since 2000, aligned with the GDP

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growth and lifestyle improvement in Malaysia.

Gas and coal accounted for 18.0% of the fuel share consumed by end-users in 2019. For the last five years, the demand for gas and coal has been stable at around 1 170 PJ and 74 PJ, respectively, with gas and coal consumers mostly belonging to the industry sector.

Figure 6: Malaysia's final energy demand by fuel, 2000 to 2019 (PJ)

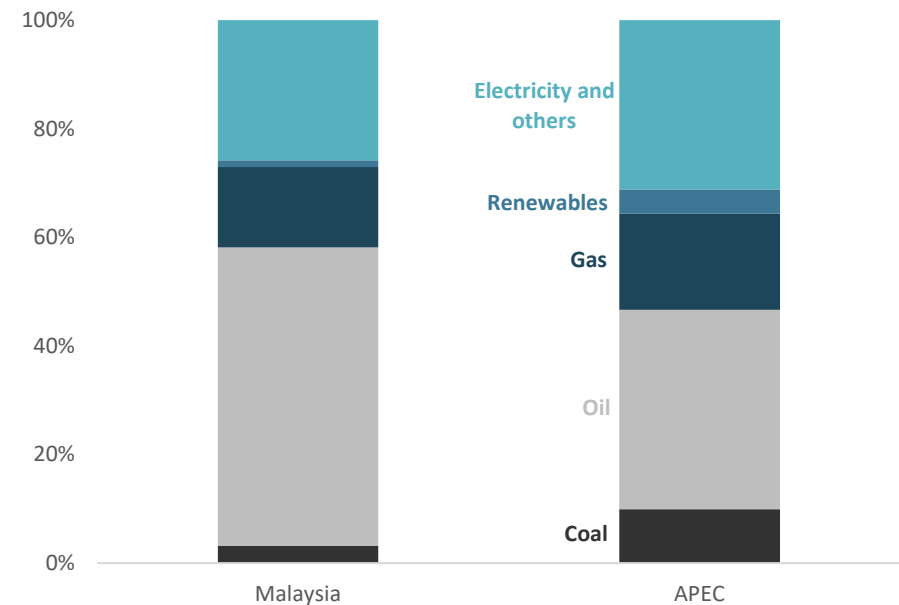


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

Malaysia's oil share was almost 0.5 times larger than that of the APEC region in 2019 (Figure 7), partly due to the high consumption of subsidised RON 95 and diesel in the transport sector. The gas and electricity shares were slightly lower than those of APEC even though the government regulated the price of both fuels to the end-users.

Figure 7: Final energy demand fuel shares, Malaysia and APEC, 2019



Source: EGEDA (2021)

Transformation

Malaysia's electricity generation increased by 4.6%, from 171 TWh in 2018 to 178 TWh in 2019 (Figure 8).

Fossil fuels have mainly fuelled Malaysia's electricity generation since 2000, and coal and gas continued to dominate Malaysia's electricity generation with a total share of 83.4% in 2019, increasing 0.6% from the previous year.

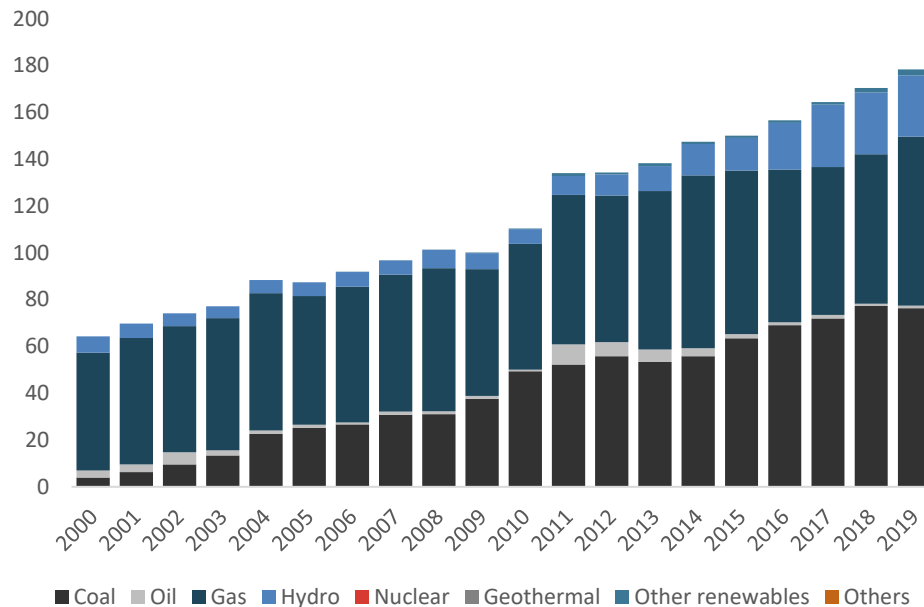
On the other hand, hydro and oil shares remained the same as the previous year, at 15% and 1%, respectively.

Notably, electricity generation from renewables rose by 26% in 2019, compared to 2018, mainly driven by Malaysia's INDC announced in

July 2017.

Furthermore, in 2019, a sizeable new capacity was added to Peninsular Malaysia's grid system with the commissioning of Pengerang Power in Johor, Jimah East Power in Negeri Sembilan and 12 large-scale solar (LSS) farms to meet the increasing electricity demand and replace the retiring capacity⁸.

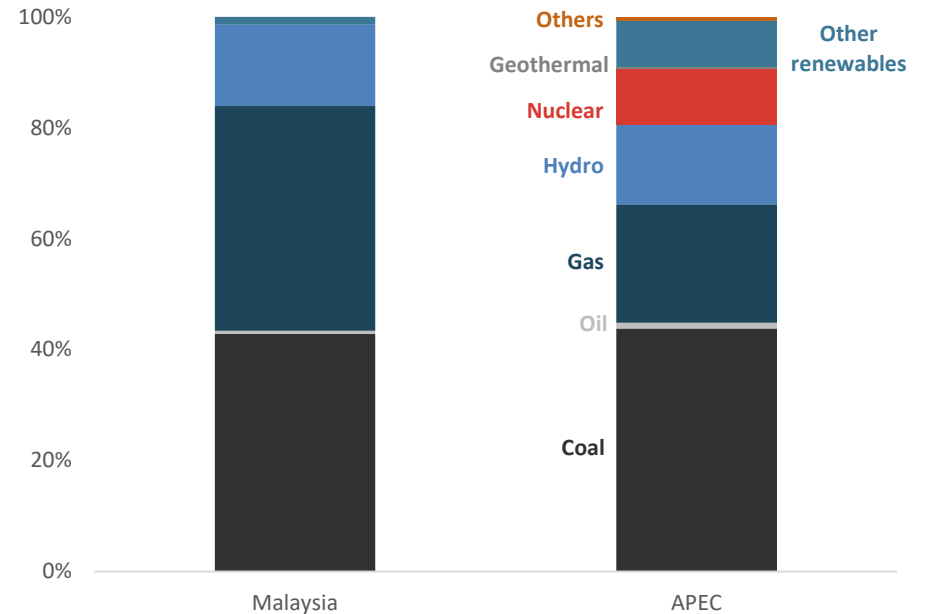
Figure 8: Malaysia's electricity generation by fuel, 2000 to 2019 (TWh)



Source: EGEDA (2021)

In Malaysia's electricity generation, the share of coal and hydroelectricity was almost similar to the APEC region, while the share of gas was nearly double compared to the APEC region in 2019. Other fuels, namely other renewables and oil, accounted for a minimal share of about 2.0% of the electricity generation in Malaysia in the same year.

Figure 9: Electricity generation by fuel share, Malaysia and APEC, 2019



Source: EGEDA (2021)

APEC Goals

There are two energy-related objectives that APEC member economies have agreed to meet as a collective. These are to improve the energy intensity by 45% in 2035 when compared to 2005 and to double the share of modern renewables in the energy mix by 2030 compared to 2010.

Energy Intensity Goal

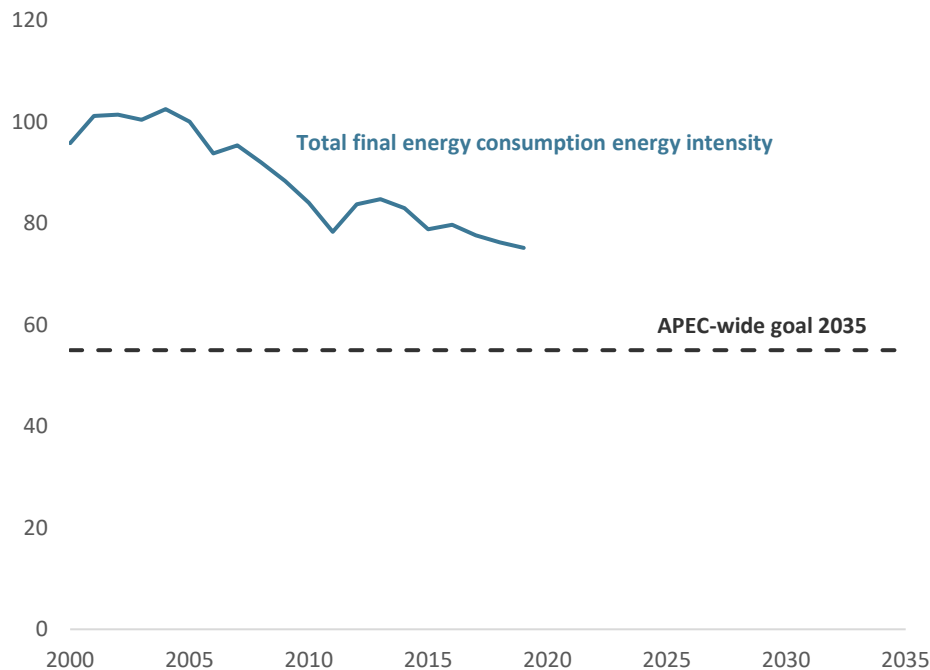
In 2011, APEC member economies agreed to work towards reducing their energy intensities by 45% in 2035 instead of the original goal of

25% by 2030, both relative to a 2005 baseline.

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

Malaysia's total final energy consumption (excluding non-energy) energy intensity has been improving at an average rate of 2.0% annually, with a reduction of 25.1% in 2019 from 2005 (Figure 10).

Figure 10: Malaysia's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



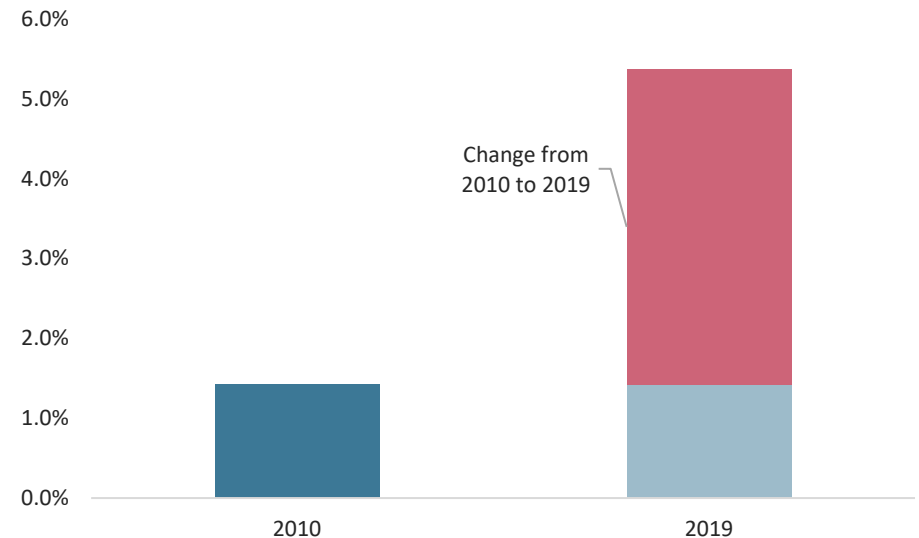
Source: EGEDA (2021)

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. Though there is no economy-level goal for individual member economies, improvements by individual economies will contribute to the doubling goal.

It is essential to note that modern renewables do not include traditional biomass. The share of modern renewables to final energy consumption (not including non-energy sector consumption of energy products) in 2010 was 1.4%.

Figure 11: Malaysia's modern RE share, 2010 and 2019



Source: EGEDA (2021)

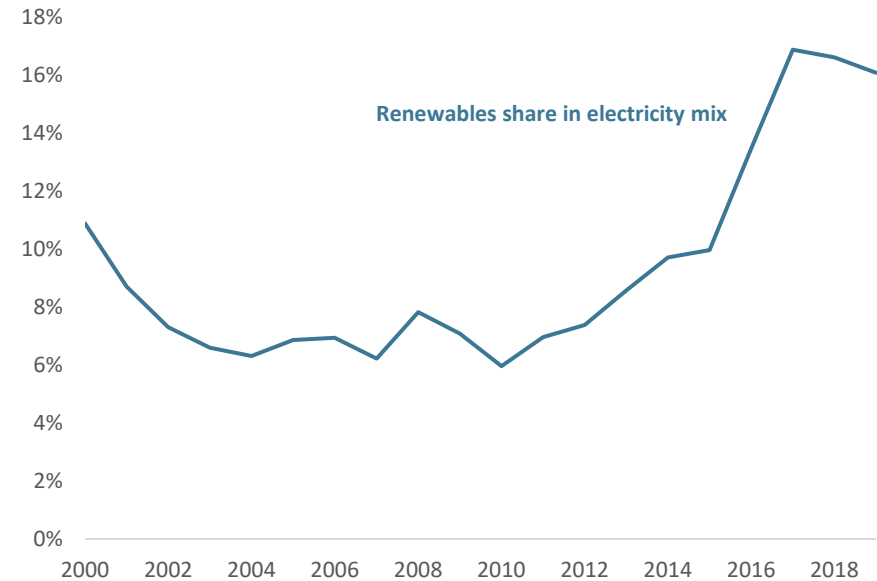
Note: Biomass used in residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industries, hydroelectricity, geothermal electricity, etc.) are considered modern renewables. Modern renewables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

Malaysia's consumption of modern renewables has been increasing since the introduction of the National Renewable Energy Policy and Action Plan (NREPAP) in 2010. In 2019, the proportional share was 5.4%, representing an almost threefold increase in modern renewables compared to 2010 (Figure 11).

Malaysia's electricity generation from renewables increased to slightly above 16.0% in 2019, about 0.5 times more than the 2005 level (Figure 12). Further, the electricity generation from renewables grew substantially, from 7 TWh in 2010 to almost 29 TWh in 2019, driven by NREPAP 2010 and supported by various RE plans and initiatives, including the Feed-in Tariff (FiT) scheme, solar auctioning and rooftop solar quota through the LSS, Net Energy Metering (NEM) and Self Consumption (SELCO) Programme.

However, the increase in electricity generation from renewables has been outweighed by the rise in the generation of coal and gas after the operation of new coal and gas power plants, resulting in a slight decrease in the share of renewables from 2017 to 2019.

Figure 12: Malaysia's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy Policy

Energy Policy	Objectives/Details	Reference
National Petroleum Policy 1975	To ensure the efficient utilisation of petroleum resources to facilitate industrial and economic development while ensuring effective regulation and majority control in the ownership, management and operation of the oil and gas industry.	Economic Planning Unit
National Energy Policy 1979	The main policy that governs the energy sector in Malaysia to achieve an efficient, secure and environmentally sustainable supply of energy. Its details are as follows: <ul style="list-style-type: none"> • 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 of energy production, transportation, conversion, utilisation and consumption on the environment. 	Economic Planning Unit
National Depletion Policy 1980	To prolong the lifespan of 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.	Economic Planning Unit
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 Energy and Natural Resources
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 and encourage efficient energy utilisation.	Ministry of Energy and Natural Resources
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. This includes stewardship of the environment, continuous improvement of environmental quality and sustainable use of natural resources, patterns of consumption and production.	Ministry of Environment and Water
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 source of energy 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 Industries 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 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 Environment and Water

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National Renewable Energy Policy and Action Plan 2009	To enhance the utilisation of RE resources to contribute towards supply security and sustainable socio-economic development by increasing RE contribution in the power generation mix, facilitating the growth of the RE industry, ensuring reasonable RE generation costs, conserving the environment for future generations and enhancing awareness on the role and importance of RE.	Ministry of Energy and Natural Resources
National Policy on Climate Change 2010	To promote the effective management of resources and enhanced environmental conservation to strengthen economic competitiveness and improve quality of life, integrate climate change considerations into policies, and strengthen institutional and implementation capacities to address challenges and opportunities related to climate change.	Ministry of Environment and Water
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 the market pricing, initiatives to secure and manage reliable energy supply with third-party access (TPA) and the building of Re-Gasification Terminals (RGTs) and RAPID and 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.	Economic Planning Unit
National Biodiesel Program	To utilise palm oil in the domestic biodiesel mix which will boost domestic consumption and as a means for the palm oil industry to manage the excess palm oil stock. Transport sector: B5: Started in June 2011 and was implemented nationwide in March 2014. B7: Started in November 2014 and was implemented nationwide in December 2014. B10: Was implemented nationwide in February 2019. B20: To be implemented in Langkawi and Labuan in January 2020 and in Sarawak in September 2020. Later postponed to end-2022 due to the COVID-19 pandemic.	Ministry of Plantation Industries and Commodities
Nationally Determined Contribution to the UNFCCC 2015	Industry sector: B7: Was implemented nationwide in July 2019. 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 Environment and Water
National Energy Efficiency Action Plan 2016	To enhance energy efficiency with a target of 8% reduction (saving up to 594 MWh) in electricity demand by 2025 through energy efficiency initiatives, enabled by the 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 Energy and Natural Resources
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 Environment and Water

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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 Corporation
Malaysia's Roadmap Towards Zero Single-Use Plastics 2018–2030	Towards zero single-use plastics for a cleaner and healthier environment in Malaysia by 2030.	Ministry of Environment and Water
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 International 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 capacities 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 economies and emissions, adopting EVs, low-emission vehicles and alternative fuels, and reducing GHG emissions and energy via mode shifts.	Ministry of Environment and Water
National Low Carbon Cities Masterplan 2021	To help guide the implementation of low-carbon developments and initiatives in Malaysia.	Ministry of Environment and Water
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 Environment and Water
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.	Economic Planning Unit
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 Energy and Natural Resources
Sabah Gas Master Plan	A collaborative effort between the Sabah State Government and PETRONAS to pursue the full potential of Sabah's domestic natural gas industry sustainably.	Sabah State Government and PETRONAS

Notable Energy Developments

Energy development	Details	Reference
Sipitang Oil and Gas Industrial Park (SOGIP) LNG	This is a 2.0 Mtpa LNG facility, which aims to be online in 2026.	Sabah State Government
Green Electricity Tariff program	It will replace the myGREEN+ program with a subscription to green electricity supply.	Energy Commission
Large-scale solar (LSS) PV Cycle 4 Competitive Bidding	The fourth bidding process targeted a total capacity of 1 000 Mwac, with an expected operation start date of December 2023 at the latest.	Energy Commission

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EC (Energy Commission) (2020), *Annual Report 2019*, https://www.st.gov.my/en/contents/files/download/87/Laporan_Tahunan_ST_2019.pdf⁸

EC (2022), *National Energy Balance 2019*, <https://meih.st.gov.my/documents/10620/f2f4c39b-4748-4c5d-b90a-fc36ba880264>

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.html²

EPU (Economic Planning Unit, Prime Minister's Department) (2021), *The Malaysian Economy in Figures 2021*, <https://www.epu.gov.my/sites/default/files/2021-12/MEIF%202021.pdf>¹

SEDA (Sustainable Energy Development Authority) (2021), *Malaysia Renewable Energy Roadmap*, https://www.seda.gov.my/reportal/wp-content/uploads/2022/01/MyRER_webVer2.pdf⁷

Statista (2022), *Number of registrations for passenger vehicles in Malaysia from 2016 to 2020 (in 1,000s)**, <https://www.statista.com/statistics/949227/malaysia-passenger-vehicle-registration/>⁶

Useful links

Bank Negara Malaysia — www.bnm.gov.my

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

Energy Commission — www.st.gov.my

Economic Planning Unit, Prime Minister's Department — www.epu.gov.my

Grid System Operator — www.gso.org.my

Malaysia Energy Information Hub — <https://meih.st.gov.my/>

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

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

Ministry of Energy and Natural Resources — www.ketsa.gov.my

Ministry of Environmental and Water — www.kasa.gov.my

Ministry of Finance — www.mof.gov.my

Ministry of International Trade and Industry — www.miti.gov.my

Ministry of Plantation Industries 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

Mexico

Introduction

Mexico is a large crude oil producer and consumer with abundant hydrocarbon resources. Geographically advantaged, Mexico is situated in North America and bordered by the United States of America to the north, Belize and Guatemala to the south, and the Atlantic and Pacific Oceans to the east and west respectively.

Historically, Mexico has had an important and evolving energy trade relationship with the US. Crude oil exports from Mexico account for about 10% of the US’s oil imports. Furthermore, Mexico imports large volumes of petroleum products and natural gas through pipelines from the US, which are priced at the most competitive global benchmarks.

Energy production, particularly with crude oil, has historically been a significant component of the Mexican economy. Following economic diversification and a decline in production, crude oil accounted for 5.3% of Mexico’s total export value in 2019, compared to 37% in 1990 (World Bank, 2021). Despite this declining trend, Mexico still relied on crude oil rent for 10% of its government budget in 2019. However, this was low compared to the greater than 30% share in 2004–2014 (Banxico, 2021).

Mexico has a population of 127 million people. It is the world’s largest Spanish-speaking economy, the 11th most populated economy in the world, and the sixth most populated economy in the Asia Pacific Economic Cooperation (APEC) region.

Mexico’s gross domestic product (GDP) grew at a compound annual

growth rate (CAGR) of 2.0% between 2000 and 2019, reaching USD 2 513 billion (2017 USD purchasing power parity [PPP]; EGEDA, 2020). However, GDP per capita growth was significantly lower in the same period, only increasing at a 0.5% CAGR (EGEDA, 2020). With a Gini index coefficient of 45.4 in 2018 and 44% of the its population living in poverty in 2020, Mexico still faces the urgent challenge of income inequality (CONEVAL, 2020).

Mexico is the 15th largest economy in the world and the seventh largest economy in the APEC region (World Bank 2020). The service industry accounts for the largest share of Mexico’s GDP (60%), and, with most of the economy’s exports being manufactured products, the manufacturing industry accounts for 17% of the GDP (World Bank, 2020).

Table 1: Mexico’s Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^{b, c}	
Area (million km ²)	2.0	Oil (billion barrels)	6.1
Population (million)	127	Gas (trillion cubic feet)	6.3
GDP (2017 USD billion PPP)	2 513	Coal (million tonnes)	1 211
GDP per capita (2017 USD PPP)	19 701	Uranium (kilotonnes U < USD 130/kgU)	2.5

Source: ^aWorld Bank (2020), ^bBP (2020), ^cOECD (2020)

Energy Supply and Consumption

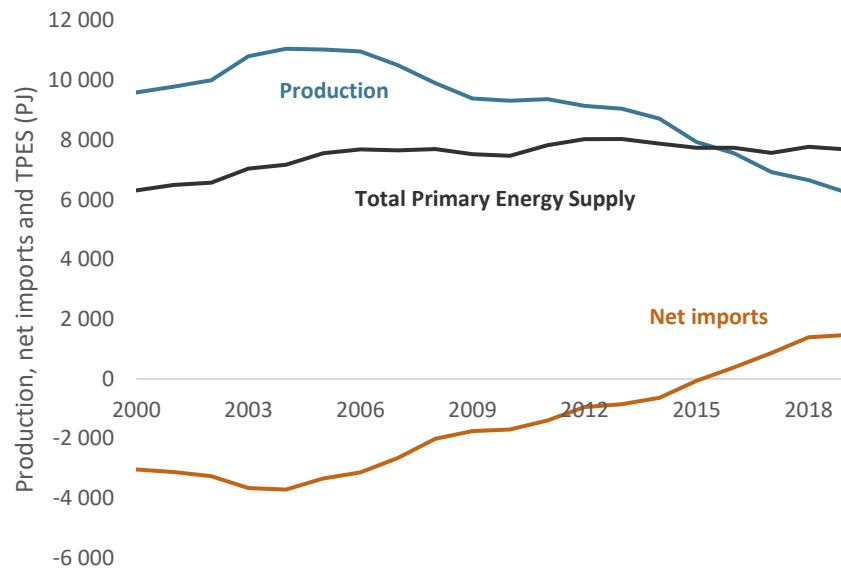
Total Primary Energy Supply

Mexico’s oil production peaked in 2004 and subsequently declined by

43% to 6 250 PJ by 2019. With crude oil accounting for 67% of Mexico’s natural gas production, domestic gas production followed a similar downward trend. As a result of this decline in domestic energy production, energy imports, particularly petroleum products and natural gas, helped fill the gap between supply and demand. The rise in imports enabled Mexico’s transition to becoming a net importer of energy (Figure 1).

Net energy imports (imports minus exports) rose by 5% to 1 472 PJ in 2019, resulting from an increase in imported petroleum products and natural gas paired and a simultaneous decline in domestic crude and natural gas production. Together, these trends led to Mexico’s total primary energy supply (TPES) declining slightly to 7 692 PJ in 2019.

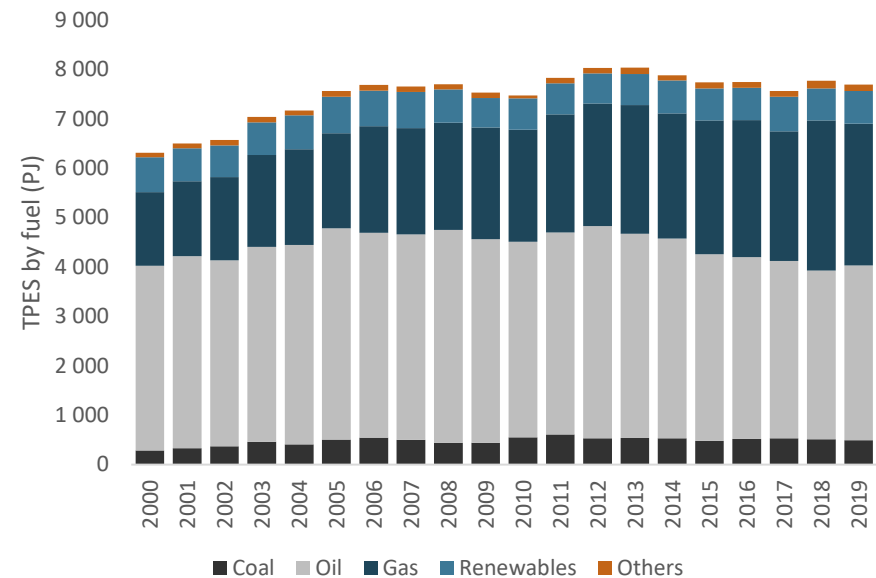
Figure 1: Mexico’s total primary energy supply, production and net imports, 2000–2019



Source: EGEDA (2021)

The decline in Mexico’s crude oil production was mainly due to the depletion of the supergiant Cantarell Field, Pemex’s largest asset, compounded by underinvestment in exploration activities. At its peak in 2004, Cantarell produced 2.1 million barrels per day, which was more than 60% of Mexico’s total crude oil production at the time. By 2019, Cantarell produced less than 0.16 million barrels per day, representing only 9.3% of Mexico’s production (CNH, 2021). Consequently, Mexico’s crude exports fell by 17% to 1.1 million barrels per day between 2010 and 2020 (SENER, 2021b). The fall in exports is anticipated to accelerate, as Mexico aims to reduce oil exports to zero by 2023 and increase the domestic crude processing capacity of its refining system.

Figure 2: Mexico’s total primary energy supply by fuel, 2000–2019



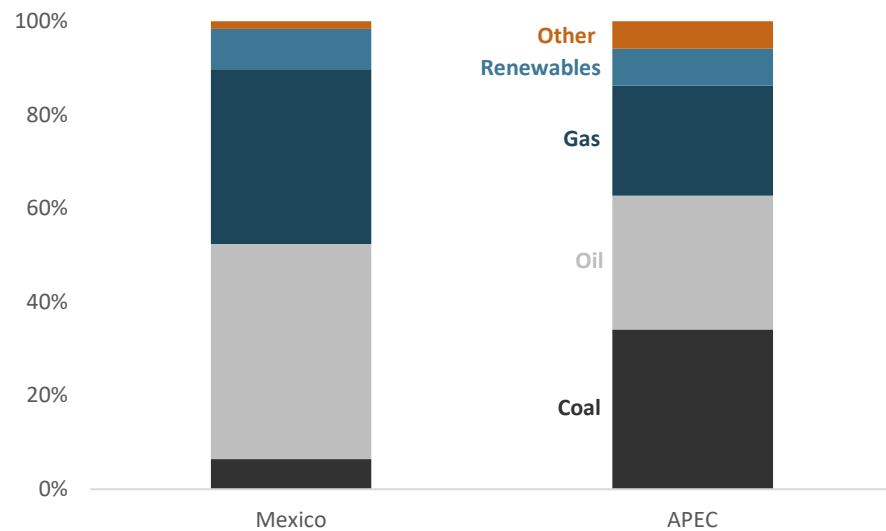
Source: EGEDA (2021)

Mexico’s TPES is still dominated by fossil fuels (90%), with oil accounting for 46% of this share in 2019. In 2013, a set of major

legislative changes liberalised the energy sector in a bid to transition from monopolistic structures to a market approach. However, the current government has vowed to favour the state-owned oil company Pemex and cancel future oil bidding rounds.

Mexico has maintained similar TPES levels throughout the decade from 2009 to 2019, increasing only by 2%. Gas saw the largest growth of 20% during this period, mainly due to an increase in the industrial and power sectors' gas demand (Figure 2). Furthermore, coal and renewable energy saw a modest increase, while oil supply fell by 14%.

Figure 3: Total primary energy supply relative fuel share – Mexico and APEC, 2019



Source: EGEDA (2021)

Mexico is highly dependent on oil and gas compared to the APEC region. Mexico's oil supply share stood at 46% in 2019, while the APEC's average was 29%. Oil's prominence in Mexico's supply mix is partly offset by the small share of coal. Coal supply fell by 1.2% to 496

PJ in 2019 and constituted only 6.4% of Mexico's supply mix. While Mexico does produce some coal, it is a net importer of coal from Colombia and the US.

Mexico's rising gas share was 37% in 2019, 14% greater than that of APEC and mostly driven by a heavy reliance on this fuel in the power sector. The relative abundance of oil products and gas minimised the share of coal, which was almost six times lower in Mexico's mix than in APEC's. While Mexico's share of renewables was slightly higher than the APEC average, bioenergy accounted for almost half of this share. However, Mexico's wind and solar potential were above the APEC average; hence, if tapped into, the share of renewables is likely to increase in the future.

Renewable energy grew at a CAGR of about 1% between 2010 and 2019, rising to 662 PJ and accounting for 9% of the total share in 2019 (Figure 3). While bioenergy accounted for the largest share of supply (5.0%), it then began to decline. In contrast, wind, solar and other renewables rose rapidly and accounted for 2.7% of total supply in 2019. Hydropower remained stable at 87 PJ and a 1.2% share. Lastly, nuclear represented a 1.6% share of Mexico's TPES in 2019.

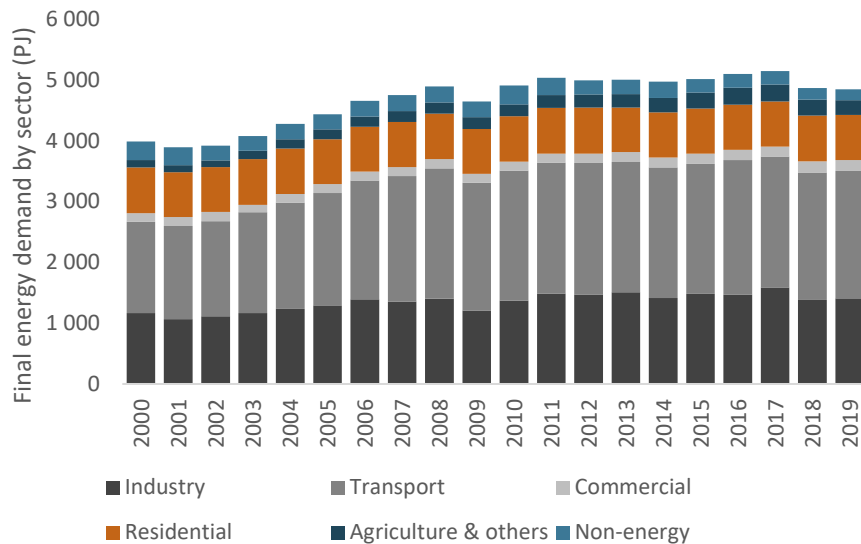
Total Final Consumption

In 2019, total final consumption in Mexico saw a marginal decline to a total level of 4 847 PJ. All sectors except for the industrial sector saw a decline. Transport was the dominant sector in terms of energy consumption, accounting for over 40% of all end-use energy consumption in 2019. Petroleum products such as gasoline, diesel, and LPG were largely used in road transport. The industrial sector was the second largest end-use sector, accounting for 29% of the final consumption in 2019 (figure 4).

Furthermore, energy consumption in the residential sector accounted for 15% of all end-use energy consumption. The 'Agriculture & others'

sector accounted for 4.0% in 2019, with energy being consumed by agricultural machinery and water pumping as well as livestock, fisheries and forestry, among others. Finally, the non-energy sector mostly corresponded to the petrochemical industry and saw an energy consumption decline of 42% between 2000 and 2019 (Figure 4).

Figure 4: Mexico's final consumption by sector, 2000–2019



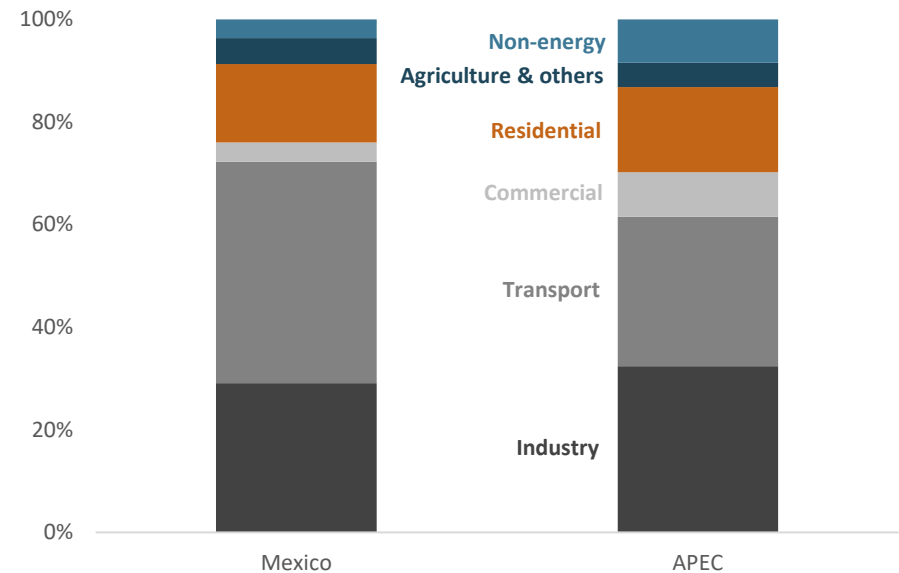
Source: EGEDA (2021)

Compared to APEC, Mexico's transport sector consumes a high volume of energy with a share of 43%. This is mainly due to the predominance of motorised modes of transportation and limited public transportation availability in Mexico, which is one of the world's top 20 economies and has a growing population.

Mexico's industrial sector uses proportionally less energy than APEC, since its main industries, such as manufacturing and construction, are less energy intensive than the industries prominent in other APEC

economies, such as steelmaking and cement. Additionally, the building sector's energy demand in both residential and commercial areas is notably lower than that of APEC, as extreme temperatures are rarely observed in most of Mexico and the need for space cooling or heating is minimal.

Figure 5: Final consumption sectoral share – Mexico and APEC, 2019



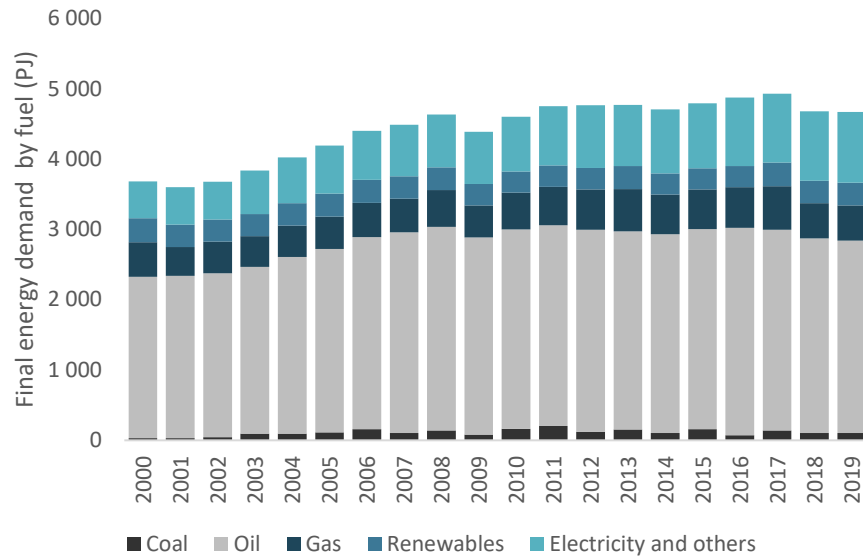
Source: EGEDA (2021)

Final energy demand (FED) increased by 21% between 2000 and 2019 due to economic growth and population increase in Mexico. The demand for electricity almost doubled during this period, reaching an FED of about 1000 PJ in 2019.

Furthermore, domestically produced oil was a primary fuel in Mexico's economy; due to this, the need for coal reduced, and its demand was proportionally much lower than that of the APEC region. From 2010 to 2019, oil demand reduced slightly (3%), partly due to increased energy

efficiency and a fuel switch from oil to natural gas in some end-use applications. However, growth in domestic oil production, the population and the middle class contributed to the strong demand for oil in Mexico compared to APEC.

Figure 6: Mexico’s final energy demand by fuel, 2000–2019

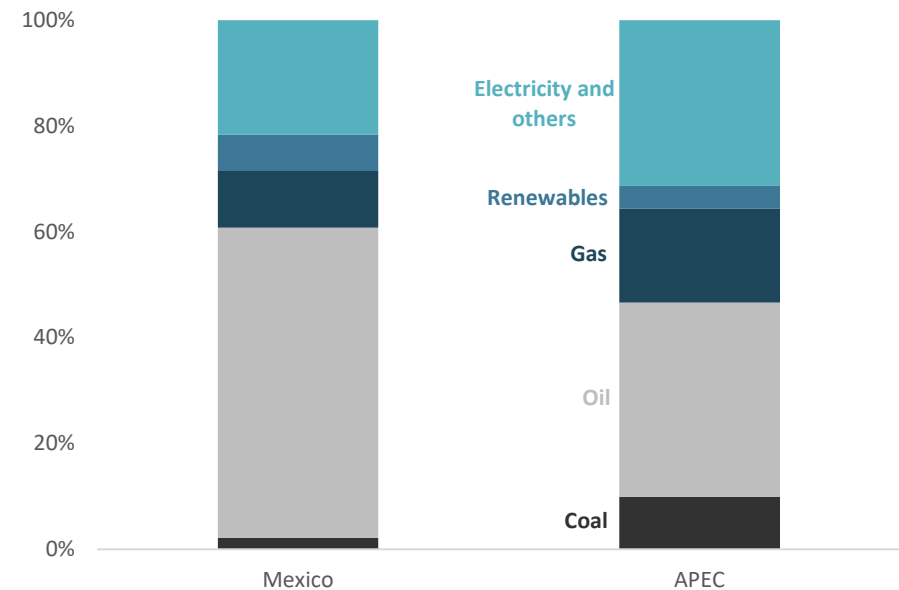


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

With respect to energy source, Mexico relied more heavily on fossil fuels than the APEC region in 2019. Consequently, the end use of oil was much greater in Mexico than in the APEC region (Figure 7). Oil-based products, mostly used in the transportation sector, accounted for 58% of Mexico’s total final energy demand in 2019. Electricity was the second-largest energy source (20%), while natural gas accounted for 11%, renewables accounted for 7%, and coal accounted for 2% of the FED.

Figure 7: Final energy demand fuel shares – Mexico and APEC, 2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

Transformation

Electricity generation in Mexico grew by an average of 2% annually since 2010, totalling 344 terawatt-hours in 2019. Fossil fuel-based generation accounted for 77% of the total. Hydro was the largest source of renewable energy generation at 7% (Figure 8). Although Mexico has a relatively diverse power generation technology portfolio, natural gas was, by far, the dominant source of power generation in 2019, accounting for 56% of the total supply.

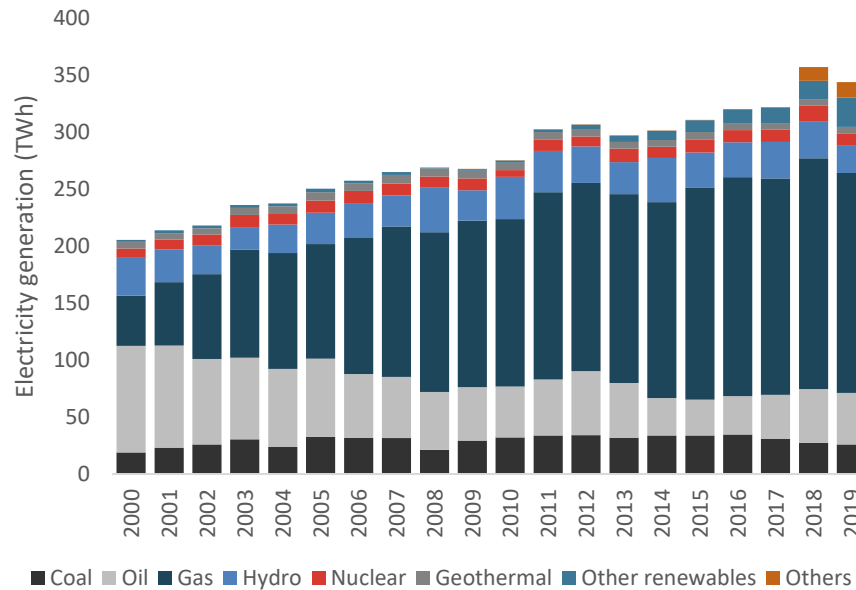
This was the result of an oil-to-gas switch led by Comisión Federal de Electricidad (CFE), a state-owned utility company. As shown in Figure 8, gas accounted for 21% of the total electricity generated in 2000, and

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oil dominated the economy with a 46% share. Conversely, in 2019, oil-fuelled (mostly fuel oil but also diesel) power generation accounted for 13%, while the share of gas-fired generation increased to 56%. Coal's share increased to 9% in 2019 compared to 7% in 2000. Furthermore, renewable energy accounted for 20% of total electricity generation in 2019, with solar and wind accounting for a combined 7% as 'Other renewables' in Figure 8.

In the period from 2015 to 2019, solar and wind energy shares increased by 61%. As of 2020, installed power capacity was 86 gigawatts (GW) (SENER, 2021d). Natural gas was the dominant fuel in terms of power capacity and accounted for 46% of the total share, followed by oil (15%), hydropower (15%), wind (8%), solar (7%), coal (6%) and nuclear and other renewables (combined 3%).

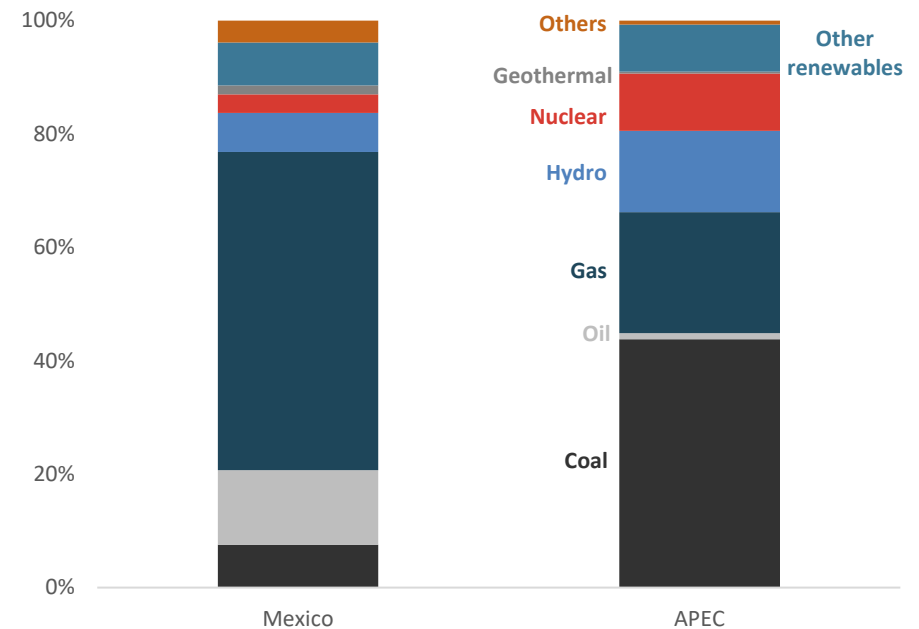
Figure 8: Mexico's electricity generation by fuel, 2000–2019



Source: EGEDA (2021)

The prominence of natural gas in Mexico's power sector is clearly visible when the economy's electricity generation mix is viewed in comparison with that of the APEC region in 2019 (Figure 9). In contrast, hydro and coal were proportionally lower in Mexico's generation mix, while oil's share was substantially higher. The share of other renewables (particularly solar PV and wind) is still relatively low in Mexico, despite the abundant solar radiation and wind potential in the economy and the declining cost of associated technologies.

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



Source: EGEDA (2021)

APEC Goals

APEC member economies have collectively agreed to meet two energy-related objectives: to improve energy intensity by 45% in 2035, as compared to the 2005 level, and to double the share of modern renewables in the energy mix by 2030, as compared to 2010.

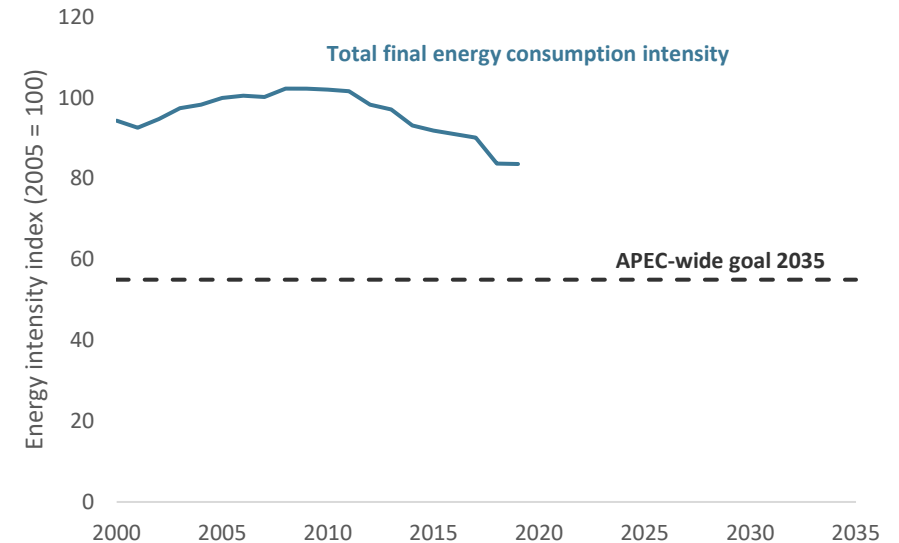
Energy Intensity Goal

In 2011, APEC member economies agreed to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. This was an increase from the original goal of a 25% improvement by 2030, relative to a 2005 baseline.

APEC is on track to achieving this energy intensity improvement. The goal does not impose individual economy targets, but the progress of individual APEC economies can be tracked in relation to the overarching proportional improvement.

In 2019, Mexico's total final energy consumption (not including non-energy) intensity improved by 16%, relative to the 2005 baseline (Figure 10); primary energy supply intensity improved marginally by 24%; and final energy consumption energy intensity improved by 12%.

Figure 10: Mexico's total final energy consumption intensity index, 2000–2019 (2005 = 100)



Source: EGEDA (2021)

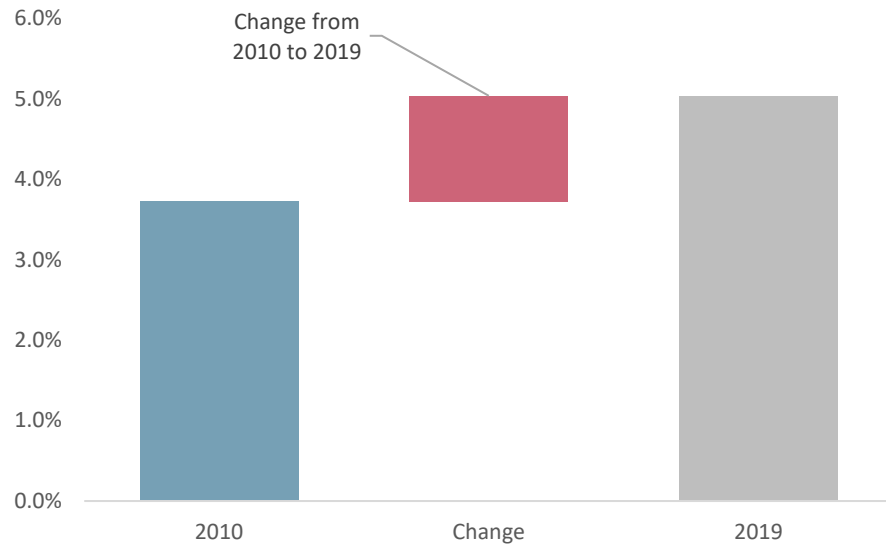
Doubling of Renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix during the period 2010–2030. Modern renewables do not include traditional biomass, and their share is relative to final energy consumption, which does not include non-energy consumption.

While there are no economy-level goals for the individual member economies, improvements contribute to the overall doubling goal. Mexico's share of modern renewables in final energy consumption was 3.7% in 2010. Subsequently, this share was 5% in 2019, representing a 35% increase from the 2010 level (Figure 11). Notably, the use of renewables for power generation, particularly solar PV and wind, has

grown rapidly in the past five years; continued growth will lead to a parallel increase in the share of modern renewables in Mexico’s energy mix.

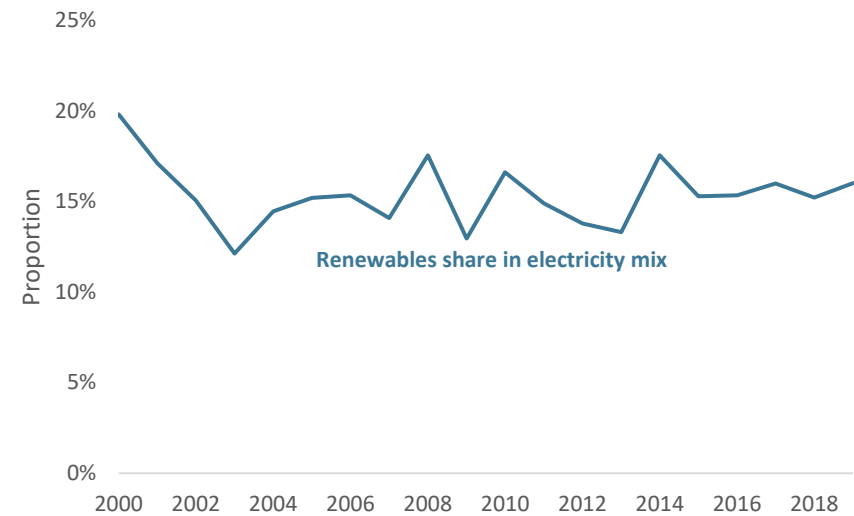
Figure 11: Mexico’s modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

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 generated from renewable sources.

Figure 12: Mexico’s renewable electricity generation share, 2000–2019



Source: EGEDA (2021)

Mexico’s electricity generation has increased by 40% in the period from 2000 to 2019, largely driven by rapid economic growth, population growth and increased electrification in rural areas. According to Mexico’s Energy Ministry, 98% of the population had access to electricity in 2018, compared to 96% in 2005.

The energy reform facilitated three renewable energy auctions to take place between 2016 and 2017, increasing the number of renewable energy projects launched throughout Mexico. However, recent years have seen a halt in renewable energy auctions, which has prevented a further increase in the share of renewable energy. Considering the last decade, renewable electricity generation share in Mexico was highest at 18% in 2017, dropping to 16% in 2019.

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 state-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 policy regarding clean energy obligations, sustainable energy use and energy productivity improvements.	Official Federal Gazette
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 grids extensions and modernisations.	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 national 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 transportations 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

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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 said 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 (MEPS) for 12 appliance groups	This set of standards regulate 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 full-fledged ETS. The pilot ETS covers the power, oil and gas and industrial sectors, which account for approximately 40% of Mexico's GHG 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 state-owned utility 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 damages. 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 state-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 economy 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

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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 abovementioned Reliability Energy Policy was the subject of a constitutional controversy promoted by the anti-trust commission COFECE. Mexico's Supreme Court of Justice invalidated some of the key points of this policy, considering them unconstitutional.	Supreme Court of Justice
CENACE's 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 Center for Energy Control of Mexico (CENACE)
Pemex's Purchase of the Deer Park Refinery	The state-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 increase refining capacity by 25%.	Dos Bocas Refinery
Commissioning of the VAG Gas Pipeline	The Villa de Reyes-Aguascalientes-Guadalajara (VAG) pipeline started commercial operations in June 2020, connecting new demand markets in Mexico to natural gas production centres in the US. This was the last segment of the 1 251 km-long Wahalajara system, a group of new pipelines connecting the Waha hub in Texas to Guadalajara and other population centres in west-central Mexico.	Argus Media

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Construction of the Cuxtal Gas Pipeline	Cuxtal I is a 16-kilometer pipeline connecting Sistrangas, the economy-wide pipeline system, with the Mayakan pipeline (which goes from a Pemex processing centre to the Yucatan Peninsula). This pipeline will increase gas supply by allowing imported volumes to flow to the peninsula, a region suffering from a shortage of natural gas.	Ministry of Energy (SENER)
ECA LNG Final Investment Decision	In November 2020, the American company Sempra reached a final investment decision (FDI) to develop a natural gas liquefaction facility called Energía Costa Azul (ECA) LNG Phase 1. ECA LNG, located in Mexico's northwestern Pacific coast, will use feed-in gas produced in Texas to export liquefied natural gas (LNG) to Asian markets. It is the first project to export US shale gas from the Pacific coast and is expected to start operations in 2024.	ECA LNG
Construction of an LNG Receiving Terminal in Pichilingue Port	The American company New Fortress Energy has initiated the operations of an LNG-receiving terminal in Pichilingue Port, which consists of a small-scale regasification facility of 0.8 MTPA, a 135 MW power plant and truck loading bays. The plant also supplies CFE's power plants and other users in La Paz, Baja California Sur.	New Fortress Energy

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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 (CNSNS) – 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>

New Zealand

Introduction

New Zealand is an island economy located in the Pacific Ocean, consisting of two main islands south-east of Australia.

Renewables make up a large share of New Zealand’s supply and accounted for 82% of electricity generation in 2019. Hydro is the economy’s dominant renewable energy source, with support from geothermal and wind sources. New Zealand’s wind resources are excellent, though they have yet to be significantly utilised.

A major factor in the current New Zealand energy landscape is the potential closure of the Tiwai Point Aluminium Smelter. This industrial facility makes up about 13% of New Zealand’s annual electricity consumption, so its potential closure holds significant sway in the future of New Zealand’s electricity generation development.

During the COVID-19 pandemic, in 2020 and 2021, New Zealand maintained one of the strictest border closures in the world. By embracing its remote location, New Zealand successfully eradicated the virus, allowing economic activity to outperform many other regions around the world.

Coal and natural gas are New Zealand’s most abundant fossil energy resources. Almost all the coal produced is sub-bituminous and bituminous coal, though most of New Zealand’s coal resources are in the form of low-value lignite.

In 2018, the New Zealand Government banned new offshore exploration for oil and gas reserves, except for onshore Taranaki. This

effectively banned all oil and gas exploration but allowed companies to look for and extract oil and gas under existing permits. However, the economy’s natural gas reserves are not enough to maintain current rates of consumption, partly a result of the ban on exploration.

The Reserve Bank of New Zealand is one of the few global central banks to have raised rates in the latter half of 2021. The hikes have been in response to the rise in housing prices that accelerated during the pandemic. The moves by the Bank are an attempt to balance the need to suppress rapid asset price growth without constraining economic activity in this time of uncertainty due to the pandemic.

Table 1: New Zealand’s macroeconomic data and energy reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (thousand km ²)	268	Oil (million barrels)	62.5
Population (million)	5.1	Gas (PJ)	2 074
GDP (2017 USD billion PPP)	216	Coal (million tonnes)	7 575
GDP per capita (2017 USD PPP)	42 404	Uranium (kilotonnes U < USD 130/kgU)	–

Source: ^a Stats NZ (2021); ^b World Bank (2021); ^c MBIE (2021); ^d BP (2021)

Note: Reserves are total proved reserves.

Energy Supply and Consumption

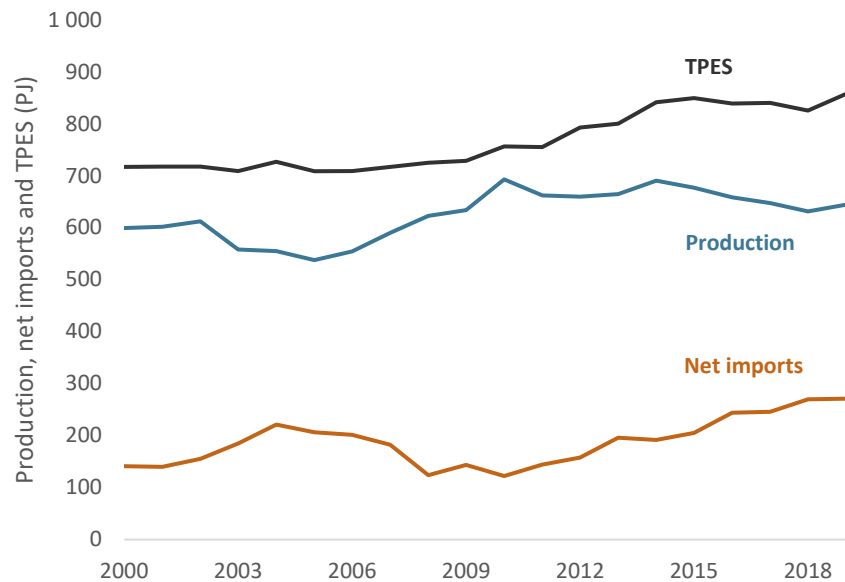
Total Primary Energy Supply

Total primary Energy Supply (TPES) in 2019 was 856 picojoules (PJ), which is a 13% increase from what it was in 2010. Growth in the TPES

over the last 10 years has been driven by growth in net imports, which is generally a result of the decline in coal and crude oil exports.

Crude oil production, which is mostly exported, has declined due to declining international oil prices and the oil and gas ban in 2018. About equal amounts of bituminous coal and sub-bituminous coal make up most of the coal production in New Zealand. Coking coal (bituminous) is exported to other economies for steel production, especially since New Zealand's steel factory is designed to use lower grade, sub-bituminous coal. In the last 10 years, coal exports have declined by about a half, which reflects the long-term outlook of coal demand, causing a lack of investment.

Figure 1: New Zealand's total primary energy supply (TPES), production and net imports, 2000 to 2019



Source: EGEDA (2021)

New Zealand's net energy imports in 2019 were 290 PJ, which is almost double that of 2010. Almost 60% of these imports were crude oil and a third were petroleum products. In the future, imports will shift exclusively to petroleum products as New Zealand's only oil refinery at Marsden Point confirmed its decision to close in April 2022. The closure is unlikely to affect prices or the security of supply in New Zealand. The rest of New Zealand's imports are coal (9%), mostly sub-bituminous coal for electricity generation at the Huntly Power Station.

The major components of renewable supply are 27% hydro for electricity generation, 12% biomass for direct use (mainly for process heat production in the manufacturing sector), and 54% for geothermal electricity generation supply.

Geothermal generation has been the main cause of renewables growth in the last 10 years. However, 187 PJ (22%) of TPES is made up of geothermal energy used for electricity generation, which has very low conversion efficiency (estimated at 15% in New Zealand). This leads to the renewables share of TPES overstating the true extent of renewable energy available for use in the economy. A relatively low amount (29 PJ) of this geothermal energy is converted to useful electricity.

Since all of New Zealand's oil production is exported, supply is mostly made up of imports of crude oil (218 PJ), gasoline (42 PJ) and diesel (54 PJ). Crude oil is used in the Marsden Point Oil Refinery.

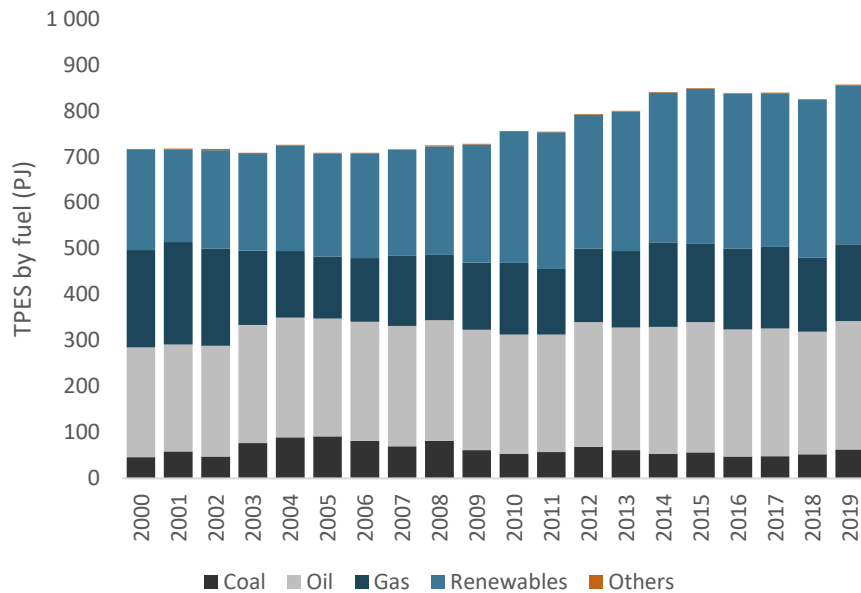
Up to two-fifths of New Zealand's gas supply is used for producing methanol for export and urea for fertiliser production (mostly for domestic use). However, the share of the supply used in these chemical sectors can vary as a result of changes in domestic gas prices. Methanol production is especially variable as it is also reliant on international methanol prices. This variability has caused gas supply to vary by more than 25% over the last 20 years. About 60% of gas

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supply to the chemicals sectors can be apportioned to non-energy use (as a feedstock) and the rest is for energy use.

New Zealand's coal supply is mostly made up of sub-bituminous coal. This is generally used for a mix of electricity generation, steel production and heat in the dairy processing industry.

Figure 2: New Zealand's total primary energy supply by fuel, 2000 to 2019

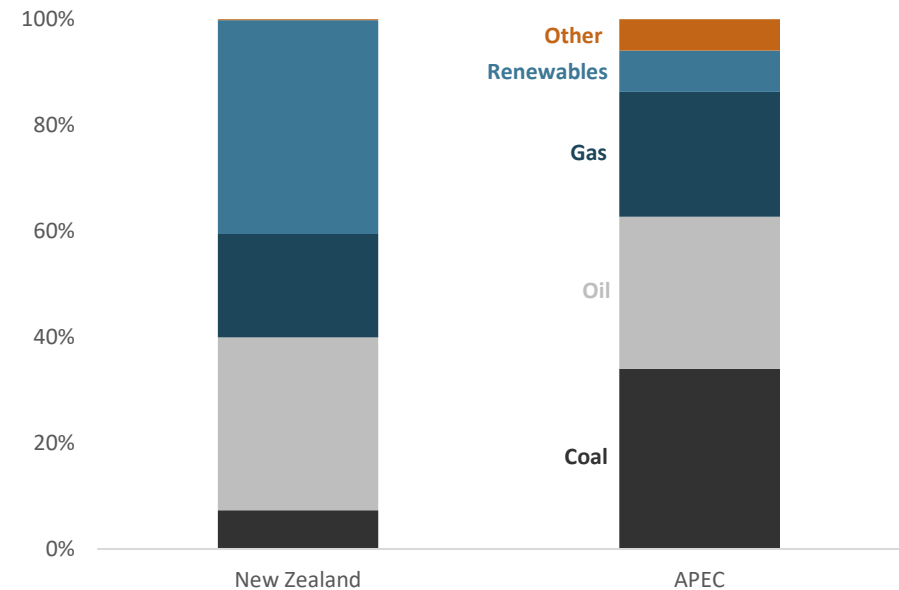


Source: EGEDA (2021)

Relative to APEC's average, New Zealand has a larger supply of renewables. Even though this is exaggerated by the prominence of geothermal electricity generation, the hydro supply and biomass supply still cause renewables to outweigh the APEC average.

Coal supply is much lower than the APEC average, which reflects the comparatively low amount used for electricity generation in New Zealand, which is a result of the high amount of renewables supply for generation.

Figure 3: Total primary energy supply relative fuel share, New Zealand and APEC, 2019



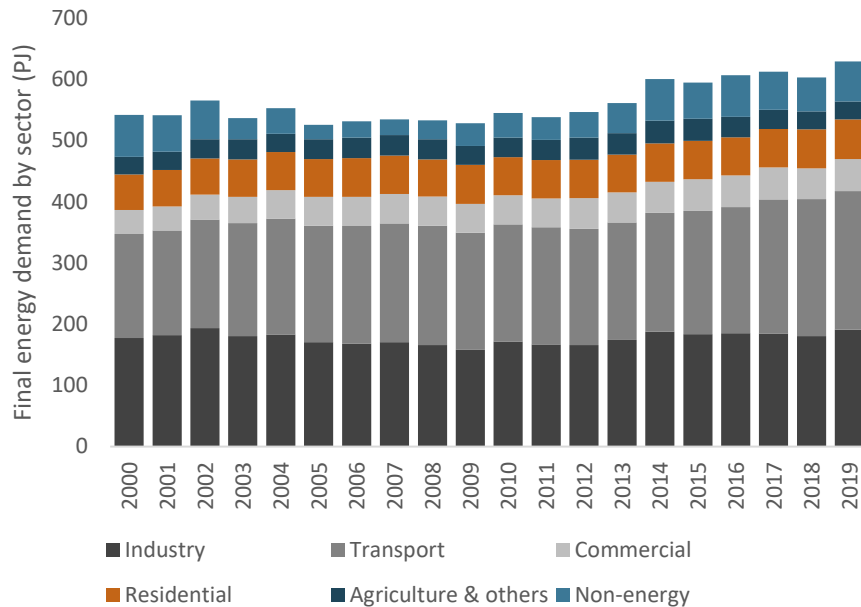
Source: EGEDA (2021)

Total Final Consumption

In 2019, the economy's TPES was 856 PJ, which amounted to a total final consumption of 629 PJ. This means that more than a quarter of TPES was consumed in transformation, own use and losses, and non-energy use.

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Figure 4: New Zealand’s final consumption by sector, 2000 to 2019

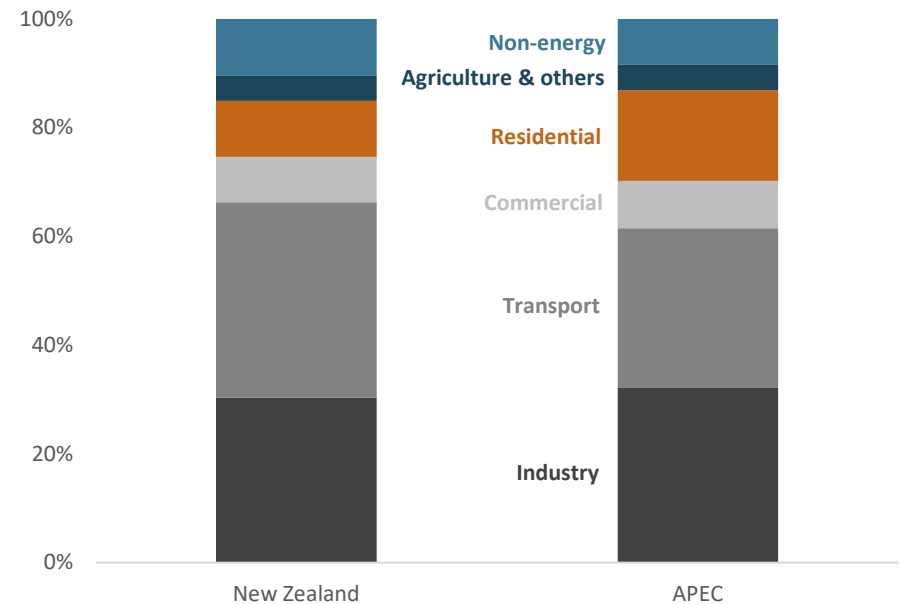


Source: EGEDA (2021)

Transport remains the largest end-use sector, accounting for more than a third of energy consumption. Transport energy use has also increased by about 13% over the last five years due to increased road activity, which is partly a result of the high number of personal vehicles.

New Zealand’s residential share of energy use is low compared to other economies in APEC. This difference reflects the low population compared to economic output (high gross domestic product [GDP] per capita) and improving efficient energy use in housing. Some of this efficiency can be attributed to energy efficiency measures enacted by the government, which have led to energy use in the average New Zealand household falling by 10% since 2000.

Figure 5: Final consumption sectoral share, New Zealand and APEC, 2019



Source: EGEDA (2021)

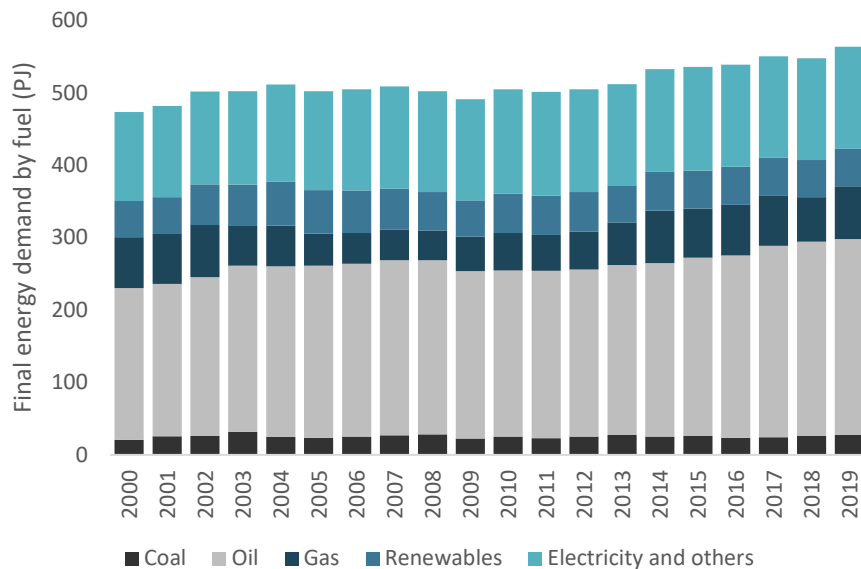
As a result of the high transport activity, oil use is also high for New Zealand, at 49%, compared to the APEC region’s average of 37%. More than 80% of New Zealand’s oil use is for transport.

New Zealand’s electricity use makes up all the demand in the Electricity and others category in Figures 6 and 7. New Zealand’s electricity use is similar in size to APEC for each of the industry, residential and commercial sectors. Roughly 13% of New Zealand’s electricity generation is currently consumed by the Tiwai Point Aluminium Smelter. The smelter is expected to close in 2025 and is a big factor in New Zealand’s electricity generation development plans.

Almost all final consumption of coal (predominately sub-bituminous coal) within New Zealand is dominated by industrial sector consumption for process heat. Within the industrial sector, 69% of this is for food and beverage manufacturing (most of which is dairy), 16% is for non-metallic mineral manufacturing, and the rest can be split into wood and pulp processing, textiles and leather, and chemical manufacturing.

A major portion of renewables is used in the industrial sector for process heat. The rest is used in the buildings sectors (residential and commercial).

Figure 6: New Zealand's final energy demand by fuel, 2000 to 2019



Source: EGEDA (2021)

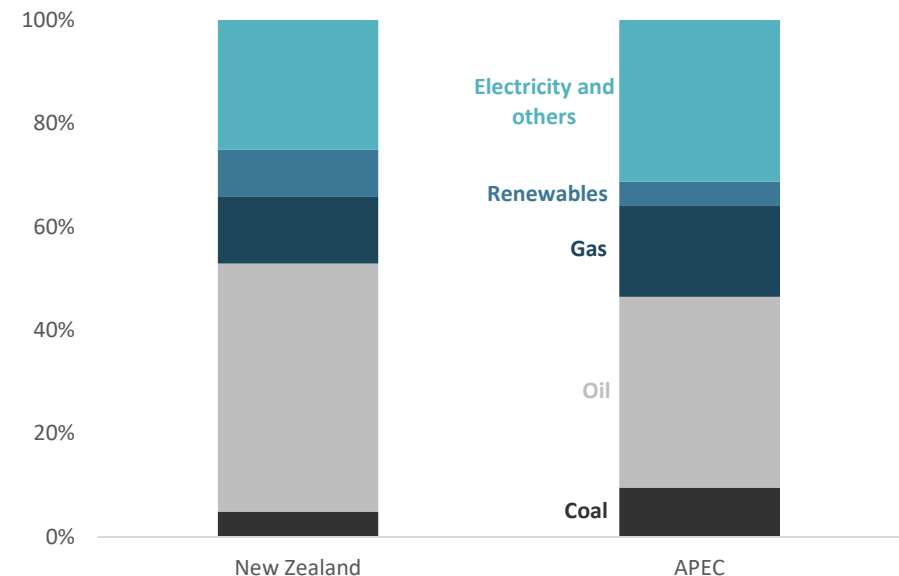
Note: Does not include non-energy consumption of energy commodities.

In 2019, most end-use gas consumption was used by the industrial sector for process heat, with half of the consumption by the chemicals

subsector. The chemicals subsector varies its output based on the international market for petrochemical goods and domestic gas prices. The subsector's consumption of gas has typically been lower in the past. The rest of New Zealand's gas is used for buildings.

As industrial process heat makes up almost 80% of industrial energy use in New Zealand, it is being targeted by the government as one of the best options for the economy to reduce its fossil fuel consumption in the short to medium term. This could result in switching from coal and natural gas to low emission energy types such as biomass, electricity and geothermal heat.

Figure 7: Final energy demand fuel shares, New Zealand and APEC, 2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

New Zealand’s fuel shares of energy demand are relatively similar to the APEC averages, with small differences being the lower use of coal, gas and electricity but higher use of oil and renewables.

There is lower energy use in the economy’s industrial sector, which is the main cause for less electricity, gas and coal use. Also, compared to the APEC average, renewables are used a lot more in the industrial sector, which further decreases the prominence of the other fuel types.

The higher proportional use of oil is due to high transport activity in New Zealand.

Transformation

Hydro is the highest contributor to electricity generation in New Zealand. This has been the case since before 1974, as it is especially suited to New Zealand’s natural landscape. However, hydro dry years are a significant issue for New Zealand. These occur when there is not enough rain or snowmelt and the level of water stored in lakes runs low. When this occurs, some form of backup generation is needed, which is currently provided by fossil fuel generation.

Even though geothermal generation has a conversion rate of 15%, it still forms a large portion of New Zealand’s generation mix (1 231 megawatts [MW] of installed capacity). This is especially noteworthy because geothermal energy provides a form of baseload generation, so it always runs and can help to counter the intermittency of newer generation types such as wind and solar. While geothermal is a source of renewable energy, there are some emissions associated with its use, depending on the geology and plant technology. These emissions are generally far lower than for fossil fuel generation plants.

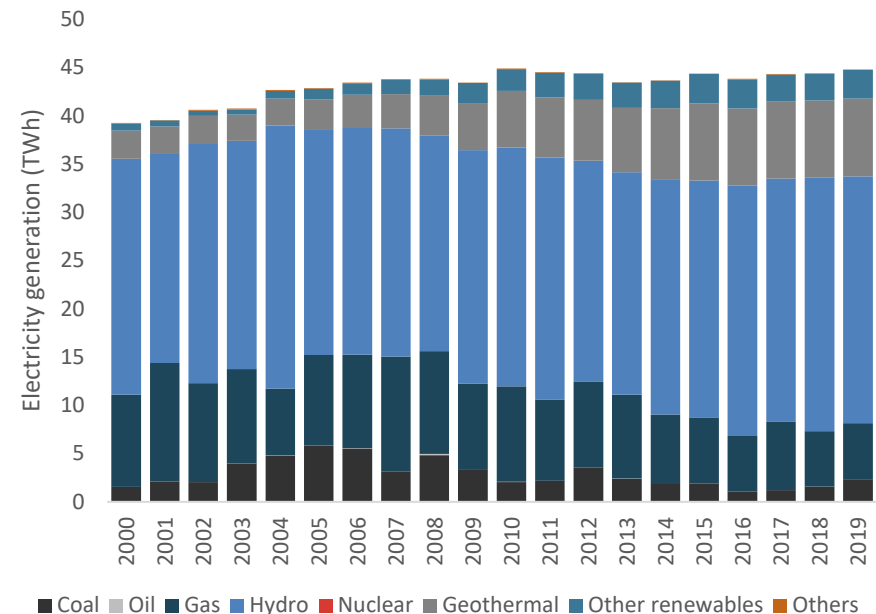
Solar and especially wind generation are quickly becoming key components of the generation mix. Wind makes up about 5% of total generation, with solar making up about 0.05%. New Zealand has

especially favourable wind conditions, which have led to its remarkable development without subsidies.

Gas made up 13% of New Zealand’s generation in 2019. It is useful for variable generation, especially to cover for hydro dry years. Coal also serves this function, but it produced only 3.6% of total generation in 2019 and is limited to the Huntly Power Station, which makes up 5% of total installed capacity.

Coal use has decreased markedly since its elevated period of use between 2004 and 2009. This is because of an increase in the development of renewable generation types that are cheaper to run.

Figure 8: New Zealand’s electricity generation by fuel, 2000 to 2019

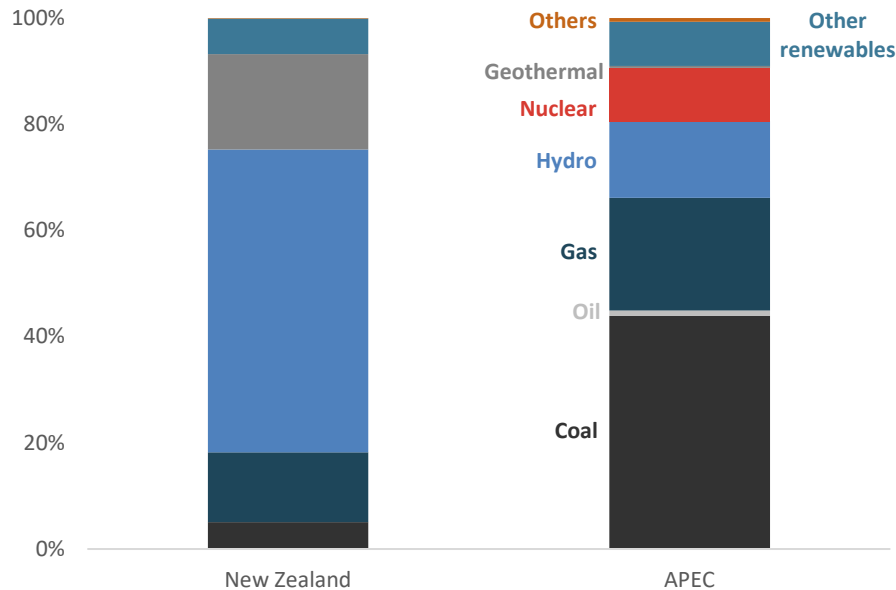


Source: EGEDA (2021)

Hydro is very important for New Zealand’s electricity sector. This is clear when viewing New Zealand’s 2019 electricity generation mix alongside APEC’s (Figure 9). Hydro is the main reason why New Zealand has been able to achieve such a high share of renewables in its electricity generation mix (82.7% in 2019).

New Zealand’s geothermal share of generation is also very high (18%). This is partly because of the access to quality geothermal natural resources and well-developed expertise in the field. Some other economies that rely on this energy type are Indonesia; Papua New Guinea; the Philippines and the United States.

Figure 9: Electricity generation by fuel share, New Zealand and APEC, 2019



Source: EGEDA (2021)

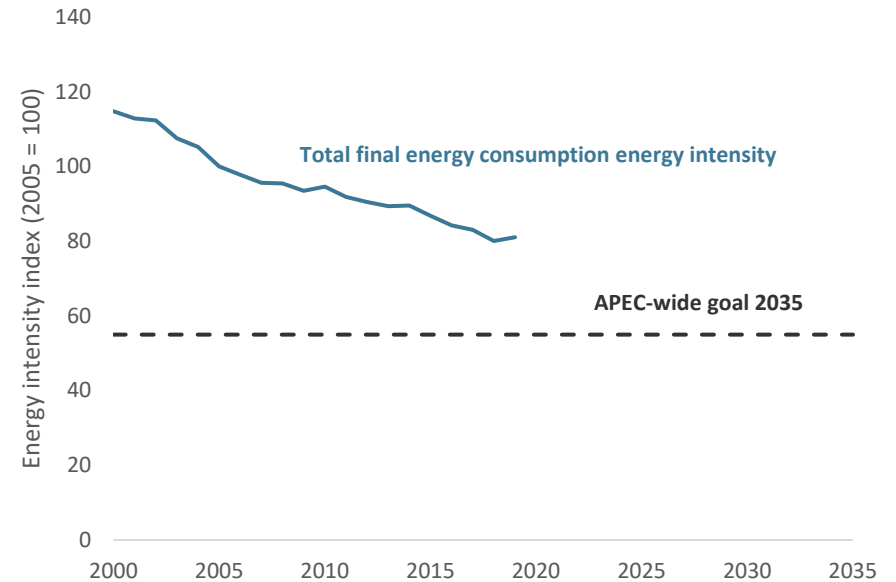
APEC Goals

Energy Intensity Goal

In 2018, New Zealand’s energy intensity was 81 PJ per billion USD purchasing power parity (PPP) of GDP, which represents a 19% improvement since 2005. This improvement is occurring at a similar pace to that of the wider APEC region.

APEC member economies have agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to the 2005 baseline. However, this APEC-wide target does not apply to individual economies.

Figure 10: New Zealand’s total final energy consumption intensity index, 2000 to 2019 (2005 = 100)

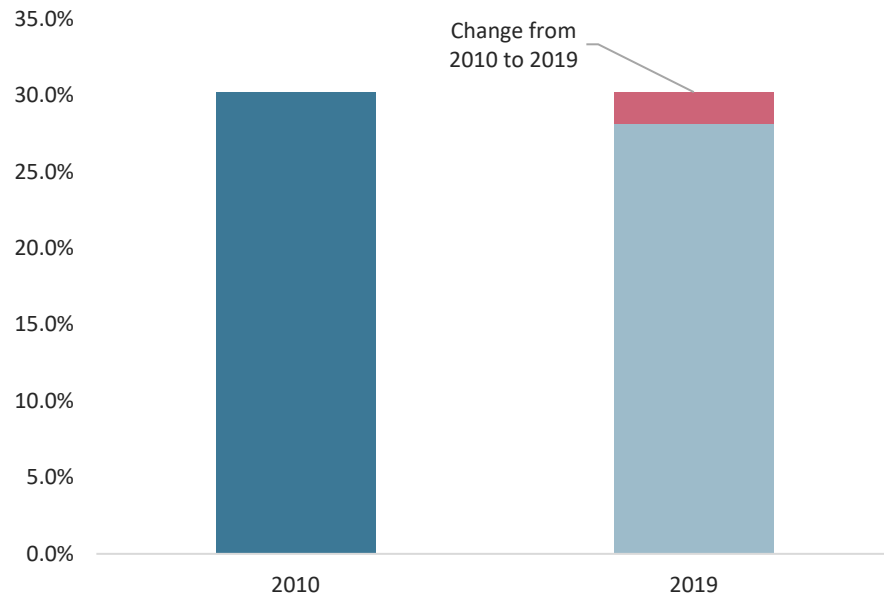


Source: EGEDA (2021)

Doubling of Renewables

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

Figure 11: New Zealand’s modern renewable energy share, 2010 and 2019

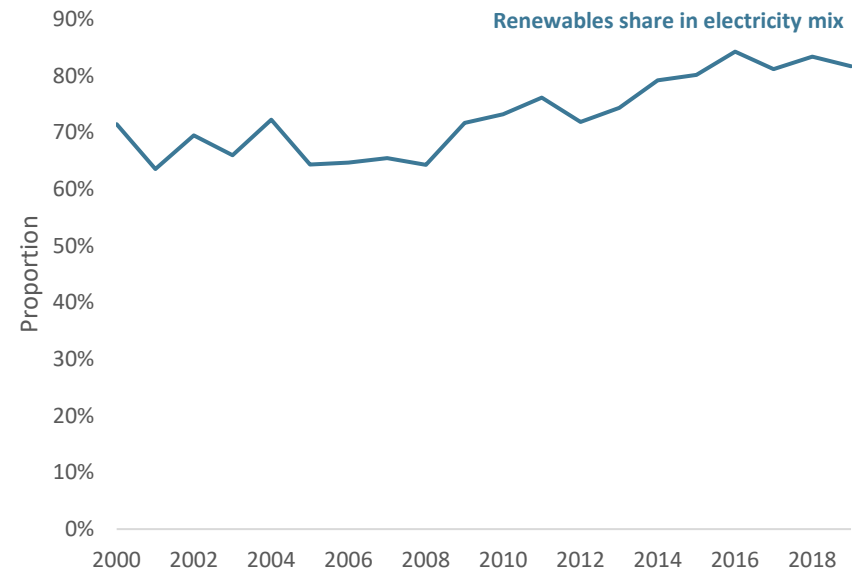


Source: EGEDA (2021)

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 penetration of renewables in its energy mix of all APEC member economies. There has been a small reduction in New Zealand’s renewables share since 2010 (the base year for the doubling goal). In 2019, New Zealand’s renewable share was 28%, which is 2% lower than it was in 2010. Overall, APEC had a 9.1% share of renewables in 2019. While New Zealand can contribute to the APEC goal of overall renewables doubling by 2030, the current and former high penetration levels make significant growth challenging when compared to economies with much lower penetration rates for renewables.

Figure 12: New Zealand’s renewable generation share, 2000 to 2019



Source: EGEDA (2021)

In recent years, electricity generation from renewables has been increasing due to the installation of new renewable energy generation capacities, but the effect of dry weather on the amount of water in the

hydro storage lakes has caused a certain variation. For example, the share of renewables fell from 84.3% in 2018 to 82.7% in 2019 due to a dry spell in the North Island and an associated fall in hydro generation. Such dry conditions were also present in 2017.

Energy policy

The May 2019 amendment to the Climate Change Response Act (Zero Carbon) set a legally binding goal of achieving a zero-carbon economy by 2050 (Ministry for the Environment [MFE], 2018). This policy will mean radical changes within New Zealand’s energy sector and a drastic reduction in the intensity of emissions over the next 30 years. Further details of the specific policies aimed at supporting the low-carbon transition are provided in the table below.

Energy Policy	Details	Reference
Climate Change Response (Zero Carbon) Amendment Act	In 2019, the Climate Change Response (Zero Carbon) Amendment Act set into law a new domestic target of net-zero emissions of all greenhouse gases other than biogenic methane by 2050, with biogenic methane emissions to be reduced 24–47% below 2017 levels by 2050, including 10% below 2017 biogenic methane emissions by 2030.	MFE
Nationally Determined Contribution (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.	MFE
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 million metric tonnes of carbon dioxide equivalents (Mt CO ₂ e). It contains price ceiling and price floor mechanisms to maintain market stability. Currently, it excludes emissions from the agricultural sector.	MFE
Exemption for electric vehicles (EVs) and hybrids from road user charges	The exemption will be available to light vehicles until 2024 and heavy vehicles until 2025.	NZ Transport Agency
Renewable electricity target	Renewable electricity target of 100% by 2035	NZ Parliament
Oil and gas exploration ban	The Crown Minerals Amendment Bill has ended all new offshore oil and gas explorations and limited onshore exploration to a small region.	MFE
New Zealand energy efficiency and conservation strategy (NZEECS)	Between 2017 and 2022, the economy aimed to decrease the intensity of industrial emissions. In 2022, a new five-year energy efficiency and conservation strategy is being developed. It is intended that the new NZEECS will complement, and integrate with, the broader government-led energy strategy.	NZEECS

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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. By the end of 2022, 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 business case, which will cost up to USD 70 million.	Ministry of Business, Innovation and Employment
Government Investment in Decarbonising Industry (GIDI)	A co-investment capital grant worth USD 69 million 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 USD 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 Programme requires public sector agencies to measure and publicly report their emissions and deliver offsets. The program is backed by the USD 200 million State Sector Decarbonisation Fund.	Energy Efficiency and Conservation Authority
Biofuels mandate	In January 2021, the Government made an in-principle decision to implement a biofuels mandate across the transport sector. The proposed mandate requires fuel suppliers to reduce the greenhouse gas emissions from transport fuels by a defined percentage each year. There will be a separate mandate for aviation fuel.	Ministry of Business, Innovation and Employment
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 New Zealand's only oil refinery. It is now being converted into an import terminal with the potential to improve New Zealand's security of supply.	Argus Media
New Zealand Aluminium Smelter might be closed at the end of 2024	New Zealand Aluminium Smelter is supposed to remain in operation until at least the end of 2024.	Business Wire

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Coal phase-out	Genesis has pledged to stop using coal to generate electricity, except in exceptional circumstances, by 2025 and to fully retire coal in 2030. This is the only coal plant in New Zealand (excluding cogeneration). It is also capable of using gas.	Radio New Zealand
Climate Change Commission submitted advice to the government	In 2021, the Climate Change Commission submitted its final recommendations for reducing emissions in Aotearoa, New Zealand. The recommendations advise on the first three emissions budgets until 2035 and the direction for the emissions reduction plan for 2022–2025.	Climate Change Commission
Emissions Reduction Plan released in May 2022	Following the Climate Change Commissions' advice to Government, the Emissions Reduction Plan was released in May 2022. It sets out how New Zealand will meet its first emissions budget (2022–2025) and set the path towards meeting long-term climate targets.	Ministry of Business, Innovation and Employment
Hydrogen development	Numerous hydrogen projects are currently under development or investigation in New Zealand, including partnerships with Japan; Korea and Singapore, signalling their intention to develop hydrogen technology and supply together in the future.	Ministry of Foreign Affairs and Trade
Geothermal research funding	Geological and Nuclear Sciences (GNS) was awarded a USD 10 million grant by the Ministry of Business, Innovation and Employment Endeavour Fund Research Programme 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.	MFE
Review of the energy efficiency regulatory system for products and services	The Ministry of Business, Innovation and Employment is seeking feedback on proposals to enhance the energy efficiency regulatory system for products and services.	Ministry of Business, Innovation and Employment
New energy research development centre (Ara Ake)	The Ministry of Business, Innovation and Employment has funded Ara Ake, which is intended to support energy innovations with funding, services and information.	Ara Ake
2018–2019 Electricity Price Review (EPR)	The EPR investigated whether the current electricity market delivered a fair and equitable price to consumers. The report, with a set of recommendations, was delivered to the Minister of Energy and Resources in May 2019. Following the government's response, agencies are now progressing several workstreams related to it.	Ministry of Business, Innovation and Employment

Papua New Guinea

Introduction

Papua New Guinea (PNG) is an island economy located in the Pacific Ocean, consisting of roughly 600 islands stretching from just south of the equator to the Torres Strait, near Cape York Peninsula, Australia. PNG is the largest of the Pacific Island countries, with a total land area of 462 840 square kilometres (km²). The largest PNG islands are New Britain, New Ireland and Bougainville. Port Moresby is the capital of the economy, located in south-eastern New Guinea on the Coral Sea.

PNG sits along the volcanically active 'Ring of Fire' and witnesses frequent earthquake and tsunami risks. Amidst the mountainous terrain, tropical rainforests and scattered small islands lie the economy's rich natural resources, dominated by gold, copper, oil, gas, timber and crops for agricultural export (coffee, cocoa, tea, palm oil and copra). PNG has high temperatures and humidity, combined with wet and dry seasons.

In 2019, PNG's real gross domestic product (GDP) was US dollars (USD) 39.1 billion (2017 USD purchasing power parity [PPP]), which was a 5.9% increase from the previous year. The GDP growth rate has been increasing at an average rate of 5.4% every year since 2005.

³ imf.org/en/Countries/PNG

PNG has been hit hard by the COVID-19 pandemic, and a 3.9% decrease in GDP is expected for the year 2020 as a result³.

Table 1: PNG's macroeconomic data and energy reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (km ²)	462 840	Oil (billion barrels)	0.16
Population (million)	8.8	Gas (trillion cubic feet)	5.6
GDP (2017 USD billion PPP)	38.1	Coal (million tonnes)	–
GDP per capita (2017 USD PPP)	4 350	Uranium (kilotonnes U < USD 130/kgU)	–

Source: ^a ABS (2021); ^b World Bank (2021); ^c BP (Natural gas, 2020); ^d EIA (Oil, 2020)

Note: Reserves are total proved reserves.

Energy Supply and Consumption

Total Primary Energy Supply

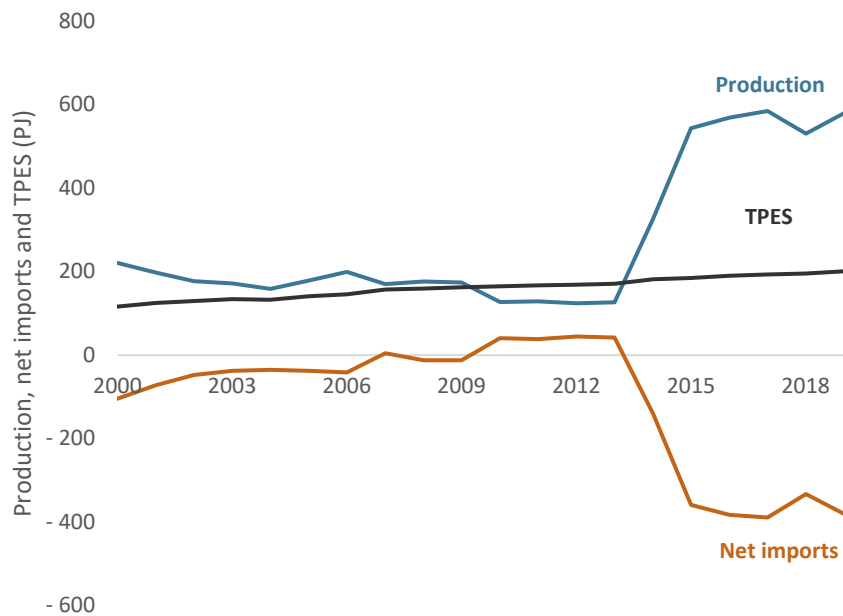
Total primary energy supply (TPES) in 2019 was 195 picojoules (PJ), which was almost a fifth greater than the amount in 2010. This growth was a result of oil and gas supplies, which was tied to increasing activity and output, especially within the transport and industry sectors. For this same period, the supply of renewables remained steady. Most of the demand for renewables came from residential firewood use (traditional renewables), which has not been growing in PNG.

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Oil constituted the largest share of the TPES, at 46%, in 2019 (Figure 3). The use of this supply was spread over the transport, industry and electricity generation sectors.

In the same year, renewables made up 44% of TPES, and natural gas accounted for the remaining 9%.

Figure 1: PNG's total primary energy supply (TPES), production and net imports, 2000 to 2019

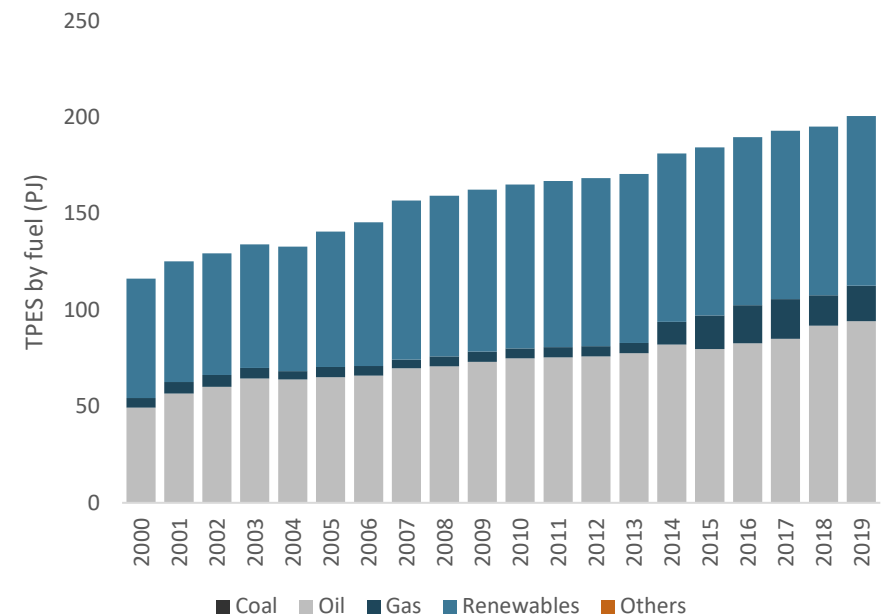


Source: EGEDA (2021)

Most of PNG's supply of oil is equal parts diesel and fuel oil. Generally, diesel is used for transport and industrial uses, with only a small amount used in power generation, whereas fuel oil is mainly used for power generation.

PNG has rich gas resources, with large volumes of production beginning in the mid-2010s. Most of the current production is exported as LNG, with 445 PJ (96% of production) exported in 2019. The large amount of gas production that is then exported leads to a large negative net imports balance (Figure 2).

Figure 2: PNG's total primary energy supply (TPES) by fuel, 2000 to 2019



Source: EGEDA (2021)

Of the 18 PJ of gas supply (domestic consumption of gas), the economy's own use and losses account for 60% and power production makes up for the remaining 40%. Own use and losses occur through the entire upstream natural gas supply chain, including significant volumes required to liquefy the gas for export.

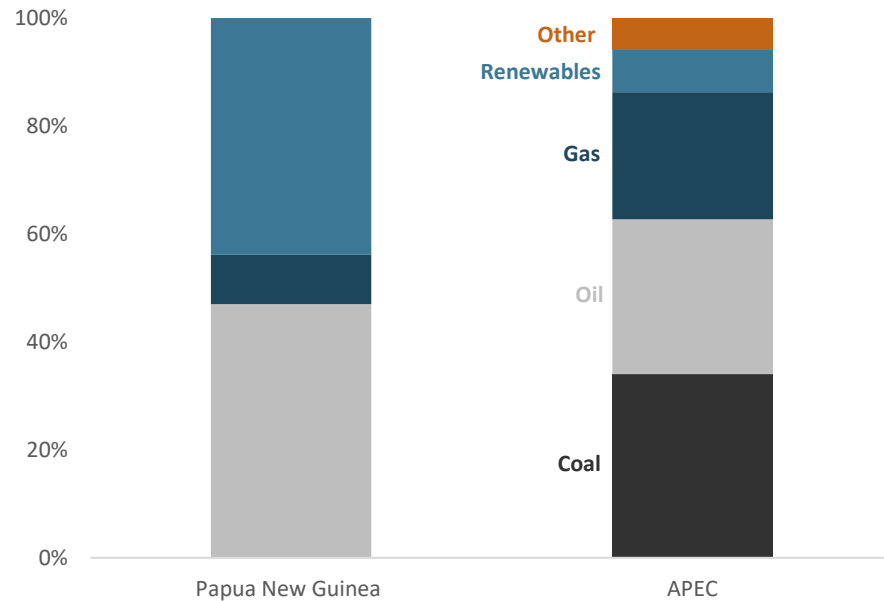
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PNG's renewables supply includes 75% traditional biomass for the residential sector, 3% biomass for the industrial sector, 17% geothermal for electricity generation and 4% hydro for electricity generation.

PNG's TPES composition is significantly different from the wider APEC region. One of the main differences is that PNG does not have any coal-fired electricity generation or any significant domestic consumption of coal.

Oil and renewables hold a much larger share of TPES relative to the collective of APEC members.

Figure 3: Total primary energy supply relative fuel share, PNG and APEC, 2019



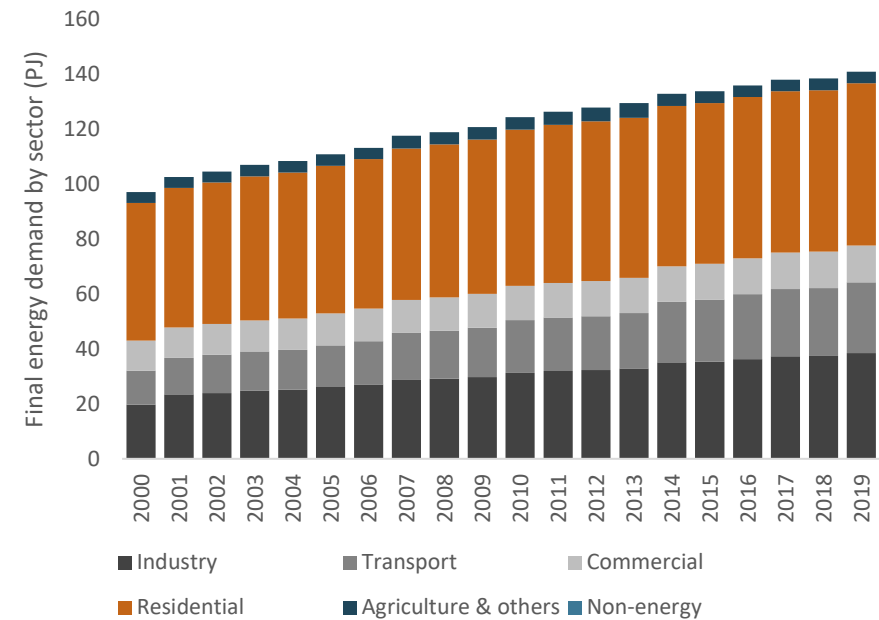
Source: EGEDA (2021)

Total Final Consumption

In 2019, PNG's total final consumption was 140 PJ. The residential sector accounted for 42% of final consumption. The industrial sector (27%) and the transport sector (18%) were the next two largest energy-consuming sectors. Agriculture accounted for all of the 'Agriculture & others' category and used 4.3 PJ of diesel.

Demand for energy has been increasing since 2000, although at a slower rate than GDP. The transport and industry sectors have both almost doubled their energy use, which emphasises the importance of energy in fuelling economic growth.

Figure 4: PNG's final consumption by sector, 2000 to 2019

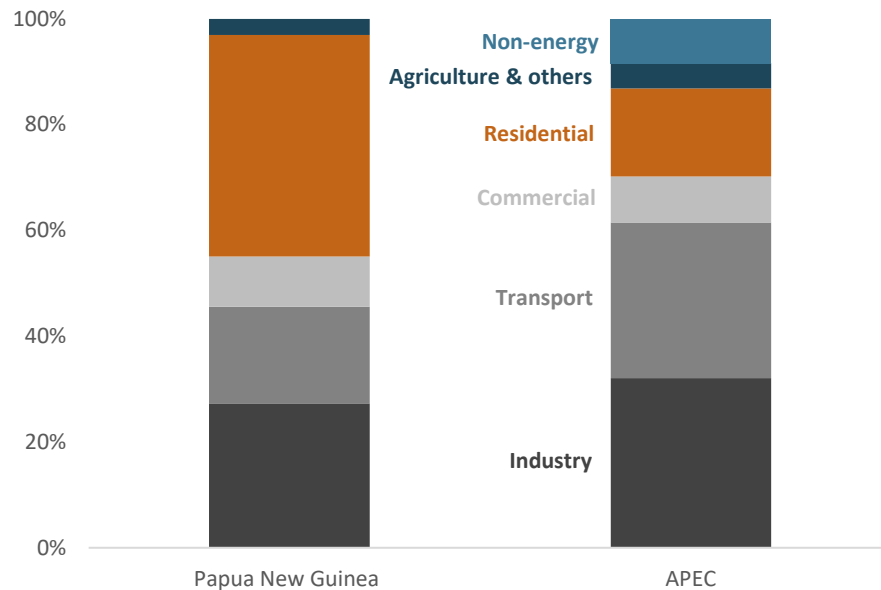


Source: EGEDA (2021)

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The buildings (residential and commercial combined) sector's consumption has increased by only about a fifth since 2000, but it remains the largest sector. One reason for this is the inefficiency of traditional biomass, which makes up most of the residential sector's energy use. Because of traditional biomass prominence, a lot more energy is consumed compared to if other, more efficient, fuels were being used.

Figure 5: Final consumption sectoral share, PNG and APEC, 2019



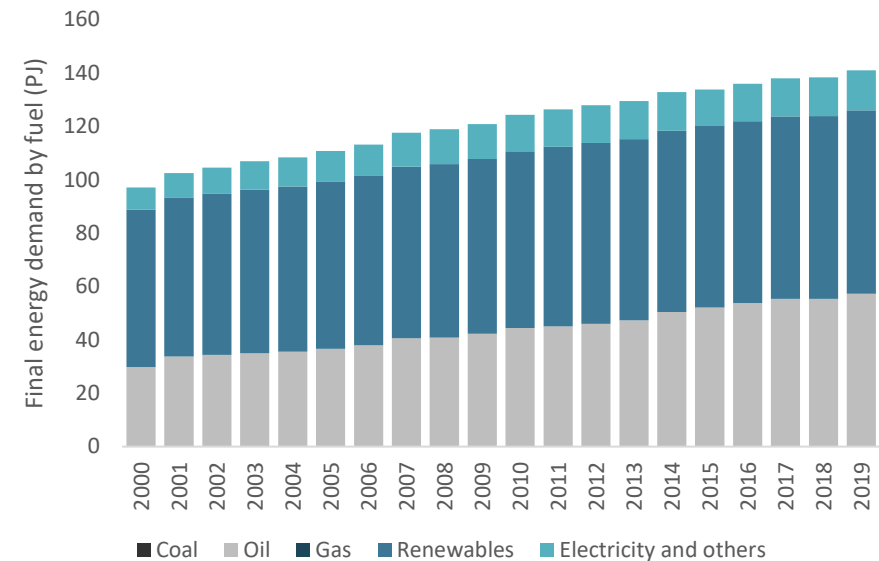
Source: EGEDA (2021)

Most of PNG's industrial energy demand comes from mining. Over two-thirds of industrial energy demand is for oil, and just less than a third is for electricity. Mining attracts a large portion of foreign direct investment in PNG.

PNG's residential sector accounts for a much larger share of energy use than APEC, whereas the economy's transport and industry sectors account for smaller shares.

The energy use of the commercial and agriculture sectors is similar in size to the wider APEC region. However, the size of the commercial sector appears larger than would be the case if looking at alternative metrics. This difference is because the commercial sector uses 70% firewood, which is inherently inefficient.

Figure 6: PNG final energy demand by fuel, 2000 to 2019



Source: EGEDA (2021)

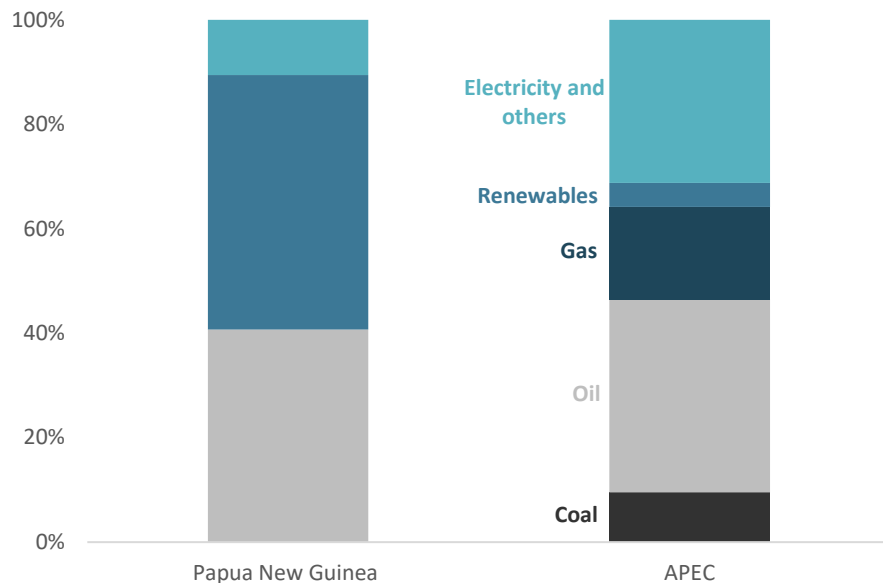
Note: Does not include non-energy consumption of energy commodities.

Electricity use accounts for 12% of final energy demand (it makes up the entirety of the Electricity and others category in Figures 6 and 7). This electricity is mostly consumed by the industrial sector (71%), and

most of it is generated privately by mining companies. The remaining electricity use is by the buildings (residential and commercial combined) sector within the major cities where there is access to electricity.

Where there is no electricity access (or it is too expensive to afford), residential and commercial energy comes from firewood. Since only a fifth of the population has access to electricity, renewable energy (mostly firewood) contributes the largest share of final energy consumption (49%). As electricity access increases through the National Electrification Rollout Plan (NEROP), a large drop in traditional biomass use is expected. This is further explored in the forthcoming eighth edition of the *APEC Energy Demand and Supply Outlook*.

Figure 7: Final energy demand fuel shares, PNG and APEC, 2019



Source: EGEDA (2021)

Petroleum products, specifically diesel and fuel oil, have driven growth in demand since 2000. Oil use grew by about 90% between 2000 and 2019, and it now accounts for 40% of final energy consumption.

PNG currently has zero coal and gas use. However, it is likely that PNG will invest in industrial enterprises that use gas. This development is due to the large proven reserves that are almost exclusively exported.

Transformation

The use of electricity is low in PNG compared to the APEC average (Figure 7). Total generation is also low.

Electricity is mostly generated from thermal sources (74%), as shown in Figure 8. The largest of these thermal sources is oil, accounting for 60% of total electricity generation. This oil generation comes from the economy's reliance on fuel oil generators because of their suitability to the economy's needs (low capital investment, relative ease in instalment and variable power generation). It is expected that this reliance will decrease in future years, as investments enable the use of PNG's large wealth of renewable and natural gas resources. This is further explored in the forthcoming eighth edition of the *APEC Energy Demand and Supply Outlook*.

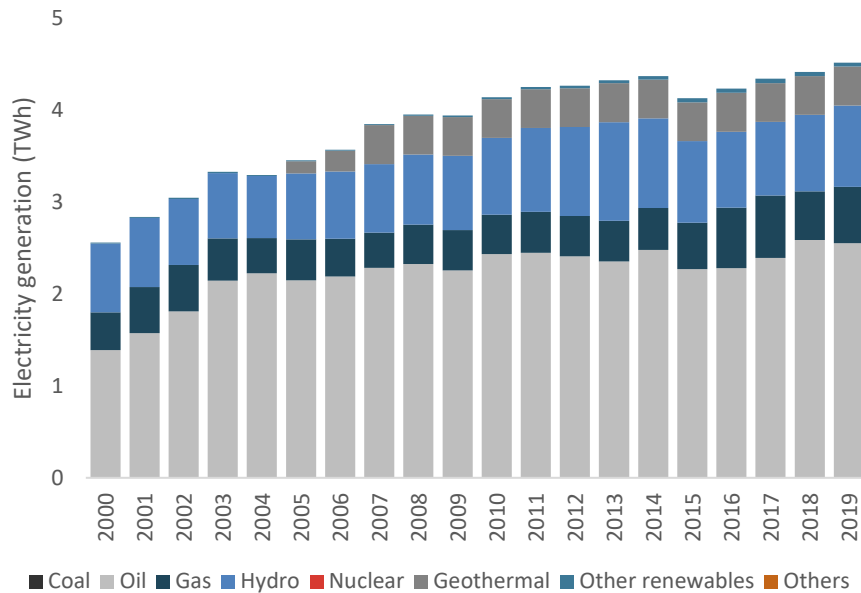
Hydropower is the largest source of renewable energy (17%), while geothermal and others contribute to 9% of the electricity generation mix. All geothermal generation comes from the Lihir gold mine generation scheme.

Electricity generated from geothermal power (0.4 terawatt hours [TWh] or 1.5 PJ) is much smaller than the total geothermal input (15 PJ). This is because geothermal has a very low conversion efficiency (~10%).

In 2019, twice as much electricity was generated and used on-site by private industrial facilities than the amount produced by generators connected to the main grid. This is typical of APEC economies and

reflects the lack of distribution infrastructure within the economy. However, building a centralised electricity network in PNG is difficult due to the rugged and undeveloped terrain between major cities, towns and villages.

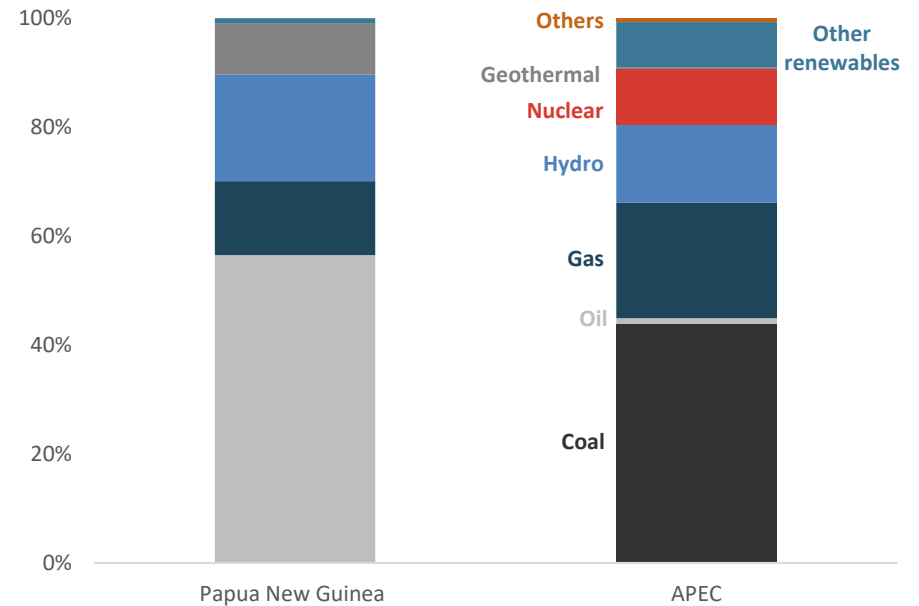
Figure 8: PNG electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

PNG uses a large proportion of oil compared to the APEC region, which reflects the economy’s high use of fuel oil generators. The economy’s hydro and geothermal generators are an important part of the transformation system, but their prominence is also a reflection of the low amount of generation capacity that is needed to make that generation type prominent, compared to the APEC average.

Figure 9: Electricity generation by fuel share, PNG and APEC, 2019



Source: EGEDA (2021)

APEC Goals

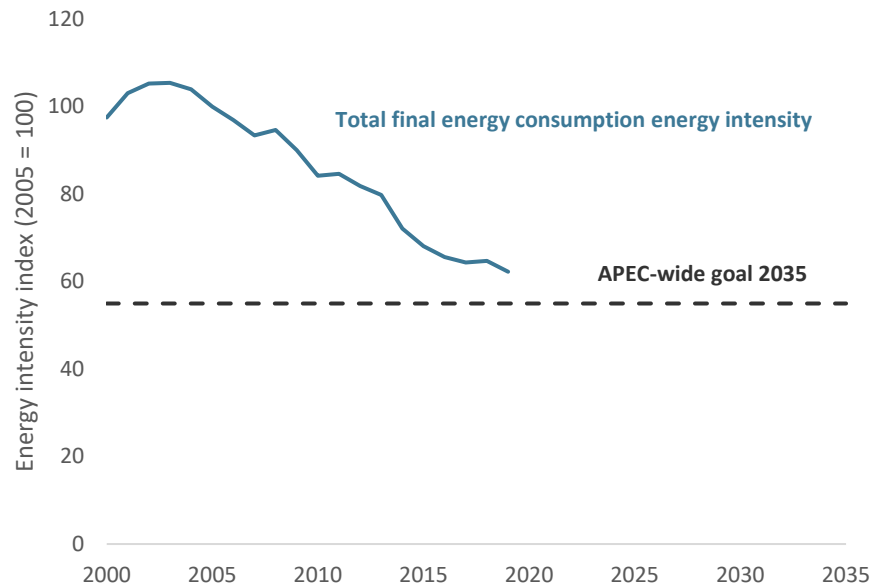
Energy Intensity Goal

PNG’s final energy intensity has improved by almost a third over the past two decades, as the rate of GDP growth continues to outpace the increase in energy use. This improvement in intensity is expected to continue, especially driven by electrification in the economy.

Energy intensity was 62 PJ per one billion USD PPP in 2019, having improved by a third since 2000. One major factor in the improved energy intensity has been the GDP growth the economy attained by exporting LNG from 2014 onwards.

APEC member economies have agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to the 2005 baseline. However, this APEC-wide target does not apply to individual economies.

Figure 10: PNG's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

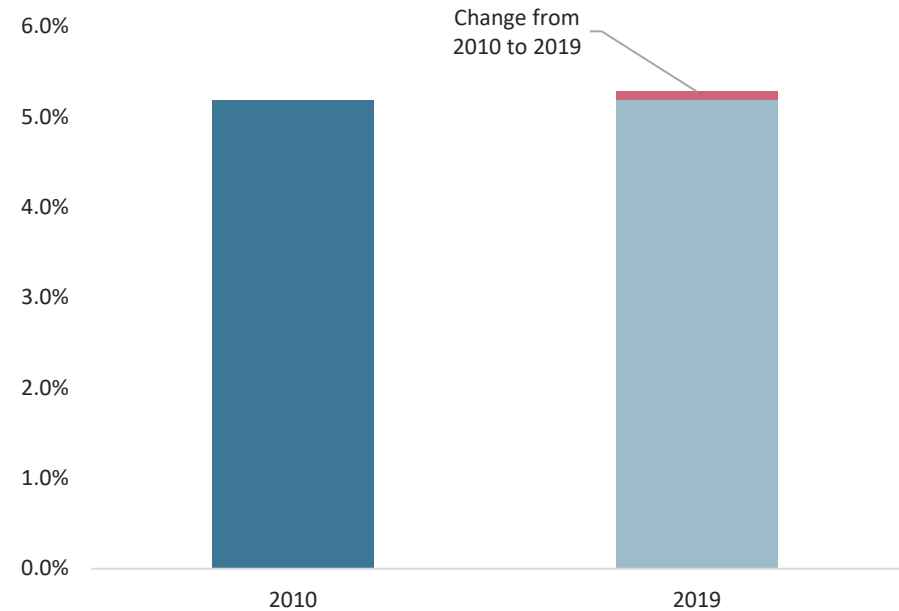
Doubling of Renewables

The second energy goal involves doubling the share of modern renewables 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).

PNG's modern renewable energy share is 5.3%, and there has been no significant change since 2010. The APEC average is 9.1%. Moreover,

60% of the share of modern renewables in the economy is from hydro and geothermal electricity generation. Approximately 40% of the share comes from modern biomass use in the industrial sector, for example, palm oil mills using their own agricultural wastes.

Figure 11: PNG's modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

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.

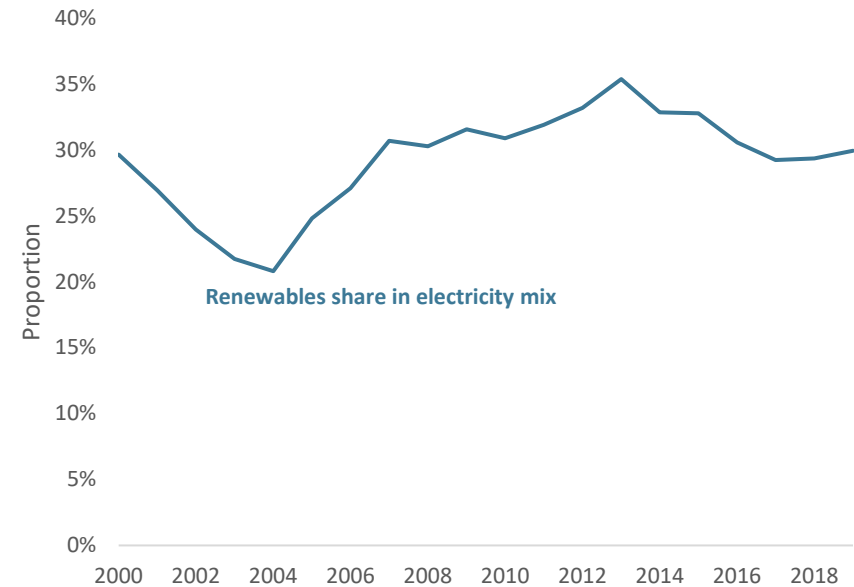
The majority of PNG's renewable energy consumption is satisfied by traditional biomass, which does not show up in PNG's modern

renewables share. Otherwise, PNG's renewables share including traditional biomass would have been 52% in 2019.

The share of renewables in electricity generation is a result of the use of hydro (65%), geothermal (41%), biogas (2%) and modern biomass (1%). It is calculated based on the generation output.

The renewable share in electricity generation is at the same value it was in 2000. The intermediate variation was caused by major effects of new capacity developments, such as the commission and expansion of the Lihir geothermal generation scheme between 2004 and 2007, which added 422 GWh of generation to the mix.

Figure 12: PNG's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy Policy

Energy policies in PNG have historically been focused on developing the rich natural resource sector. More recently, there has been some shift in focus towards supporting a more rapid rollout of electrification, strengthening governance and institutional frameworks in the energy sector, and meeting future challenges in the energy sector such as climate change.

PNG’s Department of Petroleum is concerned with upstream oil and gas. While the National Energy Authority (NEA) under the Ministry for Energy and Rural Infrastructure regulates the energy and electricity sector. The NEA is also concerned with midstream and downstream of the Petroleum sector.

Energy Policy	Details	Reference
100% renewable energy	A target to achieve in 100% renewable electricity sector by 2050	Vision 2050
Economy-wide electrification	Electrification rate of 70% by 2030 and 100% by 2050	Vision 2050
Enhanced Nationally Determined Contribution (Enhanced NDC) (2020)	The NDC was revised to a target a 78% target share of installed capacity of renewable energy by 2030	Enhanced NDC
Domestic resource utilisation	The government will ensure that 15% of gas reserves in new oil and gas projects are made available for domestic gas utilisation.	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
Energy Authority Bill	Passed in April 2021, it will decommission all the regularity powers and functions of PNG Power Limited and vest them in the National Energy Commission.	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 government entities priority in tenement applications over 'reserved land'. The Oil and Gas Amendments give the respective Minister greater flexibility in determining whether to grant or refuse petroleum development licences and affect the sanctity of petroleum 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 completed, it will add 6 million tonnes per annum (mtpa) 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 the target of 70% of electrification by 2030. Some of this funding is already being committed to projects.	Post Courier

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

Peru is a democratic constitutional republic with a multiparty system. With a land area of 1.28 million square kilometres (km²), Peru is the eighth-largest economy by size in the Asia Pacific Economic Cooperation (APEC). Located in South America, Peru is bordered by the Pacific Ocean in the west, Chile in the south, Ecuador and Colombia in the north, and Brazil and Bolivia in the east. The major population centre of Peru is the city of Lima, located on the coast, which contains nearly one-third of the total population. It is estimated that most of the population, 82%, lives in urban areas in 2021 (Instituto Nacional de Estadística e Informática [INEI], 2021).

Peru is one of the most diverse economies, rich in natural resources and biodiversity. It has been traditionally divided into three geographical regions: the coastal region to the west, where most of the population lives; the mountain region (Andes Mountains); and the Amazonian region to the east. The presence of the Andes has defined the great range of climates that can be observed in Peru, from a humid tropical climate in the Amazonian rainforest to a desert-arid-subtropical climate in most of the coastal region. The climate in the Andes varies depending on the altitude.

Peru has 25 administrative areas, called *regiones*. In 2020, the population reached 33 million (WorldBank,2021), with 30.1% living below the poverty line, an increase of 9.9% from 2019, and 5.1% of this population affected by extreme poverty (INEI, 2021). The increase in poverty is a consequence of the impact of the COVID-19 pandemic on

the economy, which altered the constantly declining trend of poverty observed during the previous decades.

Table 1: Peru's macroeconomic data and energy reserves

Key data ^a		Energy reserves ^{b,c}	
Area (million km ²)	1.3	Oil (MMB)	349
Population (million)	33.0	Gas (PJ)	11611
GDP (2017 USD billion PPP)	371.3	Coal (Mt)	5.8
GDP per capita (2017 USD PPP)	11 261	Uranium (PJ)	745.0

Source: ^aWorld Bank (2021), ^bMinistry of Energy and Mines (MINEM, 2019), ^cMinistry of Energy and Mines (MINEM, 2021a)

Peru's gross domestic product (GDP) was USD 371.3 billion (2017 USD purchasing power parity [PPP]) in 2020, a decrease of 11.1% from 2019 (World Bank, 2021). The Nation Society of Industries has projected a GDP increase of 12.6% in 2021 and 2% in 2022.

The economy's industrial sector contributes 30% of its GDP (World Bank, 2021). Peru has a large and dynamic mining industry, mainly engaged in copper and gold extraction. In 2020, the pandemic also impacted the mining sector as several projects were paralysed. According to the Ministry of Energy and Mines (MINEM, 2021b), mining exports represented 62% of total export value in 2020. In 2020, Peru was the second-largest producer of silver and copper; the third-largest producer of zinc; the fourth-largest producer of lead, tin and molybdenum; and the eighth-largest supplier of gold (MINEM, 2021b).

According to the MINEM (2021a), Peru has substantially proven gas reserves, which are estimated at 717.7 petajoules (PJ). The most abundant gas reserves are in Selva Sur (Ucayali, Madre de Dios), Costa, Zocalo and Talara, where the natural gas liquids reserves are estimated to be 514 million barrels (MMB) and the proven oil reserves are estimated at 348 MMB. Peru's proven mineral coal reserves are around 5.8 million tonnes (Mt), with approximately 36.8% consisting of anthracite and the remainder formed by bituminous coal (MINEM, 2021a). Most of the reserves are in the La Libertad, Ancash and Lima regions.

Energy Supply and Consumption

Despite its vast renewable energy potential, mainly hydro, solar and wind energy, fossil fuels continue to dominate the Peruvian fuel mix. The first objective of the current National Energy Policy for 2010–2040 is to diversify the economy's energy matrix, focusing on renewable energy and energy efficiency. Additionally, the seventh objective of this policy is to develop a natural gas industry and its use in residential, transport, commercial and industrial sectors as well as in efficient electricity generation.

In 2021, the Peruvian government expanded the coverage of the BonoGas program, which finances the cost of natural gas connections for residential users, to more regions in order to support natural gas massification and reduce the consumption of liquefied petroleum gas (LPG) and electricity.

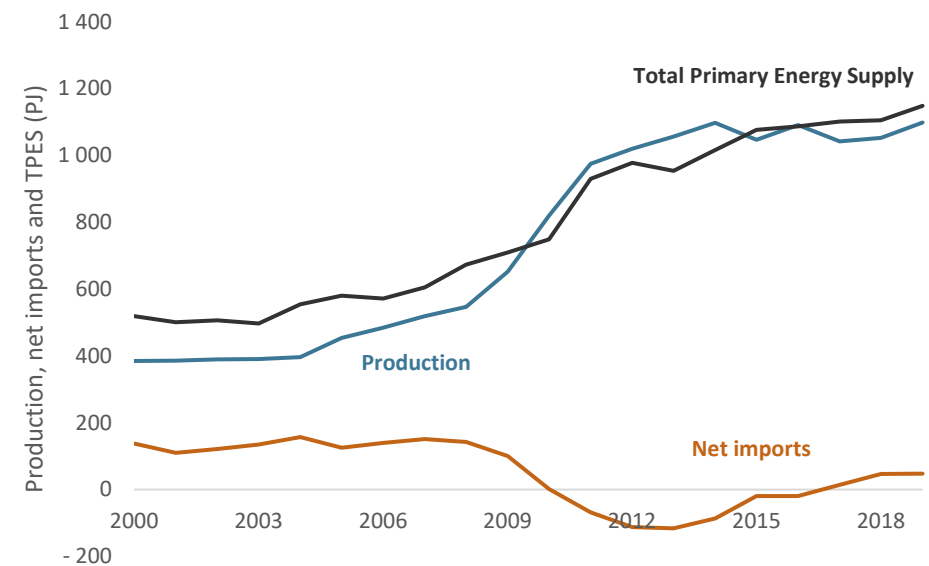
Diesel and gasoline are consumed mainly in transport, the biggest energy consuming sector in Peru. Because of the complex geography and the lack of refuelling infrastructure, the use of alternative vehicle fuels is still challenging. However, conversion of conventional vehicles to vehicular LPG and natural gas can be observed.

By May 2021, installed renewable energy capacity could be broken down into solar capacity with 289 megawatt (MW), wind capacity with 409 MW, biomass with 170 MW and biogas with 13 MW. Most of this capacity is the result of four renewable energy auctions that Peru held between 2009 and 2016. In 2021, new renewable energy projects, mainly wind and solar, were announced by several companies outside the auction scheme. The construction of these projects is expected to begin in 2022.

Total Primary Energy Supply

Peru's total primary energy supply (TPES) was 1 149 PJ in 2019, 4% higher than in 2018. This growth continues to show the increasing trend observed from 2010 to 2019.

Figure 1: Peru's total primary energy supply, production and net imports, 2000 to 2019



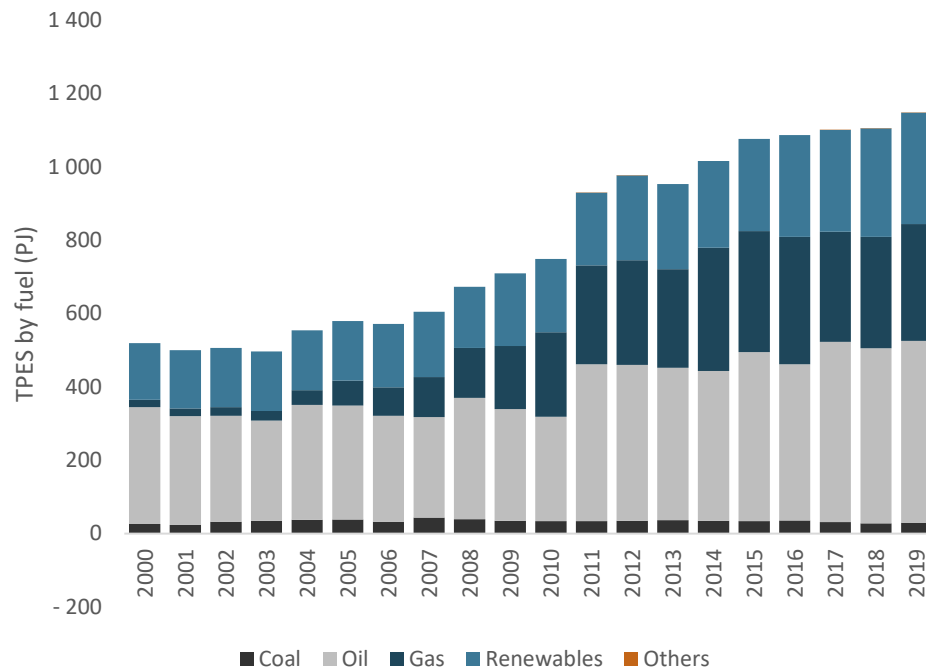
Source: EGEDA (2021)

APEC ENERGY OVERVIEW 2022

Energy supply growth was driven by the increase of oil (4%) and gas (5%) supply (Expert Group Energy Data Analysis [EGEDA], 2021). Additionally, indigenous production reached 1 099 PJ in 2019, a growth of 4% from 2018. Peru was a net energy importer in 2019 with 47 PJ of net imports and representing 4% of the economy's TPES.

In 2019, Peru was a crude oil importer because domestic production was insufficient to meet domestic demand. Domestic oil production supplies approximately 30% of crude oil consumed in local refineries (MINEM, 2021a).

Figure 2: Peru's total primary energy supply by fuel, 2000 to 2019

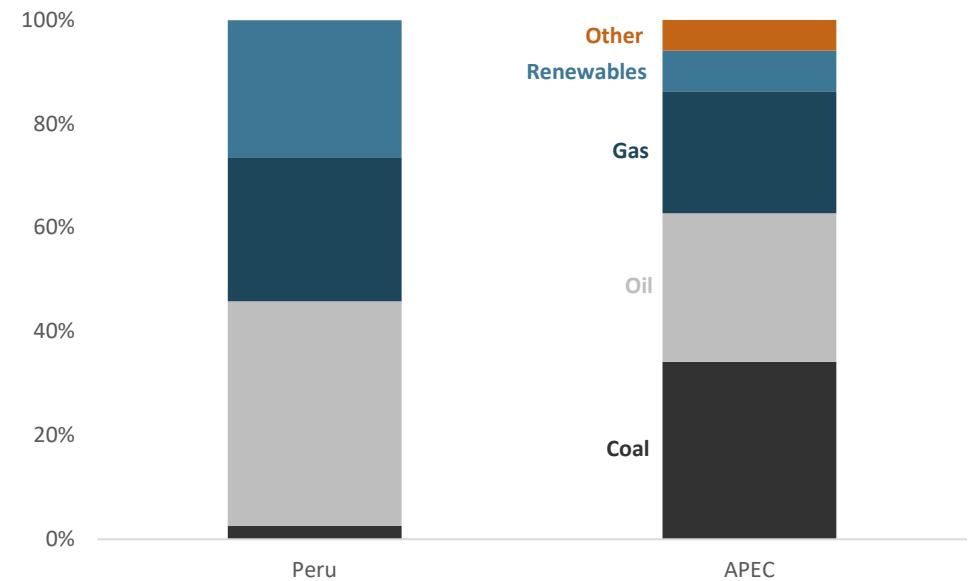


Source: EGEDA (2021)

Oil represents the largest share of TPES (43%) followed by renewables (26%), mainly hydro and fuelwood, natural gas (28%), and coal (3%).

Since the launch of the Camisea Gas Project in 2004, the share of natural gas in the Peruvian energy mix has increased at 4.8% annual growth rate. This increase is the consequence of the increase of natural gas consumption in electricity generation and direct consumption in the industry and residential sectors. In 2019, natural gas residential connections reached 1.1 million, surpassing the 1 million connection goal for that year according to the Ministry of Energy and Mines (2020, December 28).

Figure 3: Total primary energy supply relative fuel share—Peru and APEC, 2019



Source: EGEDA (2021)

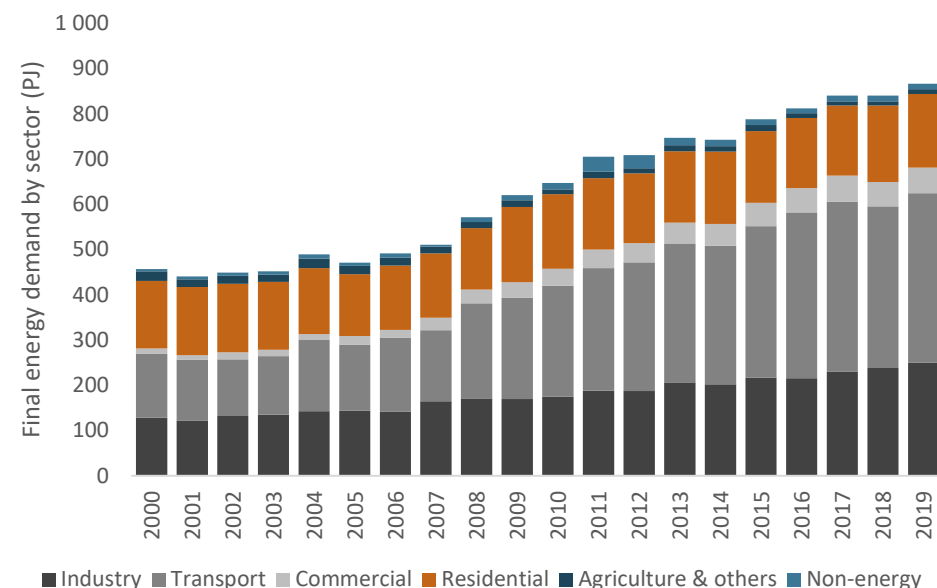
When compared to the entire APEC region, Peru exhibits a different fuel mix (Figure 3), where the share of renewables is larger due to hydro energy being utilised in the power sector and in the residential sector, mostly as fuelwood. Total renewable energy supply in Peru in 2019 was 303 PJ, which represents 26% of Peru's TPES. Production increased by 2.5% from the previous year (296 PJ), with a growth in hydro and modern biomass (EGEDA, 2021).

Total Final Consumption

Total final consumption (TFC) in Peru was 866 PJ in 2019. Transport is the dominant end-use sector, accounting for 371 PJ or 43% of all end-use energy consumption (including non-energy) in 2019, which is an annual growth of 5%. The industrial sector is the next largest, consuming 250 PJ or 29% of TFC, which is an increase of 5% from 2018. Residential energy demand fell 3% in 2019, though it remains the third-largest sector, consuming 163 PJ or 19% of TFC (EGEDA, 2021).

The economic growth Peru experienced during the late-2010s drove increased activity in the industrial and transport sectors. There was also an increase in energy efficiency in the residential sector due to the displacement of traditional biomass stoves with more efficient fuels and technologies (Figure 4).

Figure 4: Peru's final consumption by sector, 2000 to 2019

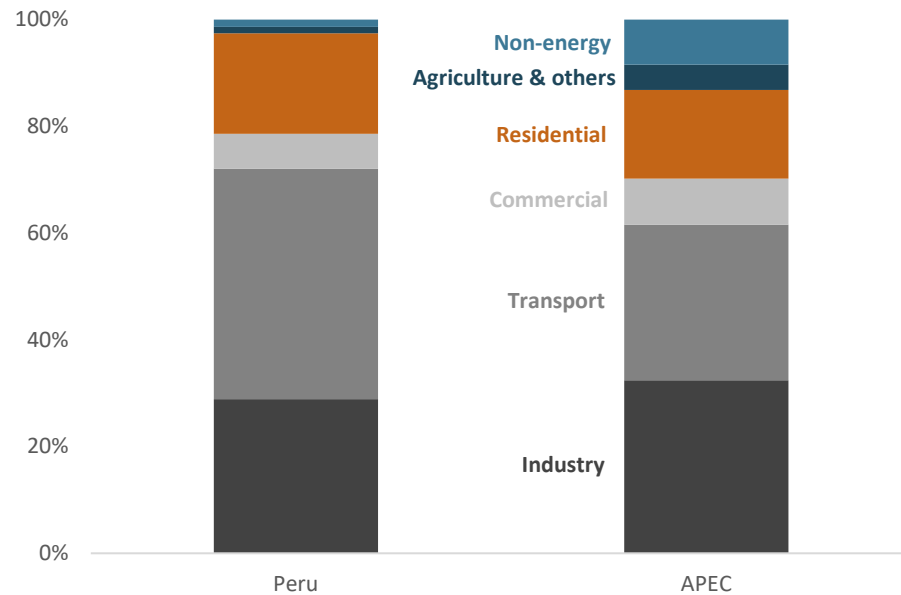


Source: EGEDA (2021)

Peru's transport energy demand share is notoriously larger than other APEC member's (Figure 5), a situation that is incited by the challenging geography and insufficient transport infrastructure. Peru has started to design and implement the legal framework that is needed to promote and regulate the construction of charging stations for electric vehicles. In parallel, Peru is funding the conversion of conventional gasoline and LPG vehicles to natural gas vehicles through the BonoGas program.

APEC ENERGY OVERVIEW 2022

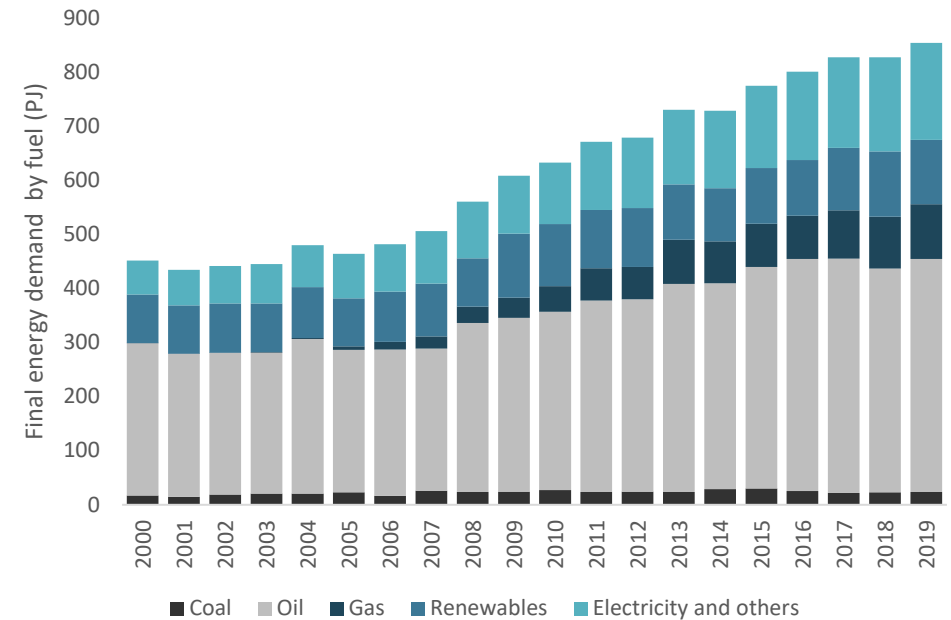
Figure 5: Final energy demand sectoral share—Peru and APEC, 2019



Source: EGEDA (2021)

Figure 6 shows the weightage of fossil fuels in Peru's final energy demand (FED). Oil and oil products represent 431 PJ, 50% of FED excluding non-energy. The transport sector is responsible for a big part of this demand. Renewables represent 119 PJ, or 14% of FED. In Peru, it is mandatory that diesel and gasolines are mixed with biodiesel and ethanol, respectively, to be commercialised in several important regions, including Lima. Electricity and others account for 179 PJ, or 21% of FED, while natural gas consumption is 102 PJ or 12% of FED. It is important to highlight that most natural gas is used in electricity generation. So, the actual share of natural gas might be higher if that transformation is considered (EGEDA, 2021).

Figure 6: Peru's final energy demand by fuel, 2000 to 2019

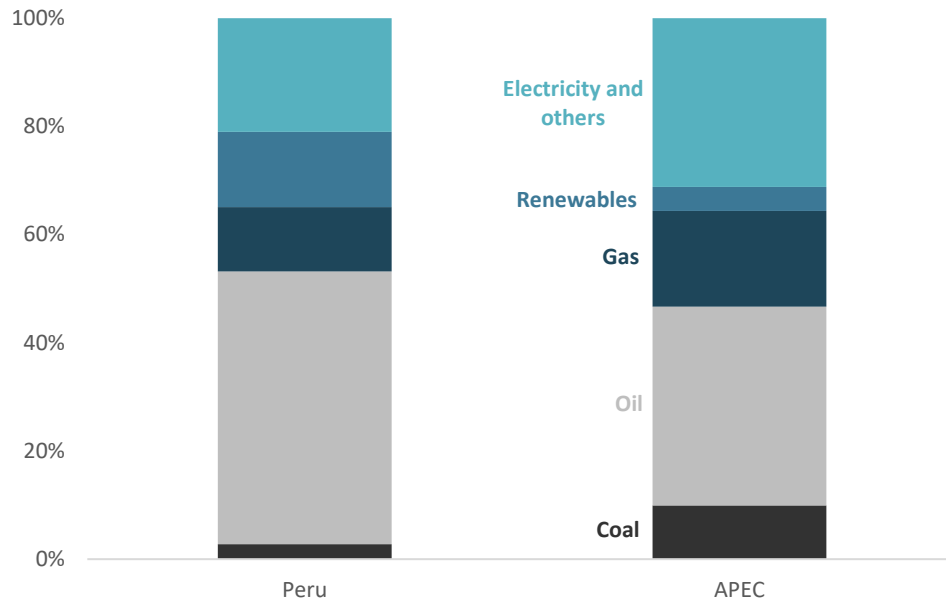


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

The contribution of renewable energy to the economy's FED is higher than in the APEC region; however, this is due to the high share of contaminated traditional biomass in cooking in rural and isolated regions of Peru. The Peruvian government is implementing policies to reduce fuelwood consumption for cooking and to extend the use of natural gas in households in different regions. As such, it is expected that the FED share will decline to a level that is closer to the share for the entire APEC region.

Figure 7: Final energy demand fuel shares—Peru and APEC, 2019



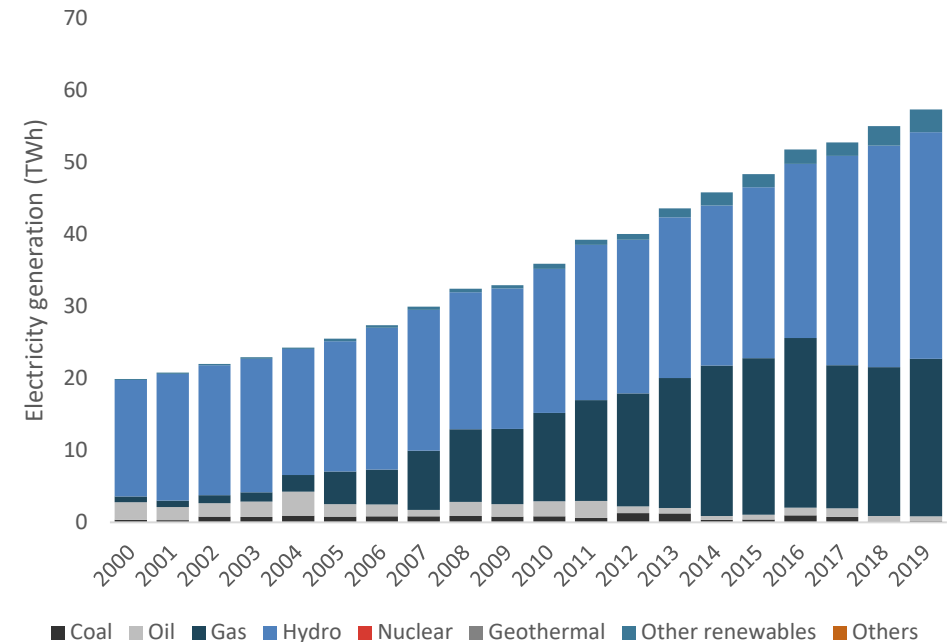
Source: EGEDA (2021)

Transformation

In 2019, Peru's electricity generation totalled 57 327 gigawatt-hours (GWh), an increase of 4.2% from 2018. Of this, 60% came from renewable sources, 38% from natural gas, 1.2% from oil and 0.3% from coal (EGEDA, 2021). In 2019, the power sector consumed around 55.8% of the natural gas available for domestic consumption.

Coal has marginal participation in electricity generation. Peru generates greater amounts of renewable energy than APEC (60% in 2019), mainly due to hydro generation. Other renewables, including solar photovoltaic, wind and biomass, account for 6% of electricity generation.

Figure 8: Peru's electricity generation by fuel, 2000 to 2019

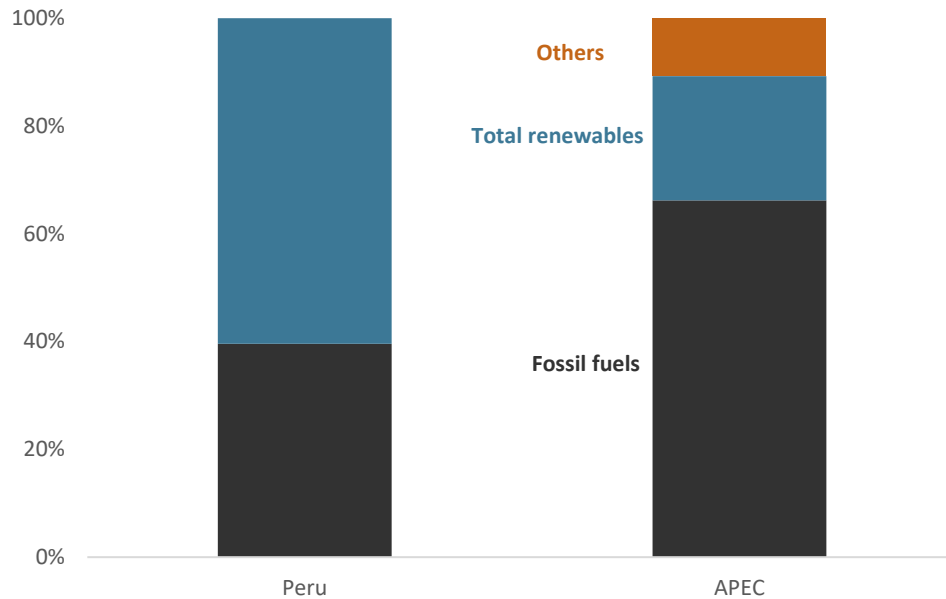


Source: EGEDA (2021)

Figure 9 illustrates the Peruvian electricity generation mix. Most of the fossil fuels shares corresponds to natural gas, which make up 93% of total fossil fuels (MINEM, 2021a). Most of the renewable energy corresponds to hydro, contributing to 93% of total renewables.

Peru still has big renewable energy potential to exploit. The MINEM has identified 58 gigawatt (GW) of potential hydro development, 28 GW of potential wind developments and 3 GW of potential geothermal developments throughout its territory. The National Renewable Energy Lab (NREL) has also identified 260 GW solar PV potential and 136 GW of concentrated solar power (CSP).

Figure 9: Electricity generation by fuel share—Peru and APEC, 2019



Source: EGEDA (2021)

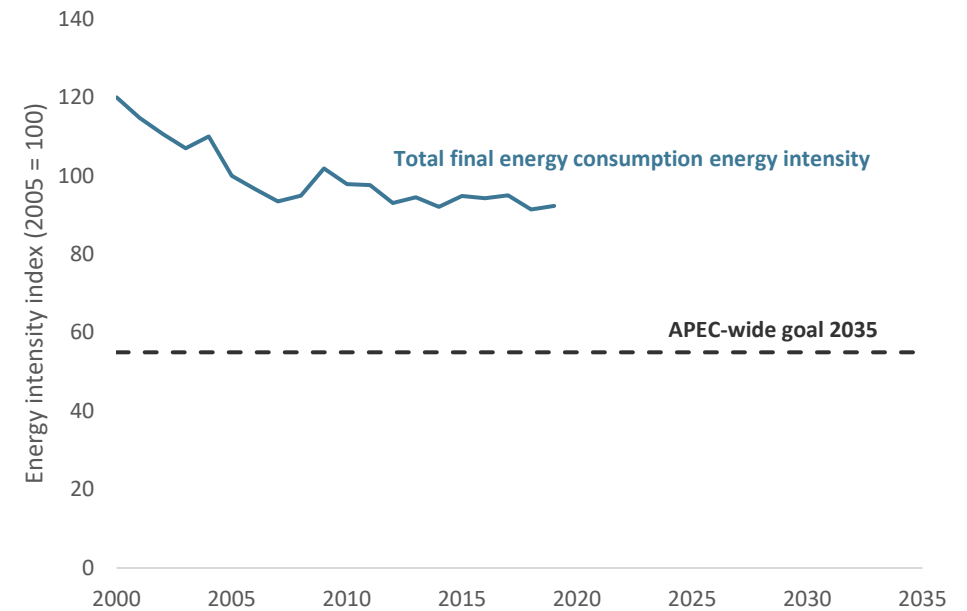
APEC Goals

Energy Intensity Goal

Despite its size, Peru is one of the smallest energy consumers in APEC, ranking 18th of the 21 APEC economies in both absolute and per capita values.

Peru's energy intensity, measured as total final energy consumption intensity (not including non-energy), has been declining since 2000 (Figure 10). APEC has a goal of a 45% reduction from the 2005 level by 2035, though there are no economy-level commitments. In 2019, Peru reduced its energy intensity by 8% with respect to the 2005 level.

Figure 10: Peru's total final energy consumption intensity index, 2000 to 2019



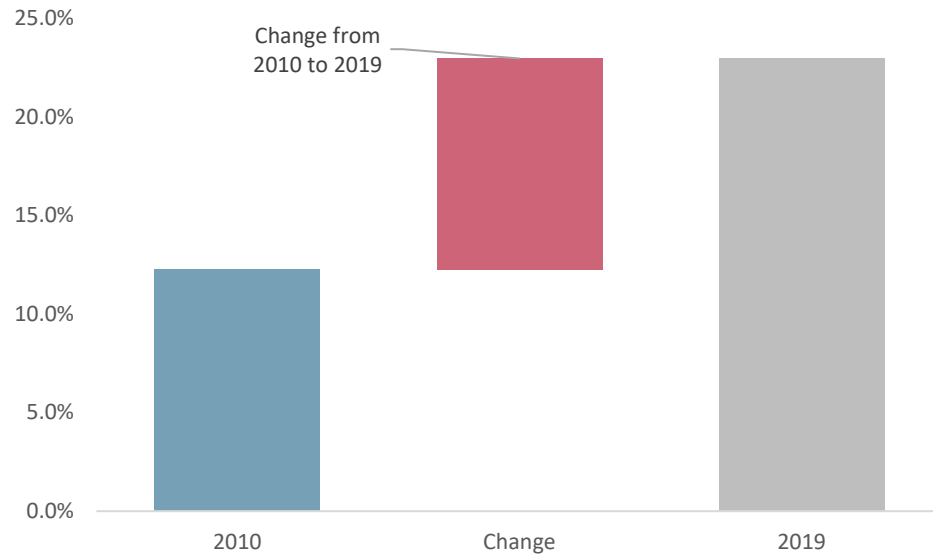
Source: EGEDA (2021)

Doubling of Renewables

There is a second energy goal that involves doubling the share of renewables in the APEC energy mix for 2010–2030. This goal is not for each individual member, but the members contribute to the APEC's goal by increasing the share of renewables in their economies.

Modern renewables do not include traditional biomass, and their share is relative to final energy consumption. Peru's contribution to that goal can be observed by the increase in the share of renewables from 12.2% in 2010 to 23% in 2019.

Figure 11: Peru's modern renewable energy share, 2010 and 2019



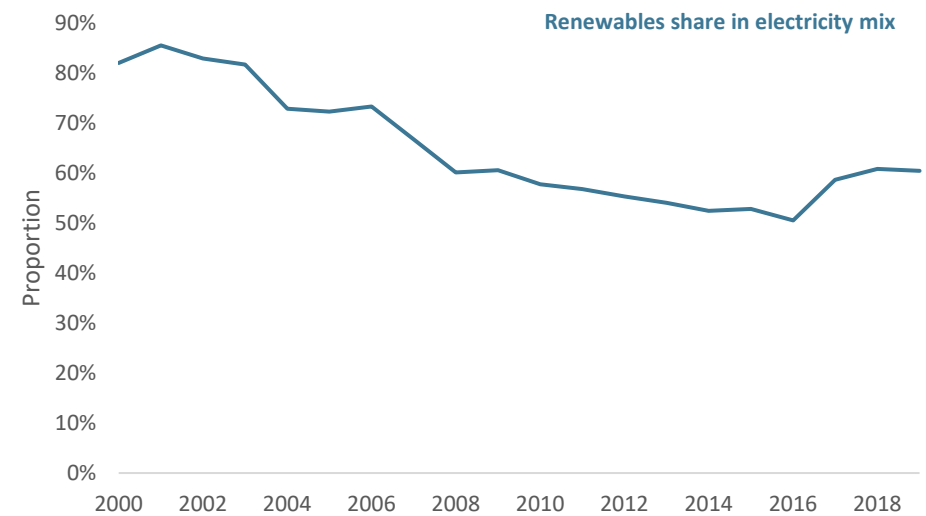
Source: EGEDA (2021)

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.

Thus, the Peruvian electricity mix has a high share of renewable energy, mainly hydro. The declining trend observed from the early 2000s to 2016 is due to the installation of natural gas-fuelled power plants that were

promoted because of the policies implemented to develop a domestic natural gas market. In 2016, there was an increase in the share of renewables due to the operation of new hydro plants such as Cerro del Águila and Chaglla, with a combined capacity of 1 GW, and the addition of solar, wind, small hydro and biomass projects as the result of renewable energy auctions.

Figure 12: Share of renewables in electricity mix, 2010 and 2019



Source: EGEDA (2021)

Energy Policy

Energy Policy	Details	Reference
<u>Natural gas massification</u>	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.	<u>ProInversion</u>
<u>Modernisation of Talara Refinery</u>	The project involves the construction and extension of facilities aimed at increasing refining capacity from 65 000 to 95 000 barrel per day (bpd) by 2022, producing cleaner fuels, reducing imports of such products, and thereby improving Peru's trade balance.	<u>Petroperú</u>
<u>Increase in hydrocarbon production</u>	The purpose of the plan is to increase oil production to 100 000 bpd and natural gas production to 1 500 millions of standard cubic feet per day (MM SCFD) by 2023. Investment 2019–2023: USD 3 935 million	<u>Perupetro</u>
<u>2021 to 2030 Transmission Plan</u>	The transmission plan, elaborated by the Comité de Operación Económica del Sistema (COES) and approved by the MINEM, defines a list of projects that reinforces the electric transmission grid. The estimated investment is USD 981 million.	<u>Ministry of Energy and Mines</u>
<u>National plan for rural electrification</u>	The objective of the Rural Electrification Plan is to achieve the reduction in greenhouse gas emissions through the use of renewable energy in rural areas for the provision of electricity. In 2018, rural electrification reached 86.7%; economy-wide electrification was 92%. The policy target is to reach 100% by 2022. In addition, residential natural gas access through domestic pipelines reached 16.4% in 2019.	<u>Ministry of Energy and Mines</u>
<u>The Southern Peruvian gas pipeline</u>	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)	<u>Ministry of Economy and Finance</u>
<u>Vehicular natural gas program</u>	Through the program “Ahorro GNV”, the government will fund the conversion of gasoline and LPG vehicles to natural gas for vehicles. The conversion of 74 buses for public transportation.	<u>Ministry of Energy and Mines</u>
<u>Electric vehicles charging infrastructure</u>	Peru has approved the statutory provisions for charging infrastructure and electricity supply for electric vehicles. A proposal for specific regulation for the installation and operation of electric vehicle charging stations has been presented.	<u>Ministry of Environment</u>
<u>Energy efficiency audits</u>	In 2021, Peru approved legal requirements for energy efficiency audits to promote energy efficiencies in public and private buildings.	<u>Ministry of Environment</u>

<u>Energy efficiency labelling regulation</u>	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 the using the labels was postponed.	<u>Ministry of Energy and Mines</u>
<u>Energy efficiency standards</u>	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.	<u>Ministry of Energy and Mines</u>
<u>National Determined Contributions (NDCs)</u>	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.	<u>Ministry of Environment</u>

Notable Energy Developments

Energy development	Details	Reference
<u>MINEM will continue with the 7 Regiones Project</u>	After the 7 Regions contract was not awarded, the government decided the MINEM would develop the required infrastructure in two phases: the first one includes Ayacucho, Ucayali and Cusco and the second one includes Puno, Junín, Huancavelica and Abancay.	<u>Ministry of Energy and Mines</u>
<u>2021 Annual Promotion Program</u>	The MINEM approved a new natural gas massification project to be implemented in 2021. The BonoGas Residencial program will reach an additional 285 000 houses, and the BonoGas vehicular will reach 18 500 users in 2021.	<u>Ministry of Energy and Mines</u>
<u>Shutdown of Talara Refinery</u>	Modernisation of the Talara Refinery required it to be shut down since 2020. The new refinery is expected to be operational by April 2022.	<u>Ministry of Energy and Mines</u>
<u>Renewable Energy Projects</u>	In 2021, four renewable energy projects entered into operation: hydroelectric project Manta (20 MW), biomass project Callao (2.4 MW), and wind projects Huambo (18.4 MW) and Duna (18.4 MW).	<u>Ministry of Energy and Mines</u>

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Useful Links

Government Institutions

Ministerio de Energía y Minas—<https://www.gob.pe/minem>

Ministerio del ambiente—<https://www.gob.pe/minam>

Osinergmin—<https://www.osinergmin.gob.pe/>

Comité de Operación Económica del Sistema Interconectado Nacional—<https://www.coes.org.pe/>

Instituto Nacional de Estadística e Informática—<https://www.inei.gob.pe/>

Banco Central de Reserva del Perú—<https://www.bcrp.gob.pe/>

Energy Associations

National Society of Mining, Oil and Energy—<https://www.snmpe.org.pe/>

National Society of Industries—<https://sni.org.pe/>

The Philippines

Introduction

The Philippines is an archipelago comprised of 7 641 islands and with a total land area of 343 448 square kilometres (km²) (gov.ph, 2021). It is divided into three main island groups that also correspond to the three major electricity grids – Luzon, Visayas and Mindanao; Manila City in Luzon is the capital of the Philippines.

The Philippines is one of the economies in APEC that frequently experiences natural calamities such as typhoons and earthquakes. To address this and build a resilient energy infrastructure, the government, through the Department of Energy (DOE), institutionalised the Energy Resiliency Policy (ERP). The implementation of ERP aligns the plans and programs of all energy industry players with the resiliency goals of the economy. Along with the ERP, the National Energy Contingency Plan was developed to address oil and electricity supply disruptions (DOE, 2020). In Asia-Pacific Economic Cooperation (APEC), to promote energy resiliency, the Energy Resiliency Task Force was created which the Philippines co-chairs with the United States.

The economy and energy sources

The Philippines is one of the fast-growing economies in Southeast Asia. The average growth rate of its GDP increased to 6.3% in the 2010–2019 period from an average of 4.5% in 2000–2009. The GDP increased by 6.1% to USD 964 billion (2017 USD purchasing power parity [PPP]) from 2018 to 2019 (World Bank, 2021b). Economic growth was facilitated by strong consumer demand supported by a vibrant

labour market and robust remittances. Business activities were likewise buoyant and showed notable performance in the services sector, including the business process outsourcing, real estate, tourism, and finance and insurance industries (World Bank, 2021a). The Philippines population in 2019 rose by 1.4%, reaching 108 million people. While among the lowest in APEC, GDP per capita maintained strong growth in the 2010–19 period and increased by 4.7% to USD 8 915 (2017 USD PPP) in 2019.

Table 1: The Philippines’ Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^c	
Area (thousand km ²)	343	Oil (million barrels)	96.6
Population (million)	108.1	Gas (billion cubic feet)	637
GDP (2017 USD billion PPP)	963.8	Coal (million tonnes) ^d	2 367
GDP per capita (2017 USD PPP)	8 915	Uranium (kilotonnes U < USD 130/kgU)	

Sources: ^agov.ph, ^b(World Bank, 2021b), ^{c, d}(DOE, 2021)

Note: Oil and gas reserves data were as of June 2021.

The Philippines’ modest sources of oil, gas and coal continue to play an important role in the economy’s energy security. In terms of production, in 2019, 775.9 thousand barrels of oil, 155.7 billion standard cubic feet (BCF) of gas and 4 million barrels (MMB) of associated condensate were realised, while 700.1 thousand barrels of oil, 141.5 BCF of gas and 3.4 MMB of associated condensate were recovered in 2020. Meanwhile, coal production declined by 13.2% to 13.3 MMT in 2020

(DOE, 2021), and the Philippines continued to harness its vast renewable energy resources. To date, the economy is the third-largest geothermal energy producer in the world with 1 928 megawatts (MW) of installed geothermal power capacity. Relatedly, geothermal energy (25.5%) is the economy’s second biggest power source in terms of installed capacity, following hydropower (39.9%) (IRENA, 2021).

Response to COVID-19

The COVID-19 pandemic heightened the inequalities and vulnerabilities among Filipinos, prompting the government to develop related policies. Among the key programs of the national government to mitigate the impact of the COVID-19 pandemic was the issuance of *Bayanihan*⁴ 1, 2 and 3 in 2020, consisting of the Republic Act (RA) 11469 or the *Bayanihan to Heal as One Act*, also known as *Bayanihan 1*; the *RA 11494 or Bayanihan 2 and House Bill 9411 or Bayanihan 3*. In general, the *Bayanihan* provides emergency (financial) subsidy, social amelioration, livelihood interventions and food security and health interventions, among others (PIDS, 2021).

Bayanihan 1 and *2* likewise provide emergency measures that are applicable to the entire electric power value chain, including generation companies, transmission utilities, distribution utilities and suppliers. Grace period of payments without interest are allowed for both consumers (for electricity consumption) and power companies (for obligations and taxes).

Further, the government ensures compliance with the Minimum Inventory Requirement of a 30-day supply of crude oil and finished products (combined), a 15-day supply of finished products, and a seven-day supply of LPG, respectively, for refiners, bulk oil suppliers and LPG importers without refining capacity (DOE, 2020).

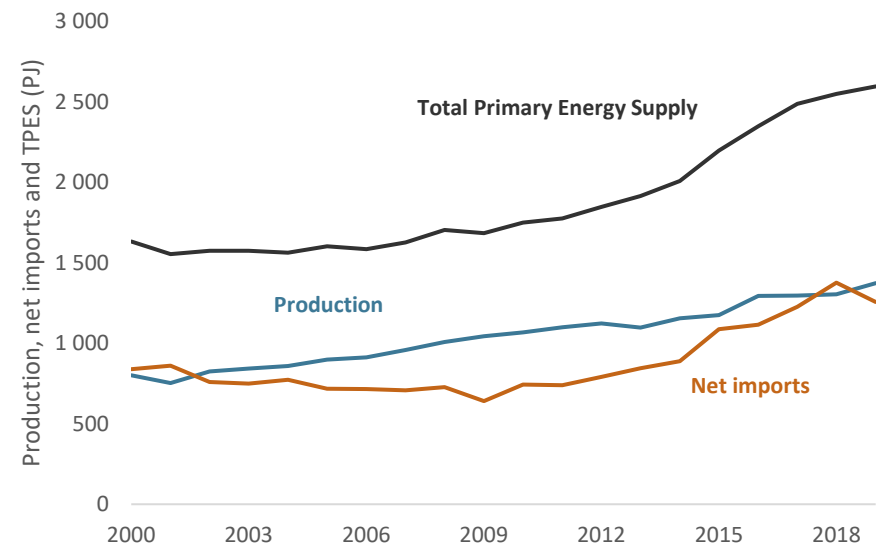
⁴ Bayanihan was coined from the Filipino root word “bayani”, meaning hero. It denotes

Energy Supply and Consumption

Total Primary Energy Supply (TPES)

The Philippines was historically a net importer, although the level of net imports dropped by 8.7% from the year 2018 to 2019, marked by significant declines in bioethanol (-18.3%) and oil (-6.8%) imports. The economy’s indigenous resources provided more than 50% of its energy requirements, most of which were renewables (65% of total production). Its total primary energy supply in 2019 was 2 595 PJ, marking a 1.8% increase from the 2018 level (Figure 1).

Figure 1: The Philippines’ total primary energy supply, production, and net imports, 2000–2019



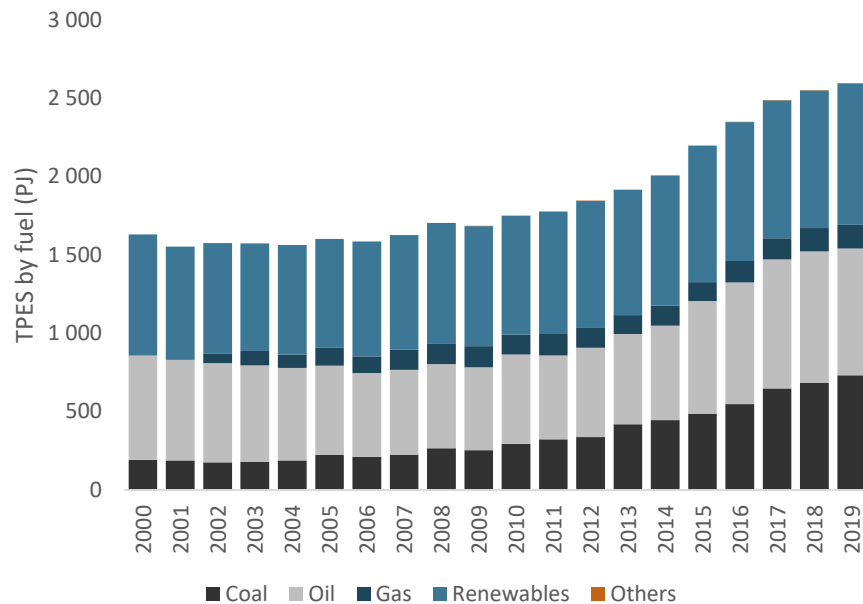
Source: EGEDA (2021)

a spirit of civic unity and cooperation or solidarity among Filipinos.

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As a result of low importation, oil supply fell by 3.5% in 2019, but its TPES share was still significant (31%). Other energy sources and coal were the main contributors to the rise in TPES, with 17% and 6.9% growth, respectively (EGEDA, 2021) (Figure 2). In preparation for the natural gas depletion by 2027, the Philippines DOE spearheaded the establishment of the LNG infrastructures necessary to ensure the continuous supply of gas, especially for power generation. Between 2018 and 2020, the DOE approved and issued the “*Notice to Proceed*” permits, authorising the development and construction of three (3) LNG Regasification Terminal projects in Batangas and one (1) in Quezon (DOE, 2020).

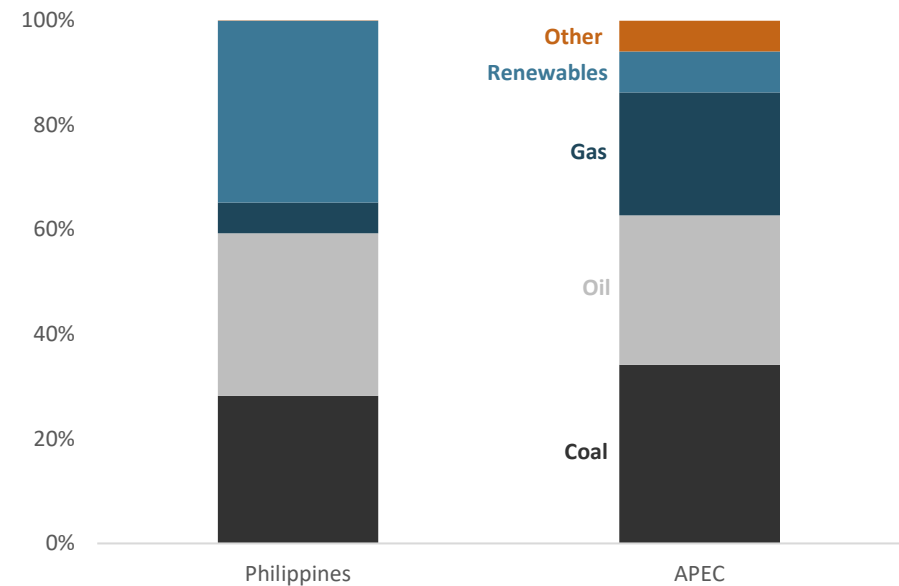
Figure 2: The Philippines’ total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

The Philippines’ energy sources are relatively small when compared to other APEC economies. With regard to relative shares by fuel in 2019, as Figure 3 shows, the economy had a much bigger relative share of renewables to TPES than the entire APEC region. Gas share was relatively small, but oil was almost at par with the relative share of APEC. The relative share of coal to TPES was small compared with APEC but relatively significant in the Philippines’ TPES.

Figure 3: Total primary energy supply relative fuel share – the Philippines and APEC, 2019



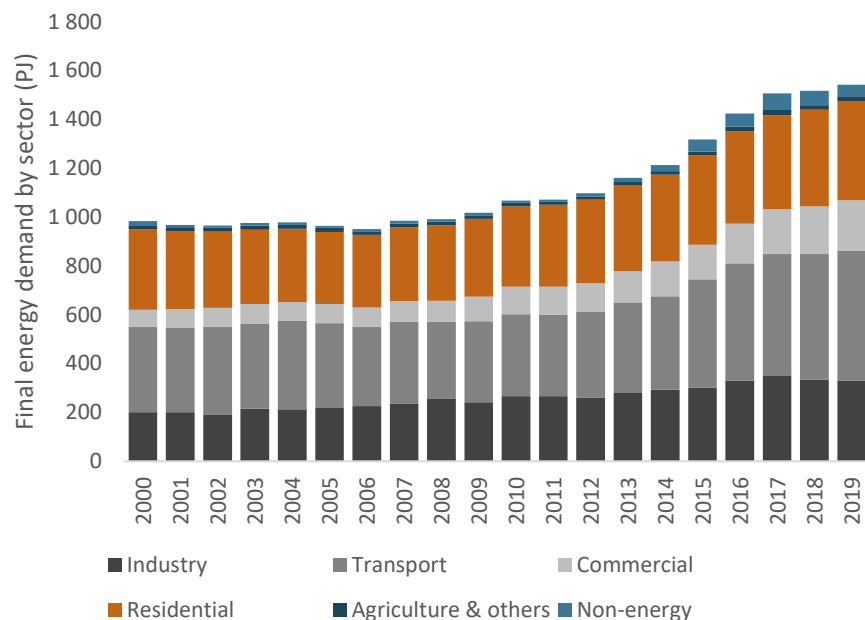
Source: EGEDA (2021)

Total Final Consumption

The Philippines’ total final consumption (TFC; including non-energy use) grew by 1.6% to 1 543 PJ in 2019 (Figure 4). Excluding non-energy use, total final energy consumption (TFEC) grew by 2.5% to 1

495 PJ in 2019 (EGEDA, 2021). The fuel consumption trends of the Philippines in 2019 were influenced mostly by smaller sectors. Consumption for non-energy use plunged dramatically to less than 48 PJ in 2019 (-20%) after showing strong growth in the past. This was the second year that non-energy consumption dropped due to the call to reduce single-use plastics, which led to the decline in the volume of fuels used as feedstock and raw materials for industries (DOE, 2019). Meanwhile, the agriculture (and others) sector saw a contraction in the previous year that drove the increase in the economy's final consumption in 2019 by 7.3% to almost 20 PJ. This was spurred by a heightened demand in agricultural activities such as crop production as well as in livestock and poultry sectors in 2019 (DOE, 2019).

Figure 4: The Philippines' final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

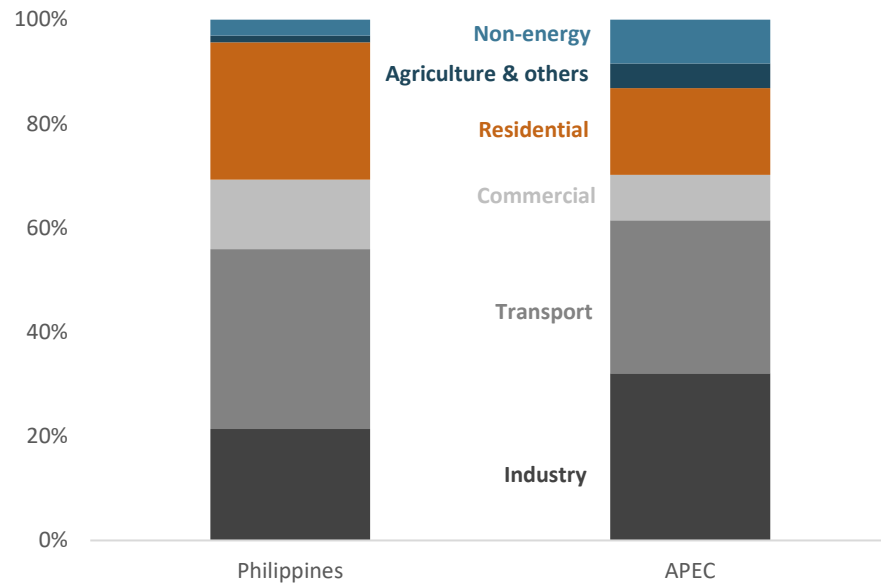
The transport sector continued to account for the highest share (35%) of the economy's total consumption and grew by 3.7% to 533 PJ in 2019. Consumption in the building sector (combining the residential [26% of TFC] and commercial sectors [13% of TFC]) went up by 3.7% in 2019, mainly driven by the significant increase in the services sector (5.3%). The industry sector, however, saw a decrease for the second consecutive year, with a 1.6% drop to 330 PJ in 2019. This was propelled mostly by lower energy demands in the energy-intensive sub-sectors of industry, such as food processing, cement production, paper production and printing, chemicals, basic metals and machineries (DOE, 2020).

The energy consumption levels of the transport, residential and commercial sectors in the Philippines were relatively higher than that of the APEC, as seen in Figure 5. The increasing per capita income raised the purchasing capacity of consumers. Increased volumes of vehicles, domestic tourism and affordable tour packages and fares drove the surge in transportation consumption. Although traditional biomass use was still popular, a greater number of households gained access to electricity, which boosted electricity consumption in the residential sector. The service sector continued to play an important role in the Philippines, as the performance of retail trade, financial institutions and hotel and restaurant activities continued to be robust.

In contrast, the industry and non-energy sectors in the Philippines were relatively small compared with APEC, which was reflected by the reduced fuel consumption in the manufacturing of consumer goods.

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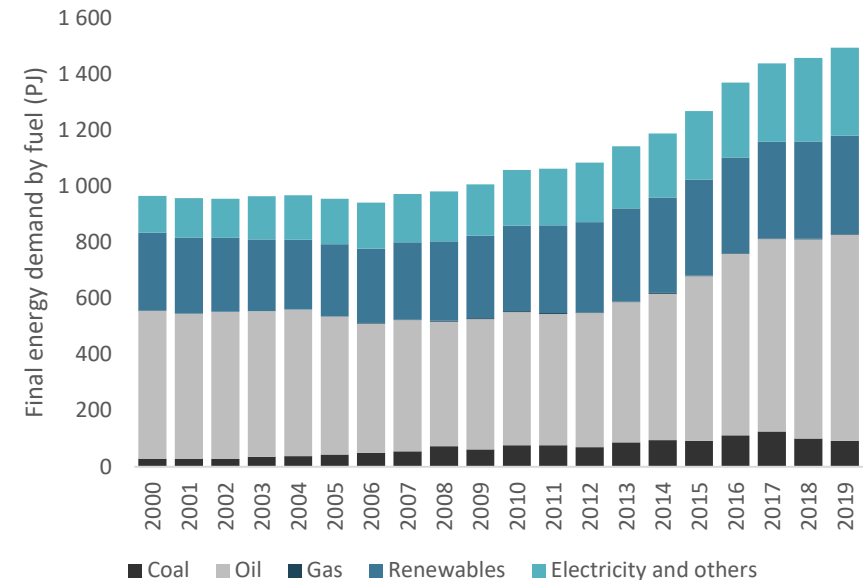
Figure 5: Final consumption sectoral share – the Philippines and APEC, 2019



Source: EGEDA (2021)

In terms of fuel source, electricity drove TFEC growth by 5.4% to 314 PJ, and it was the third (21%) most utilised fuel in 2019 (Figure 6). The household and industry sectors each accounted for more than one-third of electricity consumption. Oil (49%) accounted for the bulk of TFEC as transport activities grew significantly. Renewables comprised 23% of TFEC and were the second most consumed type of energy in 2019. Traditional biomass was largely used in the household sector, especially in rural areas, as biomass was used for cooking, lighting and heating. Coal (-8%) consumption declined for the second consecutive year, driven by a significant slump in construction activities and the associated lower production of cement (which relies heavily on coal).

Figure 6: The Philippines' final energy demand by fuel, 2000–2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption.

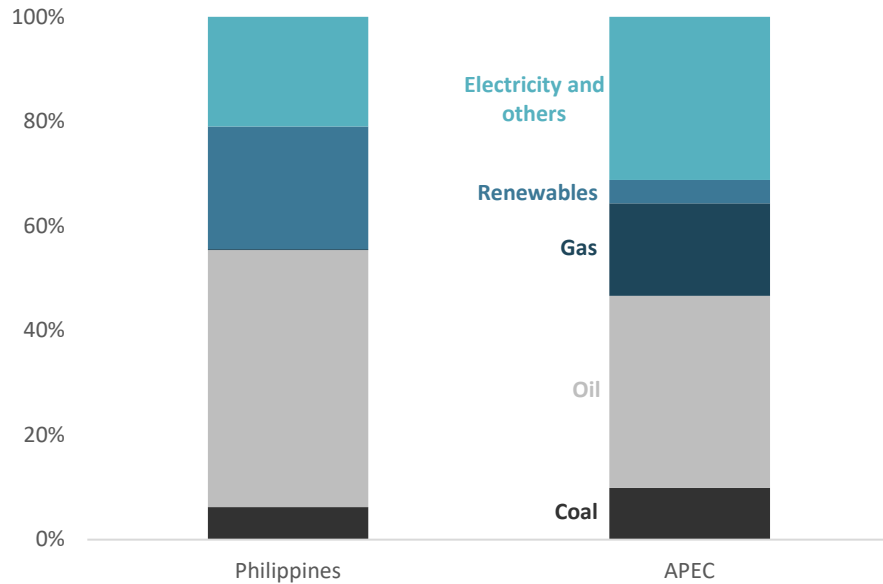
The Philippines' oil and renewables shares to TFEC were relatively larger than APEC (Figure 7)

The relative share of electricity in the Philippines was not as high as that of the APEC, but it was still significant. Electricity demand was almost evenly spread across industry, household and commercial activities.

The relative share of coal was relatively small compared to that of the APEC, as coal demand was limited to a small sub-sector of industry in the Philippines. The relative share of gas was insignificant because the Philippines only has a domestic source of gas that is predominantly

used for power and a smaller portion used for industry activities.

Figure 7: Final energy demand fuel shares – the Philippines and APEC, 2019



Source: EGEDA (2021)

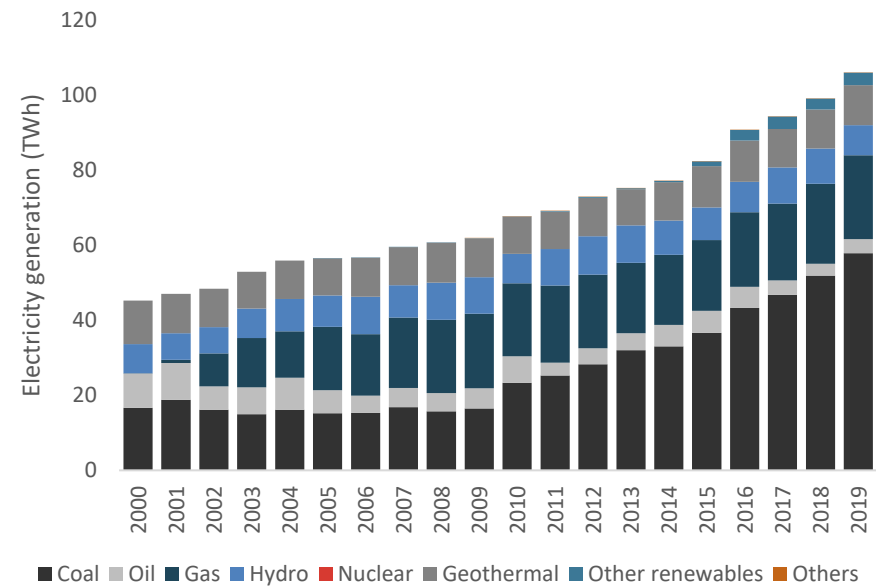
Transformation

Electricity generation in the Philippines notably grew by 6.9% to 106 TWh in 2019 (Figure 6). Electricity output from oil, which experienced a contraction in the previous year, rebounded by 18.3%. However, the new coal-fired power plants and associated 11.2% growth in coal were what supported the increase in electricity generation. Coal accounted for 55% of the generation mix in 2019, followed by gas, which accounted for 21%.

Geothermal sources accounted for the third largest share of energy generation with 10%. Electricity output from the other main renewable

source, namely hydro, declined by 14.5% in 2019, which was attributed to the El Niño phenomenon affecting hydro production. Electricity output from non-renewable wastes increased significantly (16.9%) and contributed a small amount to electricity generation growth.

Figure 8: The Philippines' electricity generation by fuel, 2000–2019

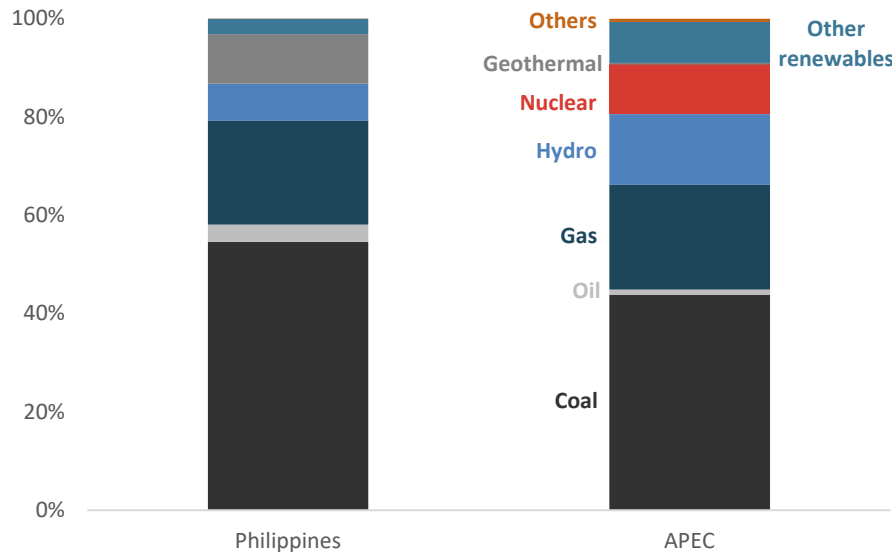


Source: EGEDA (2021)

The Philippines is recognised as the third largest producer of geothermal energy in the world, and its relative share compared to APEC was more than evident in 2019, as shown in Figure 9. Similarly, coal and oil continued to play important roles in the economy's electricity generation, and their relative shares were larger than those of the APEC. Meanwhile, the Philippines' own natural gas resources for power generation placed the economy's relative share of gas at par with the 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: Electricity generation by fuel share – the Philippines and APEC, 2019



Source: EGEDA (2021)

APEC Goals

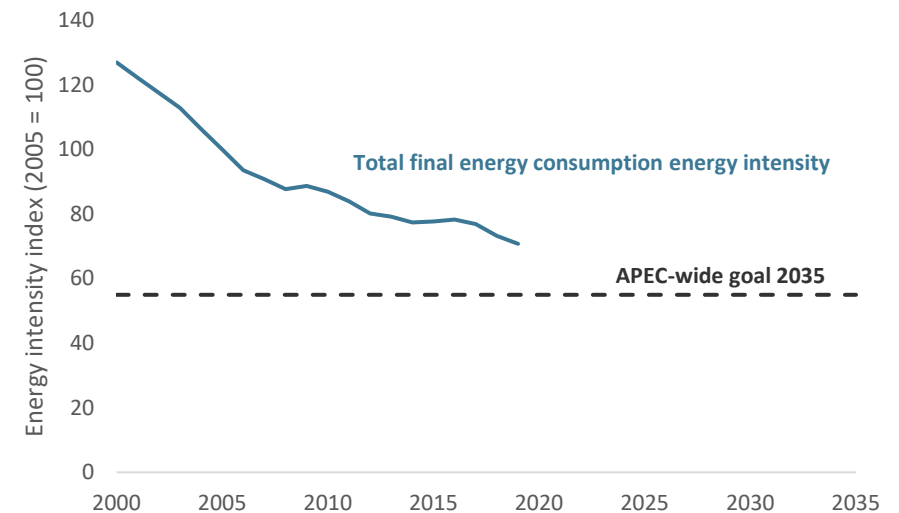
There are two energy-related objectives that APEC member economies have agreed to as a collective: to improve energy intensity by 45% in 2035 as compared to 2005 and to double the share of modern renewables in the energy mix by 2030 as compared to 2010. The goals do not impose on the individual economy targets. Nevertheless, the Philippines is working towards the achievement of these goals in its own energy portfolio.

Energy Intensity Goal

In 2011, the APEC member economies agreed to increase their ambitions and 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 achieving this energy intensity improvement.

In 2018, the Philippines' TFE (not including non-energy use) energy intensity had improved by 29%, relative to 2005. The 2% intensity improvement from the previous year further confirms the economy's commitment to improving its energy intensity level, as shown in Figure 10. Energy intensity relative to total primary energy supply and final consumption, which includes the non-energy sector's consumption of energy products, shows similar improvements.

Figure 10: The Philippines' total final energy consumption intensity index, 2000–2019 (2005 = 100)

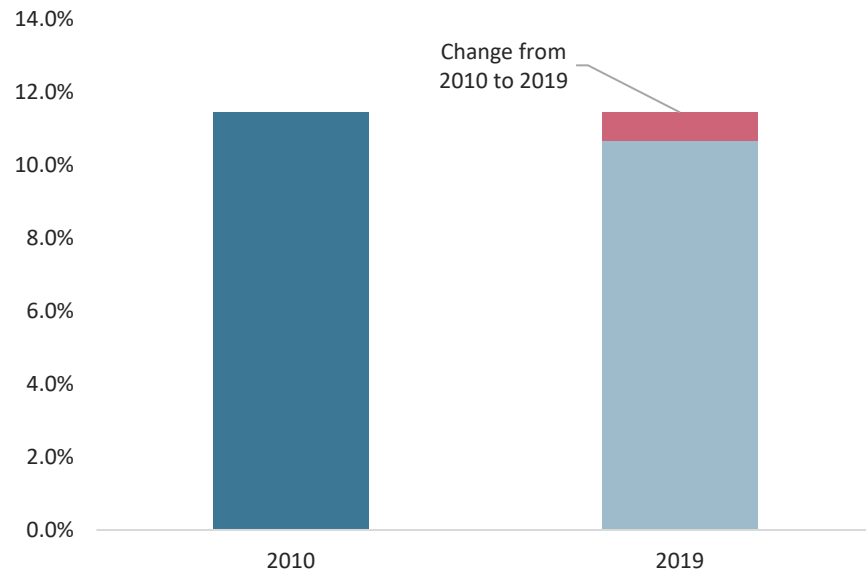


Source: EGEDA (2021)

Doubling of Renewables

The second energy goal involves doubling the share of modern renewables in the APEC energy mix during the 2010–2030 period. The Philippines also has its own target to increase renewables, and this can contribute to the APEC’s doubling goal.

Figure 11: The Philippines’ modern renewable energy share, 2010 and 2019



Source: EGEDA (2021)

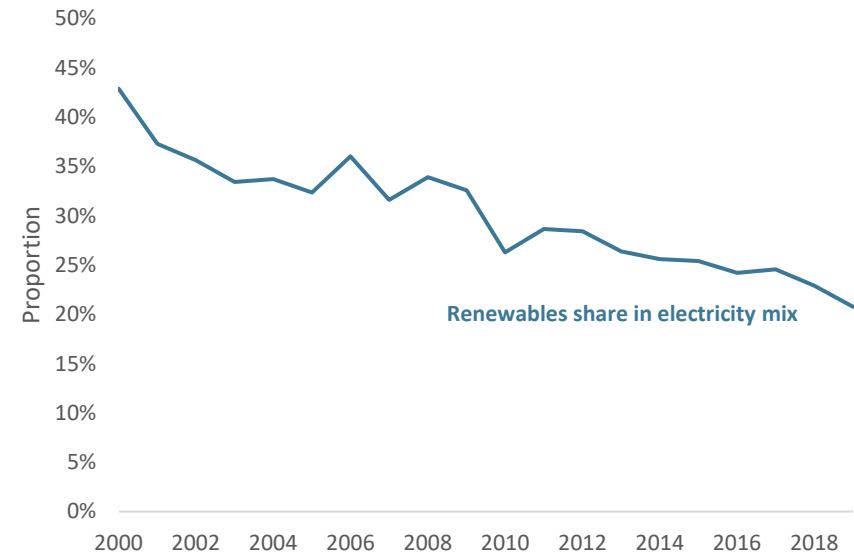
Note: Biomass used in the residential and commercial sectors is assumed to be traditional biomass and is not included in the definition of modern renewables. All other renewables (biomass used by industry, hydro, geothermal, etc.) are considered modern renewables. Modern renewables also include the share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

Modern renewables do not include traditional biomass. In the Philippines, the share of renewables to final energy consumption (not

including non-energy sector consumption of energy products) in 2010 was already high at 11.4%. However, in 2019, the proportional share of modern renewables reduced by 7% from the 2010 level to 10.7% (Figure 11). Meeting the doubling goal will require the APEC’s modern renewables share to reach 12.3% by 2030.

Electricity generation from modern renewables in the Philippines was more than 20% in 2019. This marked a 21% reduction from the 2010 proportional share of more than 26% (Figure 12). The reduction may be attributed to the continuous drop in hydro generation due to drought and the limited penetration of other modern renewable technologies, such as solar and wind, in the generation mix. The economy continues to work towards implementing measures that allow new renewable capacities to enter the system.

Figure 12: The Philippines’ renewable generation share, 2000–2019



Source: EGEDA (2021)

Energy policy

The energy sector is guided by the directives of the Filipino President in AmBisyon Natin 2040 (NEDA, 2017). To realise this vision, a sectoral roadmap has been crafted for each energy subsector, containing long-term objectives, deliverables and targets consistent with the Strategic Directions and Nine-Point Energy Agenda (DOE, 2020b).

Energy Policy	Details	Reference
NDC targets	<ul style="list-style-type: none"> * This policy targets an economy-wide 75% reduction of GHG emission 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 10.9% or 365.2 MTCO_{2e} reduction from the Business-as-usual (BAU)/Reference Scenario. Of this total, the energy sector is expected to contribute 45.9 MTCO_e (12.6% share to 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 64.1% avoidance, thereby completing the target of 75% GHG. 	UNFCC
Philippine Energy Plan (PEP) 2020-2040 <i>Towards a Sustainable and Clean Energy Future</i>	<ul style="list-style-type: none"> * 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 <i>AmBisyon Natin 2040</i>. * 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	<ul style="list-style-type: none"> * 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, the off-grid and missionary areas, household electrification, and the institutional support mechanisms. 	Department of Energy
Republic Act (RA) 9367 (Biofuels Act 2006)	<ul style="list-style-type: none"> * 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

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<p>RA 9513 (Renewable Energy Law)</p>	<ul style="list-style-type: none"> * 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 Renewable Energy Law. 	<p>Department of Energy</p>
<p>National Renewable Energy Program (NREP)</p>	<ul style="list-style-type: none"> * 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 5,439 MW to 15,304 MW by 2030. 	<p>Department of Energy</p>
<p>National Energy Efficiency and Conservation Program (NEECP)</p>	<ul style="list-style-type: none"> * This is a continuing program that aims to make energy efficiency and conservation (EE&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: <ul style="list-style-type: none"> - Reduction in the economy's final energy demand by 10% - Energy savings of 69,100 ktoe - Deferment of 6.780 Mwe of additional capacity - Reduction of 178,980 kT of CO₂ emissions 	<p>Department of Energy</p>
<p>Energy Efficiency and Conservation Act of 2019</p>	<ul style="list-style-type: none"> * This Act institutionalises energy efficiency and conservation, 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. 	<p>Department of Energy</p>
<p>RE Roadmap</p>	<ul style="list-style-type: none"> * This focuses on attaining the target of at least 35% renewable energy share in the power generation mix by 2030 and 50% by 2040. 	<p>Department of Energy</p>
<p>FIT Installation Target (MW)</p>	<ul style="list-style-type: none"> * Policy mechanism under RE Law <ul style="list-style-type: none"> - Run-off river hydro (250 MW) - Biomass (250 MW) - Wind (400 MW) - Solar PV (500 MW) 	<p>Department of Energy</p>

- Ocean (10 MW)

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&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.

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Power Generation Roadmap

* Short-term goals (2021–2022):

- Implement the coal moratorium.
- Establish guidelines for power plant decommissioning.
- Firm-up 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 rationalization 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 alternative fuels and energy technologies (AFETs) for application

* Long-term goal (2023–2040):

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- Preparation of the regulatory and infrastructure requirements of the identified AFETs

Upstream Oil and Gas Roadmap	<p>* This roadmap focuses on attaining the following objectives by 2040:</p> <ul style="list-style-type: none">- Increase indigenous petroleum reserves to 116 MMB oil and 5.87 TCF gas.- Produce 66 MMB crude oil and 3.5 TCF natural gas.	Department of Energy
Upstream Coal Roadmap	<p>* This targets an increase of up to 766 MMT in delineated mineable coal reserves by the end of 2040, with additional reserves of 65 MMT in the medium term and 223 MMT in the long term.</p>	Department of Energy
Downstream Oil Roadmap	<p>* This is an improved policy governing the downstream oil industry to ensure continuous supply of high quality and right quantity of petroleum products in the market by 2040.</p>	Department of Energy
Downstream Natural Gas Roadmap	<p>* This roadmap aims to establish a world-class, investment-driven and efficient natural gas industry, making natural gas the preferred fuel for all end-use sectors by 2040.</p>	Department of Energy
Energy Efficiency and Conservation Roadmap	<p>* The aim is to attain a measurable reduction in energy intensity and consumption per year versus business-as-usual (BAU) by 2040</p> <p>* The medium-term and long-term frameworks focus on two priority areas, namely the strengthening and sustaining of EEC policies and initiatives.</p>	Department of Energy

Notable Energy Developments

During the EWG 62 hosted virtually by Canada on 17–21 October 2021, the Philippines reported that it has issued several laws, department circulars and orders, conducted public consultations and projects and entered into a Memorandum of Agreement with the aim of ensuring energy security, equity and sustainability.

Energy development	Details	Reference
Passage of RA 11646 or the Microgrid Systems Act	It serves to complement the government’s continuing efforts towards total electrification by encouraging the installation of microgrids in unserved and underserved areas	gov.ph
Passage of RA 11697 or Electric Vehicle Industry Development Act (EVIDA)	Establishes the Comprehensive Roadmap for the Electric Vehicle Industry (CREVI) that aims “to accelerate the development, commercialisation and utilisation of EVs” in the Philippines.	gov.ph
Revised Circular for the Accreditation and Submission of Notices and Reports of the Philippine Downstream Oil Industry Pursuant to the Biofuels Ac	Reinforces the government’s mandate of strictly monitoring compliance with existing rules and regulations as part of the Philippines’ call for the exhaustion of locally sourced biofuel	Department of Energy
Philippine Strategic Petroleum Reserve Program	A directive meant to lessen the economy's vulnerability brought about by disruptions in the supply or price of imported oil	Department of Energy
Department order on the Guidelines on Energy Efficiency Excellence Awards	An initiative to promote energy management systems and the best practices for energy efficiency in designated establishments, including local and government facilities	Department of Energy
Guidelines for the Green Energy Auction Program in the Philippines” and “Amending Section of DC entitled, Implementing Rules and Regulation of the renewable energy act	Aims to go beyond the RE Program’s objective, particularly the government’s aspirational target of 35% RE share in the generation mix by 2030, and attain a share greater than 50% by 2040, thus dominating the generation mix	Department of Energy
Prescribing the Policies and Programs to Further Promote and Enhance the Development of Waste-to-Energy (WTE) Facilities in the Philippines.	A department circular promoting WTE facilities, as baseload renewable energy can contribute to solid waste management, benefit the local economy and create green jobs, among others	Department of Energy

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Productive Use of Renewable Energy (PURE)	A project that aims to increase electricity access through renewable energy utilisation, boosting energy efficiency	Department of Energy
Memorandum of Agreement (MOA) on real-time pump price monitoring	To help establish the importance of reporting domestic fuel prices to further empower consumers as well as assist in policy formulation and the implementation of retail market sector plans and programs	Department of Energy
MOU with German firm MAN Energy Solutions SE (MAN ES)	Conduct of a feasibility study on the development of small- to medium-scale liquefied natural gas (LNG) importation and regasification to power projects in Visayas and Mindanao.	Department of Energy
MOU between the DOE and Tokyo-based Hydrogen Technology Inc. (HTI)	Research and development of hydrogen energy.	Department of Energy
MOU between the DOE and Australia-based research and development company Star Scientific Ltd.	To fast-track research and development activities for hydrogen and explore the use of hydrogen as a fuel for power generation.	Department of Energy
MOU with United States of America	To further deepen the cooperation between the two economies in developing the Philippines' nuclear energy program.	Department of Foreign Affairs

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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 highest energy intensity of GDP among APEC economies.

These factors determined the development in Russia of not only centralised power supply systems but also of centralised heat supply systems, which, in turn, 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.

In 2019, Russia’s GDP reached USD 4 065 billion 2017 USD PPP, the 4th largest in APEC. 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.

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 is the world’s largest energy exporter overall, exporting about 30 EJ in 2019.

Russia was the third-largest power producer in APEC, accounting for 6.4% of APEC’s total electricity generation in 2019; it was also the largest heat producer.

Russia has significant reserves of fossil fuels as well as of uranium.

Table 1: Russia Macroeconomic Data and Energy Reserves

Key data ^{a, b}	Energy reserves ^{c, d, e}
Area (million km ²)	17 Oil (billion barrels) 107.8
Population (million)	146 Gas (trillion cubic feet) 1 321
GDP (2017 USD billion PPP)	4 065 Coal (billion tonnes) 162
GDP per capita (2017 USD PPP)	28 155 Uranium (kilotonnes U < USD 130/kgU) 211

Source: ^a ROSSTAT (2020), ^b World Bank (2020), ^c EGEDA (2020), ^d BP (2020), ^e NEA (2020)

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 of 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: 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).

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 socio-economic development of the economy. The law proposes the creation of a roster of greenhouse gas emissions. This roster will be the government information system, which the authorised federal executive body will maintain.

Energy Supply and Consumption

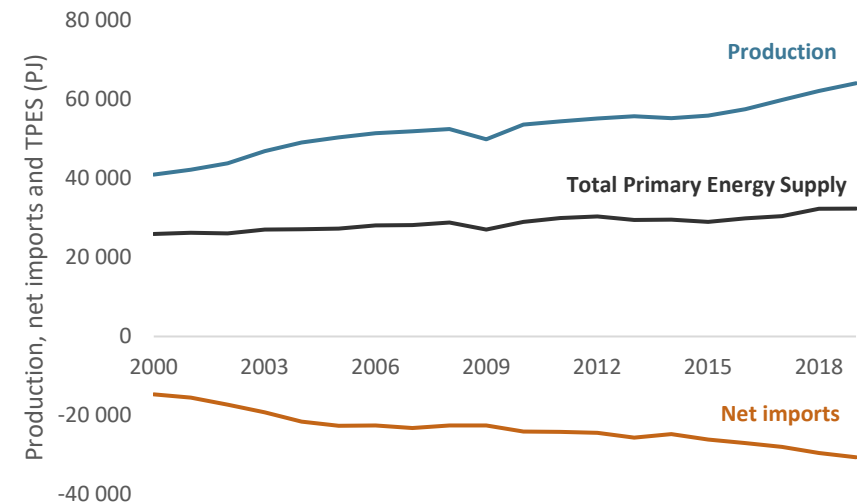
Total Primary Energy Supply

Russia is the third-largest energy producer in both the APEC and the world, after China and the US. Russia’s total primary energy supply (TPES) in 2019 was 32 349 PJ, almost equal to 2018 (EGEDA, 2021). The average annual growth rate of TPES from 2000 to 2019 was 1.1%.

Energy production has grown consistently since 2000 with a CAGR of

2.4%. In 2019, production was 64 056 PJ. The only year of decline for the period was in 2009 due to lower domestic consumption. Net exports grew at a much higher rate than production, with a CAGR of 3.9% from 2000 to 2019.

Figure 1: Russia’s total primary energy supply, production and net imports, 2000 to 2019

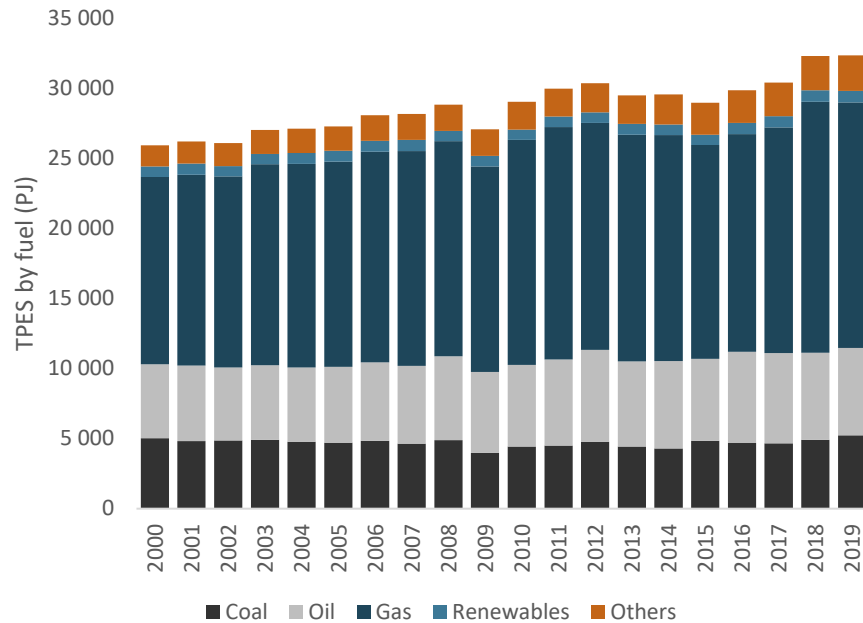


Source: EGEDA (2021)

Russia’s TPES fuel mix remained stable for 2000–2019; natural gas accounted for more than half with a slight decrease in the share of coal. In 2019, the TPES fuel mix comprised the following: natural gas (54%), crude oil and petroleum products (19%), coal (16%) and others, including nuclear and hydro (10%) (EGEDA, 2021). 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 4000 PJ.

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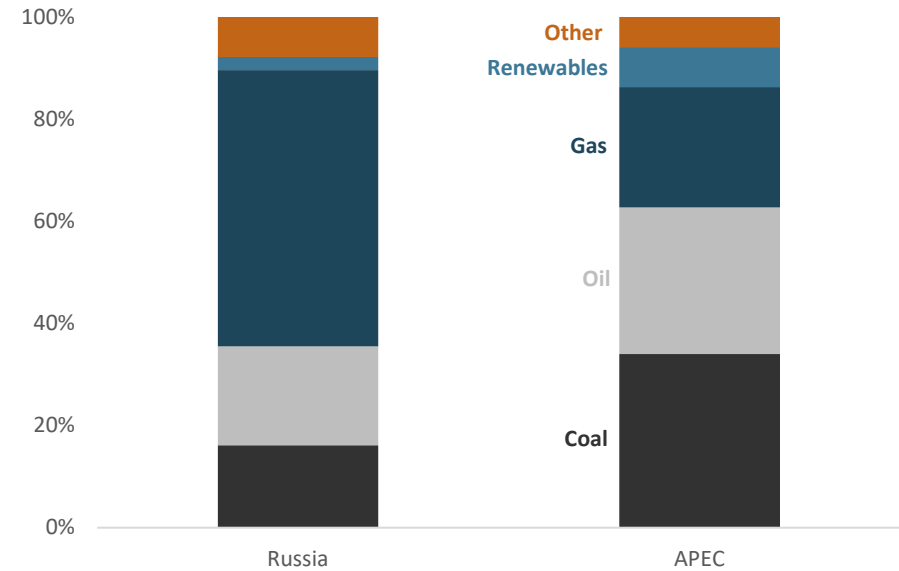
Figure 2: Russia's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

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. The territorial structure of gas consumption is uneven, 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, for example, is due to the uneven distribution of renewable energy sources, a large share of which is concentrated in remote areas and indicates limited government support for new projects.

Figure 3: Total primary energy supply relative fuel share – Russia and APEC, 2019



Source: EGEDA (2021)

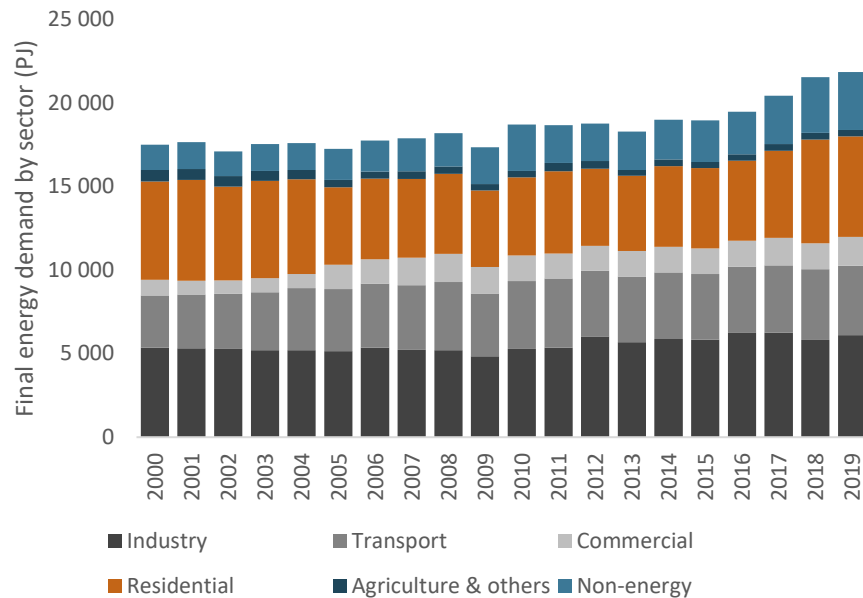
Total Final Consumption

Russia's final consumption in 2019 was 21 832 PJ, 1.4% higher than in 2018 (EGEDA, 2021). This makes Russia the third-largest energy consumer in APEC after China and the US (EGEDA, 2021). The industrial (6 108 PJ, 28%) and the residential sector (6 020 PJ, 28%) accounted for the two most significant shares of final energy consumption. One of the main reasons residential buildings are the largest consuming sector is the significant energy consumption for heating during almost eight months 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 economy statistics. The third-largest sector was transport (4 151 PJ, 19%). Non-energy use has more than doubled since 2000 and accounted for 16% of Russia’s energy product use in 2019. Agriculture and the commercial sector accounted for the remaining 9%.

Figure 4: Russia’s final consumption by sector, 2000 to 2019

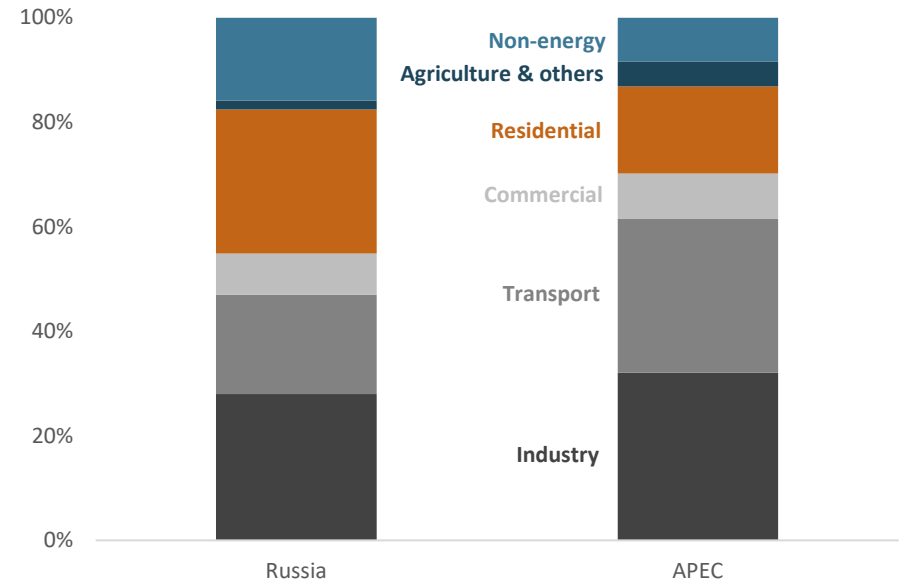


Source: EGEDA (2021)

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 structure 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. Non-energy use share is higher than in APEC due to its considerable consumption as a

feedstock in the chemical industry.

Figure 5: Final consumption sectoral share, Russia and APEC, 2019

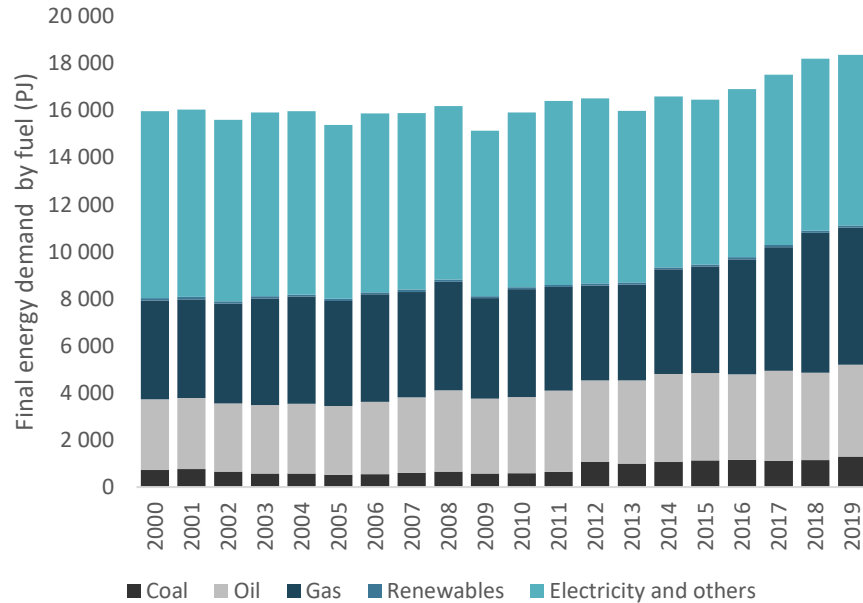


Source: EGEDA (2021)

Russia’s final energy consumption in 2019 was 18 373 PJ, 1% higher than in 2018 (EGEDA, 2021). About 40% of the final energy consumption in 2019 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 60% in 2019. 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, 2000 to 2019

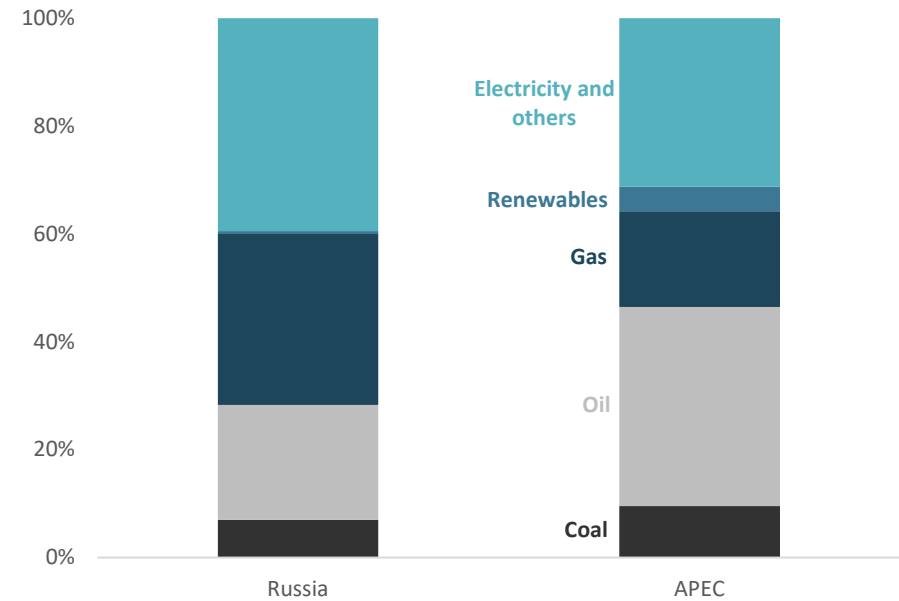


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

In Russia, fossil fuels accounted for 60% of final energy consumption in 2019, 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 about 30%. The share of renewables was less than 1%, several times lower than for the entire APEC region.

Figure 7: Final energy demand fuel shares, Russia and APEC, 2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

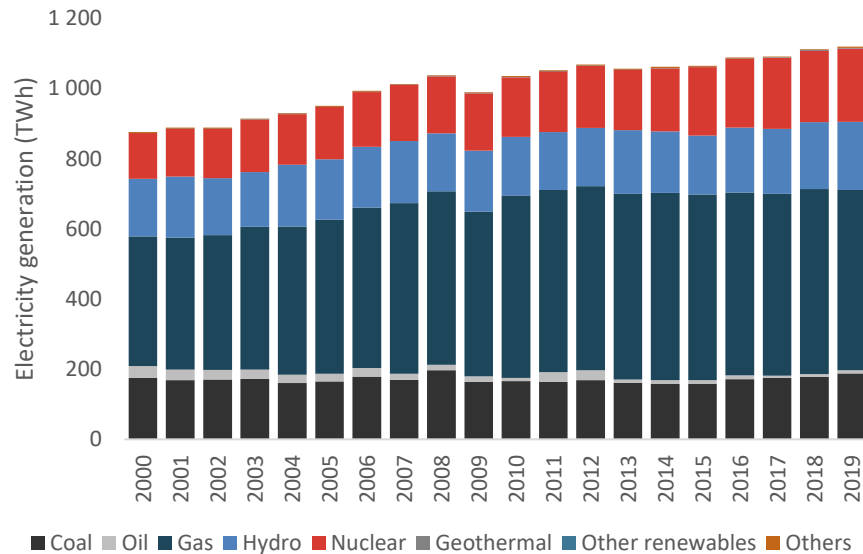
Transformation

Electricity generation has grown consistently since 2000 (except in 2009) with a CAGR of 1.3%. Incremental electricity generation since 2000 has been fuelled almost exclusively with natural gas (54%) and nuclear power (29%). In contrast, oil-fuelled power generation declined by 25% during the same period. Renewable energy sources accounted for 12% of the growth in electricity generation, with only 0.6% coming from wind and solar energy sources.

In 2019, Russia generated 1 120 TWh of electricity, an increase of 0.6% over the previous year. Fossil fuels accounted for the largest

share of this generation (64%), of which natural gas contributed almost three-quarters. The remaining 36% of electricity generation came from hydropower and nuclear power in roughly equal shares.

Figure 8: Russia's electricity generation by fuel, 2000 to 2019



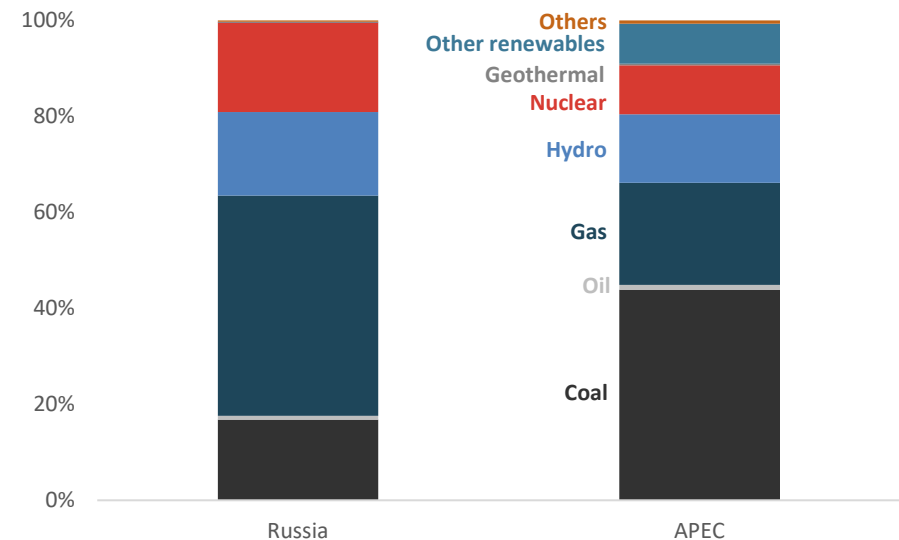
Source: EGEDA (2021)

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 the APEC differ. Natural gas accounts for a much larger share (46%) in Russia, while coal account 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 by fuel share, Russia and APEC, 2019



Source: EGEDA (2021)

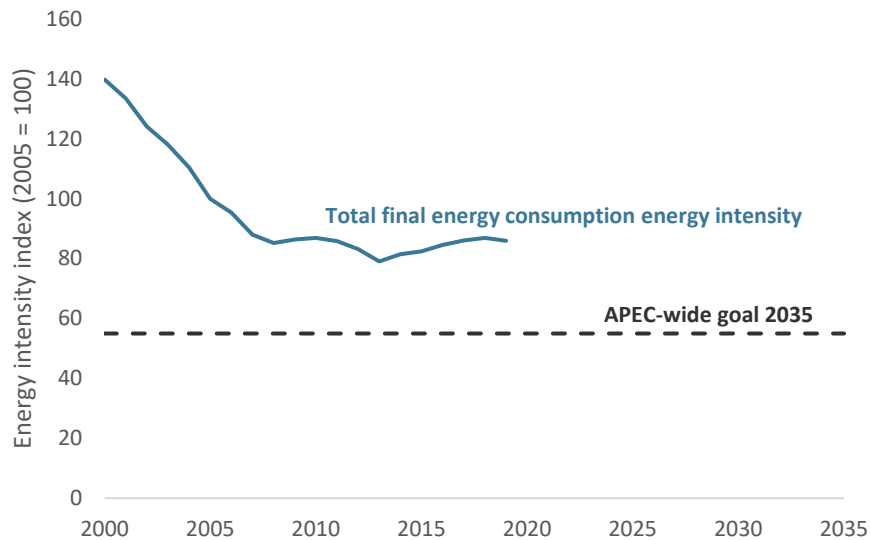
APEC Goals

There are two energy-related goals that APEC member economies have agreed to meet as a collective. These objectives are meant to improve energy intensity by 45% in 2035 compared to 2005 and to double the share of modern renewables in the energy mix by 2030 compared to 2010.

Energy Intensity Goal

Russia is the most energy-intensive economy in the APEC region. However, improvements are occurring. In 2019, Russia's total final energy consumption (excluding non-energy) intensity improved by 14% compared to that in 2005.

Figure 10: Russia's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

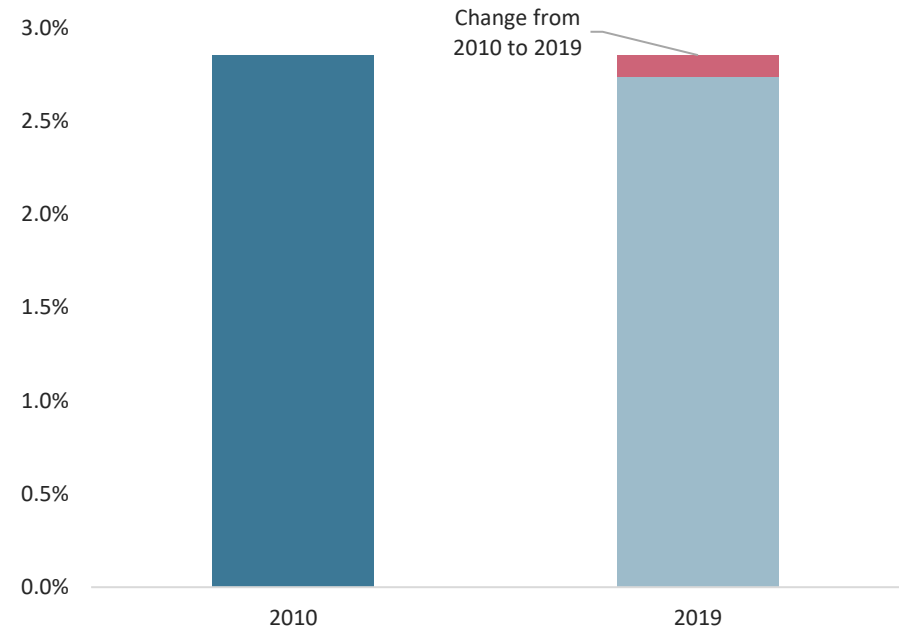
Doubling of Renewables

There is no economy-level goal for individual member economies, but the improvements made by respective economies will contribute to the doubling goal.

Russia's share of modern renewables to final energy consumption in 2010 was 2.9%. In 2019, this share decreased to 2.7% as shown in

Figure 11. This slight decrease highlights the complexities of expanding renewables in Russia.

Figure 11: Russia's modern renewable energy share, 2010 and 2019



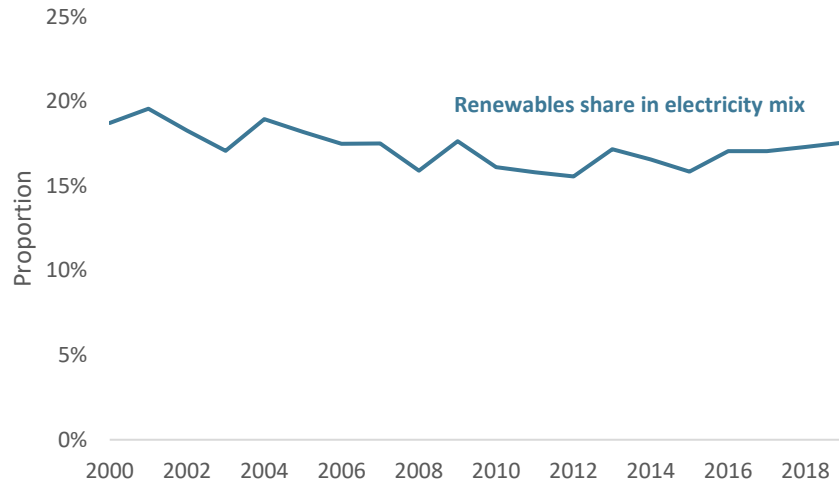
Source: EGEDA (2021)

Note: Biomass used in the residential and commercial sectors is assumed to be traditional 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 2000–2019 averaged 17–18%. Almost all electricity is generated by large hydropower plants (HPPs). In this regard, a decrease in the share of HPPs in some years is associated with low-water periods. The share

of generation by solar and wind power plants does not exceed 1%.

Figure 12: Russia's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

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 increasing the share of processed natural gas liquids (NGLs) 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 an increase in the use of associated gas to 90% by 2024 and 95% by 2035	Ministry of Energy
Own use in gas pipelines	Russia's Energy Strategy 2035 assumes reducing unit consumption of energy as own use in gas pipelines by 12% in 2024 and 17% in 2035 with respect to the 2018 level	Ministry of Energy
Thermal efficiency in the power sector	Russia's Energy Strategy 2035 assumes increasing 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 national gas transportation system	Russia's Energy Strategy 2035 assumes an increase in the share of regions with access to the economy-wide gas transportation system to 75% by 2024 and 83% by 2035	Ministry of Energy
Russia's Energy Security Doctrine	A foreign policy challenge to 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

<p>Limiting Greenhouse Gas Emissions</p>	<p>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 thousand tons of carbon dioxide per year or more for the period until January 1, 2024. Such companies will have to report on January 1, 2023. Those who produce 50 thousand tons of carbon dioxide per year or more will be subject to regulation from January 1, 2024. They will have to submit reports on greenhouse gas emissions on January 1, 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 socio-economic development of the economy. The law proposes the creation of a roster of greenhouse gas emissions. This roster will be the government information system, which the authorised federal executive body will maintain.</p>	<p>Federal Law</p>
<p>Development of electric transport</p>	<p>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 (8 times).</p>	<p>The Russian Government</p>

Notable Energy Developments

Energy development	Details	Reference
<p>Arctic LNG-2</p>	<p>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. At the end of the first quarter 2021, the overall progress for Arctic LNG 2 is estimated at 39%, the first train is roughly 53% completed. It is expected to reach full capacity by 2025.</p>	<p>Novatek</p>
<p>Baltic LNG</p>	<p>The plant is going to become the largest gas processing plant in the economy and will process 45 bcm of natural gas and produce: 13 million tons of LNG, up to 3.8 million tons of ethane and up to 2.4 million tons of LPG. Construction began in May 2021.</p>	<p>Gazprom</p>
<p>Nord Stream 2</p>	<p>The pipeline will be fully completed in September 2021. The certification process for the pipeline is currently underway.</p>	<p>Gazprom</p>

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Power of Siberia	Gas supplies began on December 2, 2019. Design capacity of 38 billion cubic meters of natural gas exports to China will be reached by 2025.	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 meters 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
Amursky Gas Processing Plant	Amursky GasPP will process 42 bcm of natural gas from Chayandinskoye and Kovyktinskoye fields and will produce 60 million cubic metres of helium, up to 2.5 million tons of ethane and up to 1.5 million tons of LPG by 2025. The first production train was put in operation in June 2021.	Gazprom
Vostok Oil	At the end of 2020, the state-owned company 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
Competitive selection of renewables	According to the results of the competitive selection of renewables projects in 2021, 0.8 GW of solar farms and 1.9 GW of wind farms were selected	Trading system administrator

Singapore

Introduction

Singapore is a city-economy located in the south of the Malay Peninsula, between the Strait of Malacca and the South China Sea. In 2019, the economy had a land area of 725 square kilometres (km²) and a population of 5.7 million.

Singapore is completely urbanised and highly industrialised but lacks domestic energy and mineral resources, and its small land size hinders renewable resource deployment. Even so, the economy is diverse and has enjoyed impressive economic success because of its extensive financial, shipbuilding, petroleum, and biotechnology sectors, and due to Singapore being a regional hub for tourism. Singapore has also been expanding its role in international cargo and fuel shipping.

Singapore's gross domestic product (GDP) grew by 1.2% to USD 561 billion (2017 USD purchasing power parity [PPP]) in 2018, and GDP per capita grew by 0.2% to USD 98 412 (EGEDA, 2021). The services industry accounted for 64% of the GDP, the goods-producing industries (manufacturing and construction) accounted for 26%, and ownership of dwellings accounted for the remainder (DOS, 2021a).

Table 1: Singapore's Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^{b, c}	
Area (km ²)	725	Oil (billion barrels)	–
Population (million)	5.7	Gas (trillion cubic feet)	–
GDP (2017 USD billion PPP)	561	Coal (million tonnes)	–
GDP per capita (2017 USD PPP)	98 412	Uranium (kilotonnes U < USD 130/kgU)	–

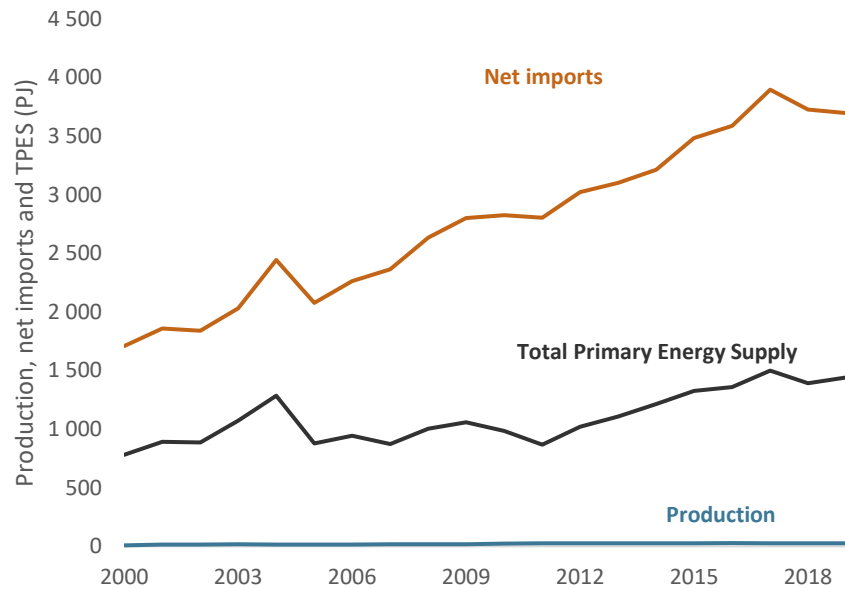
Source: ^{a, b} Department of Statistics Singapore (2021b, 2021c); EGEDA (2021)

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 7 244 petajoules (PJ) in 2019. Exports of refined products mostly land in the Asia-Pacific Economic Cooperation (APEC). The total energy exports were 3 547 PJ in 2019 (EGEDA, 2021).

Figure 1: Singapore's total primary energy supply, production, and net imports, 2000 to 2019



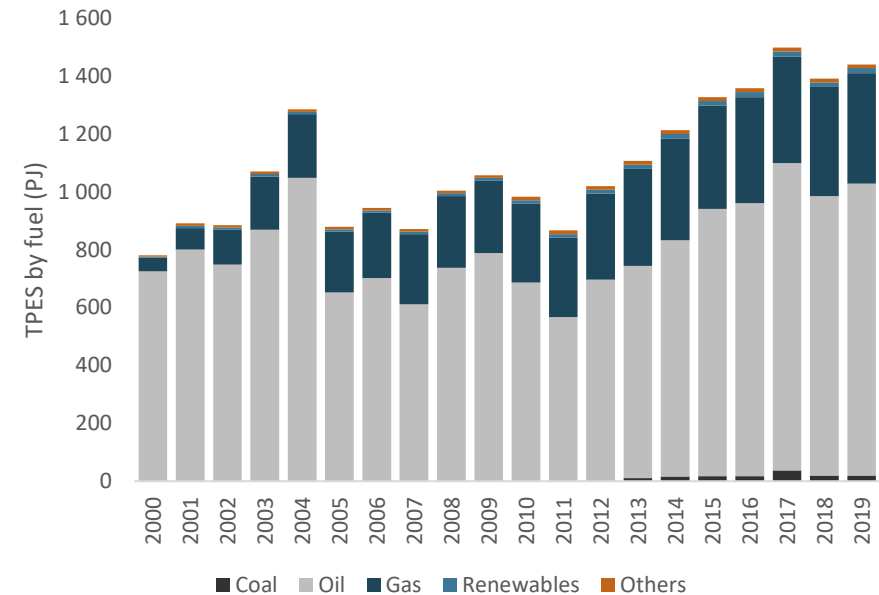
Source: EGEDA (2021)

Singapore plays an important role in international shipping and aviation. In 2019, international marine bunkers received 1 920 PJ of its refined fuel and gas/diesel oil, and aviation bunkers received 376 PJ of aviation fuel.

Singapore's total primary energy supply (TPES) in 2019 was 1 441 PJ, 3.5% higher than in 2018. Figure 2 depicts Singapore's reliance on fossil fuels in its energy mix. Efforts to decrease reliance on oil imports have increased the role of natural gas in fuelling Singapore's power generation the last two decades, while it is also pursuing solar targets and electricity trade to reduce its reliance on gas imports. Singapore is currently looking to reduce its reliance on fossil fuels as it develops its pathway for an energy transition (EMA, 2022a). This transition will rely

on the switches of natural gas, solar, regional power grids, and emerging low-carbon fuels, and also leverage energy efficiency to reduce energy supply requirements (EMA, 2019a; EMA, 2022b).

Figure 2: Singapore's total primary energy supply by fuel, 2000 to 2019

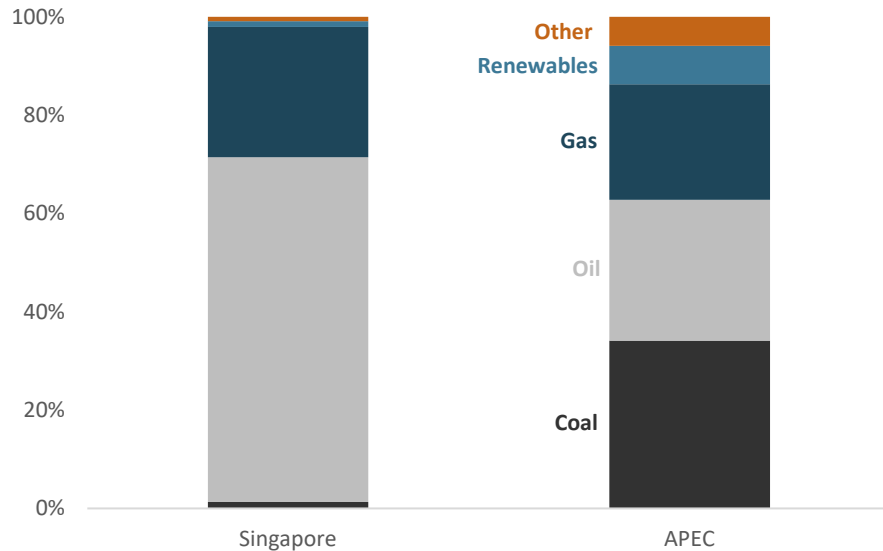


Source: EGEDA (2021)

To reduce its dependence on piped natural gas imports from Malaysia and Indonesia, Singapore began importing liquefied natural gas (LNG) in May 2013. The economy's regasification and storage capabilities, along with its auxiliary services, have increased the share of gas in the energy mix and enabled Singapore to diversify its gas supplies. Singapore has imported LNG from over 20 economies in the last five years, and LNG now makes up a third of gas imports (UN Comtrade, 2021; EMA, 2021a). With Indonesian gas pipeline imports set to decline in 2023, the role of LNG in Singapore's fuel mix will likely increase over

the next decade (ESDM, 2019).

Figure 3: Total primary energy supply relative fuel share, Singapore and APEC, 2019



Source: EGEDA (2021)

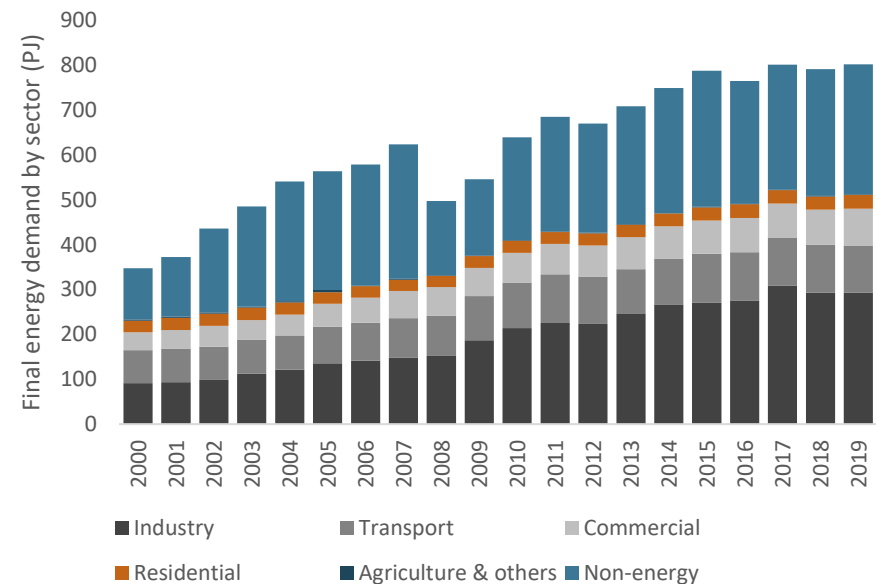
In 2019, oil accounted for the largest share of TPES at approximately 70% (1 010 PJ), followed by natural gas at 27% (382 PJ), coal at 1.3% (19 PJ) and renewables at 1.2% (17 PJ) (EGEDA, 2021). Figure 3 presents a comparison of Singapore’s TPES fuel shares with those of the entire APEC region. While fossil fuels play a more dominant role in Singapore than in APEC, comprising 98% of the fuel mix, Singapore has a significantly lower share of coal in its mix. Another notable aspect is the low proportion of renewables; Singapore has limited options in terms of renewables because of its geological and geographical location. Hydro, wind, and tidal energies are not feasible, leaving solar PV systems and waste-to-energy (WtE) plants as Singapore’s main sources of

renewable energy. Once thought to be infeasible, technological advancements in deep geothermal systems have made geothermal energy a possibility in Singapore. The feasibility of utilising these new technologies in Singapore is currently being studied (EMA, 2021f).

Total Final Consumption

Final energy consumption grew by 1.3% in 2019 to 802 PJ. The recent energy use plateau seen in Figure 4 reflects a decline in Singapore’s export-oriented manufacturing sector due to rising global trade tensions and moderate energy efficiency improvements (MTI, 2019).

Figure 4: Singapore final consumption by sector, 2000 to 2019



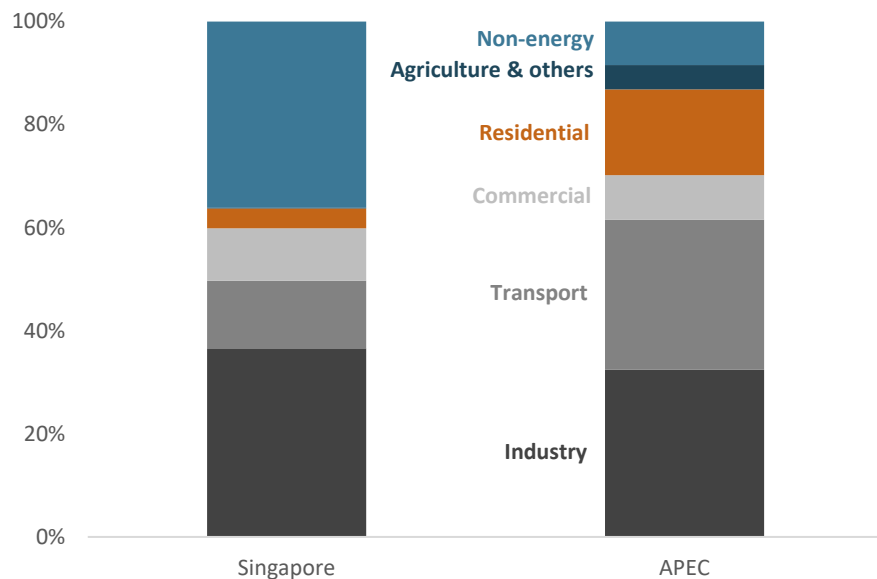
Source: EGEDA (2021)

The industry (37%) and non-energy (36%) sectors account for the largest share of total final consumption. Singapore’s large-scale petrochemical industry drives much of this, using energy feedstocks to

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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. Other sectors (including the buildings sectors) accounted for 14% of total final consumption, and the transport sector accounted for 13% (EGEDA, 2021). 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 29%.

Figure 5: Final consumption sectoral share, Singapore and APEC, 2019

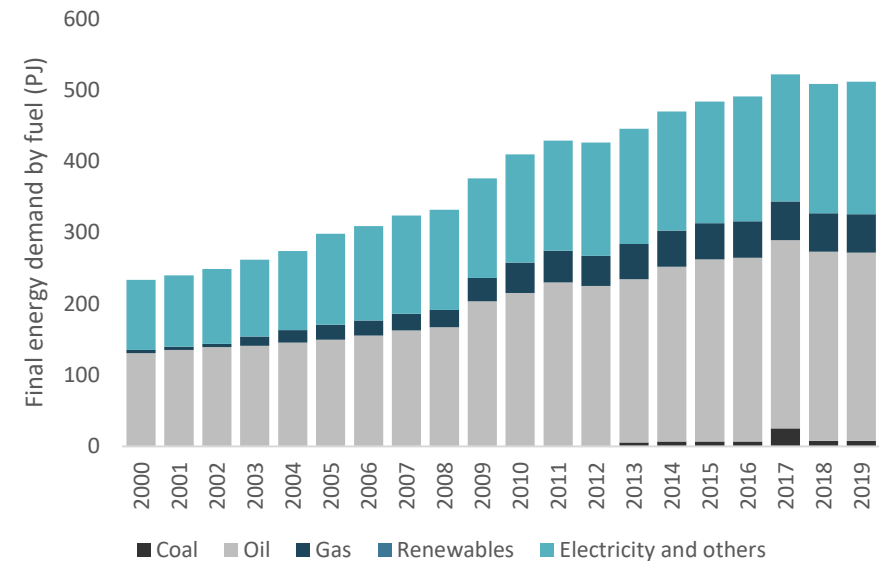


Source: EGEDA (2021)

Singapore's final energy demand was 512 PJ in 2019, marking a 0.7% 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's final energy demand by fuel, 2000 to 2019

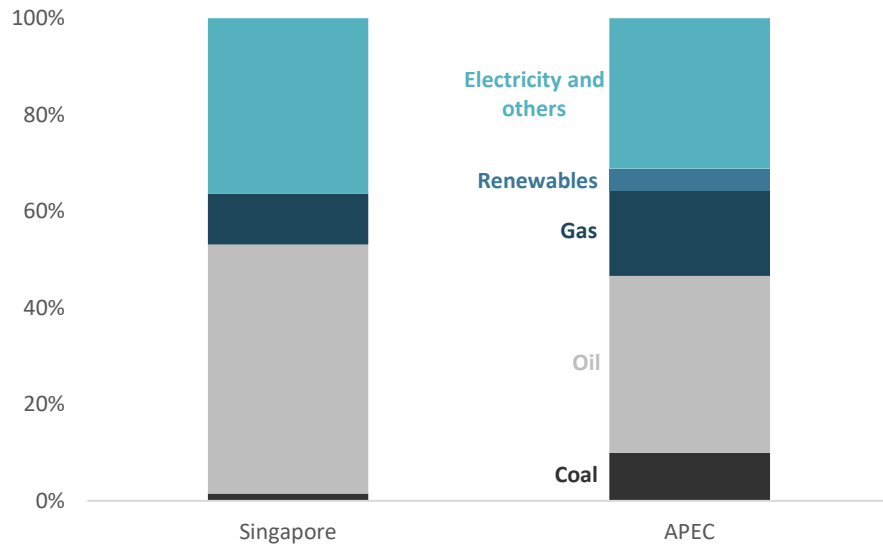


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

In 2019, fossil fuels constituted 64% of Singapore's energy demand, and electricity use accounted for the remainder. As shown in Figure 7, compared to APEC, Singapore derived 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 shares, Singapore and APEC, 2019



Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

Transformation

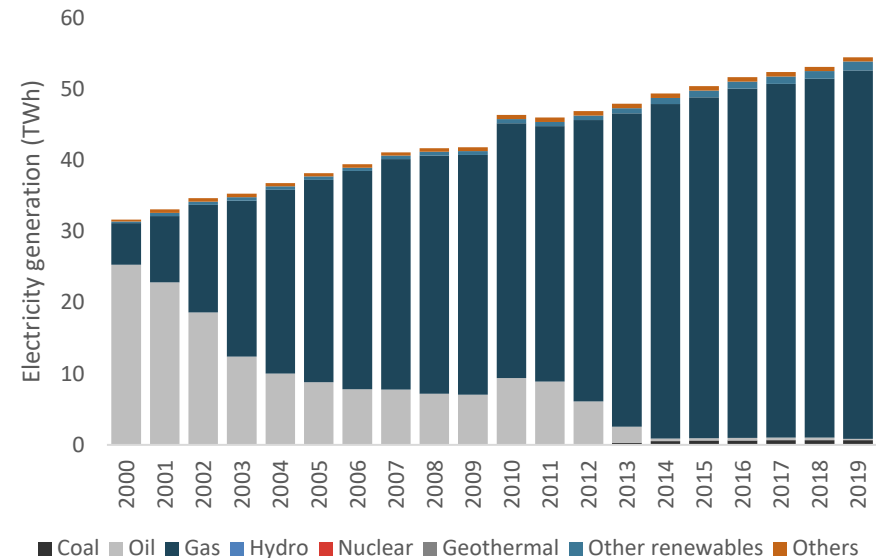
Singapore's electricity generation increased by 2.5% in 2019 to 54 470 gigawatt hours (GWh) (EGEDA, 2021). The peak demand for electricity saw a 0.4% annual increase and stood at 7 404 megawatts (MW) (EMA, 2021a). Seven main power producers in Singapore contributed to the bulk of power generation (80%) in 2019.

Total licensed generation capacity fell to 12 564 MW in 2019, 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 84% (10 491 MW) in 2019. The share of steam turbine plants dropped

from 48% (4 640 MW) in 2005 to 11% (1 364 MW) in 2019. Open-cycle gas turbine plants comprised 1.4% (180 MW) of the capacity in 2019, WtE plants accounted for 2.0% (257 MW), and solar made up 2.1% (272 MW) (EMA, 2021a).

Figures 8 and 9 illustrate how technology, markets and policy collectively influenced Singapore's fuel mix over the past two decades. Oil-based generation fell from over 80% of the fuel mix in 2000 to 0.4% in 2019, while gas grew from under 20% to 95%. Coal and other fuels, including WtE and solar, constituted the remaining 4.6% of generation (EGEDA, 2021). Due to land scarcity, solar and WtE were the only viable forms of renewable energy generation in Singapore.

Figure 8: Singapore's electricity generation by fuel, 2000 to 2019



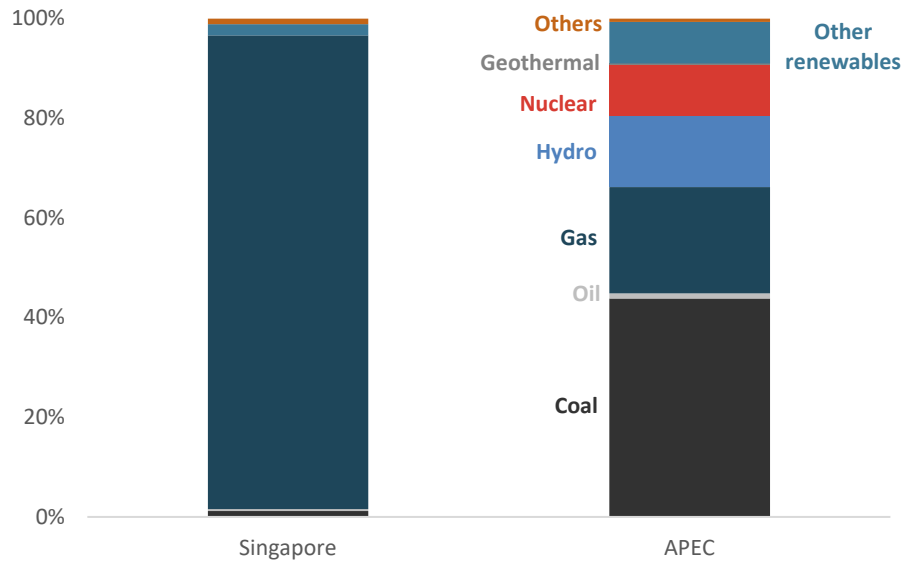
Source: EGEDA (2021)

Total grid-connected solar PV installed capacity in Singapore increased

by 70% to 354 megawatt-peak (MWp) in 2019, meeting the economy's target of 350 MWp by 2020 ahead of schedule. Singapore has since set two more targets, aiming to install 1.5 gigawatt-peak (GWp) of solar capacity by 2025 and 2.0 GWp by 2030 (EMA, 2020a; EMA, 2020f).

Singapore is striving to increase its deployment of rooftop PV deployment via its SolarNova programme and the deployment of floating PV. As of December 2020, the Housing Development Board (HDB) has committed to installing 260 MWp on 8 400 housing blocks and has already installed modules on 2 470 blocks. HDB's solar target is for 540 MWp of installed capacity by 2030 (HDB, 2021). A 60 MWp floating storage system in the Tengeh Reservoir was deployed in 2021 (PUB, 2022).

Figure 9: Electricity generation by fuel share, Singapore and APEC, 2019



Source: EGEDA (2021)

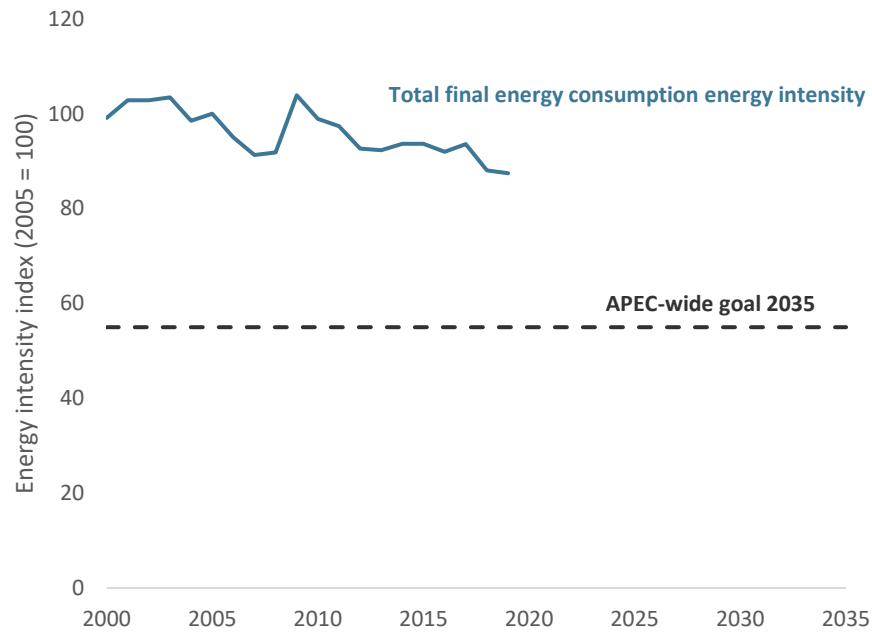
APEC Goals

APEC has two aspirational goals: to reduce energy intensity by 45% between 2005 and 2035 and to double the share of modern renewables in the fuel mix (including the electricity mix) by 2030, compared to the 2010 levels. However, it is important to note that APEC does not specify or institute any economy-specific targets. Therefore, Singapore is not required to achieve the targets but progressing towards them can help APEC achieve its goals.

Energy Intensity Goal

In 2009, Singapore targeted a 35% reduction in energy intensity by 2035 and, in 2015, issued its first nationally determined contribution (NDC), pledging a 36% intensity reduction below 2005 levels by 2030 (NCCS, 2018a). Thereafter, energy intensity fell 13% below 2005 levels (Figure 10).

Figure 10: Singapore's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

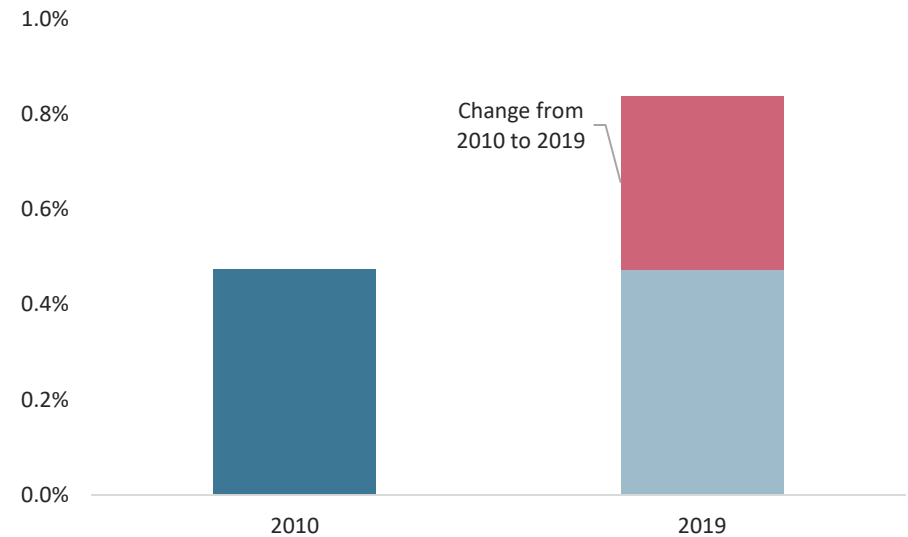
Singapore is committed to improving its energy efficiency. Recent measures to meet this commitment include electrifying cooking and heating, reducing space cooling needs and space cooling efficiency, phasing out internal combustion engine (ICE) vehicles, improving manufacturing efficiency through digitalisation, 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. Singapore is also exploring market strategies, such as setting the right carbon price and collaborating with other economies, to establish a global carbon market (EMA, 2020a). Together, these policies can accelerate energy intensity

reductions and further help APEC achieve its aspirational targets.

Doubling of Renewables

Due to the prevalence of fossil fuels in its supply mix, Singapore started from a very low modern renewable energy share of 0.47% in 2010 (Figure 11). By 2019, this share increased to 0.84%.

Figure 11: Singapore's modern renewable energy share, 2010 and 2019



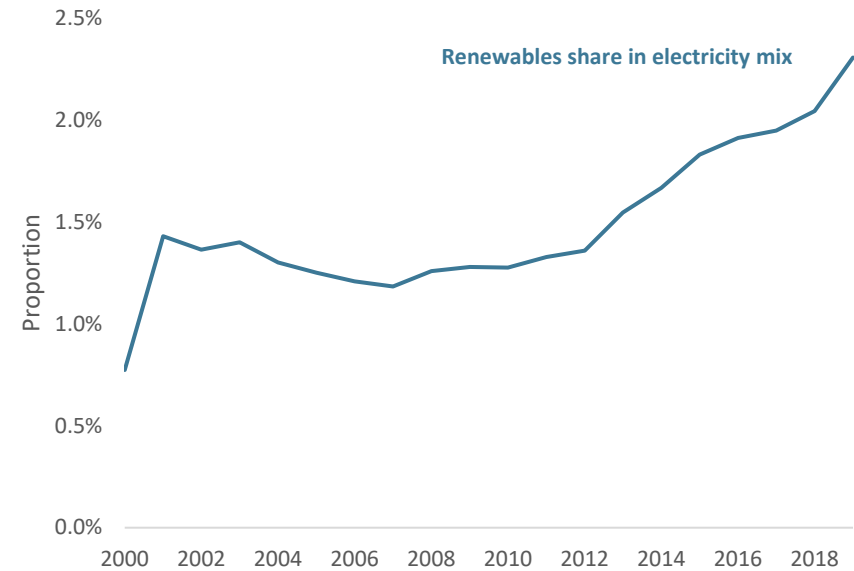
Source: EGEDA (2021)

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 includes the share of electricity generated from renewable sources

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 2.3% of the electricity mix in 2019 (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 12: Singapore's renewable generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

Singapore annually announces major energy policies during the keynote address at Singapore International Energy Week (SIEW). At SIEW 2019, Singapore unveiled its “4 Switches” to guide its future energy story: (natural) gas, solar, regional grids and low-carbon technologies (EMA, 2019a). At SIEW 2020, he presented a vision of Singapore becoming a “Bright Green Spark” for urban societies to emulate in the energy transition. Furthermore, a key focus of the SIEW 2021 announcements was the promotion of regional power grids to increase Singapore’s access to low-emitting electricity. To this end, Singapore set the target of importing 4 GW of low-carbon electricity by 2035 (EMA, 2021b), and the EMA began seeking proposals to import 1.2 GW of low-carbon electricity by 2027 (EMA, 2021c). EMA has also issued a second Request for Proposals in July 2022 for participants to submit non-binding proposals as an Expression of Interest for preliminary discussions with the EMA.

Several policies launched at these events are presented in the table below, as are other recent policies that will shape Singapore’s energy system going forward, such as the Singapore Green Plan 2030 (MSE, 2022a). While inexhaustive, the table highlights recent announcements that are expected to be more impactful in the energy system (EMA, 2020a). Some notable policies include an update to Singapore’s NDC, with the economy pledging to peak emissions at an absolute level of 65 MtCO_{2e} around 2030 (NCCS, 2022). Singapore has also announced plans to raise its climate ambition to achieve net-zero emissions by or around mid-century. Furthermore, Singapore announced its intention to phase out ICE vehicles by 2040 (Reuters, 2020a).

Notably, tighter global markets for natural gas and disruptions to integral gas suppliers, particularly Indonesia, brought energy security and resilience to the forefront of Singapore policy in 2021. Singapore is acting quickly to mitigate the impact of natural gas supply disruptions on its electricity grid by establishing standby fuel power-generating facilities and ensuring that generators have ample supplies to withstand the market turmoil (EMA 2021d).

UNFCCC NDC Pledge 2020	Absolute emissions target to peak emissions at 65 MtCO _{2e} around 2030. Now including NF ₃ as a GHG.	National Climate Change Secretariate
Long-term climate ambition	In 2020, Singapore announced a Low Emissions Development Strategy (LEDS) to halve emissions from its NDC peak to 33 MtCO _{2e} by 2050. In 2022, Singapore strengthened this, committing to net zero emissions by or around mid-century.	National Climate Change Secretariat
Singapore Carbon Tax	Carbon tax of SGD 5 per tCO _{2e} in 2019 will covers 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
UNFCCC NDC Pledge 2015 (archived)	Reduce emissions intensity by 36% below 2005 levels by 2030.	United Nations Framework Convention on Climate Change
Singapore Economy-wide Solar and storage targets	Solar targets: 350 MWp by 2020 (achieved), 1.5 GWp by 2025, 2 GWp by 2030; storage target: 200 MW of energy storage systems deployed beyond 2025.	Energy Market Authority

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SolarNova Programme	Targeting 540 MWP of solar on HDB housing blocks by 2030.	Housing Development Board
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.	National Environment Agency
Commercial Vehicle Emissions Scheme	Incentive scheme that provides a rebate (up to SGD 30 000) or charge (up to SGD 10 000) to the MRSP new commercial vehicles based on their pollutant performance.	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 7 EV-ready towns with chargers at all HDB carparks by 2025 and targeting 60 000 charging points by 2030.	Ministry of Sustainability and the Environment
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
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.	Ministry of Sustainability and the Environment

Notable Energy Developments

The table below presents the milestones, project announcements, pilot initiatives and prospective technological developments that can shape Singapore's energy future. This list is not exhaustive, but it highlights recent announcements that are expected to be more impactful in the energy system and highlights the significant impacts of tight natural gas markets on the Singapore energy system.

Neste biorefinery expansion	Increase capacity 1.4 Mtpa to 4.5 Mtpa by 2023	Neste
Capacity reduction at Shell's Pulau Bukom Refinery	Halve refinery capacity from 500 000 b/d to 250 000 b/d by 2023.	Reuters
Open Electricity Market enters second year	Providing retail competition for electricity services prompted almost half of households and businesses to opt for retailer choice over regulated rates.	Energy Market Authority
Indonesia halts gas exports to Singapore via Grissik-Singapore pipeline in 2023	Singapore gas pipeline import capacity from Indonesia to fall by 465 MMcf/d in 2023	Ministry of Energy and Mineral Resources, Indonesia
Electricity import trial	EMA will be embarking a two-year electricity import trial from Malaysia and plans to issue a Request Proposal for 100 MW of electricity imports that could begin in end-2021.	Energy Market Authority
Singapore's First Utility-Scale Energy Storage System	EMA and SP Group deployed a 2.4MW/2.4MWh ESS at a substation in 2020. The ESS will participate in the wholesale electricity to mitigate intermittency caused by solar, as well as reduce peak demand.	Energy Market Authority
Singapore's First floating Energy Storage System (ESS)	Keppel O&M working to deploy a 7.5 MW/7.5MWh lithium-ion battery ESS on its Floating Living Lab (FLL) by 2023.	Energy Market Authority
2020 Solar Target Achieved	350 MWp of solar capacity surpassed in early 2020	Energy Market Authority
Low emissions MOU signed with Australia	Collaborate on projects and initiatives to advance low-emissions solutions, such as CCUS, hydrogen and renewable trade, as well as measurement, reporting and verification mechanisms.	Singapore International Energy Week
Low-carbon hydrogen technology MOU with Chile	Collaborate on projects and initiatives to advance low-carbon hydrogen as an energy source.	Ministry of Trade and Industry
Funding Research for Low-Carbon Energy 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

Impacts of tight global natural gas supplies on Singapore energy security	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 a supply disruptions.	Energy Market Authority
Exploring Singapore's Geothermal Potential	The EMA is exploring the feasibility of new technology to develop geothermal supplies as an indigenous energy supplier for Singapore.	Energy Market Authority

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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/>

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Ministry of the Environment and Water Resources – <https://www.mewr.gov.sg>

Ministry of Trade and Industry – <https://www.mti.gov.sg>

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Chinese Taipei

Introduction

Chinese Taipei’s gross domestic product (GDP) in 2019 reached US dollars (USD) 1 353 billion, 2017 USD purchasing power parity (PPP), a 4% increase from 2018. GDP grew at a compound annual growth rate (CAGR) of 6% between 2000 and 2018. With a population of 24 million, Chinese Taipei’s GDP per capita was one of the highest in the APEC region, at 57 328 (2017 USD PPP), in 2019 (Directorate-General of Budget, Accounting and Statistics [DGBAS], 2020).

In 2019, the GDP growth rate of Chinese Taipei was mainly driven by the service sector, which contributed 2.2% to the overall growth rate, followed by the industry sector (0.6%). The contribution from the agricultural sector was slightly negative (-0.03%) (DGBAS, 2020).

The economy owns very small deposits of energy reserves. According to data from the Central Intelligence Agency’s (CIA’s) World Factbook, as of 2018, Chinese Taipei held only 2.4 million barrels of proven oil reserves and 6.2 billion cubic meters of proven gas reserves (CIA, 2022). Coal reserves in the economy are scarce, and owing to the high cost of mining, there has been no coal production in the economy since 2001 (Bureau of Energy [BOE], 2022).

Chinese Taipei was one of the few economies in APEC that prevented the spread of COVID-19 infection quickly. Pandemic-prevention policies included border control, home quarantine, QR code real-name registration, and other measures (Ministry of Health and Welfare

[MOHW], 2022). Energy usage during the pandemic was due to the decline in external demand and the rise in remote work (BOE, 2022).

In 2021, the economy increased its ambition to achieve the ‘zero-emission by 2050’ target. The original goal was a 50% improvement by 2050 as compared to the 2005 baseline. The roadmap proposed in 2022 plans for 12 different key strategies with energy, technology, law, finance, and just aspects to reach the target (NDC, 2022).

Table 1: Chinese Taipei’s Macroeconomic Data and Energy Reserves

Key data ^{a, b}		Energy reserves ^c	
Area (thousand km ²)	36 197	Oil (million barrels)	2.4
Population (million)	24	Gas (billion cubic metre)	6.2
GDP (billion, 2017 USD PPP)	1 353	Coal (million tonnes)	–
GDP per capita (2017 USD PPP)	57 328	Uranium (kilotonnes U ₃ O ₈)	–

Source: ^a Ministry of the Interior [MOI] (2020); ^b DGBAS (2020); ^c CIA (2022)

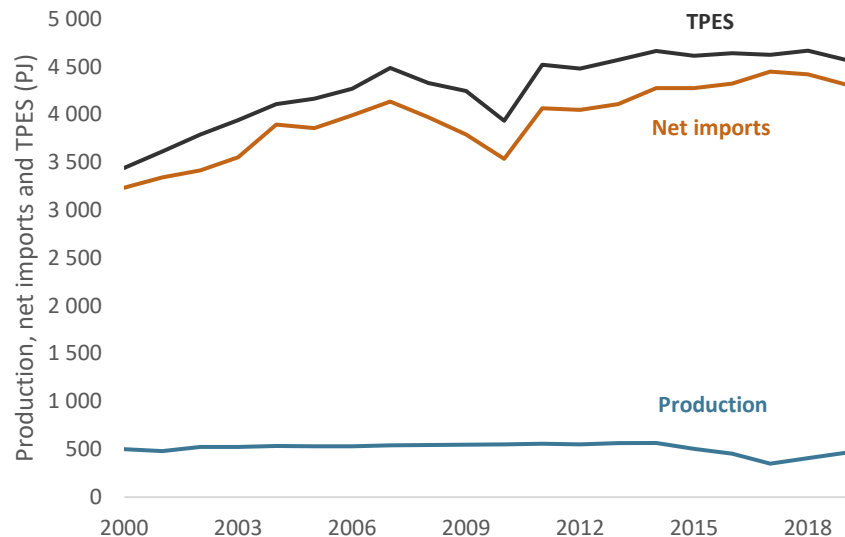
Note: ‘Energy reserves’ indicates proven reserves.

Energy Supply and Consumption

Total Primary Energy Supply

Total primary energy supply (TPES) in Chinese Taipei dropped 2.1% to 4 571 petajoules (PJ) in 2019 (Figure 1). This decline can be attributed to the significant decreases in oil (-6.5%) and coal (-2%), both comprising 36% of TPES in 2019. The decline resulted in slower compound annual growth from 2000 to 2019 (1.5%).

Figure 1: Chinese Taipei's total primary energy supply (TPES), production, and net imports, 2000 to 2019



Source: EGEDA (2021)

Nuclear and renewables supply led to large increases in 2019, increasing by 16.8% and 15.1%, respectively. However, these large increases were not sufficient to offset the decreases posted by oil, coal, and gas.

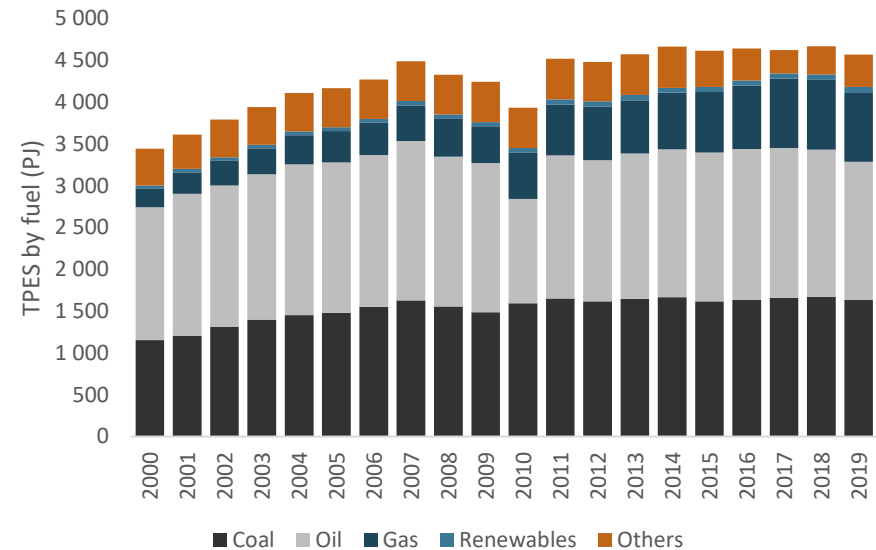
Chinese Taipei's energy needs depend heavily on foreign energy supplies. In 2019, net imports accounted for more than 90% of TPES, despite the 2.4% drop from the 2018 level (Figure 1).

Oil accounted for the largest share of net imports (42%), though levels fell 2.6% to 1 813 PJ in 2019. Oil imports include crude oil imports that feed Chinese Taipei's domestic refineries and refined product imports for domestic consumption. Refined product imports are largely offset by significant volumes of refined product exports, given that the domestic

refinery output does not perfectly match domestic demand requirements. Coal is exclusively imported, and it accounted for a 38% share of Chinese Taipei's net imports in 2019. Coal import volumes were 1.3% lower in 2019. Chinese Taipei was one of the top liquefied natural gas (LNG) importers in the world in 2019 (International Group of Liquefied Natural Gas Importers [GIIGNL], 2020).

Oil and coal account for most of Chinese Taipei's energy supply, with a combined total of 3 286 PJ (72% of TPES) in 2019. Coal was mainly used for power generation, and oil supply was mainly used as feedstock for the economy's fuel refinery. Gas supply has consistently grown in the last two decades, though a 1.1% decline to 824 PJ was seen in 2019 (Figure 2).

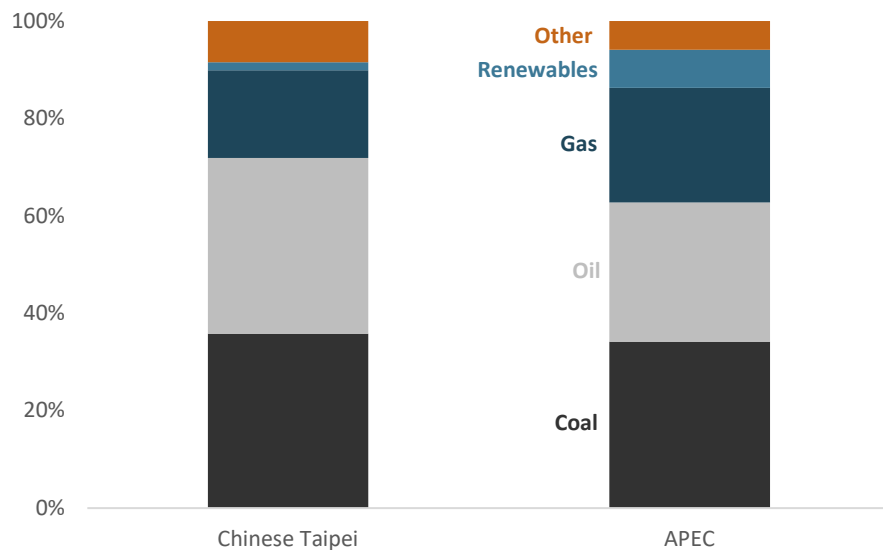
Figure 2: Chinese Taipei's total primary energy supply (TPES) by fuel, 2000 to 2019



Source: EGEDA (2021)

Renewables are increasingly significant in Chinese Taipei given the economy's efforts towards 'greening' its economy. It opened the door for potential European Union (EU) and Chinese Taipei collaboration in the field of renewable energy (European Business & Regulatory Cooperation [EBRC], 2021).

Figure 3: Total primary energy supply relative fuel share, Chinese Taipei and APEC, 2019



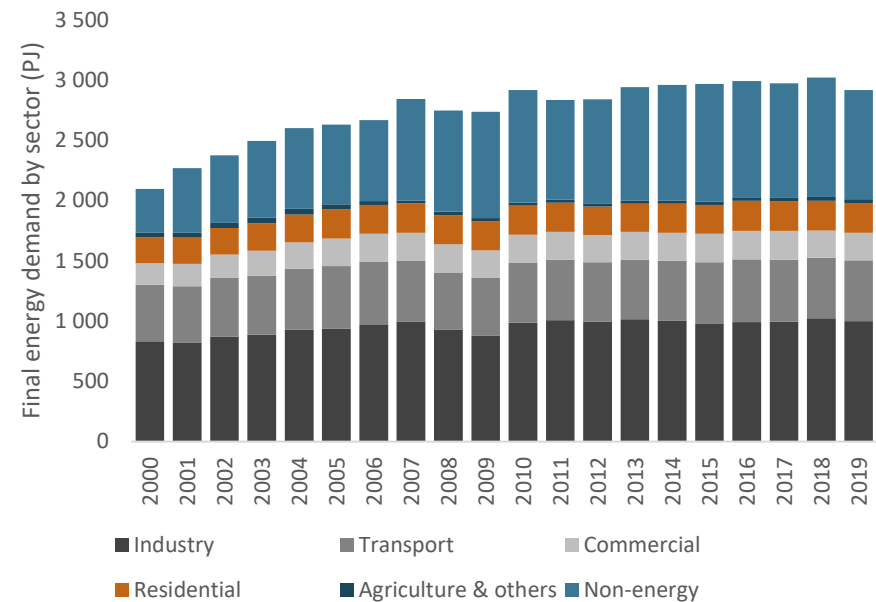
Source: EGEDA (2021)

Total Final Consumption

Total final consumption (TFC, including non-energy) in Chinese Taipei in 2019 was 2 919 PJ, which was 3.4% lower than the 2018 level (Figure 4). This decrease can be attributed to the significant dip in the demand of the non-energy (-8.6%) and industry sectors (-2.2%), two of the economy's largest consumers, in 2019.

The industrial sector remained the largest energy-consuming sector in Chinese Taipei, with a 34% share in TFC in 2019. Consumption levels of the chemical industry (including petrochemical), the biggest industry subsector, decreased 2.8% in 2019 and contributed the most to the decline in the industry's energy consumption. The non-energy sector, accounting for 31% of TFC in 2019, was the second-largest energy-consuming sector in Chinese Taipei. The non-energy sector's use of energy products is susceptible to fluctuations in oil prices and external demand. In 2019, trade disputes between China and the United States hampered global demand, and the non-energy sector experienced a large decline.

Figure 4: Chinese Taipei's final consumption by sector, 2000 to 2019



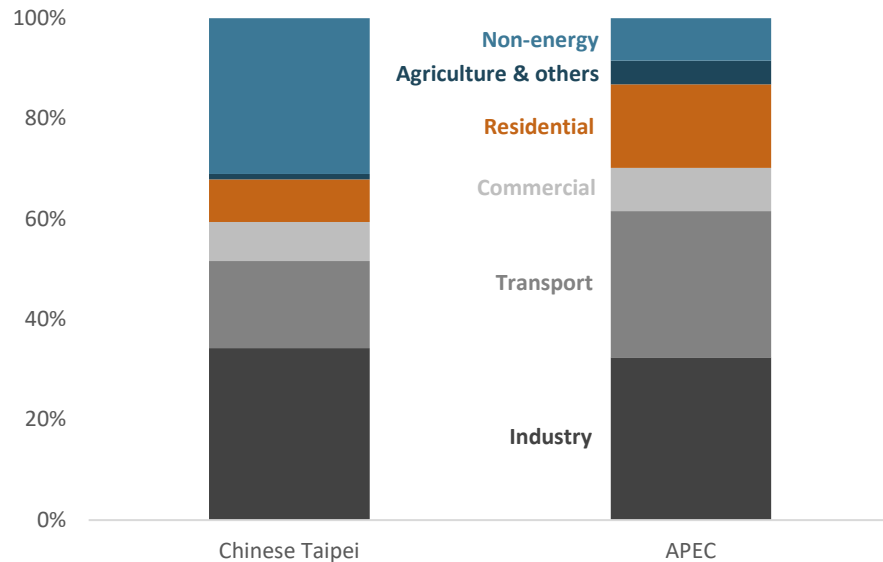
Source: EGEDA (2021)

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The transportation sector was the third-largest energy-consuming sector in Chinese Taipei, with a 17% share of TFC in 2019. The building sector (commercial and residential) was slightly smaller, accounting for a 16% share. These sectors have been relatively stable in terms of TFC share over the past decade.

The relative share of the non-energy sector in TFC in Chinese Taipei remained greater than in the whole APEC region. This difference 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 relative shares of the rest of the sectors (transportation, building, and agriculture & others) were all less than that of the APEC region (Figure 5).

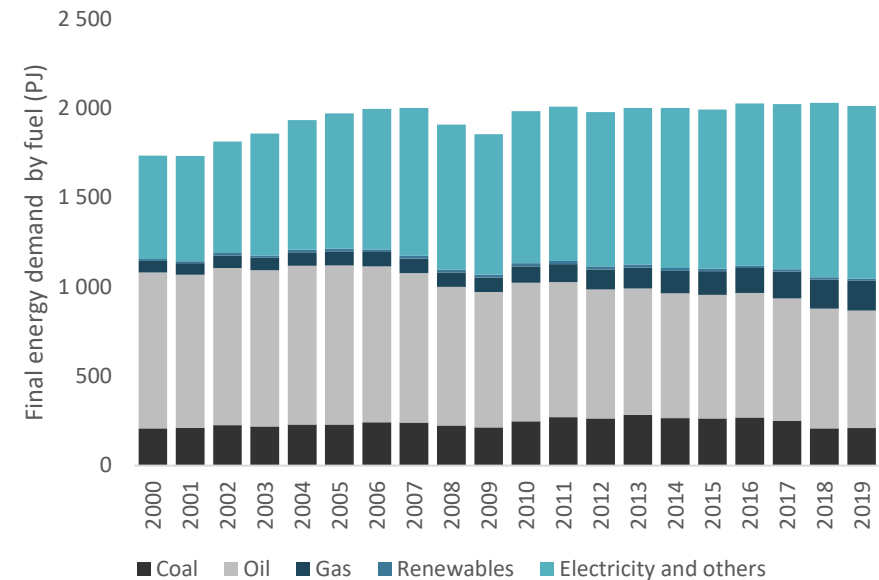
Figure 5: Final consumption sectoral share, Chinese Taipei and APEC, 2019



Source: EGEDA (2021)

Total final energy consumption (TFEC), which excludes non-energy, in Chinese Taipei in 2019 was 2 012 PJ, which was slightly lower than the 2018 level. This decline was due to declines in the demand for renewables, oil electricity, and others. However, as mentioned previously, the decline in TFC was mainly due to the non-energy sector; the fall in TFEC between 2018 and 2019 was minor (Figure 6).

Figure 6: Chinese Taipei's final energy demand by fuel, 2000 to 2019



Source: EGEDA (2021)

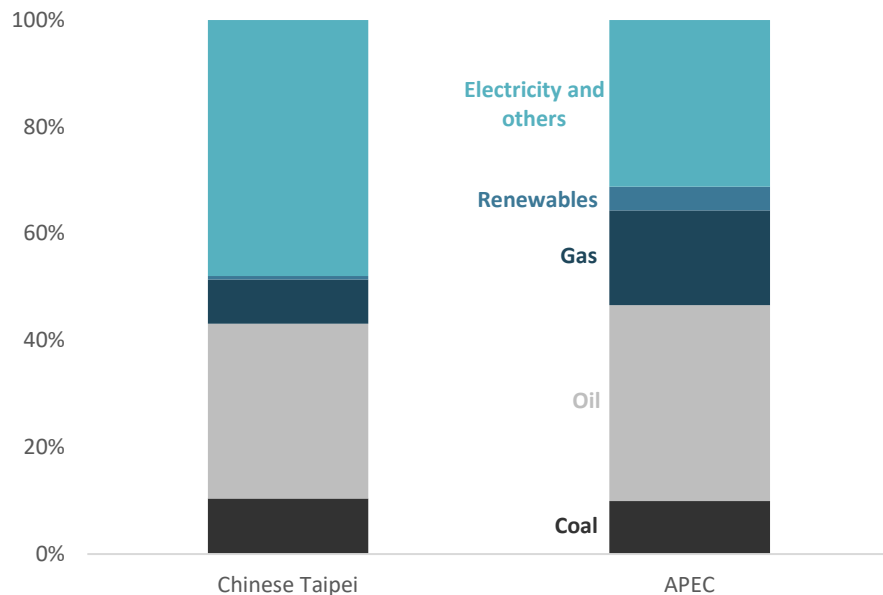
Note: Does not include non-energy consumption of energy commodities.

The TFEC trend tells more than the annual change in 2019. From 2010 to 2019, the CAGR of coal (-1.7%), oil (-1.6%), and renewables (-3.5%) were all negative. These falls were offset by the positive CAGR of gas (6.2%) and electricity (1.3%). The strong growth trend in gas was mainly driven by the industrial and building sectors. The moderate

growth trend in electricity suggests that electricity remains an important component of the economy's TFEC.

In 2019, electricity and others accounted for almost half of TFEC (48%) in Chinese Taipei, which was greater than in most APEC economies, except for Hong Kong, China. The relatively high share of electricity and others in TFEC was mainly due to usage of the industry and building sectors. The share of oil in TFEC was 33%, which was slightly less than the whole APEC economy. The share of oil in TFEC was mainly driven by the transport sector (76%), and a downward trend is expected in the future with the rise of electric vehicles (EVs; Figure 7).

Figure 7: Final energy demand fuel shares, Chinese Taipei and APEC, 2019

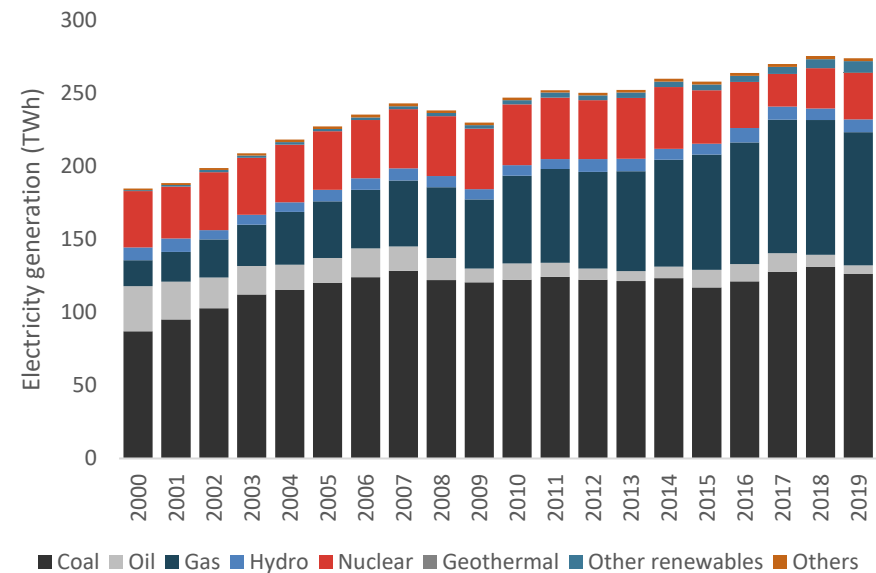


Source: EGEDA (2021)

Transformation

Chinese Taipei's electricity generation was 274 Terawatt-hour (TWh) in 2019, which was 0.49% lower than in 2018 (Figure 8). This decrease was mainly caused by the industry sector, which was affected by the trade dispute in 2019. The electricity generation mix in Chinese Taipei was dominated by fossil fuel power plants (coal, gas, and oil), with a share of more than 81% in 2019. Among fossil fuel power plants, coal accounted for the largest share (46%) of electricity generation, followed by gas (33%) and oil (2.1%).

Figure 8: Chinese Taipei's electricity generation by fuel, 2000 to 2019



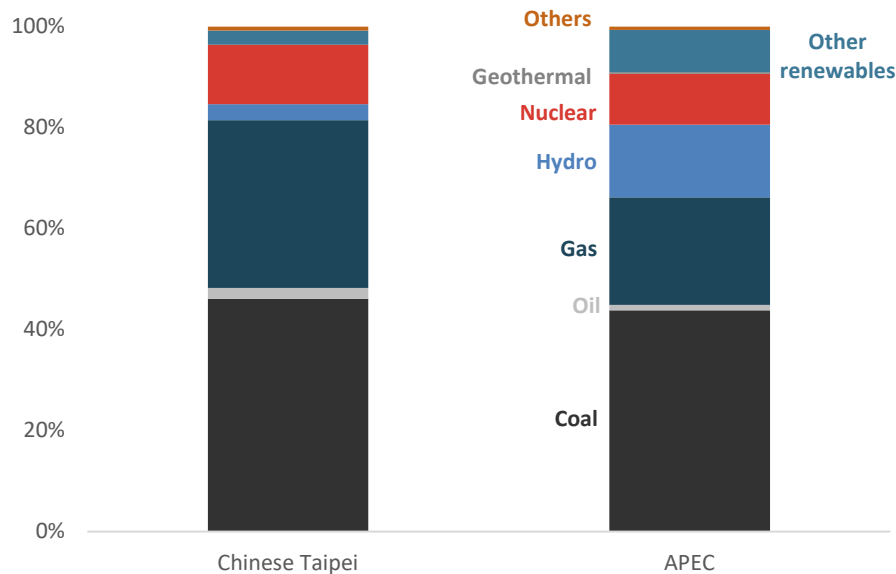
Source: EGEDA (2021)

From 2010 to 2019, the CAGR of the electricity generated by oil (-6.2%) and nuclear (-2.5%) was negative, while that of electricity generated by coal (0.32%), gas (4.23%), hydro (1.89%), renewables

and others (8.12%) was positive. According to the CAGR of electricity generation, Chinese Taipei has transitioned to more gas and renewables and cut down on generating electricity using oil and nuclear during the past decade.

In 2019, coal accounted for almost half of Chinese Taipei’s electricity generation (46%), which was slightly higher than that of the whole APEC economy (Figure 9). It is also worth noting that the share of gas-fired electricity generation was 11.8% higher than the whole APEC economy. The share of gas-fired electricity generation is expected to increase due to the importance of gas-fired generators with higher renewable energy penetration in the context of Chinese Taipei’s nuclear-free target.

Figure 9: Electricity generation by fuel share, Chinese Taipei and APEC, 2019



Source: EGEDA (2021)

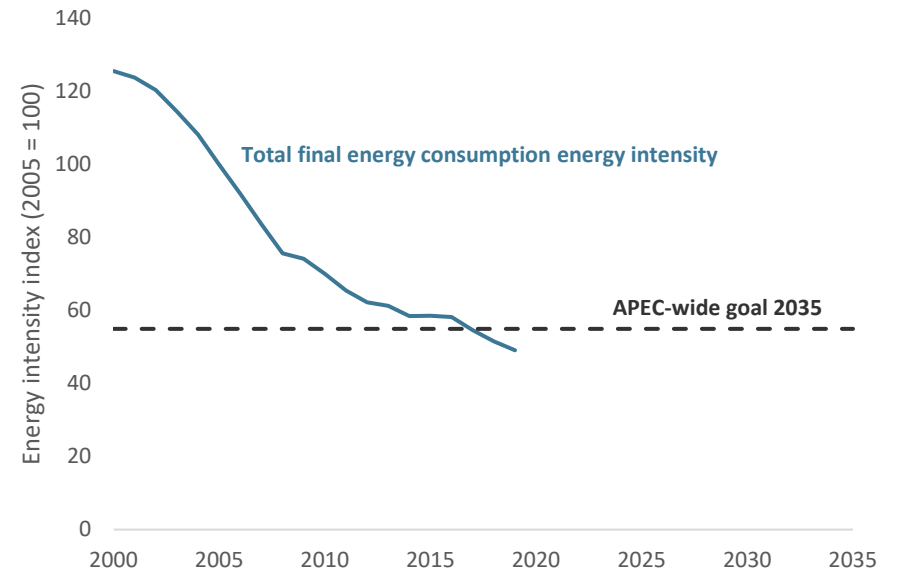
APEC Goals

APEC member economies have agreed to meet two energy-related objectives. These objectives are to improve energy intensity and to increase the share of renewables in the energy mix.

Energy Intensity Goal

In 2011, APEC member economies agreed to revise their goal of reducing energy intensity by 45% in 2035 compared to the 2005 baseline. The former goal was a 25% improvement by 2030 as compared to the 2005 baseline.

Figure 10: Chinese Taipei’s total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

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

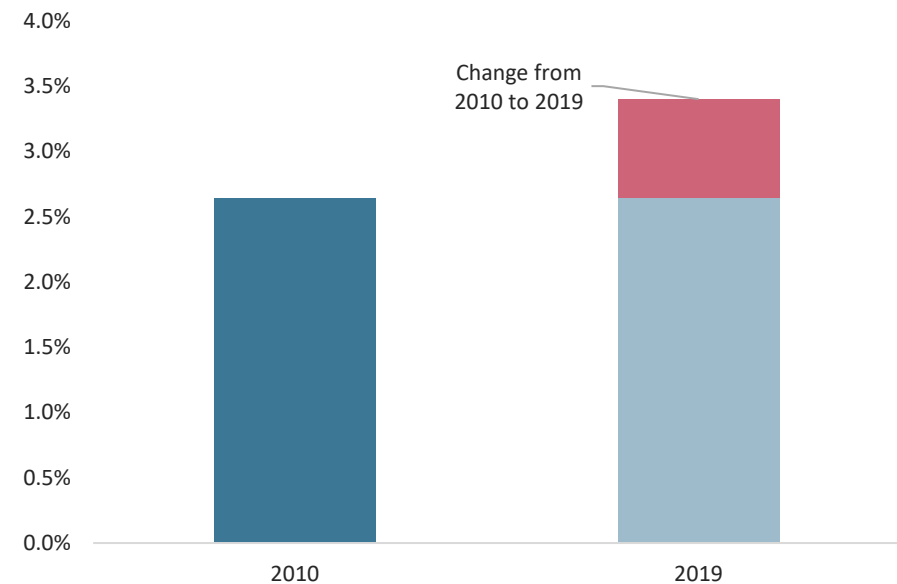
In 2019, the energy intensity of Chinese Taipei's total final energy consumption (excluding non-energy) improved by almost 51% and has outpaced the APEC-wide commitment. Energy intensity relative to total primary energy supply and total final consumption (including the non-energy sector) showed similar trends.

Doubling of Renewables

The second energy goal involves doubling the share of the modern renewables in the APEC energy mix for the period 2010 to 2030. Similarly, individual member economies have no economy-level goal, but it is possible to calculate the contribution of individual economies to better understand whether the goal will be achieved.

Chinese Taipei's share of modern renewables in its TFEC was 2.6% in 2010. In 2019, this share increased to 3.4%, representing a 29% improvement from 2010 (Figure 11). Going forward, the APEC-wide doubling goal will require the share of APEC's modern renewables to reach 12.3% by 2030.

Figure 11: Chinese Taipei's modern renewable energy share, 2010 and 2019

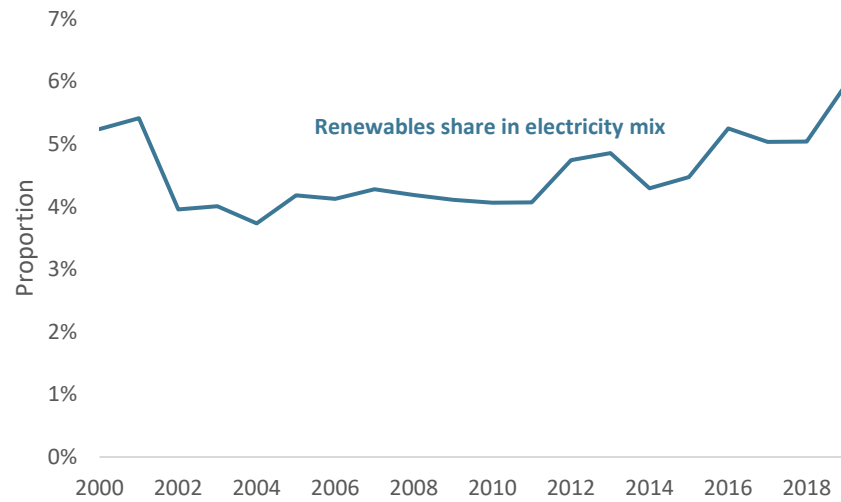


Source: EGEDA (2021)

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 electricity generation of renewable energy reached 6.0% in Chinese Taipei in 2019, which was a record high since 2000. The share of renewables in electricity generation was relatively stable in the 2000s but has been slowly growing over the past decade.

Figure 12: Chinese Taipei's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy Policy

Energy policy	Details	Reference
Greenhouse Gas Reduction and Management Act	It aims to reduce annual GHG emissions by 2050 to less than half of 2005 levels.	Ministry of the Justice [MOJ] (2015)
INDC	It has an economy-wide target to reduce GHG emissions (214 million tonnes of carbon dioxide equivalent [MtCO ₂ eq]) by 50% from the business-as-usual level (428 MtCO ₂ eq) by 2030.	Environmental Protection Administration [EPA] (2015)
Energy Administration Act	The Act's purpose is to promote a rational and efficient way of energy usage. It includes the Guidelines on Energy Development to promote energy security, green economy, environmental sustainability, and social equity, consistent with the target of a nuclear-free economy, by 2025.	MOJ (2016)
Energy Transition Policy by 2025	It 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] (2018)
Renewable Energy Development Act	It sets 27 000 megawatts (MW) as the objective for electricity generated by renewable energy power generation facilities by 2025.	MOJ (2019)
Long-term Power Development Plan by 2025	It aims to include additional capacities of gas and to retire oil, coal, and nuclear plants by 2025.	TPC (2021)
Climate Change Response Act (draft)	The Environmental Protection Administration of Chinese Taipei proposed the draft Climate Change Response Act in 2021, an amendment to the Greenhouse Gas Reduction and Management Act. The major revisions of the amendment include the goal of net-zero emissions by 2050, enhancing the level of climate governance, imposition of carbon levy, etc.	EPA (2021)
Pathway to Net-Zero Emissions in 2050	In 2022, the NDC of Chinese Taipei proposed the pathway for the target of net-zero emissions in 2050. The roadmap consists of four strategies (transition of energy, industry,	NDC (2022)

lifestyle, and social) and two foundations (technology research and development [R&D] and climate legislation).

Notable Energy Developments

Energy development	Details	Reference
Renewable Energy Certificates	The Renewable Energy Certification Center (NRECC) has issued over one million Renewable Energy Certificates (T-REC) since 2017. NRECC issues T-REC for those who use renewable energy by direct supply, wheeling, and self-use and helps the public track the certificates (from issue to declaration).	MOEA (2022)
Geothermal power	Chinese Taipei's first commercial geothermal power plant (Qingshui Geothermal Power Plant) started to provide eco-friendly and stable electricity in 2021. It is worth noting that geothermal energy is not only renewable but also stable and can serve as a baseload in the electricity system.	TGE (2021)
Offshore wind	The development of offshore wind in Chinese Taipei was behind schedule because of the COVID-19 pandemic. However, it is estimated that the plan will get back on schedule by the end of 2022, and the target of 5 617 MW installed capacity by 2025 remains.	MOEA (2021)
Referendums related to energy policy	Two questions of the referendum held in 2021 were related to Chinese Taipei's energy policy: 'Do you agree the activation of CT's mothballed Fourth Nuclear Power Plant?' and 'Do you agree to relocate the construction site of CPC Third LNG Receiving Terminal away from the coastal and sea areas of Taoyuan's Datan Algae Reef?' If the questions had been accepted, the energy transition policy the government had planned would have been largely changed. However, these two questions were rejected so Chinese Taipei could continue to pursue the original goal of the energy transition.	Central Election Commission [CEC] (2021)

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Thailand

Introduction

Thailand is known as ‘the window to South-East 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 (km²) and had a population of 69.8 million in 2020. In 2020, its gross domestic product (GDP) dropped to USD 1 206 billion (2017 USD purchasing power parity [PPP]), a 6.1% decrease from its GDP in 2019 (World Bank, 2021) as a result of slowdown of economic activities in response to the COVID-19 pandemic.

Thailand has limited domestic energy resources. At the end of 2020, Thailand had proven reserves of 252.7 million barrels of oil, 5.1 trillion cubic feet of natural gas and 1 063 million tonnes (Mt) of coal. Based on the current rates of production, its domestic supply will soon become depleted – oil resources in less than two years and natural gas within four years (BP 2021). Most coal-fired power plants in Thailand use low-quality, domestically produced lignite and imported bituminous coal. Thailand is highly dependent on energy imports, particularly oil, with approximately 88% of its oil and 31% of its gas supply coming from imports (EPPO, 2021).

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 2019, the coal supply was 606 PJ – a 21% decrease from the previous year’s level. The natural gas supply in 2019 was 1 666 PJ, a 12%

decrease from 2018. Natural gas is not only used for power generation in Thailand but has also been promoted in the transport sector as a replacement for diesel and gasoline; however, its popularity is currently declining due to an unattractive price subsidy. Thailand has increased its reliance on imported natural gas in the form of piped gas from Myanmar and liquefied natural gas (LNG) from Qatar and Malaysia, with plans in place to invest in more LNG-receiving terminals.

Table 1: Thailand Macroeconomic Data and Energy Reserves

Key data ^a		Energy reserves ^{b, c}	
Area (km ²)	513 120	Oil (billion barrels)	252.7
Population (million)	69.8	Gas (trillion cubic feet)	5.1
GDP (2017 USD billion PPP)	1 206	Coal (million tonnes)	1 063
GDP per capita (2017 USD PPP)	17 284	Uranium (kilotonnes U < USD 130/kgU)	N/A

Source: World Bank (2021), BP (2021), DMF (2020)

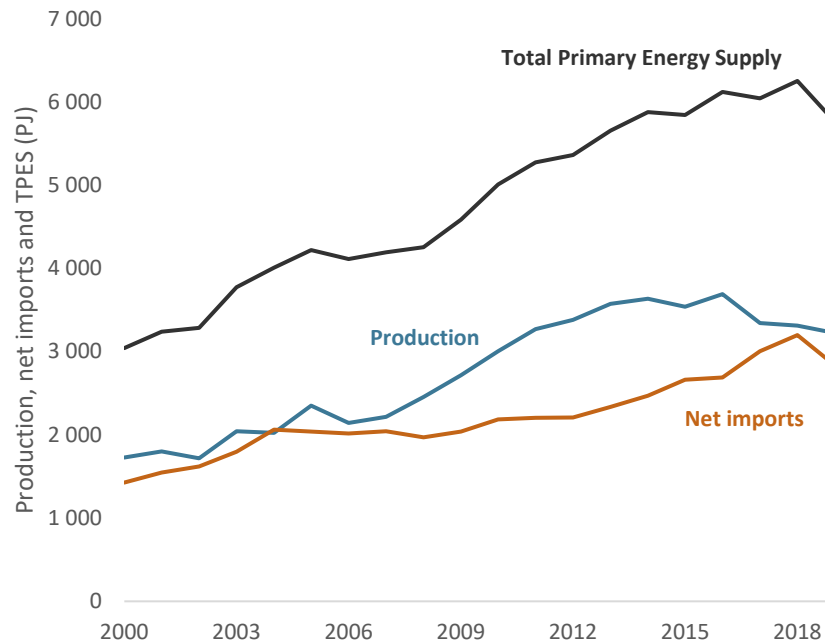
Energy Supply and Consumption

Total Primary Energy Supply

Thailand’s total primary energy supply (TPES) in 2019 was 5 764 PJ, which indicated a 7.9% decrease from the 2018 level. It has been on the rise at the rate of 2.3% annually for the past decade. Energy production declined by 2.6%, reaching 3 227 PJ in 2019, while net imports rose significantly over the decade (3.4% annually) to reach 2 835 PJ in 2019 to compensate for the declining domestic production (Figure 1).

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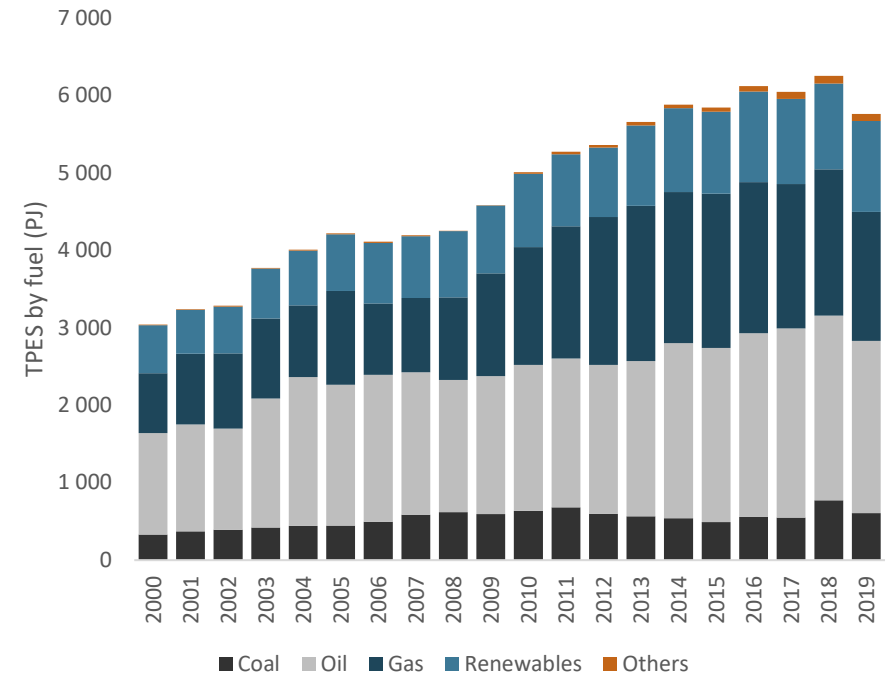
Figure 1: Thailand's total primary energy supply, production and net imports, 2000 to 2019



Source: EGEDA (2021)

Thailand's TPES fuel mix has fluctuated by a small amount from 2000 to 2019 (Figure 2). The share of oil has declined from 43% to 39% for the period, while the share of natural gas has increased from 25% to 29%. Coal and renewables have remained almost constant at 11% and 20%, respectively.

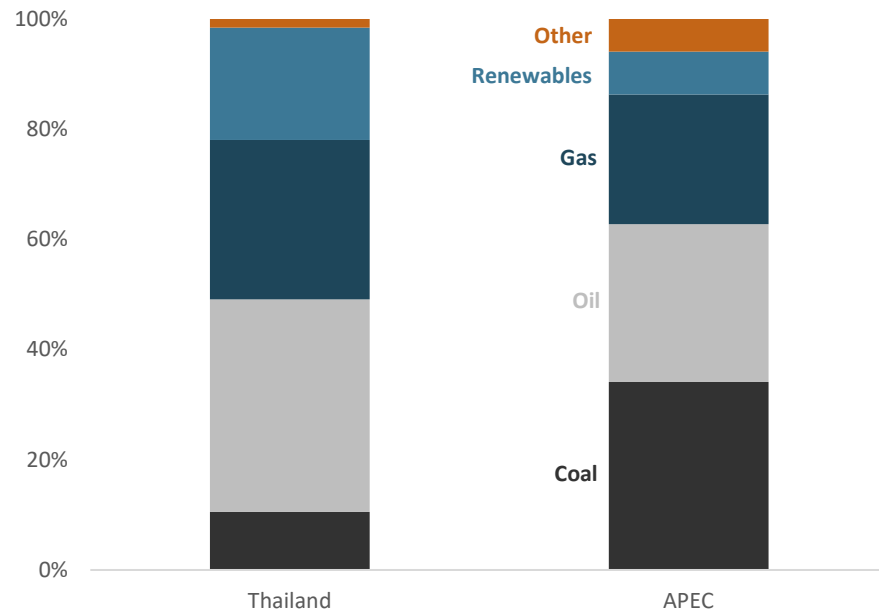
Figure 2: Thailand's total primary energy supply by fuel, 2000 to 2019



Source: EGEDA (2021)

Thailand exhibits a fuel mix different from that of the APEC region (Figure 3). The share of coal is smaller, whereas those of oil, gas, and renewables are proportionally larger. Share of renewables at 20.4% in 2019 is also significantly larger than APEC. Gas supply growth is strongest among fossil fuels, suggesting that its share will be higher in the coming years due to coal-to-gas switching in the power sector and the declining domestic gas production.

Figure 3: Total primary energy supply relative fuel share – Thailand and APEC, 2019

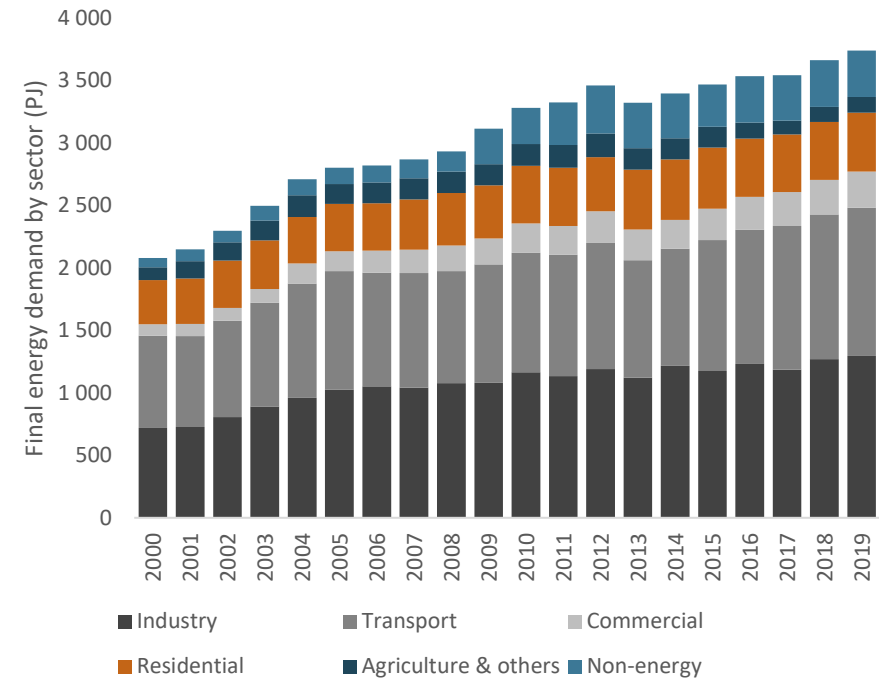


Source: EGEDA (2021)

Total Final Consumption

Thailand's total final consumption in 2019 was 3 740 PJ, an increase of 2.1% from 2018 (Figure 4). The industry and transport sectors were the two largest energy-consuming sectors, accounting for 1 296 PJ and 1 187 PJ, 35% and 32% of total final consumption, respectively. The buildings (commercial and residential) and non-energy sectors account for 20% and 10% of the total final consumption (761 PJ and 372 PJ), respectively. The non-energy sector is primarily composed of energy products that are used as feedstock (mainly in petrochemicals) instead of energy purposes.

Figure 4: Thailand's final consumption by sector, 2000 to 2019

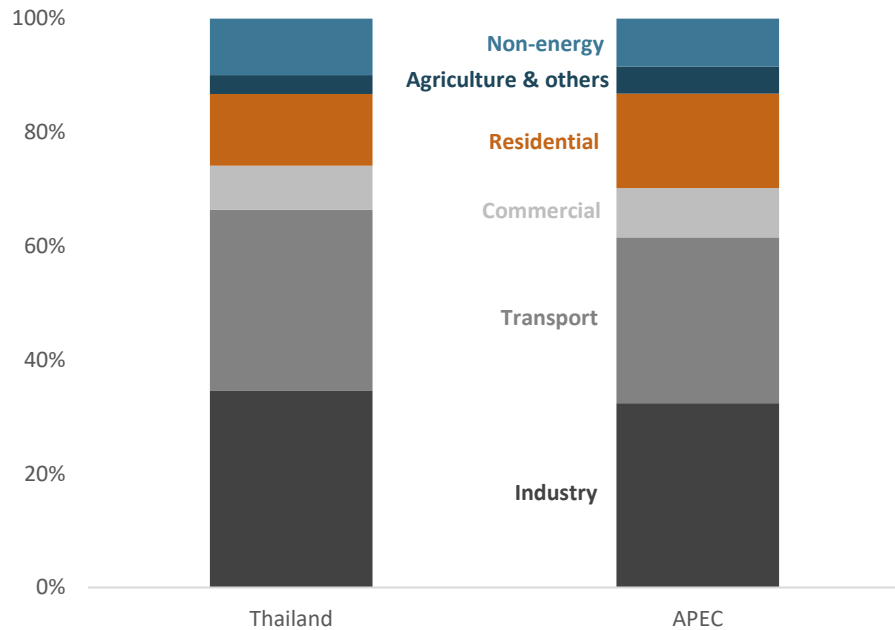


Source: EGEDA (2021)

Thailand's industry, transport, and non-energy sectors show somewhat higher proportional energy consumption, whereas the energy consumption of agriculture and buildings (residential and commercial) is somewhat lesser, compared to the APEC region (Figure 5). Industry and transport have been the key dominant sectors since 2000.

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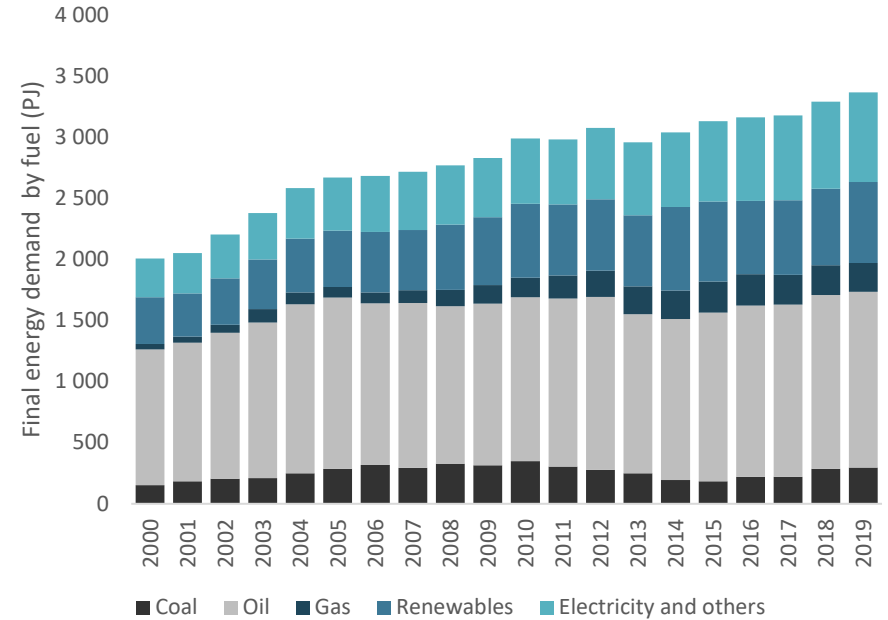
Figure 5: Final consumption sectoral share, Thailand and APEC, 2019



Source: EGEDA (2021)

Oil remains the dominant fuel for Thailand’s final energy demand, contributing 42.7% of the total (Figure 6). However, the contribution of oil has decreased, compared to its 55.3% share in 2000. Electricity, on the other hand, exhibits rapid growth, both in proportion and consumption due to urbanisation and electrification. The share of electricity and others in 2019 was 21.8% compared to 15.8% in 2000, and it has exhibited a steady growth of 4.5% for the past 19 years. The share of renewables and coal in the finale energy mix were 19.7% and 8.8%, respectively, which is a marginal increase compared to 2000.

Figure 6: Thailand’s final energy demand by fuel, 2000 to 2019

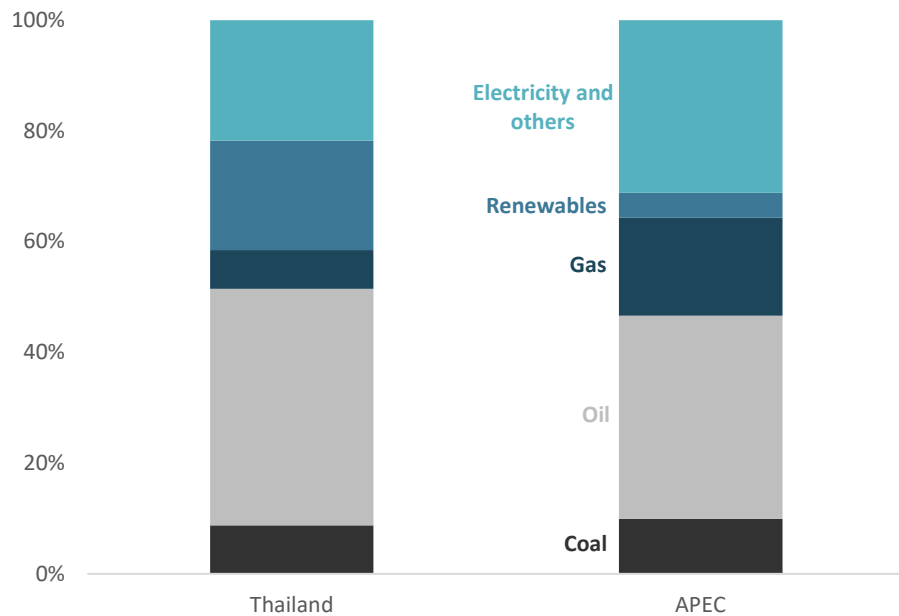


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

Thailand’s oil shows a higher share of energy demand at 42.7% versus APEC’s 36.7%, whereas renewables show a significantly higher share at 19.7% compared to APEC’s 4.5%. Gas and electricity shares are lower, compared to APEC (Figure 7). The coal share of 8.8% is slightly lower than APEC’s 9.9%.

Figure 7: Final energy demand fuel shares, Thailand and APEC, 2019



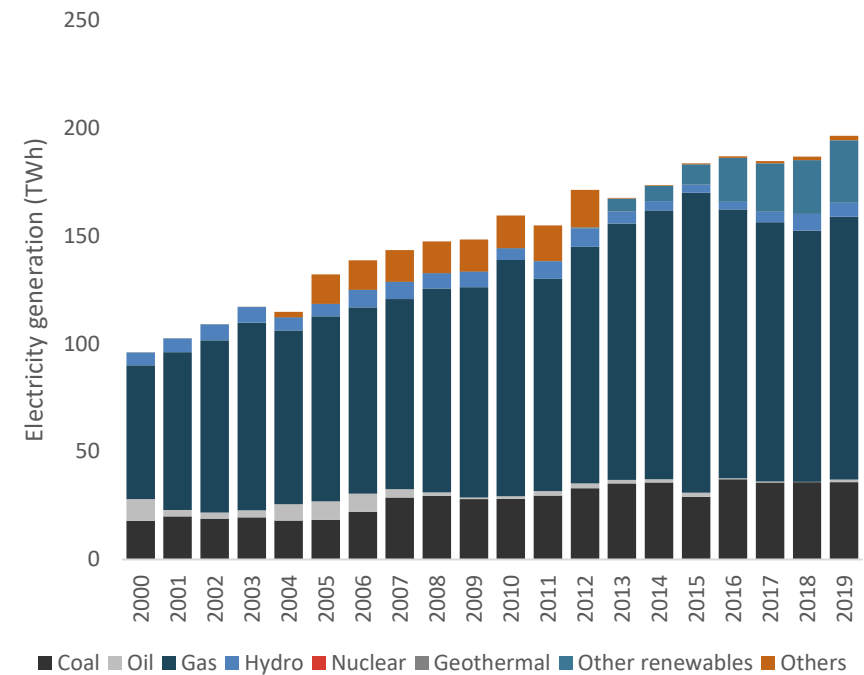
Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

Transformation

Thailand's power sector continues to be reliant on natural gas (Figure 8). About 62% of Thailand's electricity was generated by gas in 2019, a slight decrease from 65% in 2000. Coal constantly maintained its share at 19% from 2000 to 2019, while that of renewables increased substantially from 6% in 2000 to 18% in 2019. Power generation from other renewables, mainly solar PV, shows stellar growth of 32% per annum for the last five years.

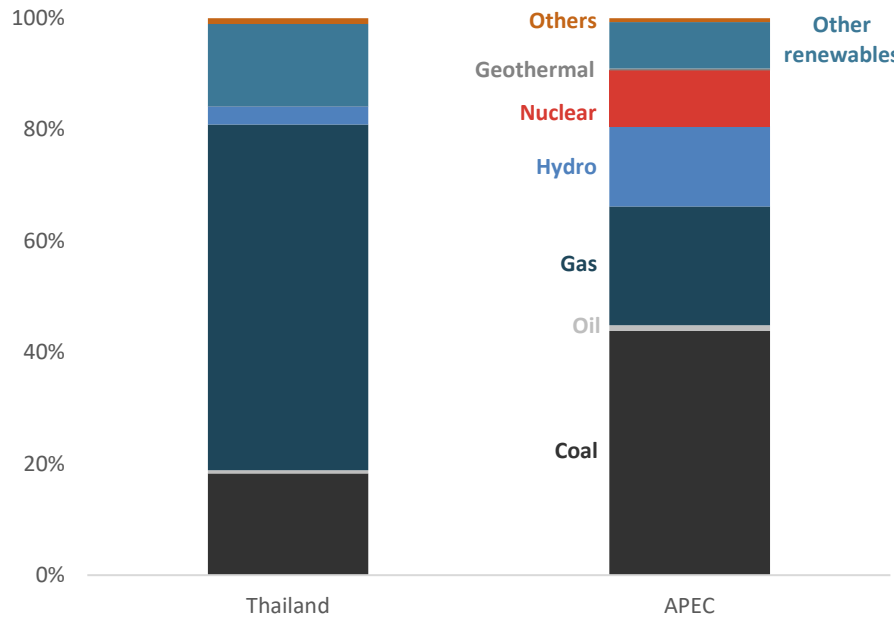
Figure 8: Thailand's electricity generation by fuel, 2000 to 2019



Source: EGEDA (2021)

The prominence of natural gas and renewables in Thailand's power sector is clear when viewed next to the generation mix for APEC in 2019 (Figure 9). Thailand also has proportionally less coal and hydro generation than that of APEC. A continued strong growth in other renewables in Thailand is expected due to abundant renewable potential and technologies that are increasingly cost competitive.

Figure 9: Electricity generation by fuel share, Thailand and APEC, 2019



Source: EGEDA (2021)

APEC Goals

Energy Intensity Goal

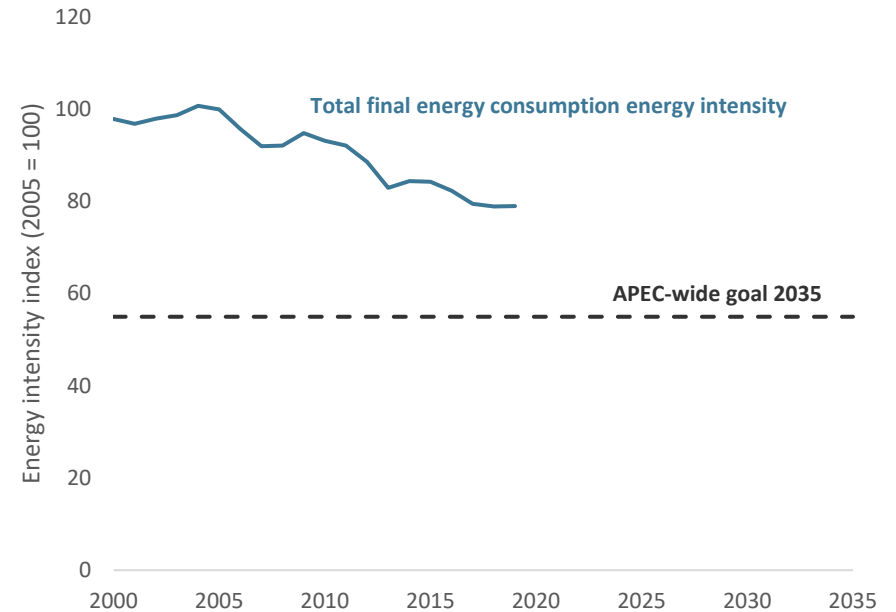
In 2011, the APEC member economies agreed to increase their ambition to reduce energy intensity by 45% in 2035, relative to a 2005 baseline. The original goal was a 25% improvement by 2030, relative to a 2005 baseline.

The APEC region is on track to meet this energy intensity improvement. This goal does not impose individual economic targets, but it is possible to track the progress of individual APEC economies relative to the

overarching proportional improvement.

In 2019, Thailand's total final energy consumption (not including non-energy) energy intensity improved by 21% relative to the 2005 numbers (Figure 10).

Figure 10: Thailand's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



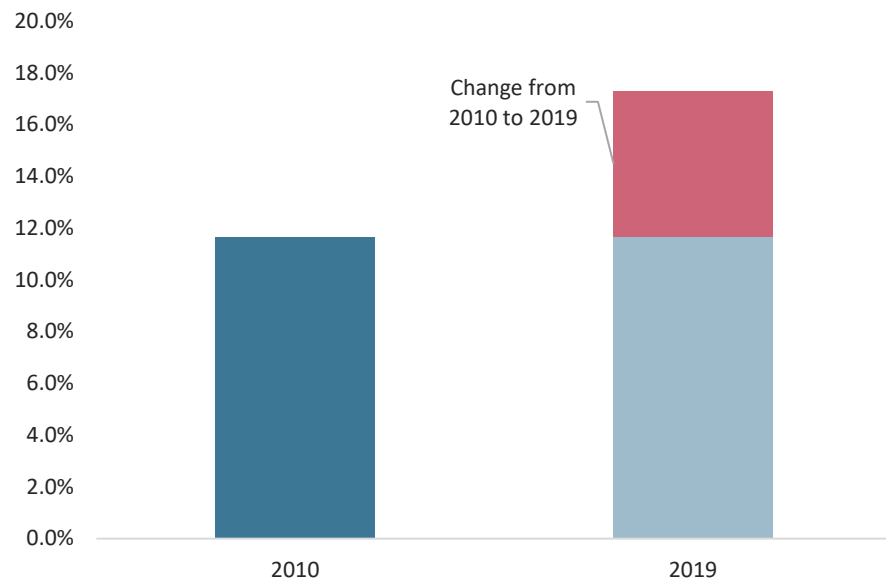
Source: EGEDA (2021)

Doubling of Renewables

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

Individual member economies do not have economy-level goals; nonetheless, it is possible to calculate the relative improvement in individual economies to get a better sense of whether this goal will be achieved. Thailand's share of modern renewables to final energy consumption in 2010 was 11.7%. In 2019, this proportional share increased to 17.3% (Figure 11).

Figure 11: Thailand's modern renewable energy share, 2010 and 2019

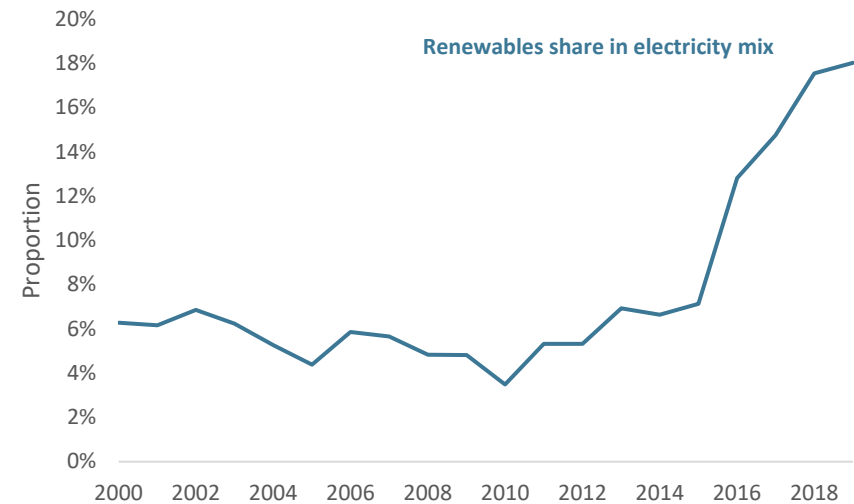


Source: EGEDA (2021)

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.

Thailand's electricity generation from renewables reached 18% in 2019, which represents an increase of more than five-fold compared to the 2010 level of 3.5% (Figure 12). The increase is largely due to the incentives and supporting schemes to promote solar PV, particularly in the power generation sector, which commenced in 2013.

Figure 12: Thailand's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

Energy Policy	Details	Reference
Climate Change Master Plan (CCMP)	The climate change master plan (2015–2050) is designed to help Thailand achieve sustainable low-carbon growth and climate change resilience by 2050.	Climate link
GHG Emission Reduction	The action plans for the decarbonisation of the energy sector aim to reduce greenhouse gas emissions by 20–25% by 2030.	GHG reduction
Power Development Plan 2018 (PDP 2018 Revision 1)	The PDP 2018 has set a goal of achieving a power capacity of 77 211 MW, of which renewable energy projects are planned to account for 29 411 MW by 2037.	EPPO
Power Development Plan 2018 (PDP 2018 Revision 1)	The PDP 2018 has set the following goal for fuel mixes in 2037: natural gas equal to 53%, non-fossil fuels equal to 36% and coal equal to 11%.	EPPO
Energy Efficiency Plan 2018 (EEP 2018)	The energy intensity should be reduced by 30% by 2037 compared to 2010.	EPPO
Alternative Energy Development Plan 2018 (AEDP 2018)	Increase the proportion of renewable energy to 30% of the total energy consumption by 2037	EPPO
Alternative Energy Development Plan 2018 (AEDP 2018)	The AEDP 2018 has set a goal of RE-based power capacity at 34.23% of the total installed capacity (5.75% of TFEC), RE-based heat at 41.61% of the total heat production (21.2% of TFEC) and biofuel at 9.99% of the total fuel consumption (3.22% of TFEC) by 2037.	EPPO
Alternative Energy Development Plan 2018 (AEDP 2018)	Increase ethanol and biodiesel consumptions to 7.5 million litres/day and 8.0 million litres/day, respectively, by 2037	EPPO
Drafted Oil Plan 2018	Increase oil reserves to 50 days by 2037	EPPO

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Drafted Oil Plan 2018	Increase E-20 to 90% of the gasoline consumption by 2027	EPPO
Drafted Oil Plan 2018	Increase Euro-V diesel production to match the total diesel demand by 2023	EPPO
Gas Plan 2018	Increase gas consumption in the industry sector by 5% annually by 2037 (versus 2018)	EPPO
Gas Plan 2018	Increase gas production to a minimum rate of 1 500 MMSCFD	EPPO
Gas Plan 2018	Increase the utilisation of LNG terminal to be at a minimum of 60%	EPPO
Imports from Myanmar	Follow the Gas Plan 2015, assuming declining imports from Myanmar that reach zero by 2031	EPPO
Thailand's Energy 4.0	The initiatives include the SMART grid, energy storage, 1.2 million EVs, 690 charging stations, and technology for heat production from renewables.	IECC
National Energy Plan 2022	Thailand's National Energy Plan 2022 (NEP 2022) is scheduled to be completed by year-end 2022. The plan will address medium-term and long-term energy policy directions for the economy.	EPPO

Notable Energy Developments

Energy development	Details	Reference
2nd PTT LNG import terminal (T-2)	A new facility with 7.5 Mtpa (expandable to 15 Mtpa) capacity, aiming for completion in 2022	EPPO
3rd PTT LNG import terminal (T-3)	A new facility with 10.8 Mtpa (expandable to 16 Mtpa) capacity, aiming for completion in 2027	EPPO
1st EGAT FSRU project (F-1)	The new 5 Mtpa capacity FSRU planned to be built in the upper gulf of Thailand by EGAT is <u>to be put on hold</u> in accordance with resolution from the National Energy Policy Council in April 2021. In turn, EGAT will invest in 50:50 joint-investment in a 2nd PTT LNG import terminal (T-2) (details above)	EPPO
Eastern Economic Corridor (EEC)	Development of the infrastructure in eastern Thailand to encourage investment as well as uplift innovation and advanced technology.	EECO
Map Ta Phut Phase III	The project is an extension to the Map Ta Phut Industrial Port and will help reduce the congestion at the port and develop logistical facilities to support the EEC.	EECO
Hydro-Floating Solar Hybrid	The EGAT project will install 16 floating solar farms with a combined capacity of 2.7 gigawatts by 2037.	EGAT
Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP)	The multilateral cross-border power trade aims to improve people's quality of life and the electrification and economic growth of the region.	Asia Pacific Energy
Euro V fuel specifications	Thailand will implement Euro V fuel specification standards in 2024 (originally planned for 2023) in order to improve air quality standards nationwide.	DOEB

United States

Introduction

Situated in North America between the Atlantic and Pacific Oceans, the United States (US) is the world’s third-largest economy in terms of land area and population. 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 among the 50 state economies.

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.

Table 1: The United States’ macroeconomic data and energy reserves

Key data ^{a, b}		Energy reserves ^{c, d}	
Area (million km ²)	9.9	Oil (billion barrels)	69
Population (million)	333	Gas (trillion cubic feet)	446
GDP (2017 USD billion PPP)	19 863	Coal (billion tonnes)	249
GDP per capita (2017 USD PPP)	59 649	Uranium (kilotonnes U < USD 130/kgU)	48

Source: a: US Census Bureau (2020), b: World Bank (2021), c: BP (2021) d: OECD (2020)

Note: Reserves are total proved reserves for oil, gas, and coal; identified recoverable resources for uranium.

In 2020, the US had 69 billion barrels of proven oil reserves, 446 trillion cubic of proved natural gas reserves and 249 billion tonnes of coal reserves (BP, 2020). In terms of global rankings, the US is the 9th largest holder of oil, 5th 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.

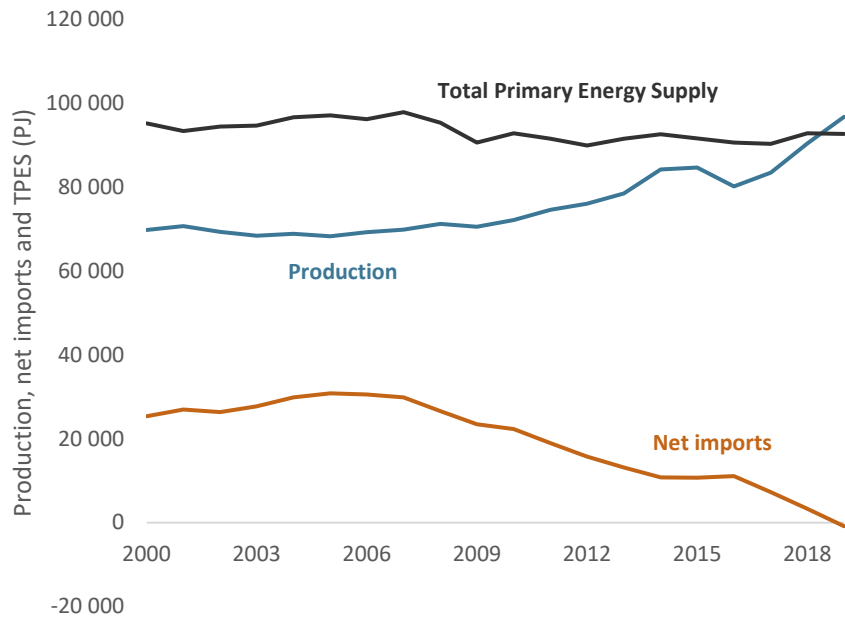
Renewable resources can be found throughout the US. Broadly speaking, the best solar resources are in the southwestern continental US as well as in Hawaii. For wind, the highest potential extends from North Dakota through Texas as well as offshore on both coasts and the western portion of the Gulf of 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 2019, energy production in the US exceeded total primary energy supply (TPES) and the US became a net exporter of energy for the first time in over 65 years.

Figure 1: The United States' total primary energy supply, production, and net imports, 2000 to 2019

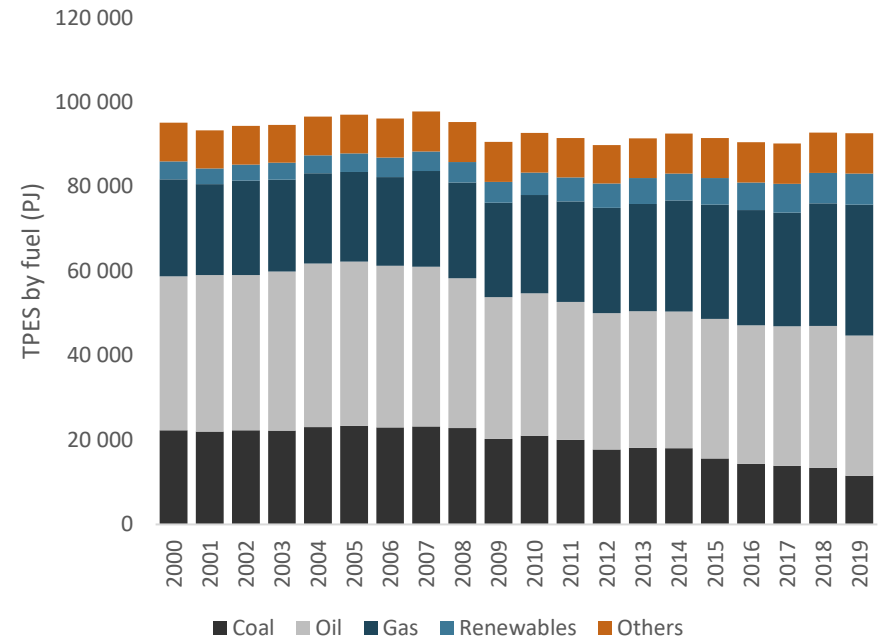


Source: EGEDA (2021)

The TPES in the US in 2019 was 96 706 PJ, which was a slight annual decline of 0.2%. However, energy production increased by a full 7.0% over the 2018 level. In 2019, US energy production exceeded TPES by 4%.

Although there was a small reduction in consumption in 2019, the primary drivers of this transition from energy importer to exporter was the substantial growth in US oil and gas production. Relative to 2018, oil production rose 11% and gas production rose 14%. The increase in total energy production occurred despite a 6% decline in coal production.

Figure 2: The United States' total primary energy supply by fuel, 2000 to 2019



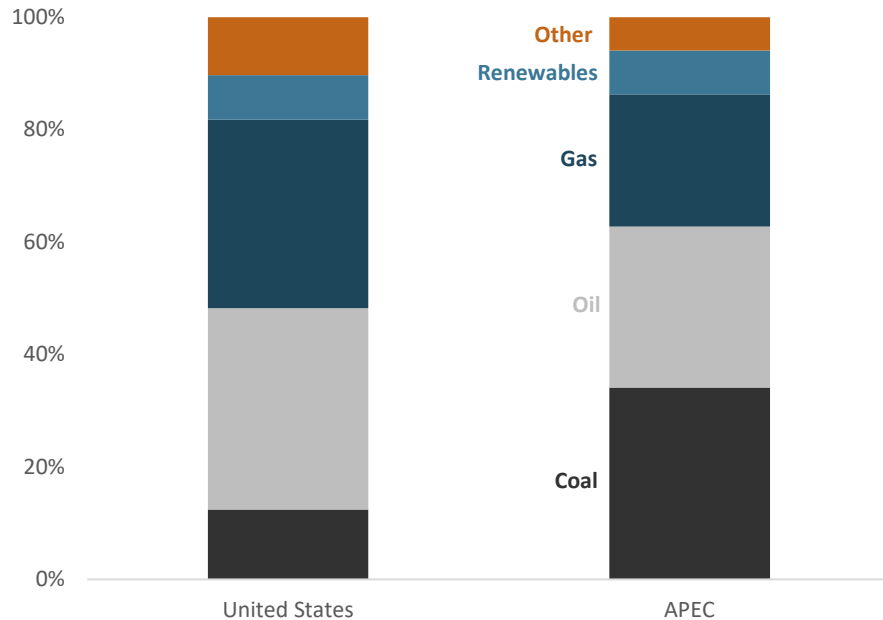
Source: EGEDA (2021)

By fuel type, 36% of TPES came from crude oil and petroleum products, 34% from natural gas, and only 12% from coal. Renewables accounted for 8% of TPES in 2019 and other sources, including nuclear and non-energy use of fuels, accounted for 10%.

Coal supply peaked in 2005 at 23 332 PJ and has declined by 51% through 2019. The oil supply of 2019 is 15% lower than the peak in 2005. Meanwhile, gas supply increased 48% through 2019 from a low of 21 024 PJ in 2006.

These dynamics are reflected in the 2019 composition of TPES of the US compared to the aggregate APEC TPES. In terms of percentage shares, the US primary energy supply contains a 7 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: Total primary energy supply relative fuel share – the United States and APEC, 2019

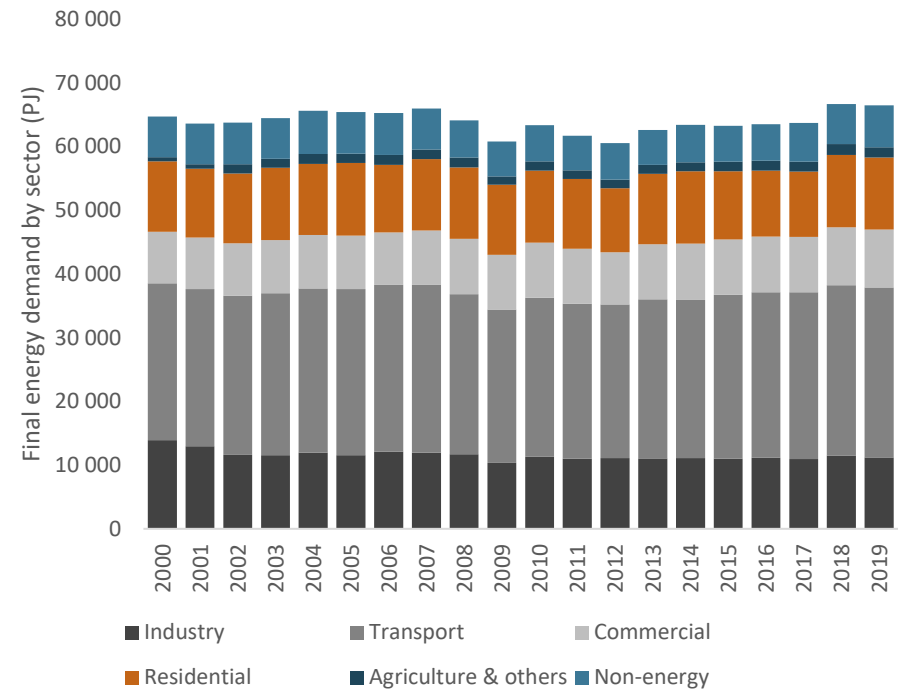


Source: EGEDA (2021)

Total Final Consumption

On the demand side, total final consumption (TFC), including non-energy, was 66 506 PJ in 2019, a slight decline of 0.3% from 2018. Although varying year to year, from 2000 through 2019, US total final consumption has increased on average only 0.14% per year.

Figure 4: The United States' final consumption by sector, 2000 to 2019

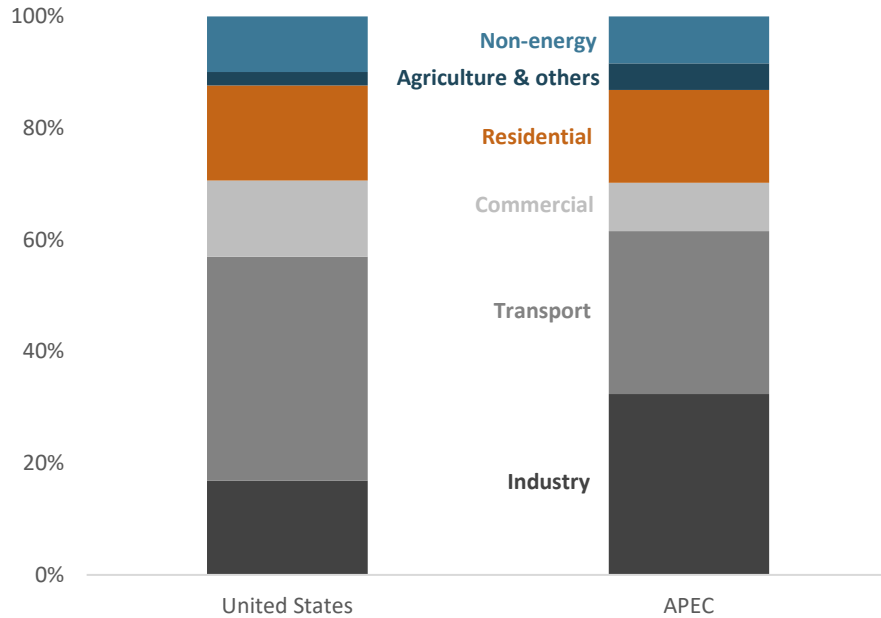


Source: EGEDA (2021)

The transport sector is the largest consumer of energy plus non-energy use of fuels in the US. In 2019, the transportation's share of TFC was 40%, followed by residential and industry (17% each), commercial (14%), non-energy (10%) and agriculture (2%). As of 2019, there had

been no marked shift in the sectoral TFC patterns in the US since 2000.

Figure 5: Total final consumption by sectoral share: the United States and APEC, 2019



Source: EGEDA (2021)

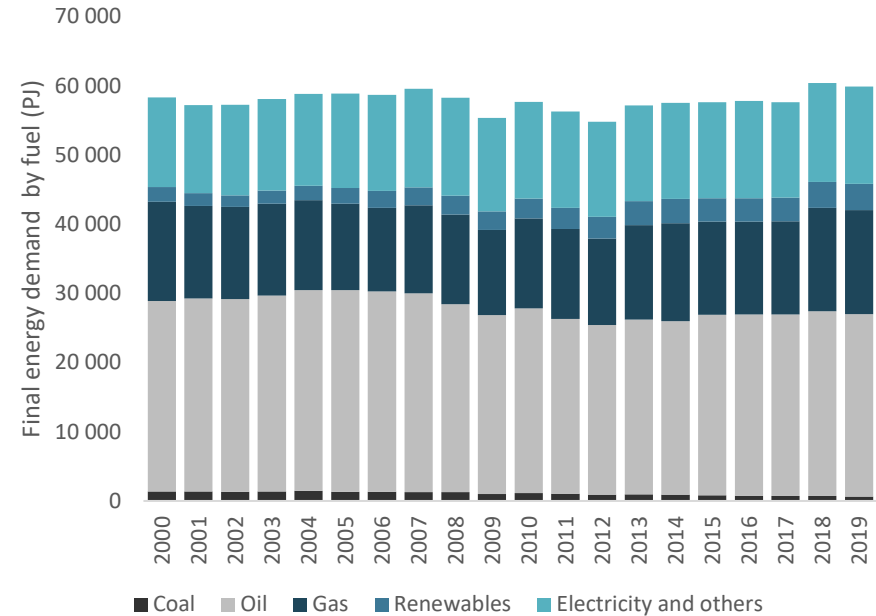
The transport sector's 40% share of TFC in the US is 11 percentage points higher than the APEC share. However, the industrial sector's share of TFC in the US is only half the aggregate share in APEC.

Total Final Energy Consumption (TFEC)

In 2019, US total final energy consumption, which excludes the non-energy use of fuels, was 59 892 PJ, which was a 0.9% decline relative to 2018. TFEC is affected by a number of factors, including economic

activity, weather, and electrification, and the year over year changes for the US have been both positive and negative. On average over the last 19 years, US TFEC has grown slowly by 0.14% by year.

Figure 6: The United States' final energy demand by fuel, 2000 to 2019



Source: EGEDA (2021)

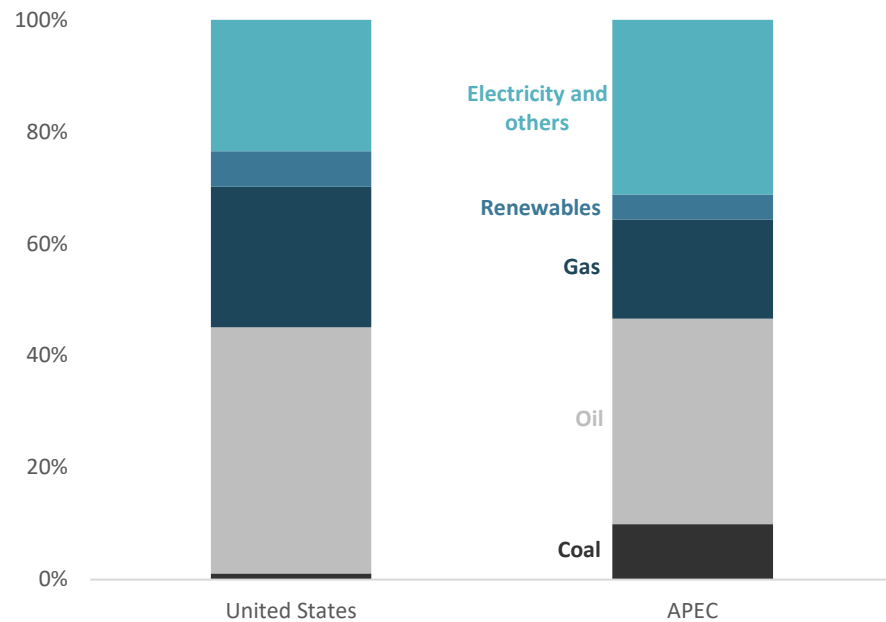
Note: Does not include non-energy consumption of energy commodities.

Petroleum products remain the dominant energy source in the US, accounting for 44% of TFEC in 2019. Natural gas and electricity were the two other main types of energy, accounting for 25% and 24%, respectively. Direct use renewables accounted for 6% of final energy consumption, but also renewables produced 17% of the electricity that was consumed.

Both natural gas and electricity slowly gained market share while oil

and coal both lost share. Since 2000, natural gas and electricity gained 2.2 and 0.8 percentage points of market share, respectively, while oil and coal lost 4.7 and 1.2 percent points. During the same period, direct use of renewables rose from a 3.3% to 6.3% market share and the renewables share of electricity generation rose from essentially zero to 4.1%.

Figure 7: Final energy demand fuel shares, the United States and APEC, 2019



Source: EGEDA (2021)

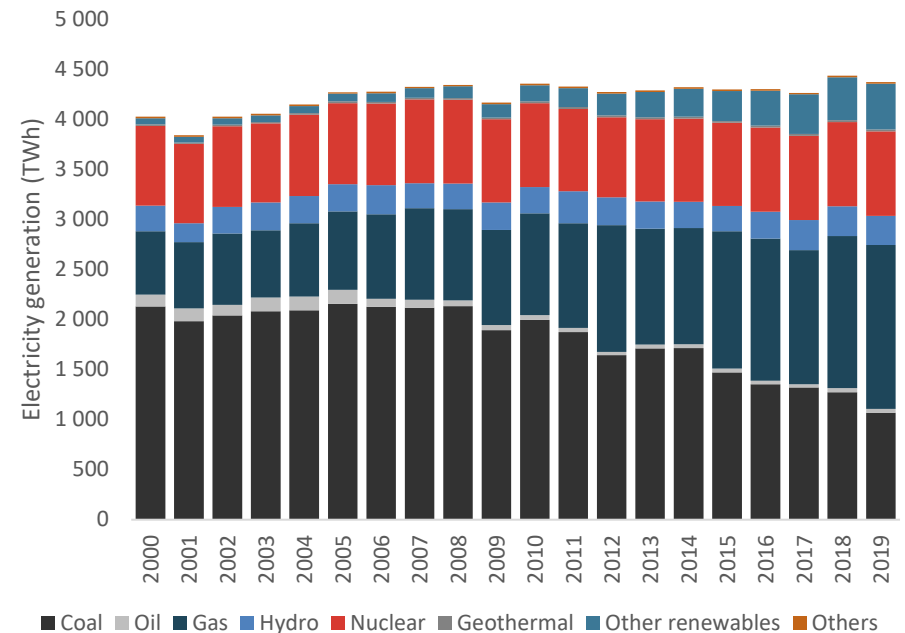
In comparison to the fuel and power shares of APEC, the US relies much more on oil and gas and less on coal and electricity. The US share of oil and gas is 7 percentage points higher for both oil and gas than the APEC average, and the economy's share of coal and electricity is 9 and 7 percentage points lower, respectively.

Transformation

Power sector

The US generated 4 371 TWh of electricity in 2019. This was slightly less than the power generated in 2018. US generation has varied from year to year but on average has increased only 0.4% per year since 2000.

Figure 8: The United States' electricity generation by fuel, 2000 to 2019

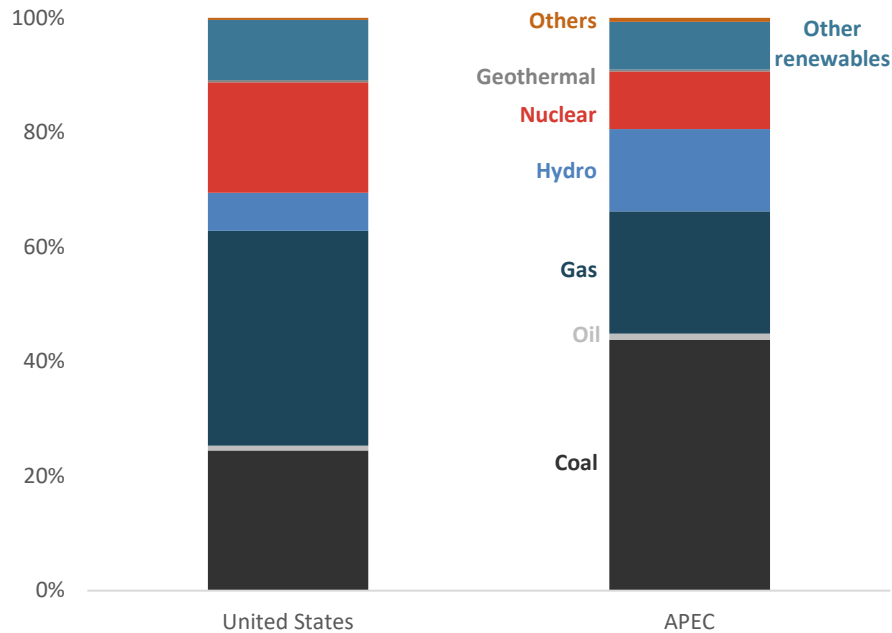


Source: EGEDA (2021)

Although the amount of generation has been relatively stable, the fuels used to generate power in the US has changed considerably over the last 19 years. From 2000 to 2006, over 50% of US electricity was

generated in coal-fired plants, but this share has steadily declined to 24% in 2019. Over the same period, the share of gas fired generation has increased from 16% in 2000 to 38% in 2019. The shares of other fuels/technologies has remained relatively constant except for non-hydro renewables, the share of which has grown from 2% in 2000 to 11% in 2019.

Figure 9: Electricity generation by fuel share, the United States and APEC, 2019



Source: EGEDA (2021)

The increase in gas use and decline in coal use has been driven by both economics and government policies. When compared to the shares of generation for APEC as a whole, natural gas and nuclear had larger shares in the US than they do in APEC. In 2019, natural gas

generated 38% of power in the US, but only 21% in APEC; nuclear accounted for 19% in the US, but only 10% in APEC. The reverse is true for coal and hydro. Coal generated 24% of US power, but 44% in APEC; hydro generated 7% in the US, but 14% in APEC. The non-hydro renewable generation was roughly comparable: 11% and 8% for the US and APEC, respectively.

APEC Goals

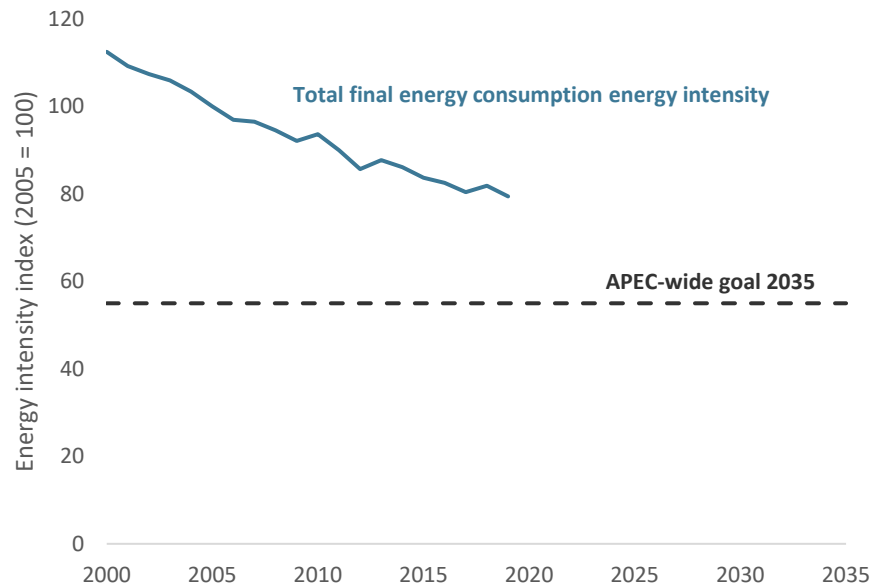
APEC member economies have agreed to meet two energy-related objectives. These are to improve energy intensity and increase the share of renewables in the energy mix.

Energy Intensity Goal

In 2011, APEC member economies agreed to revise their goal of reducing energy intensity, increasing the reduction required to 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 the progress of individual APEC economies relative to that overarching proportional improvement.

Figure 10: The United States' total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

In 2019, the energy intensity of the total final energy consumption (excluding non-energy) of the US improved by 21% relative to 2005 (Figure 10).

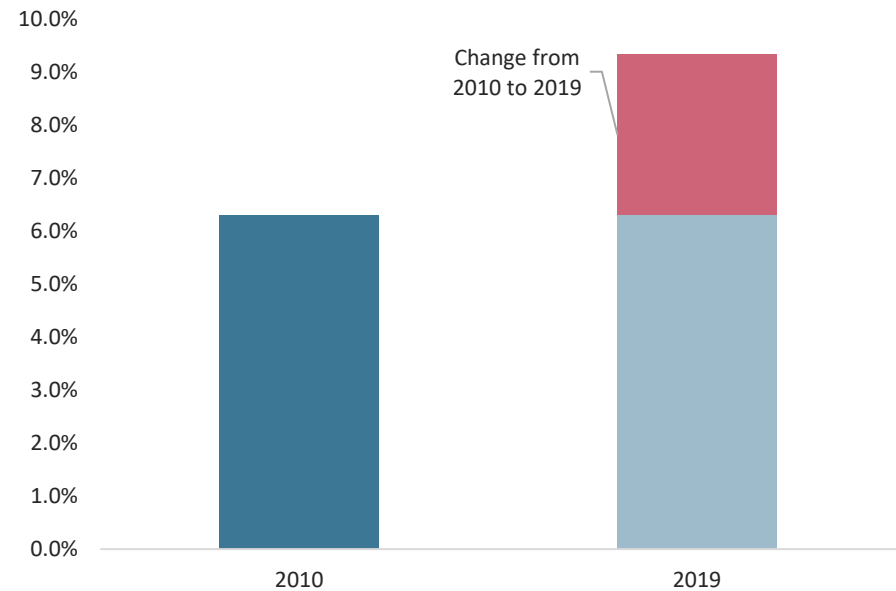
Doubling of Renewables

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

Individual member economies do not have economy-level goals, but it is possible to calculate the relative improvement of individual economies to get a better sense of how and whether the goal will be

achieved. In the US, the share of modern renewables to final energy consumption in 2010 was 6.3% and 9.3% in 2018 (Figure 11).

Figure 11: The United States' modern renewable energy share, 2010 and

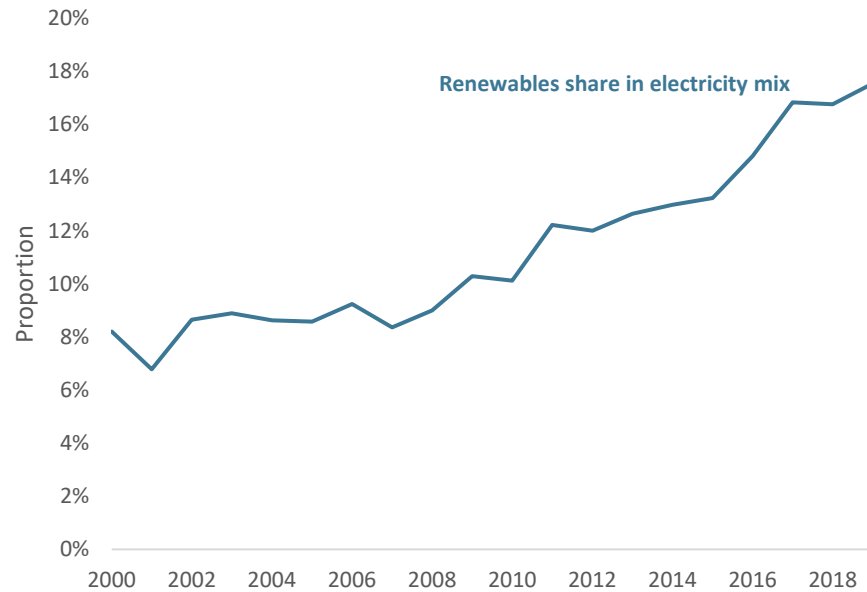


Source: EGEDA (2021)

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 account for 18% of US electricity generation in 2019 (Figure 12).

Figure 12: The United States' renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Energy policy

Energy Policy	Details	Reference
Climate Change	The United States re-joined the Paris Agreement in January 2021. The updated NDC emphasizes a whole-of-government approach to climate change policy with a target of reducing net GHGs by 50-52% by 2030 (relative to 2005). The Biden Administration's targets include a zero-carbon power sector by 2035 and a net-zero economy by 2050.	The White House
Energy Policy	The Biden Administration has a two-part strategy: i) accelerate the clean energy transition at an unprecedented rate; and ii) ensure affordable, reliable, and secure energy for all citizens.	US DOE
Bipartisan Infrastructure Law (Nov 2021)	Signed into law in November 2021, the new law includes 65 billion USD for clean energy transmission and electric grid upgrades, 66 billion USD to expand rail and transit, 7.5 billion USD for EV charging stations, 8.1 billion USD for CDR, CO2 pipelines and large scale CCUS projects, and 5.0 billion USD for expanding access to energy efficiency and clean energy for communities, families, and businesses.	The White House US DOE
Legislative mandates on biofuels	In 2007, Congress mandated annual biofuel volumes, including 136 billion litres (36 billion gallons) of biofuel by 2022. The statutory targets have never been met. EPA issues annual RFS rulemakings to establish volume requirements based on expected market conditions. The last final EPA rulemaking was issued 12/19/2019 and set targets for 2020 cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable fuel, and 2021 biomass-based diesel.	US EPA
E15 Ethanol	Nearly all the gasoline in the US contains 10% ethanol. In 2019, at the president's initiative, the EPA issued a final rule allowing gasoline with 15% ethanol (E15) to be sold year round. However, very few retail fuelling stations offer E15 (last estimated at less than 2% of stations).	US EIA
IRS USD 1 tax credit for biodiesel producers	Nearly all of U.S. biodiesel is consumed as blends with petroleum distillate/diesel in ratios of 2% (referred to as B2), 5% (B5), or 20% (B20). In the years when the tax credit was in effect, during the time of production (i.e., not applied retroactively), such as in 2013 and 2016, domestic production and imports of biodiesel increased significantly relative to the preceding years. The tax credit is in effect through 12/31/2022.	US EIA
CCS tax credits (IRS 45Q)	Any new or existing qualified CCS facility that commences construction by January 1, 2026 and captures above a certain threshold of CO ₂ for industrial applications, direct air capture, EOR or geologic storage is eligible for tax credit for up to 12 years.	US Congress
EPA Cross-State Air Pollution Rule (CSAPR)	This rule targets SO ₂ and NO _x . Under the CSAPR, in the summertime, the power plants in 22 states in the Eastern US must limit the emission of sulphur dioxide and nitrogen oxides. The implementation of the regulations began in 2015 with further modifications that began in 2017.	US EPA

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EPA Mercury and Air Toxics Standards (MATS) on air emissions	This covers Hg, As, Cr, Ni, HCl and HF. The MATS regulates acid gases and mercury from coal-fired plants of 25 MW or greater. Under the MATS, mercury emissions must be 88% below their uncontrolled levels. For example, the mercury standard for existing units not burning low-rank virgin coal is 1.2E0 lb/TBtu. (1.3E-2 lb/GWh).	US EPA
IRS Sections 45 and 48 investment and production tax credits for wind	IRS Sec. 45 and 48 production or investment tax credits for taxpayers using wind to produce electricity or for placing wind energy property into service are being gradually phased down for onshore wind generators but are held at full value for offshore wind electricity generation.	Wind Tax Credits - NLR
Solar Tax Credits Extended	The stimulus bill enacted in January 2021 extended investment tax credits for solar generation. The ITC is phased down from 26% to 10% based on beginning of construction date from 2021 to 2024.	Solar Tax Credits Extended - IDEA
NRC 89 nuclear reactor license extensions approved	These are 20-year extensions, enabling reactors to operate for 60 years. Three more units have informed the agency of their intention to seek extensions between 2022 and 2024.	US NRC
Eleven-state northeast and mid-Atlantic Regional Greenhouse Gas Initiative (RGGI)	It focuses on reducing the CO ₂ emissions of the fossil fuel power plants that are over 25 megawatts by 60% by 2020 compared with the 2005 levels. Using a cap-and-trade system, the states sell emission allowances through auctions and spend the proceeds on energy efficiency, renewable energy and other consumer benefit programs. In 2021, Virginia became the 11th state to participate in RGGI. RGGI plans an additional 30% regional cap reduction between 2020 and 2030.	RGGI
New England Governors/Eastern Canadian Premiers Climate Change Action Plan	Regional 2030 GHG reduction goal. The six New England state Governors and five Eastern Canadian Premiers resolved in 2015 to reduce the region's GHG emissions to 35–45% below the 1990 levels by 2030 and reaffirmed that goal in 2019.	Coalition of Northeastern Governors
California GHG cap and trade, 60% RPS by 2030, carbon neutrality by 2045	California's cap-and-trade program applies to both utilities and non-utilities and runs through 2030.	California Air Resources Board
Renewables Portfolio Standards and zero-carbon targets (RPS)	State-based RPS, net-zero, and clean energy programs.	Lawrence Berkeley National Laboratory
Building and Appliance Energy Efficiency	The Department of Energy has adopted policies and implemented programs to encourage building and appliance energy efficiency	DOE Energy Efficiency Programs
State Energy Efficiency Policies	Several states also have adopted incentives to meet energy efficiency standards.	Energy Efficiency Standards
IRS Section 30D tax credit of \$2 500 – 7 500 for up to 200 000 EVs per manufacturer	An ITC of USD 2 500 to 7 500 is available for plug-in electric vehicles depending on the size of the vehicle and its battery capacity. The tax credit is available until a cumulative 200 000 qualified vehicles have been sold in the US by each manufacturer.	US IRS

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EPA emission standards for heavy trucks through 2027	In 2016, the EPA released emission standards for new medium- and heavy-duty trucks, large pickup trucks and vans, and all types of buses and work vehicles for model years 2018–2027.	GOVINFO
Federal CAFE standards	On April 1, 2022, the National Highway Traffic Safety Administration finalized new Corporate Average Fuel Economy standards for passenger cars and light trucks for model years 2024–2026. The new standard increases fuel efficiency by 8% per year in model years 2024 and 2025 and by 10% in model year 2026 to a fleet average of approximately 49 miles per gallon (21 km/litre).	nhtsa.gov
State clean vehicle policies	Numerous states have adopted numerous clean vehicle policies, including zero emission vehicle (ZEV) mandates.	State Clean Vehicle Policies

Notable Energy Developments

Energy development	Details	Reference
Energy components of the “Build Back Better” (BBB) Proposals	As part of its overall support for the BBB legislation, the Biden Administration advocated for energy provisions that called for approximately 500 billion USD in climate change programs, including tax credits for nuclear power, electric vehicles, power storage, renewable electricity, and advanced energy manufacturing. It also would have penalized electric utilities that moved too slowly on renewable energy. In December 2021, West Virginia Senator Machin said he could not support the bill, which reduces the likelihood of passage in 2022. The BBB energy provisions are deemed essential to meeting Administration climate change commitments by many analysts.	Bloomberg
Supreme Court to rule on West Virginia v. EPA	In February 2022, the US Supreme Court heard arguments related to the Environmental Protection Agency’s (EPA’s) authority to regulate greenhouse gas emissions for power. The decision, which is expected in June/July 2022, could affect the ability of the Biden Administration to meet its climate change commitments.	SCOTUS News
Oil Releases from the Strategic Petroleum Reserve (SPR)	In response to the oil supply disruption associated with the Russia-Ukraine crisis and in coordination with other members of the International Energy Agency, President Biden authorized the sale of 30 million barrels of crude oil from the SPR in March 2022. The sale was fully subscribed. In April, the President authorized the sale of up to 160 million barrels to be delivered by the end of October 2022.	US DOE March and US DOE April

Oil and Gas Leasing on Federal Lands	Shortly after taking office, President Biden placed a moratorium on oil and gas leasing on federal lands; the Interior Department subsequently suspended lease sales in six states. In June 2021, a federal judge blocked the suspension but was reversed by a federal appeals court in March 2022. Interior is now moving forward with lease sales and drilling permits but with higher royalty rates and additional environmental requirements that increase costs to oil and gas producers.	Associated Press and Reuters
LNG Exports	On March 16, 2022, DOE authorized additional exports of liquefied natural gas (LNG) from two major facilities on the Gulf Coast to help European economies reduce their dependence on Russian natural gas. This authorized was previously delayed by concerns within the Administration that approving additional gas export facilities could hamper progress on reducing greenhouse gas emissions.	Reuters
Social Cost of Carbon	In February 2021, the Biden Administration decided that all federal agency should use a 51 USD social cost of carbon in their decision making until an Interagency Working Group completes development of a revised figure. The issue is currently being considered by the federal courts, which may limit the Administrations activities in this area.	The White House and FindLaw

References and 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/>

[BP Statistical Review of World Energy 2021](#)

[Uranium 2020: Resources, Production and Demand, NEA No. 7551, OECD 2020](#)

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. Additionally, Viet Nam also tried to introduce more robust measures to reduce greenhouse gas emissions in its abilities and international support in finance and technology transfer. In line with COP26, Viet Nam committed to stop deforestation by 2030 and phase out coal-fuelled power generation by the 2040s. Viet Nam plans to review and adjust the current energy policies, aligning with its high-level leaders' commitments at COP26.

Viet Nam is an economy located in Southeast Asia, with China to the north, Laos and Cambodia to the west, and the East Sea and Pacific Ocean to the east and south, respectively. The geography consists of hills and densely forested mountains in the northwest and a land area of 331 236 square kilometres (km²) (GSO, 2020). As it is in a tropical monsoon zone and profoundly affected by the East Sea, Viet Nam has warm weather throughout most of the territory, abundant solar radiation, high humidity and generous seasonal rainfall. Viet Nam has been a member of APEC since 1998.

In recent decades, Viet Nam has been one of the fastest-growing economies in Asia, with a gross domestic product (GDP) growth rate of 6.5% per annum in the 2000–2019 period. In 2019, the population was 96.5 million (World Bank, 2021), with an urbanisation rate of 35% (GSO, 2020). In 2019, Viet Nam's GDP reached USD 776 billion (2017

USD purchasing power parity [PPP]), marking a 7% increase from 2018 (World Bank, 2021).

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, 22.8 trillion cubic feet of gas and 3 360 million tonnes (Mt) of coal in 2019 (BP, 2021). 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 15.5% in 2019 (EGEDA, 2021), 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 (km ²)	331 236 Oil (billion barrels) 4.4
Population (million)	96.5 Gas (trillion cubic feet) 22.8
GDP (2017 USD billion PPP)	776 Coal (million tonnes) 3 360
GDP per capita (2017 USD PPP)	8 041 Uranium (kilotonnes U < USD 130/kgU) -

Source: ^a GSO (2020), ^b World Bank (2021), ^c BP (2021)

The economic structure has gradually shifted away from agriculture in recent decades. The industry and service sectors have expanded from 62% in the early 1990s to 75% in 2020 (GSO, 2020).

Viet Nam ranked 70th in the world for its business environment. Its access to electricity is the most progressive sub-indicator (27th globally) (World Bank, 2019). Electrification in rural areas and remote islands is 99%. The government has promoted a 'green growth'

strategy since 2012 for Viet Nam's ongoing industrialisation and modernisation (PMVN, 2012).

Energy Supply and Consumption

Total Primary Energy Supply

The rapid economic growth in Viet Nam has resulted in the rapidly growing demand for energy. Therefore, ensuring energy sources is one of the top priorities of the government. Figure 1 illustrates that TPES grew at 10.1% per annum from 2000 to 2019. In 2019, TPES rose by 11.4% relative to the previous year, reaching 3 884 petajoules (PJ) (EGEDA, 2021).

Indigenous energy production increased by only 1.7%, reaching 2 516 PJ in 2019. Energy production has fallen and plateaued in recent years after reaching a peak in 2014.

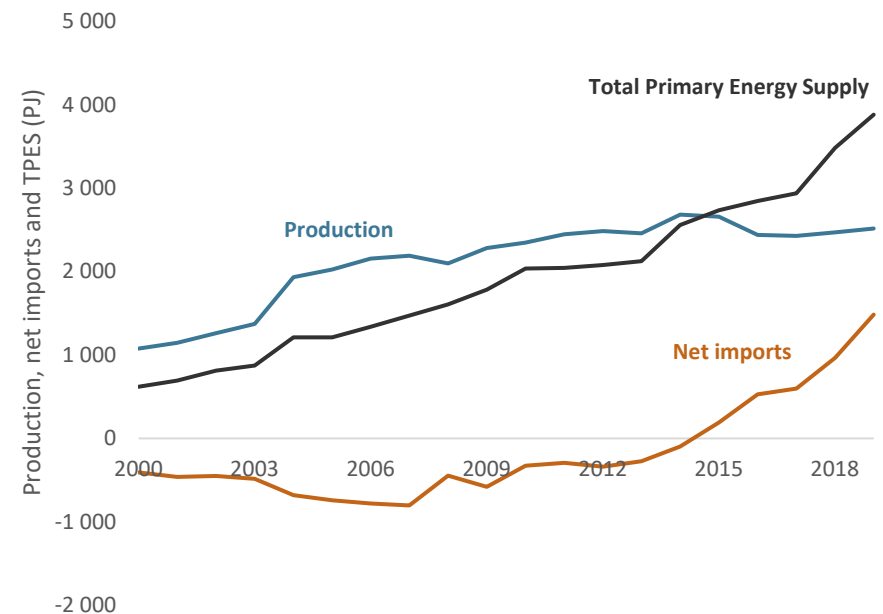
Viet Nam has abundant coal resources in the northern provinces, anthracite in the Quang Ninh coal basin, and sub-bituminous in the Red River Delta coal basin (Thai Binh, Hai Duong, Hung Yen, Nam Dinh, Hai Phong and Ha Nam). Nevertheless, the domestic coal mining industry is constrained due to technical barriers such as complex geological conditions and deep coal seams. 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 anthracite 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 coal basin has not been mined due to technical and economic issues.

Crude oil and natural gas are mainly extracted offshore in the south. However, the reserves are expected to be depleted sometime before 2030. The most significant gas field project (Ca Voi Xanh) in the central

provinces (Quang Nam and Quang Ngai) will begin production by 2024. It will supply gas-fired power and petrochemical plants in Viet Nam's central region.

Hydro is the most important renewable energy source in Viet Nam and accounted for approximately 28% of its electricity generation in 2019. Viet Nam aims to leverage hydro and other renewable sources to offset fossil energy through electrification to reach its net-zero target by 2050.

Figure 1: Viet Nam's total primary energy supply, production, and net imports, 2000 to 2019



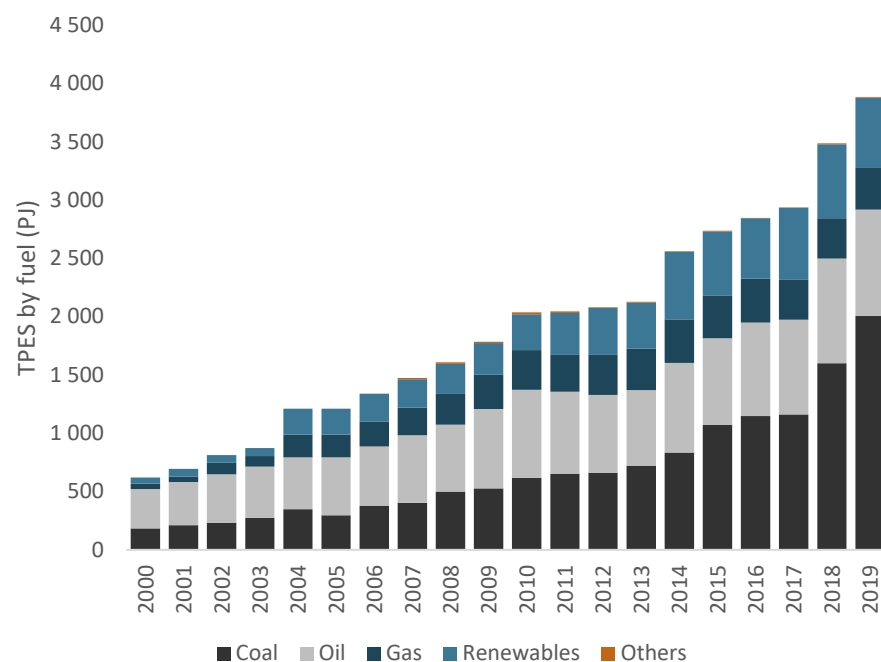
Source: EGEDA (2021)

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 demand for energy in economic development. Energy imports have

grown dramatically in recent years and are expected to continue to rise in the coming decades. Net imports increased by 53% from the previous year to 1 485 PJ in 2019, accounting for 38% of Viet Nam's TPES in 2019.

Viet Nam's TPES provided by fuel has continuously increased since 2000, surging in 2018 and 2019 (Figure 2). Coal supply rose by more than 25% from 1 600 PJ in 2018 to 2 007 PJ in 2019, accounting for approximately 52% of Viet Nam's TPES in 2019. Oil and gas supply rose slightly in 2019 relative to the previous year, by only 1.6% and 2.7%, respectively.

Figure 2: Viet Nam's total primary energy supply by fuel, 2000 to 2019



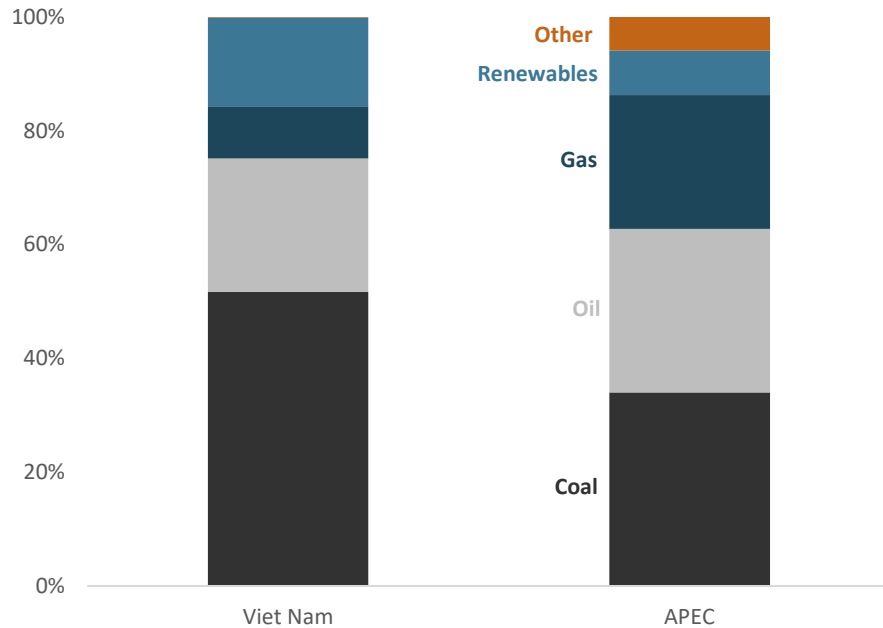
Source: EGEDA (2021)

In contrast, renewables supply declined by 4.8%, from 635 PJ in 2018 to 604 PJ in 2019 (EGEDA, 2021). A surge in renewable energy projects in 2018 resulted from new 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 switch to renewable energy, such as insufficient smart grid technologies, storage systems and transmission lines. Consequently, most solar installations were required to reduce generation capacity of the grid system in recent years.

Although policy on renewable energy development has been deployed since 2015 (PMVN, 2015), renewables are unable to meet the rapidly expanding energy needs of Viet Nam's industrial and transformation sectors. Coal-fired power plants and energy-intensive industries (steelmaking, aluminium smelting, cement manufacturing and fertiliser production) have been contributing to significant coal supply growth in recent years.

Figure 3 shows the TPES relative fuel share for Viet Nam and the APEC region in 2019. Coal has indeed dominated Viet Nam's TPES, accounting for over half of the TPES (51.7%). This share is much more prominent than coal's share in the APEC region (34%). Oil's share in Viet Nam's TPES was 23.5%, 5.2% lower than the APEC region's oil share. Further, Viet Nam's gas share accounted for only 9.2% of the TPES, much lower than the APEC gas share (23.5%). The renewables share accounted for 15.5% of Viet Nam's TPES, which is almost double the renewables share in the APEC region (7.8%).

Figure 3: Total primary energy supply relative fuel share—Viet Nam and APEC, 2019



Source: EGEDA (2021)

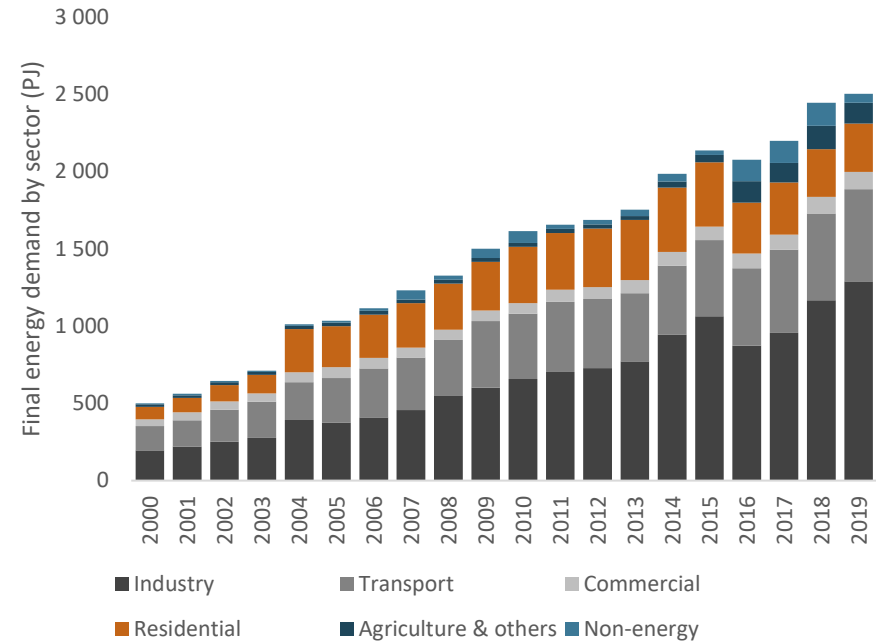
Total Final Consumption

Viet Nam's final energy demand rose five-fold over the 2000–2019 period (Figure 4). This large increase resulted from significant GDP and population growth. Final energy demand in 2019 was 2 503 PJ, a rise of 2.3% compared to the previous year.

The industrial sector was the dominant end-use sector, accounting for 51.5% of all end-use energy consumption (including non-energy) in 2019. The transport sector was the next largest with a proportion of 23.8%. The commercial and residential sectors accounted for 4.5% and 12.5% of final energy demand, respectively, while agriculture, forestry,

fishery and others accounted for 5.4%.

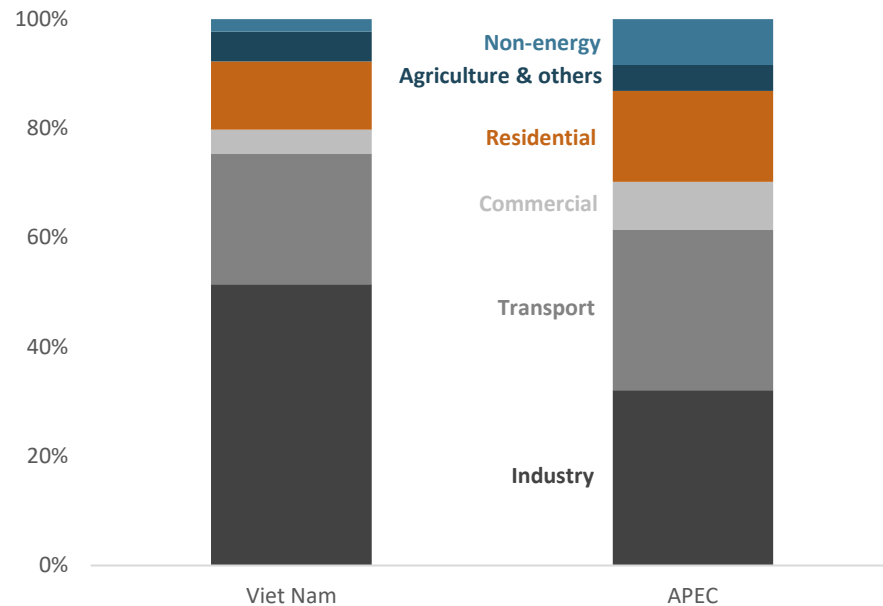
Figure 4: Viet Nam's final consumption by sector, 2000 to 2019



Source: EGEDA (2021)

Concerning APEC's sectoral energy demands as depicted in Figure 5, Viet Nam's industry end-use sector accounts for more energy use than the APEC region. In contrast, the transport sector share of Viet Nam is relatively lower than that of the APEC region. Viet Nam's extensive energy use in the industrial sector is driven by government policy to accelerate the industrialisation and modernisation process (Politburo, 2018).

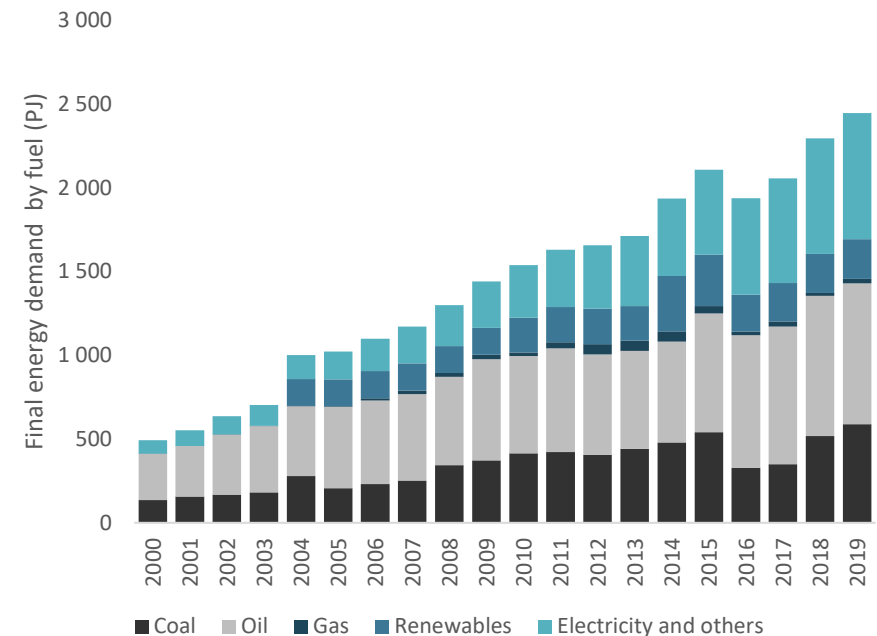
Figure 5: Final consumption sectoral share—Viet Nam and APEC, 2019



Source: EGEDA (2021)

In terms of final energy demand by fuel, the share of fossil fuels accounted for approximately 60% of Viet Nam's final energy demand in 2019 (Figure 6). Oil was consumed the most, accounting for almost one-third of the final energy consumption, followed by electricity (30.8%). Coal consumption accounted for 24.1%, while gas accounted for only 1.1% of the total final energy consumption. Renewables' share was approximately 10% of Viet Nam's end-use energy consumption.

Figure 6: Viet Nam's final energy demand by fuel, 2000 to 2019

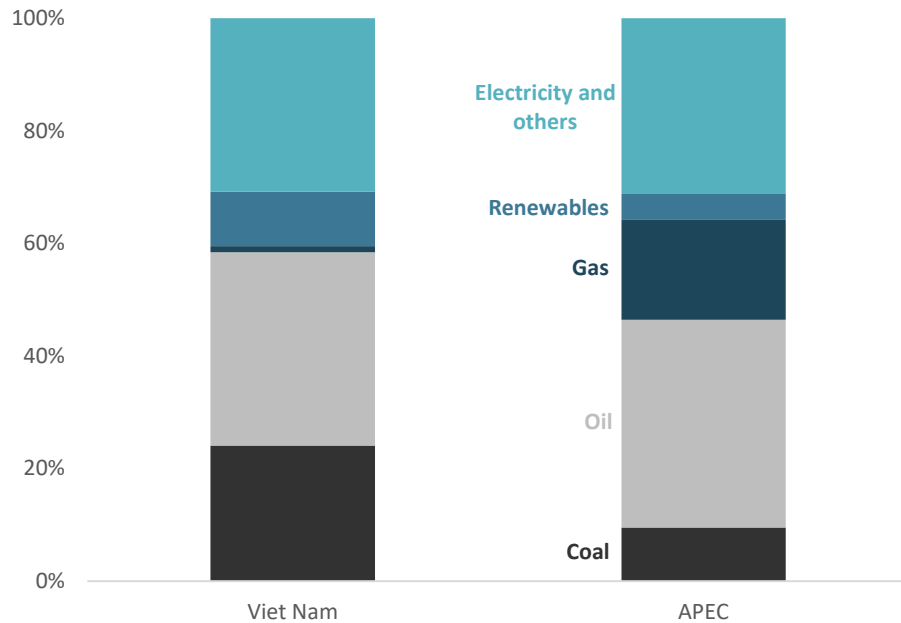


Source: EGEDA (2021)

Note: Does not include non-energy consumption of energy commodities.

While Viet Nam's final consumption share of coal was over double that of APEC's, its final consumption share of oil was slightly lower than the APEC region's in 2019 (Figure 7). Gas consumption amounted to only 1.1% of Viet Nam's final energy, which is much lower than its share of 18% for the entire APEC region. Viet Nam's renewables share was double that of the APEC region in 2019, while the share of electricity and others was almost the same in the energy mix of both.

Figure 7: Final energy demand fuel shares—Viet Nam and APEC, 2019



Source: EGEDA (2021)

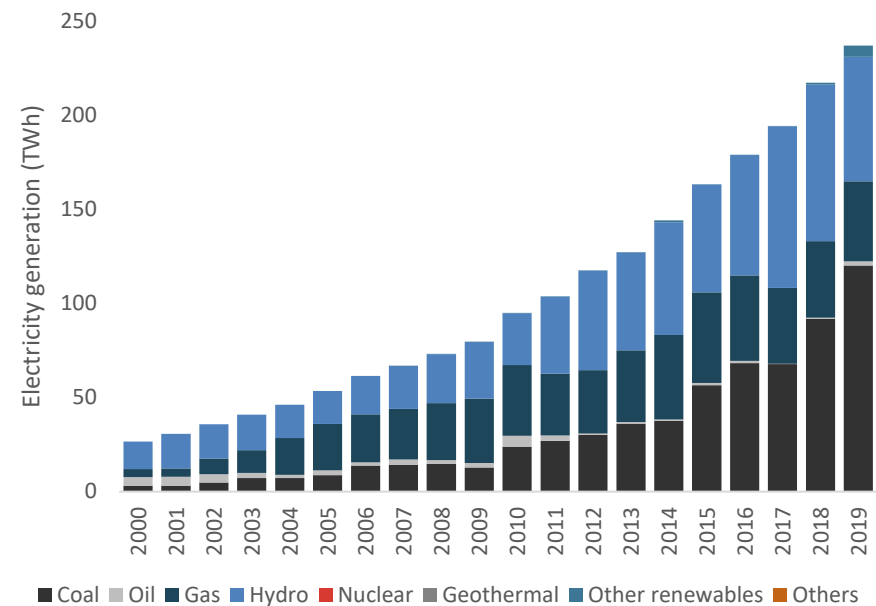
Transformation

Viet Nam Electricity (EVN) is a state-owned group that has significant control over power transmission and distribution systems, owning approximately 54% of the total power installed capacity in 2019 (EVN, 2021). Viet Nam's power sector has one of the highest growth rates in electricity grids worldwide, with a power generation growth rate of 10.7% per annum in 2010–2019 (EGEDA, 2021). 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 are located in the south.

Viet Nam generated 240 terawatt hour (TWh) of electricity, an increase of 9.1% from the previous year. Thermal power generation (coal, oil and gas) accounted for approximately 69% of the total generation mix, followed by hydro (27.6%). Biomass and others constituted less than 2.5% of the total generation mix (EGEDA, 2021).

Viet Nam's power sector is increasingly reliant on coal. Nearly half of the electricity generation (49.8%) was attributable to coal in 2019, which a dramatic annual increase of nearly 24% relative to 2018 (EGEDA, 2021). The increase resulted from the newly constructed coal-fired power plants (Vinh Tan 1, Vinh Tan 4, Thai Binh and Duyen Hai 3 expansion) that began operating in 2018–2019.

Figure 8: Viet Nam's electricity generation by fuel, 2000 to 2019

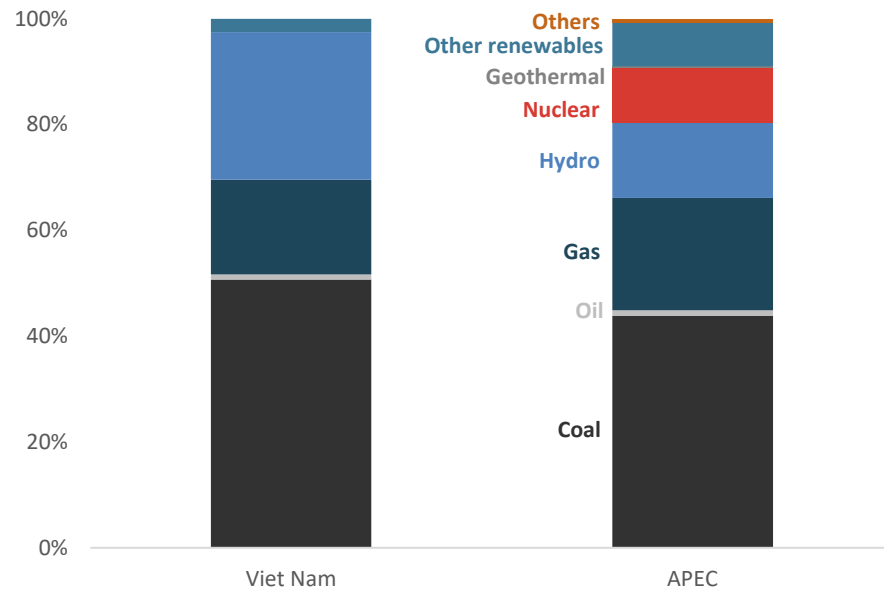


Source: EGEDA (2021), some small updates provided by Viet Nam MOIT.

Hydropower, including medium- and large-scale hydropower sources (about 20 gigawatt [GW] capacity potential), has been almost fully utilised. Small hydropower resources have a total potential of about 6.7 GW, with more than 3 GW already in operation.

Until 2017, there was only a small amount of solar and wind capacity installed in Viet Nam. For solar power, installed capacity increased from 8 MW in 2017 to almost 5 000 MW in 2019. This growth continued, with capacity more than tripling to 16 500 MW in 2020 (BP, 2021), facilitated by the government's commitment to boosting renewable energy supply and meeting the challenge of improved air quality. Wind capacity has also been growing strongly, reaching 600 MW in 2020 (IRENA, 2021).

Figure 9: Electricity generation by fuel share—Viet Nam and APEC, 2019



Source: EGEDA (2021)

Viet Nam's electricity share from coal in 2019 was 7% higher than the share for the entire APEC region (Figure 9). However, the share of gas in electricity generation for Viet Nam was smaller than for APEC.

Hydropower accounted for the second-largest share in Viet Nam's electricity generation mix in 2019. Its share was approximately 28%, almost double that of APEC's hydro share (14.3%). Other renewables generation of Viet Nam accounted for only a small proportion of generation when compared to APEC's other renewables generation share.

APEC Goals

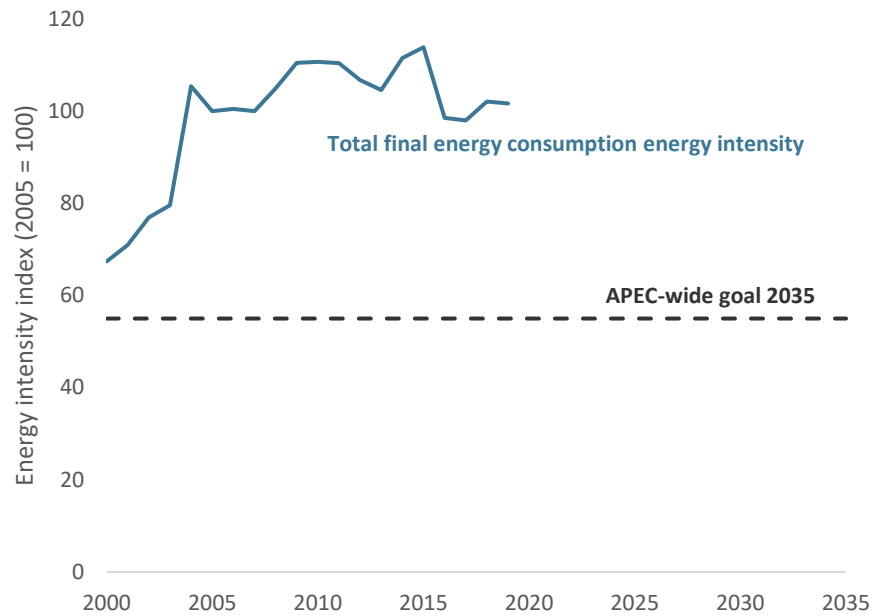
Energy Intensity Goal

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

Viet Nam has deployed the National Energy Efficiency Programme and the Law on Energy Efficiency and Conservation since 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 to 0.9% in 2010–2019, improving by 0.4% in 2019 compared to the previous year (Figure 10). 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 electric loss is below 6% (PMVN, 2019). This program will partly contribute to APEC's aspirational target in reducing energy intensity.

Figure 10: Viet Nam's total final energy consumption intensity index, 2000 to 2019 (2005 = 100)



Source: EGEDA (2021)

Doubling of Renewables

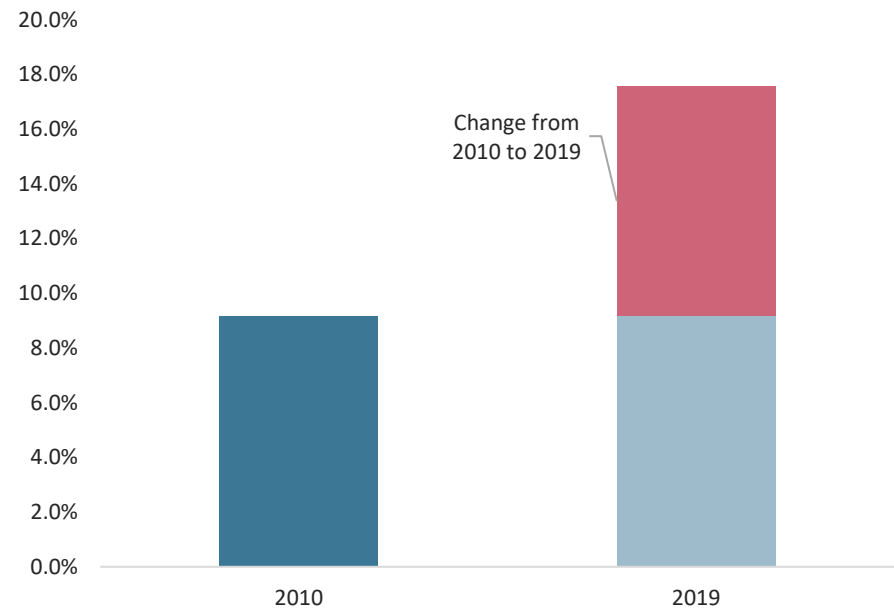
The second energy goal involves doubling the share of modern renewables in the APEC energy mix between 2010 and 2030. Modern renewables do not include traditional biomass, and their share is relative to final energy consumption (excluding non-energy consumption).

There is no economy-level goal for individual member economies, but improvements by individual economies 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 11),

while APEC's was 6%. In 2019, the proportional share reached 17.6%, which is almost double that of 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 32.3% by 2030 and 44% by 2050 (PMVN, 2015). This growth will contribute to APEC meeting its goal of doubling its renewables share by 2030.

Figure 11: Viet Nam's modern renewable energy share, 2010 and 2019

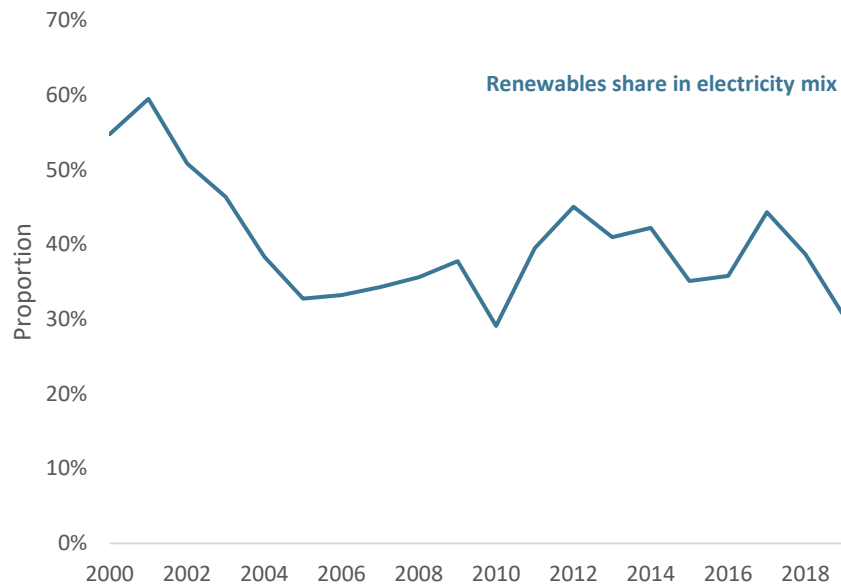


Source: EGEDA (2021)

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 generated from renewable sources

With a net-zero emission target in 2050, Viet Nam aims to boost the uptake of renewable energy in the upcoming Power Development Plan 8. Having 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's renewable electricity generation share, 2000 to 2019



Source: EGEDA (2021)

Viet Nam has 475 GW of offshore wind power technical potential within 200 km of the coast, 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 CO2 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).

In Viet Nam, the proportion of electricity output from renewables has declined substantially from 55% in 2000 to 30% in 2019 (Figure 12). 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 was not enough to offset the reduction from 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 enables 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
Updated Nationally Determined Contribution (2020 version)	Viet Nam will reduce GHG emissions by 9% compared to BAU by 2030 with domestic resources. However, this 9% contribution could be increased to 27% if international support is received through bilateral and multilateral cooperation.	United Nations Framework Convention on Climate Change
Law on Energy Efficiency and Conservation	This law provides policies and measures to promote the economical and efficient use of energy as well as the rights, obligations and responsibilities of organisations, households and individuals in such 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 Viet Nam.	Viet Nam Government Portal
Electricity Law	This law prescribes the 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 as well as the rights, powers, duties and obligations of regulatory bodies, agencies, organisations, households and individuals tasked with the task of environmental protection.	Ministry of Natural Resources Environment
Viet Nam's National Energy Development Strategy to 2030, with a Vision to 2050	This strategy addresses the 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	This strategy outlines the economy's goal that the share of produced electricity from renewable energy (including both small and large hydro) in Viet Nam's total electricity production should reach about 38% by 2020, 32% by 2030 and 43% by 2050.	Viet Nam Government Portal
National Strategy for Climate Change	This strategy aims to consolidate resources to carry out measures of climate change adaptation and GHG emission reduction to assure the safety for people and properties for sustainable development goals.	Viet Nam Government Portal

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National Program on Energy Efficiency and Conservation for the Period 2019–2030	This program aims 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, and human resource training and development.	Viet Nam Government Portal
National Strategy for Environmental Protection to 2020, Vision to 2030	This strategy involves controlling and limiting of environmental pollution levels, depleting natural resources and biological diversity, continuing to improve the environment, and enhancing the economy's capacity to cope with climate change via sustainable development.	Viet Nam Government Portal
Development Plan of the Gas Industry of Viet Nam by 2025 with a Vision to 2035	This plan includes development of the gas industry sector with all stages organised in a complete and uniform manner, including extraction, gathering, transport, processing, storage, distribution of gases, and import and/or export of gas products across the economy. It will ensure that gas production from the blocks/gas fields of the Viet Nam Oil and Gas Group (PVN) and oil and gas contractors operating in Viet Nam is fully gathered.	Viet Nam Government Portal
National Strategy on Green Growth	This strategy includes green growth towards a low-carbon economy, natural capital enrichment as a decisive tendency in sustainable economic development, and reduction in emissions and increase in the possibility to absorb greenhouse gases as mandatory and important targets in socio-economic development.	Viet Nam Government Portal
Viet Nam Power Development Plan for the Period 2011–2020 with a Vision to 2030	This plan involves the following: supplying electric power at a reasonable price for the economy's growth in terms of economy and society; utilising varied resources of primary energy for effective production of electricity; developing and using renewable energies for electricity generation to avoid reliance on import coal; contributing to energy security; mitigating climate changes; and protecting the environment.	Viet Nam Government Portal
Master Plan for Viet Nam's Coal Industry Development to 2020 and Vision towards 2030	This plan aims to develop Viet Nam's coal industry into a competitive industry by applying technological advances to coal exploration, mining and preparation, processing, and trading and to ensure the sufficiency of coal resources to meet the domestic consumption demand, especially for the thermal power industry.	Viet Nam Government Portal
Supporting Mechanism for Development of Power Generation Projects Using Solid Waste in Viet Nam	This policy document regulates the supporting mechanism for the development of power generation projects using solid waste in Viet Nam.	Viet Nam Government Portal
Support Mechanism for Development of Biomass Power Projects in Viet Nam	This 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 toward 2035	This strategy provides the overall objectives and specific targets for Viet Nam to develop its industrial sector, including state-owned, private and foreign-invested sectors. The policy focuses on agricultural and rural industrialisation and modernisation.	Viet Nam Government Portal

Notable Energy Developments

Energy development	Details	Reference
Thi vai LNG terminal	New 1 Mtpa in the first phase of Thi Vai LNG terminal is expected to be operational by the second half of 2022.	Offshore Energy
Electricity market operation	The Electricity Regulatory Authority (Ministry of Industry and Trade) issued Decision No. 98/QD-DTDL, dated 31 December 2021, on approving the plan for the electricity market operation in 2022.	Vietnam Energy
Renewable Energy	Renewable energy share (excluding hydropower) is projected to increase up to 30% by 2030 and 44% by 2045.	Electricity and Renewable Energy Authority
Strategy for developing hydrogen and offshore wind power projects in Viet Nam	PVN and the Asian Development Bank (ADB) signed a memorandum of understanding (MOU) on building a strategic partnership for 2021–2024 to promote clean and sustainable energy development in Viet Nam and support PVN to achieve its green energy transition goal, with respect to carbon capture, use and storage. This cooperation will involve developing hydrogen industry and offshore wind power projects.	Vietnam Energy
Quang Ninh LNG power plant project	The Quang Ninh LNG power project was officially launched in Cam Pha city, Quang Ninh prefecture, in 2021. This will be the first imported LNG power plant project in the northern region with a capacity of 1 500 MW. The power plant will be operational by the third quarter of 2027.	MOIT

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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 Programme (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>

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