APERC Gas Report 2021

APERC
Asia Pacific Energy Research Centre

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Foreword

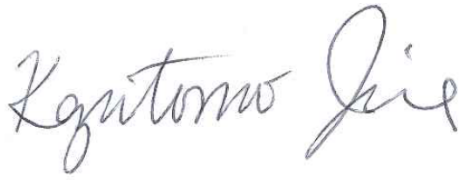
APEC economies have an outsized influence in the world gas market with four of the five largest gas consumers and three of the five largest gas producers. This report details the growth and changing role of natural gas in APEC over the last 10 years, including the substantial growth of LNG trade.

Over the last decade, the worldwide use of natural gas grew rapidly. Gas demand grew even more rapidly in the APEC economies. Against a backdrop of ongoing concerns about air pollution and climate change, government actions to address these issues are likely to accelerate global and APEC gas consumption.

Gas markets were exceptionally volatile in 2021. As the world's economies recovered, gas demand increased, and several extreme weather events in gas-consuming regions caused demand to grow even higher. However, gas supplies were limited, so high gas prices and dramatic price spikes were common last year. This report examines the trends that produced this volatility and highlights the factors that will determine the future course of the global gas market.

Given the commitment of APEC economies to reduce carbon emissions, this report also presents a case study on the changing roles of coal and natural gas in the energy mix of each of the APEC economies from 2009 to 2019.

This gas report is part of the APERC fossil fuel reports series, published annually. I would like to express my sincere gratitude to the authors and contributors for their time and effort in writing and publishing this report. I am also grateful to APEC member economies for providing updated data through the APEC Expert Group on Energy Data and Analysis (EGEDA).



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Abbreviations and Acronyms

Abbreviations

bcm	billion cubic metres
Bcf/d	billion cubic feet per day
Tcf	trillion cubic feet
LNG	liquefied natural gas
kWh	kilowatt-hour
MTPA	million tonnes per annum
MBtu	million British thermal units
USD	US Dollar
CAGR	Compound Annual Growth Rate
CO2	Carbon dioxide
MMTCO2	Million metric tons of carbon dioxide

Acronyms

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
EGEDA	Expert Group on Energy Data and Analysis
EIA	Energy Information Administration, USA
EU	European Union
IEA	International Energy Agency
NEA	Northeast Asia
SEA	Southeast Asia

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Executive Summary

The 21 economies that comprise the Asia Pacific Economic Cooperation (APEC) forum account for more than half (58%) of the world's natural gas consumption. These economies include four of the world's five largest gas consumers: the United States of America, the Russian Federation, the People's Republic of China, and Canada. The USA is the world's largest natural gas consumer with a total consumption of 791 bcm in 2019. Meanwhile, China consumes close to a third of USA gas consumption. However, China is rapidly increasing its demand for gas. From 2010 to 2019, China's gas consumption grew by 58%.

Several factors drove the gas consumption increase over the last decade. Global natural gas consumption grew by 16.8% over the last decade, reaching almost 4 000 billion cubic meters (bcm) in 2020 from 3 328 bcm a decade prior. This growth in natural gas consumption was spurred by lower gas prices, largely due to increased production of natural gas led by the USA shale gas revolution, as well as fuel switching from more carbon-intensive fuels (coal and petroleum products) to natural gas, particularly in the power and industrial sectors.

For the first time in a decade, global and APEC economies natural gas consumption declined by 1.2% and 0.86% respectively from 2019 to 2020 due to the global effects of the COVID-19 pandemic. United States and Russia saw natural gas consumption decline by 2.4% and 4.3% respectively from 2019 to 2020. In contrast, China increased its natural gas consumption by 5.9% during that same period (the only major economy to increase gas use in 2020).

Natural gas demand is projected to surpass pre-pandemic demand levels by 2022, although the new Omicron Covid variant or other variants could slow the economic and gas demand recoveries in the near term. Baring substantial slowing, we expect gas demand in the APEC economies to grow by 7% from 2020 to 2025. China will be leading the growth with an additional consumption of 163 bcm, followed by Southeast Asia (14 bcm), and Korea (11 bcm). Conversely, we expect the United States and Russia will see the largest gas consumption declines of 29 bcm and 18 bcm, respectively.

In terms of supply, APEC's share of the world's natural gas supply represented 61% in 2019 with the U.S. accounting for 39% of this share. Over the last decade, USA shale gas production grew by a remarkable 80%. The United States and Russia are the leading natural gas producers in APEC; in 2019, they produced 948 bcm and 722 bcm, respectively. During that same year, China's natural gas production (191 bcm) surpassed that of Canada's (184 bcm) for the first time in a decade.

Australia and China have seen a robust production growth of 64% and 50% respectively over the last decade. In fact, China and Australia were the only economies to have a production growth from 2019-2020, amid the COVID-19 pandemic, growing by 7-8% each. Meanwhile, non-APEC economies and Russia had the largest drop in production during that same period, falling by 3% and 6% respectively.

APEC economies play an essential role in the natural gas market as they include the largest gas importers and exporters in the world. Japan, China, and the USA are three of the five largest

natural gas importers in the world. While the USA, Canada and Russia, are three of the world's five largest natural gas exporters.

World natural gas exports have increased by 28% from 2009 to 2020, as new LNG export capacity and pipeline infrastructure have been put in service, allowing the distribution of increased volumes of gas. Over the past decade, the share of natural gas being traded via LNG has increased from 27% to 38%. From 2009 to 2020, APEC LNG exports increased at a CAGR of 10%, going from 96 bcm to 273 bcm, mainly driven by a rise in US LNG exports. In comparison, non-APEC LNG exports had a CAGR of 2.9%. In 2009, the total volume of gas traded was 421 bcm, and 77% of exports took place via pipelines. In comparison, the volume of traded gas in 2020 increased to 634 bcm, while the share of pipeline exports fell to 57%, as LNG gained market share.

During the last decade, Japan has been the largest LNG importer in the world, a distinction that it is likely to lose to China in 2021. Over the last decade China has seen a CAGR of 25% on its natural gas imports, compared to Japan's CAGR of 1.3%. In 2009, the volume of LNG imports for Japan and China represented 85 bcm and 8 bcm, respectively. In contrast to 2020, when the volume of LNG imports for Japan and China were 99 bcm and 89 bcm, respectively. As a result, Japan's share of APEC's total LNG imports has reduced from 54% in 2009 to 34% in 2020. At the same time, China's share of APEC's total LNG imports increased from 5% to 31%. China's increase in LNG imports is largely due to economic growth and increased reliance on gas in the industrial and power sectors.

The United States liquified natural gas export capacity will be the world's largest in 2022. LNG liquefaction units under construction in Louisiana, Sabine Pass and Calcasieu Pass, are expected to come in service by the end of 2022. Positioning the USA as the economy with the world's largest LNG export capacity. USA nominal capacity is projected to increase to 11.4 billion cubic feet per day (Bcf/d) or 118 bcm per year, and peak capacity is expected to increase to 13.9 Bcf/d.

In 2021, limited supply availability, increased demand from a global economic rebound, and several extreme weather events in gas consuming regions led to high gas prices and dramatic price spikes. All major gas price benchmarks have climbed to record breaking levels in 2021, an extraordinary rebound in gas prices after a steep drop in 2020. In 2020, Henry Hub (HH), the Japan-Korea Marker (JKM), and the Title Transfer Facility (TTF) benchmarks averaged: USD 2.04/Mbtu, USD 4.71/Mbtu, and USD 3.15/Mbtu respectively. In 2021, HH, JKM, and TTF benchmarks averages increased: USD 3.91/Mbtu, USD 17.92/Mbtu, and USD 15.86 /Mbtu respectively. The Asian and European gas markets in particular saw the unusual surges in prices during 2021.

Natural gas market trends and developments to watch in 2022:

- China is likely to surpass Japan as the largest LNG importer in 2021
- The USA is expected to become the world's largest LNG exporter in 2022
- Limited natural gas supplies, an increase in demand, and geopolitical tensions between Russia and Europe could put additional upward pressure on global gas prices

Chapter 1: Gas demand

Over the past decade, gas demand growth has been driven largely by the power and industrial sectors, as rapidly growing economies and populations require increasing volumes of energy and living standards improve. Environmental and economic efficiency gains from natural gas have led to an ongoing displacement of more carbon-intensive fossil fuel sources of energy like coal and oil. According to the Energy Information Administration (EIA) burning natural gas for energy results in fewer emissions of nearly all types of air pollutants and carbon dioxide (CO2) than burning coal or petroleum products to produce an equal amount of energy. It is expected that natural gas consumption growth will continue over the next decades due to economic competitiveness, national climate pledges, and new natural gas capacity infrastructure coming online while aging coal and oil-fired power plants enter retirement phase.

As part of economies' decarbonization efforts, developed economies and those who have access to affordable sources of gas have prioritized a fuel-switch from coal-to-gas, but also from gas-to-renewables. Meanwhile, rapidly growing economies have faced more challenges in adding new natural gas installed power generation capacity and displacing higher carbon-intensive sources of energy for power generation. This is due to several factors that include: a lack of economic feasibility due to domestic availability of coal and other fuel sources, as well as value chain and geographic constraints that limit their access to natural gas.

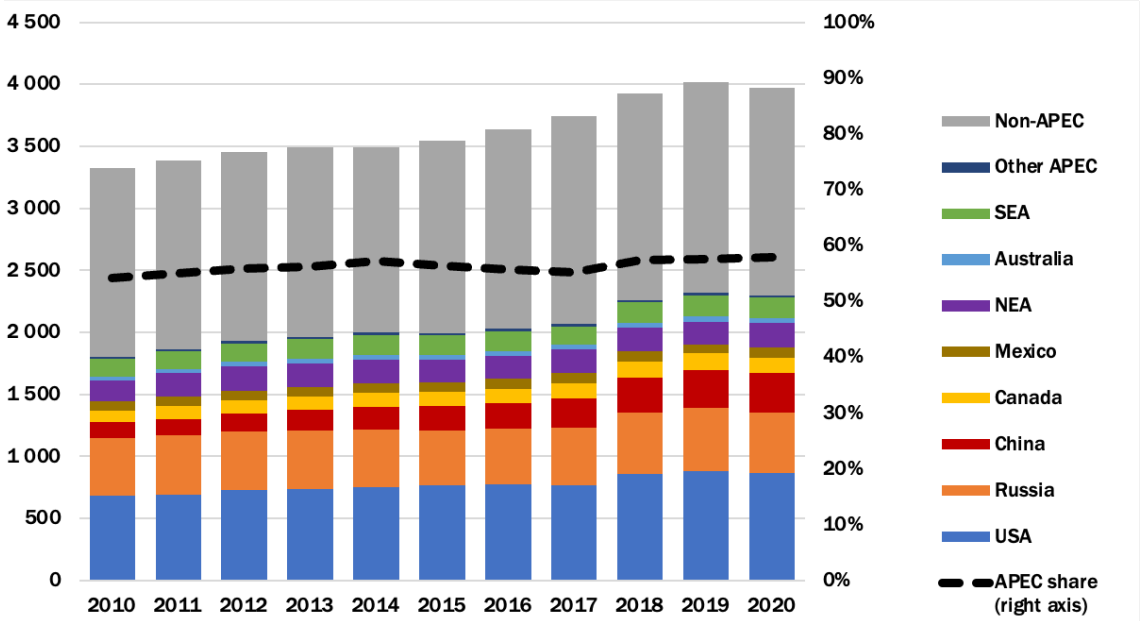
1-1 World and APEC natural gas demand

The 21 economies that comprise the Asia Pacific Economic Cooperation (APEC) forum account for more than half (58%) of the world's gas consumption. These economies include four of the world's five largest gas consumers: the United States of America, the Russian Federation, the People's Republic of China, and Canada. Chapter 1 of this report examines the dynamics of gas demand in these four large economies, the Southeast Asian region and Northeast Asian region.

Global natural gas consumption grew by 16.7% over the last decade (Figure 1-1). Reaching almost 4 000 billion cubic meters (bcm) in 2020 from 3 328 bcm a decade prior, the growth was driven primarily by lower prices caused by the United States shale gas revolution that created a rapid increase in natural gas production, and fuel switching from more carbon-intensive fuels (coal and petroleum products) to natural gas.

For the first time in a decade, global and APEC economies natural gas consumption declined by 1% and 0.9% respectively from 2019 to 2020, due to the global effects of the COVID-19 pandemic (Figure 1-1). A decline in economic activities in the USA, China, and Russia, contributed to this historic drop in natural gas demand. On one hand, the United States and Russia saw natural gas consumption decline by 2% and 4% respectively from 2019 to 2020. In contrast, China increased its natural gas consumption by 6% during that same period (the only major economy to expand in 2020). The difference in natural gas consumption dynamics between these large economies is closely related to the timing and management of the COVID-19 pandemic that led to an unprecedented global economic shock.

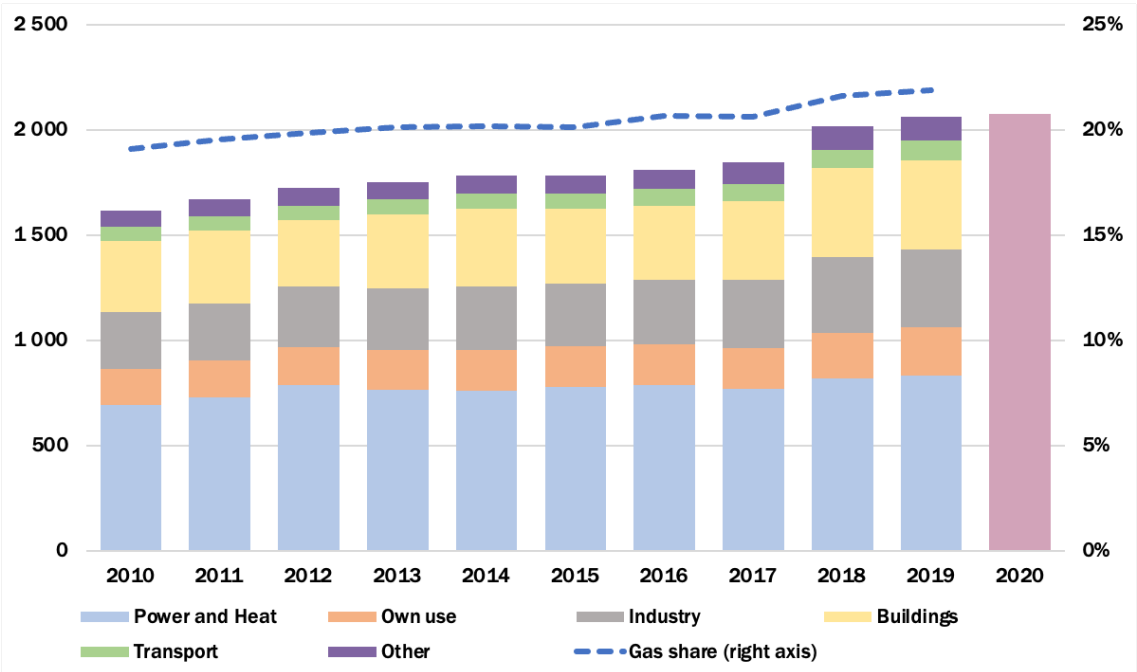
Figure 1-1: Natural gas demand in APEC, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; APEC EGEDA, Energy Balance Table, 2021; CEDIGAZ; APERC Calculations.

Natural gas demand growth in APEC member economies has been largely driven by the power and industrial sectors. The power sector represents the largest share of natural consumption (32%) in 2019, while the industrial sector had the highest annual growth rate (3.6%) from 2010 to 2019 (Figure 1-2).

Figure 1-2: Natural gas demand in APEC by sector, 2010-2020 (bcm)

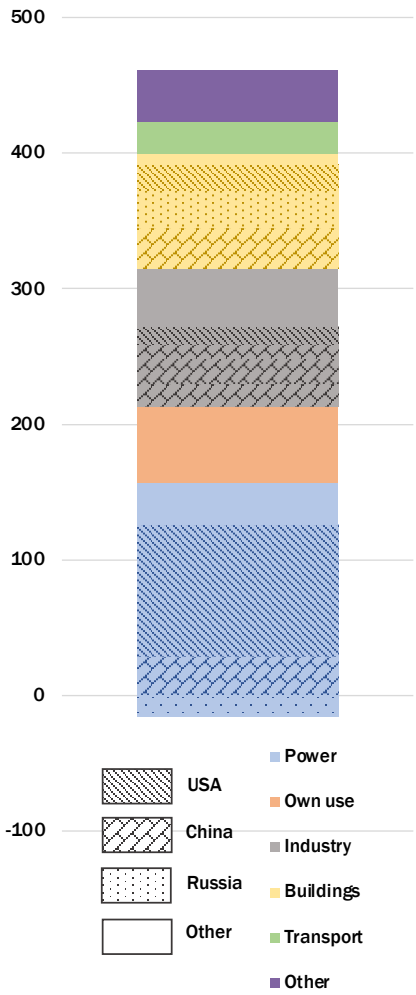


Source: IEA World Energy Balances, 2021; APERC Calculations.

In 2019, natural gas consumption in APEC member economies reached 835 bcm in the power sector, followed by the buildings sector that had a consumption of 424 bcm, and the industrial sector with a consumption of 374 bcm. As for the buildings sector, gas demand did not grow and remained practically at the same levels in 2019 as in the previous year. Annual variations in the buildings sector but relative stability in the mid-term, primarily reflect variations in weather, especially during the heating season in the USA.

In the power sector, the United States had the largest increase in natural gas consumption from 2010-2019, increasing by 97 bcm, followed by China with a consumption increase of 28 bcm. In contrast, gas consumption in the power sector fell in Russia by 16 bcm (Figure 1-3). In the industrial sector, from 2010 to 2019, natural gas demand growth was led by China with an increase of 46 bcm, while the USA and Russia had an increase of 19 bcm and 1.26 bcm, respectively. Lastly, in the buildings sector China and Russia had a similar consumption growth of 30 bcm and 28 bcm respectively, in 2010 compared to 2019. While the USA gas consumption in the buildings sector grew by 19 bcm.

Figure 1-3: Natural gas demand change in APEC by sector, 2010-2019 (bcm)



Source: IEA World Energy Balances, 2021; APERC Calculations.

Although the USA, China and Russia are the APEC economies with the largest consumption of natural gas, the share of gas in their energy mix differ from each other significantly. Russia,

compared to the USA and China has the largest share of natural gas in its energy mix, representing 45% in 2019, while the USA and China's share of gas was 31% and 7% respectively.

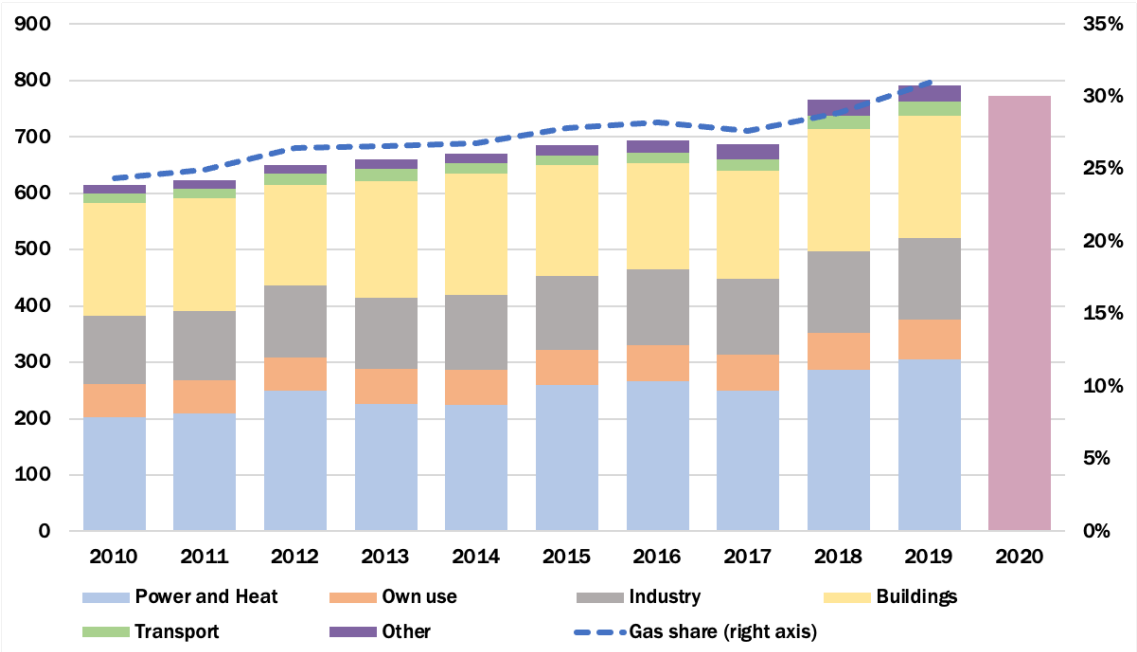
1-1-1 United States

The United States is the world's largest natural gas consumer; over the last decade, it has increased its consumption of natural gas by 26%. Reaching a total consumption of 791 bcm in 2019 (Figure 1-4), almost three times that of China's consumption. As explored in Chapter 2, this natural gas consumption growth has been largely attributed to the lower prices resulting from the United States shale gas revolution, that began around 2005 and led to a skyrocketing increase in natural gas production as a result of horizontal drilling and hydraulic fracturing techniques that opened up large reserves of natural gas that were previously too expensive to develop. The Henry Hub benchmark monthly price averaged 3.20 USD per million British thermal units (MMBtu) in the last decade. Consequently, the USA has been gradually increasing the share of natural gas in its energy mix while displacing coal. A shift that has significantly reduced greenhouse gas (GHG) emissions, particularly in the power sector.

In the USA, natural gas consumption in the buildings sector has been essentially flat, growing at an annual rate of less than 1% from 2010 to 2019. Building retrofits and energy efficiency gains from new technologies, have contributed to maintaining stable volumes of natural gas consumption in the buildings sectors, even as population growth increases real estate demand. The buildings sector is the second highest natural gas consumer, in 2019 it reached a consumption of 217 bcm followed by the industrial sector with a consumption of 144 bcm.

As the USA economic recovery accelerates in 2021 and 2022, the Energy Information Agency (EIA) expects increasing consumption of natural gas in its industrial sector, exceeding pre-pandemic 2019 levels this year.

Figure 1-4: Natural gas demand in the United States by sector, 2010-2019 (bcm)



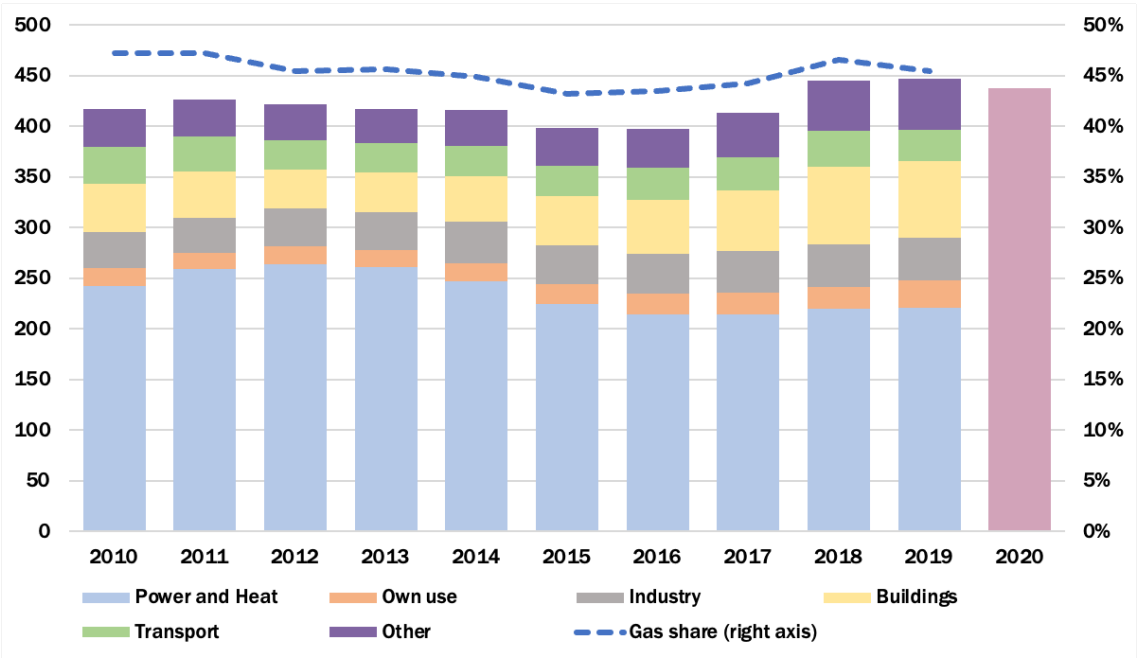
Source: IEA World Energy Balances, 2021; APERC Calculations.

1-1-2 Russia

Russia is the second largest producer of dry natural gas and holds the largest natural gas reserves in the world. It is also the second largest consumer of natural gas globally, in 2019 it consumed 447 bcm. Russia's strategy has been centered on maximizing the use of domestic energy sources, as such, natural gas has a high share in the country's electricity sector and represents 45% of the country's total primary energy mix. Natural gas demand growth from 2010 to 2019 has been driven by the buildings sector which saw an annual growth rate of 5%. While the power sector is the sector with the highest gas consumption representing 221 bcm in 2019.

Over the past decade, Russia has experienced cycles of weak economic growth in part due to a high volatility in oil and gas prices since its economy is highly dependent on oil and gas revenues. Prior to the pandemic, in 2015 the economy experienced an economic contraction of 2%, that was aggravated further in 2020 due to COVID-19, resulting in a contraction of 3%. From 2014 to 2015, gas consumption in the power sector declined by 22 bcm, and a similar decline is expected between 2019 and 2020. As a result of weak economic growth, the economy's natural gas consumption declined an average of 1% per year from 2010 to 2019.

Figure 1-5: Natural gas demand in Russia by sector, 2010-2019 (bcm)



Source: IEA World Energy Balances, 2021; APERC Calculations.

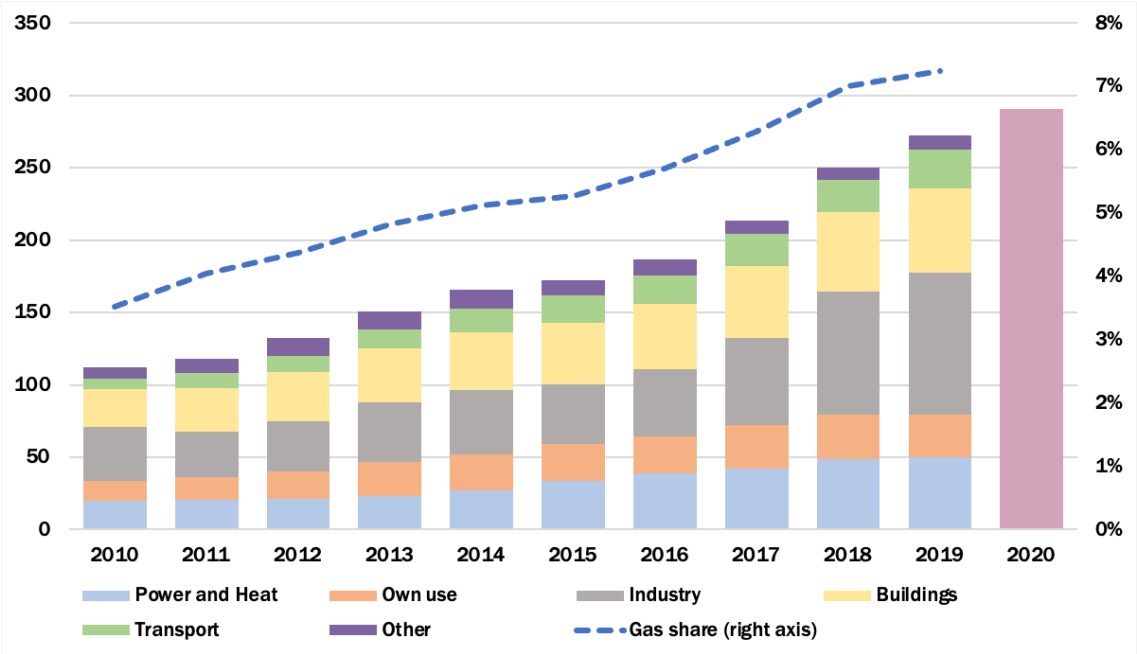
1-1-3 China

China, the world's largest economy (in terms of purchasing power parity) and largest population (1.4 billion in 2020), accounted for 16% of global GDP and 24% of energy demand in 2019. In addition, China accounts for 28% of total electricity generation globally. In contrast to other large economies that saw an electricity demand decline during 2020, China's total energy demand was 1-3% greater than in 2019. Most of China's energy supply comes from coal representing over eight times the thermal content of its natural gas use. The economy has relied heavily on coal-fired generation largely due to cost-competitiveness and its high energy density required for industrial use, as well as abundant domestic availability.

However, China's policy direction over the next five years aims to reduce energy and carbon intensity, to reduce GHG emissions primarily from coal sources to address the economy's heavy air pollution. China is rapidly increasing natural gas consumption throughout its economic sectors, displacing aging coal-fired generating units with new gas-fired combined-cycle units that are about 30% more efficient using the latest technology. China's gas consumption went from 112 bcm in 2010 to 272 bcm in 2019 (Figure 1-6). Hence, total natural gas consumption grew by 58% in that period, increasing the share of natural gas in the energy mix by 3% and placing it at a current level of 7% of the country's energy mix. This trend is expected to continue.

As China transitions to a service-based economic model, it's energy policy approach gears towards increased electrification, higher efficiency, and digital technologies, which are more compatible with natural gas and renewable energy than coal. China's industrial sector represents the largest share of natural gas consumption with a total consumption of 98 bcm (Figure 1-6). Followed by the buildings and power sectors with a consumption of 58 bcm and 50 bcm respectively.

Figure 1-6: Natural gas demand in China by sector, 2010-2019 (bcm)



Source: IEA World Energy Balances, 2021; APERC Calculations.

1-1-4 Northeast Asia

Northeast Asia (NEA) includes the following four economies: Hong Kong, China, Japan, Korea, Chinese Taipei. From 2009 to 2019 NEA natural gas consumption has grown by 18% largely driven by the power sector which consumed 107 bcm in 2019, representing an 86% share of consumption across all sectors. The buildings and industrial sectors natural gas consumption accounts for 33 bcm and 22 bcm, respectively. Urbanization and increased population density in this region coupled with a mature economy and high living standards leads to high natural gas demand in the buildings sector.

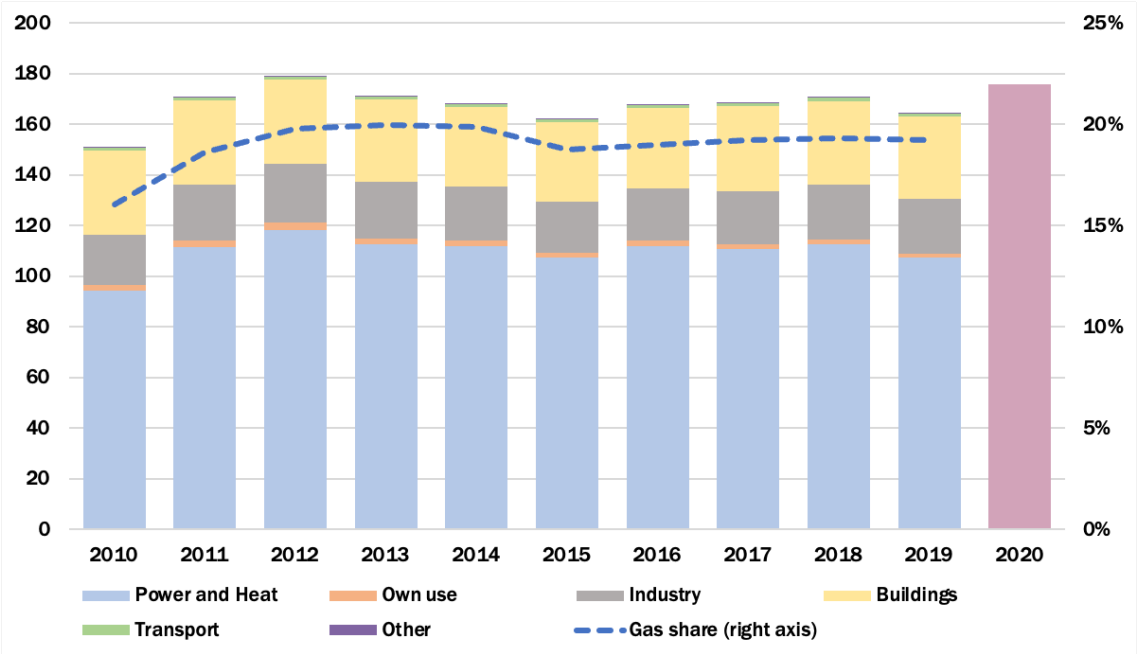
During the COVID-19 pandemic lockdown, economic activity particularly in the manufacturing sector was slowed reducing natural gas consumption in the industrial and power sector during

2020 in NEA economies, except for China. Natural gas demand in the NEA region's industrial sector mainly comes from China's large and energy-intensive manufacturing sector, that is expected to continue growing through 2030, as the country seeks to reduce GHG emissions and increase its domestic production of natural gas.

The share of natural gas in the energy mix of Northeast Asia was 19% in 2019, increasing by 4% since 2009. China and Korea have been driving natural gas consumption growth in the region as they switch from coal-to-gas fired power generation. However, lower economic growth in Korea because of the pandemic created a drop in electricity demand during 2020. The region is still largely dependent on coal due to costs, reliability, and local availability, although it is shifting to natural gas with increased generation capacity coming online up to 2034, particularly for power generation.

Japan's natural gas consumption has been declining slowly over the last decade, with an annual negative growth rate of 0.1%. The power sector consumed 64 bcm in 2019, followed by the buildings sector at 18 bcm.

Figure 1-7: Natural gas demand in Northeast Asia by sector, 2010-2019 (bcm)



Source: IEA World Energy Balances, 2021; APERC Calculations.

1-1-5 Southeast Asia

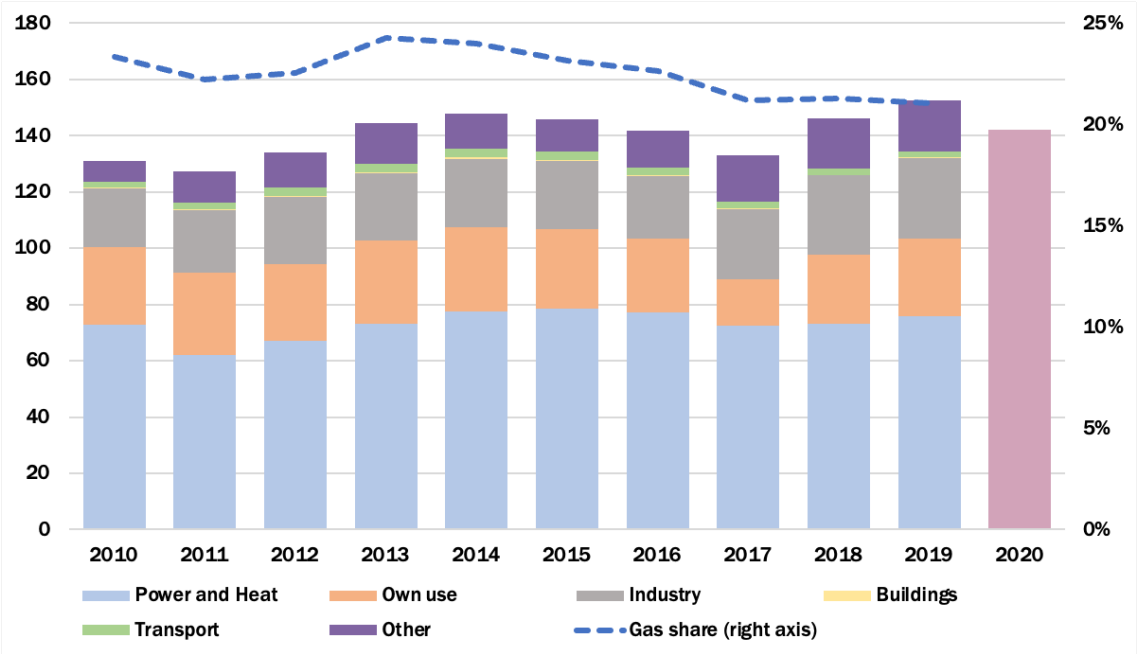
In figure 1-8, natural gas demand in Southeast Asia (SEA) is comprised of the following seven economies: Brunei, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Viet Nam.

In contrast to other regions of the world that are shifting away from coal as part of the energy transition, SEA is expanding its use for electricity generation. Particularly in Indonesia a large coal producer and the world's biggest exporter of thermal coal, and Viet Nam. This trend is attributed to more affordable coal costs and domestic availability of coal resources. "Coal power remains the most affordable option, costing about 600 rupiah (4.22 US cents) per kilowatt-hour (kWh) last year, versus gas at about 1 600 rupiah (11 US cents) per kWh, the state utility data showed."

The three economies in SEA with the largest natural gas consumption volumes are Indonesia (43 bcm), Thailand (43 bcm), and Malaysia (41 bcm). The share of natural gas in the energy mix of Indonesia, the most populous southeast Asian country, declined over the last five years from 20% in 2014 to 18% in 2019. Conversely, coal-fired power generation is on the rise, and will likely continue increasing its share over the next five years, driven by higher electricity demand due to increasing population and economic growth.

Most SEA economies have experienced positive GDP growth per capita over the last couple of decades, which has widened the middle class in countries such as Malaysia, Thailand, and Viet Nam. This increase in the standard of living has consequently increased natural gas demand, particularly for electricity generation, as for example, households purchase more appliances. The power sector represented the largest share (34%) of natural gas consumption. Followed by the industrial sector that accounts for a 25% share of natural gas consumption in the SEA region. The industrial sector had an annual growth rate of 4% from 2010 to 2019 and a consumption of 29 bcm in 2019.

Figure 1-8: Natural gas demand in Southeast Asia by sector, 2010-2019 (bcm)



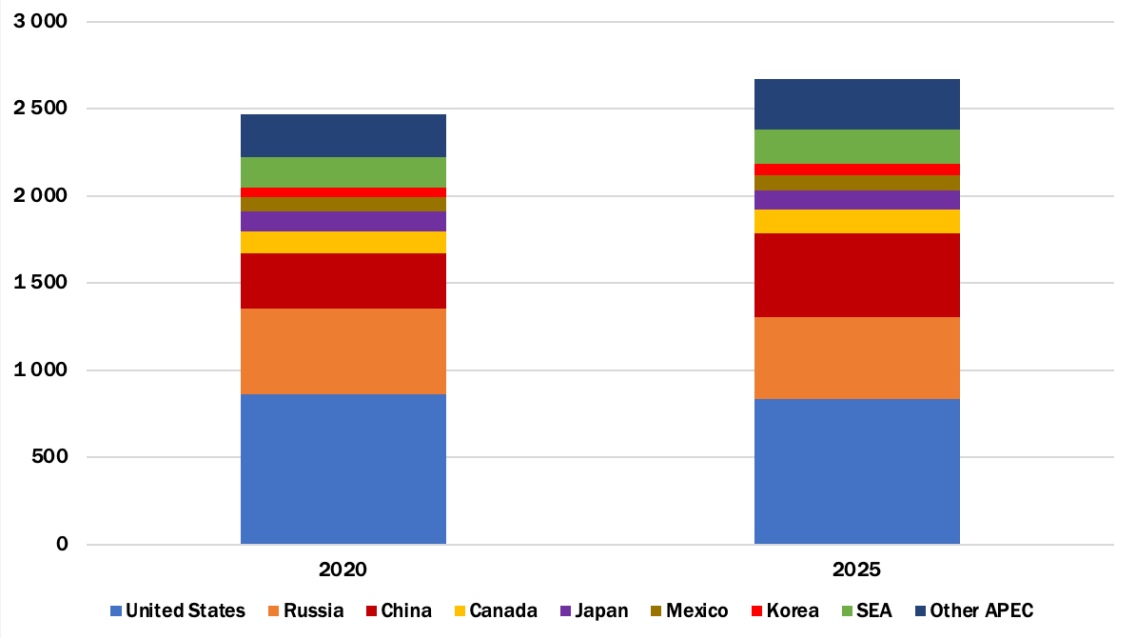
Source: IEA World Energy Balances, 2021; APERC Calculations.

1-2 Gas demand outlook

Due to the effects of the COVID-19 pandemic on the global economy, natural gas consumption and electricity sector demand saw a drop in 2020. However, increased COVID-19 vaccination rates and government economic stimulus are supporting economic recovery in 2021. As a result, electricity and natural gas demand is projected to surpass pre-pandemic demand levels by 2022, albeit the new Omicron Covid variant or other variants could slow the economic and gas demand recoveries in the near term. Baring substantial slowing, we expect gas demand in the APEC economies to grow by 7% from 2020 to 2025. China will be leading the growth with an additional consumption of 163 bcm, followed by Southeast Asia (14 bcm), and Korea (11 bcm). Conversely,

the United States and Russia will see the largest gas consumption declines of 29 bcm and 18 bcm, respectively.

Figure 1-9: Gas demand outlook 2020, 2025 by region (bcm)



Source: IEA, Natural Gas Information 2021; APEC EGEDA, Energy Balance Table, 2021; CEDIGAZ; APERC Calculations.

Chapter 2: Gas supply

The United States shale gas revolution unleashed vast and previously untapped reserves of unconventional gas, more than offsetting the decline in domestic gas production from conventional sources. These abundant natural gas supplies from the USA, at a competitive price, are increasingly being used throughout APERC economies, as demand for gas increases, driven mainly by the power and industrial sectors (as described in Chapter 1). These natural gas market dynamics are changing the energy landscape and providing countries with cleaner-burning and affordable energy choices, to increase diversification and energy security, while contributing to meet a global surge in primary energy demand.

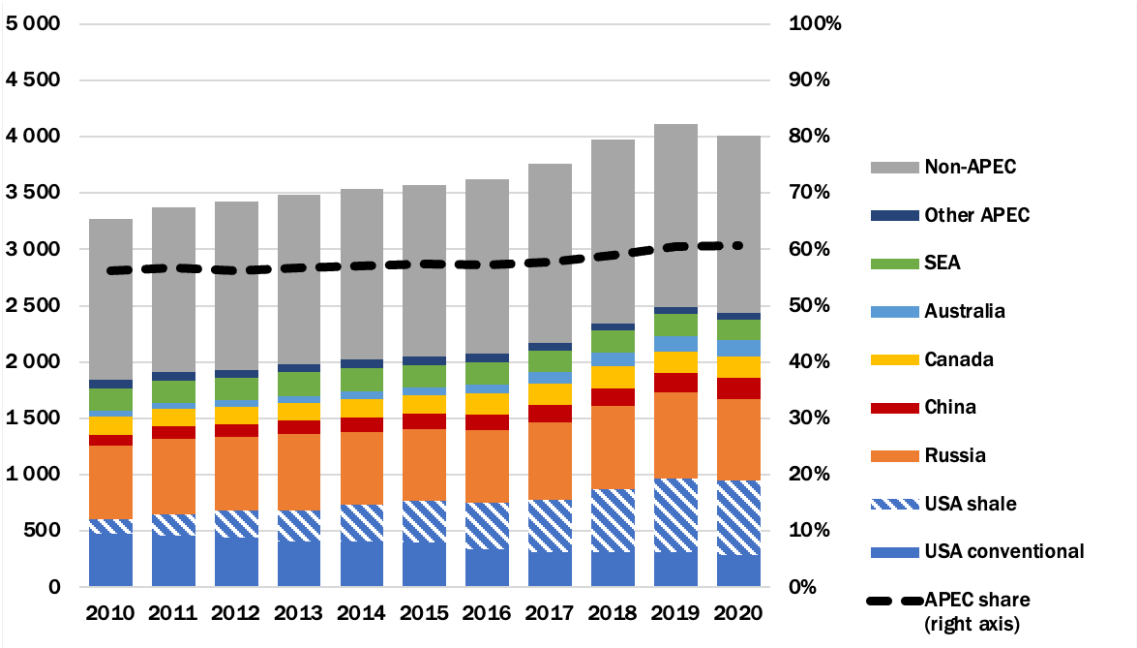
Natural gas is a flexible fuel that provides back-up for intermittent renewable energy sources increasing power grid reliability, at a time when increased renewable energy capacity for power generation is being added into the energy mix of countries seeking to transition away from high-carbon energy sources to reduce greenhouse gas emissions.

2-1 World and APEC natural gas production

The United States and Russia are the leading natural gas producers in APEC, in 2019 they reached a production of 948 bcm and 722 bcm, respectively. During that same year, China's natural gas production (191 bcm) surpassed that of Canada's (184) for the first time in a decade (Figure 2-1).

Australia and China have seen a robust production growth of 64% and 50% respectively over the last decade. In fact, China and Australia were the only economies to have a production growth from 2019-2020, amid the COVID-19 pandemic, growing by 7-8% each. Meanwhile, non-APEC economies and Russia had the largest drop in production during that same period, falling by 3% and 6% respectively.

Figure 2-1: Natural gas production of APEC member economies, 2010-2020 (bcm)



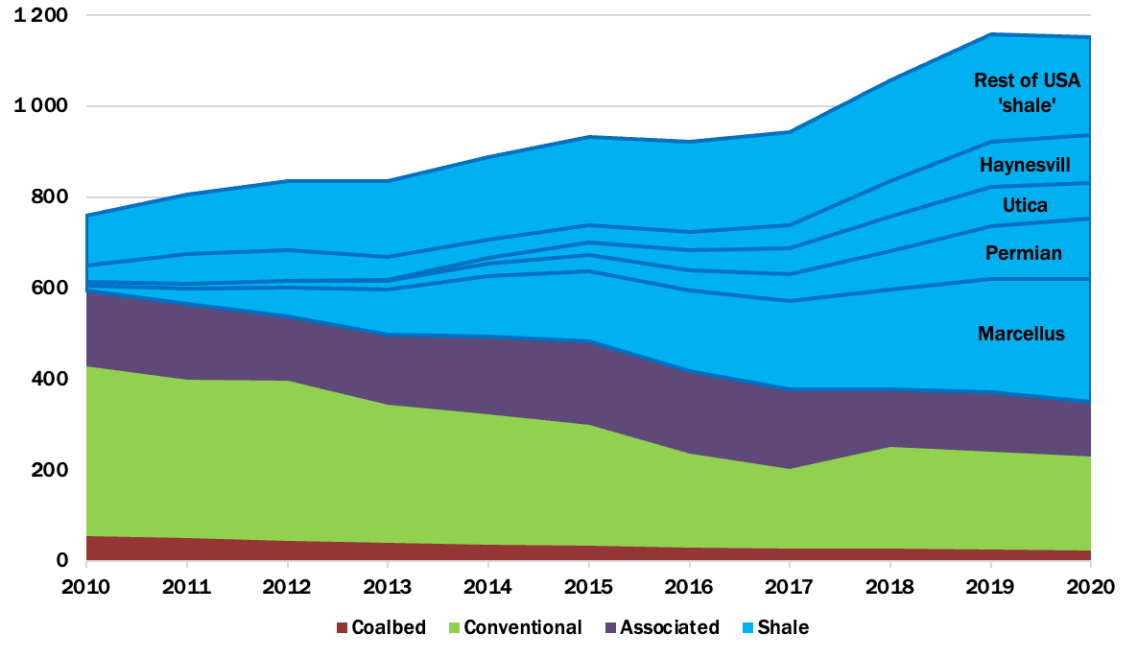
Source: IEA, Natural Gas Information 2021; APEC EGEDA, Energy Balance Table, 2021; CEDIGAZ.

APEC's share of the world's natural gas supply represented 61% in 2019 with the USA accounting for 39% of this share. Over the last decade, USA shale gas production grew by a remarkable 80%, while non-shale gas production has declined by 38%.

2-1-1 United States

Total gas production in the USA has grown substantially due to the rapid growth of unconventional production. The shale gas increase has allowed the USA to move from being a gas importer to a gas exporter. The increase in domestic natural gas production was made possible by the successful commercialization of technological breakthroughs in the first decade of the 2000s. Hydraulic fracturing and horizontal drilling techniques enabled the extraction of abundant unconventional gas resources offsetting declines in production from conventional gas reservoirs. The increase in recognized gas reserves secures domestic natural gas supplies for at least a century. Over the last decade, a rapid and vast increase in USA gas production led to reduced gas prices, benefiting the North American market, as pipelines and other midstream natural gas infrastructure makes it convenient to transport and store this resource across borders. Mexico one of the world's top 20 economies, provides a growing demand market for USA gas supporting favorable gas market conditions that benefit North America as a whole.

Figure 2-2: USA gross natural gas production, 2010-2020 (bcm)



Source: EIA, 2021.

The United States shale gas production is mainly concentrated in the following formations: Marcellus, Permian, Utica, and Haynesville (Figure 2-2). Over the last decade, total unconventional supplies have grown by 80%, while conventional supplies of gas have fallen by 27%. Associated natural gas production has been on a downward trend since reaching its highest level in a decade in 2015 with a production of 184 bcm, compared to a level of 121 bcm in 2020.

The Marcellus shale formation runs through western New York and Pennsylvania down into West Virginia accounting for the largest share of shale gas production in the USA Over the last decade,

Marcellus production has grown 96%, reaching a production of 133 bcm in 2020 (Figure 2-2). Following the Marcellus shale in terms of production volume is the Permian basin, located in West Texas and southeastern New Mexico, with production of 133 bcm.

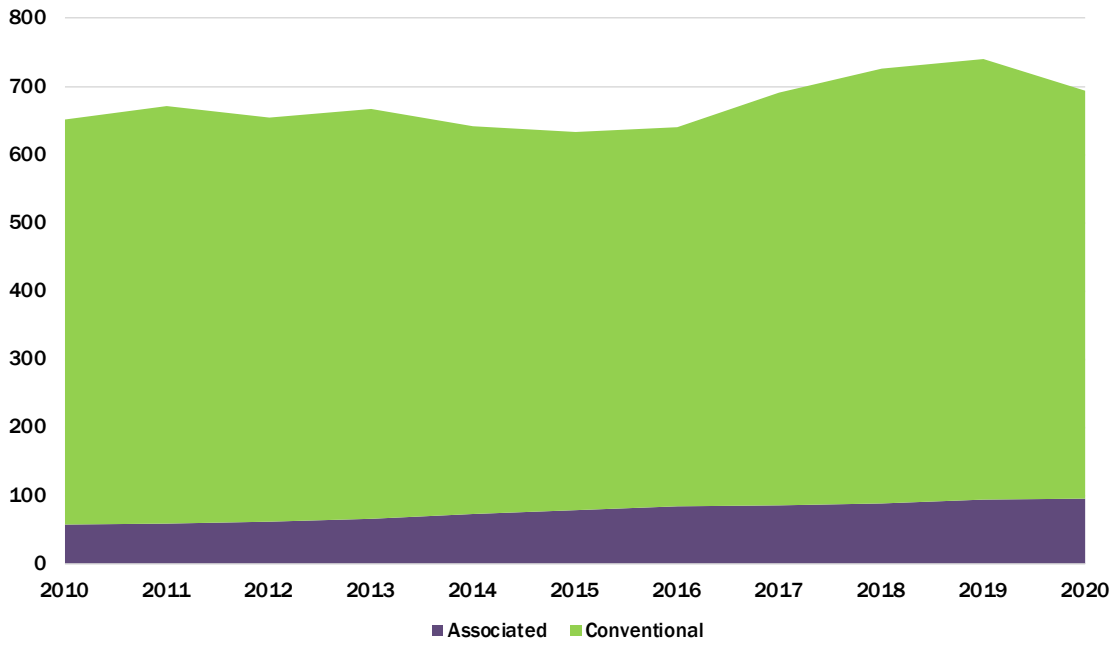
From 2019 to 2020, overall shale gas production grew by 2%, compared to a y-o-y growth of 17% from 2018 to 2019 (Figure 2-2). The reason for this was an overall lower output during 2020, due to the COVID-19 pandemic. Production in Utica and Haynesville was 79 bcm and 105 bcm respectively during 2020.

2-1-2 Russia

Russia holds the world's largest reserves of natural gas and is the second largest producer of dry natural gas. Most of these reserves are located in large natural gas fields in West Siberia, where most of the conventional gas production is found. The volume of Russia's conventional gas production represents over six times that of associated gas. A large portion of associated natural gas in Russia gets flared due to a lack of economic feasibility in bringing it online, as there is a surplus of natural gas from conventional sources on the Russian market. Higher gas prices due to a surge in global gas demand driven by China, an already big importer of Russian natural gas, could improve associated gas resource recovery.

In 2020, Western Siberia produced 535 bcm of gas, which was 89% of Russia's total conventional gas production. At the same time, Eastern Siberia and Far East produced 34 bcm, while other territories accounted for a production of 31 bcm (Figure 2-3).

Figure 2-3: Gas production in Russia, 2010-2020 (bcm)



Source: ROSSTAT, 2021.

Associated natural gas supplies have increased by 39% over the last decade. Eastern Siberia and Far East production doubled over this period, reaching a production of 25 bcm in 2020. Western

Siberia accounts for over half of total associated gas supplies and had a production of 56 bcm in 2020. Meanwhile, other territories had an associated gas production of 14 bcm.

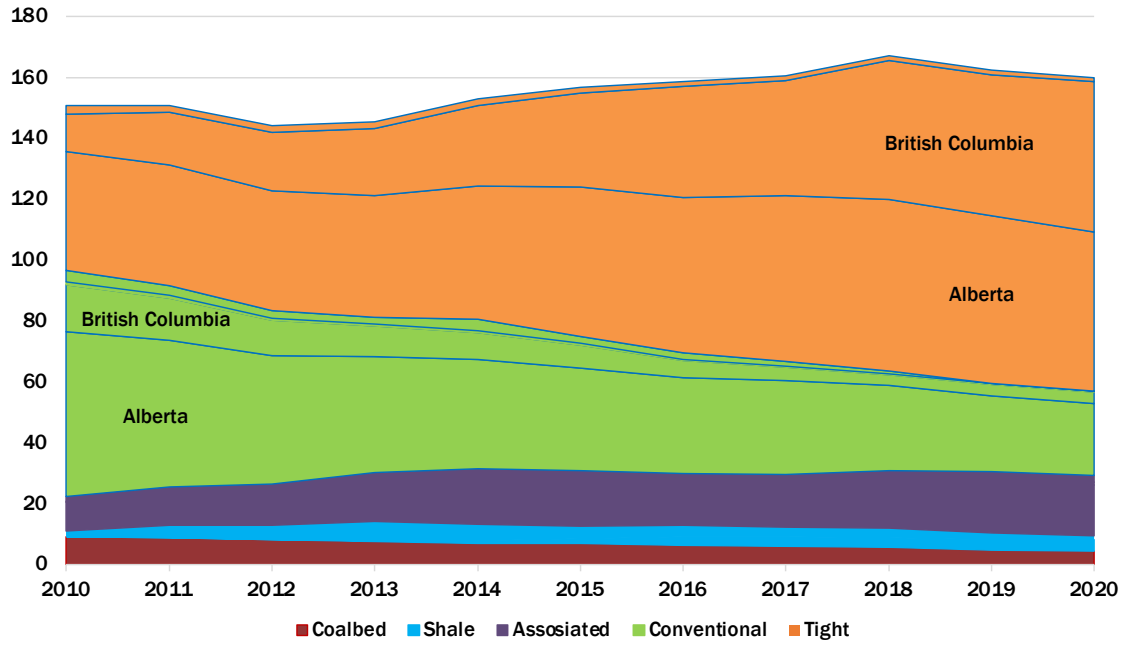
From 2010 to 2020, conventional gas supplies have remained steady, reaching their highest level (646 bcm) in 2019. However, due to the impact of COVID-19 and the collapse in oil prices in 2020, Russia decided to cut its oil production significantly, which also caused a decline in associated natural gas production. Overall pre-pandemic (2018-2019) y-o-y production growth was 2%, compared to a (2019-2020) y-o-y decline of 6%.

2-1-3 Canada

Canada is the fourth largest producer of natural gas in APEC. Production comes from the prolific Western Canadian Sedimentary Basin (WCSB) encompassing the provinces of Alberta, British Colombia, and Saskatchewan. Canada ranks sixth largest in terms of power generation in the world, nevertheless only 9.4% of its electricity generation comes from natural gas. Hydroelectric power accounts for 60% of all electricity generation in the economy. The industrial sector accounts for 55% of domestic natural gas consumption, followed by the residential and commercial sectors that use it largely for heating. As described in Chapter 3, Canada exports 45% of its gas production, representing a value of $4.9 billion in 2019. All Canadian exports go to the USA. In 2019, Canadian exports accounted for 97% of all USA gas imports.

Most of Canada's unconventional gas production comes from tight (low permeability) formations. In 2020 tight gas production was 103 bcm, compared to shale gas production of only 5 bcm. Meanwhile, total associated gas supplies increased from 11 bcm in 2010 to 19 bcm in 2020, representing only 12% of total gas production.

Figure 2-4: Gas production in Canada, 2010-2020 (bcm)



Source: Canada Energy Regulator, 2021.

Alberta is the largest natural gas producing province in Canada. In 2020 it had a conventional gas production of 24 bcm and a tight gas production of 52 bcm (Figure 2-4). British Columbia

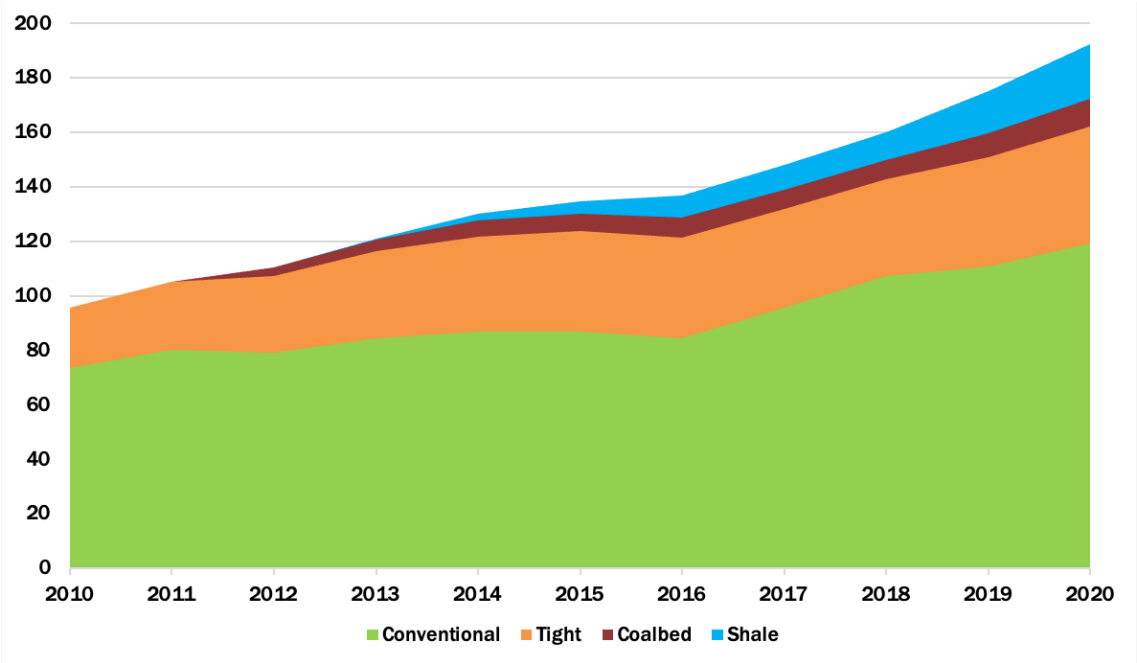
produced only 3 bcm from conventional reservoirs and 49 bcm from tight gas formations in 2020. Although Canadian production of conventional natural gas has been on a decline over the last decade, unconventional natural gas production has been on the rise helping offset these declines. From 2010 to 2020 conventional gas production declined by 62% while unconventional gas production (shale and tight) rose by 47% (Figure 2-4). Nevertheless, total natural gas supplies in Canada have remained relatively flat over the last decade.

2-1-4 China

China is the world's sixth-largest natural gas producer, over the last decade it has doubled its production from 191 bcm in 2010 to 385 bcm in 2020. Despite COVID-19, China managed to increase gas production by 35 bcm or 9% from 2019 to 2020.

As of 2020, the largest share of natural gas production came from conventional resources (62%), followed by tight (22%), shale gas (10%), and coalbed (5%). Over the last decade, there has been a change in the type of natural gas resources being extracted, coalbed and shale gas have been incorporated into the production platform. Shale gas has rapidly expanded due to higher investments targeted at developing China's unconventional gas resources, a trend that will continue, inspired by the USA shale gas growth. Shale gas production growth has contributed to total production growth, doubling from 2018 to 2020, to reach the level of 20 bcm.

Figure 2-5: Gas production in China, 2010-2020 (bcm)



Source: National Bureau of Statistics of China, 2021; HIS Markit, 2019; Argus, 2020; Reuters, 2021.

Nevertheless, China faces some economic, geologic and technological challenges in significantly expanding its shale gas production. Geological barriers to development like the depth of its shale formations make it difficult to access with current technology, population density surrounding attractive shale formations also provide an additional barrier, reducing new upstream project feasibility. However, the government is increasing investments and financial incentives for producers in technically challenging upstream hydrocarbon areas to reduce import dependency (as China is the world's largest natural gas importer) and displace coal use for environmental

reasons. In recent years, the government reduced the resource tax on shale gas production from 6% to 4%. In addition, it extended subsidies on all unconventional production through 2023.

2-1-5 Australia

Total natural gas production in Australia has more than doubled over the last decade, going from being the 16th largest global producer to being the 7th largest. Natural gas production grew by 15% to 154 bcm in the 2018-2019 financial year. In turn, realizing a domestic natural gas surplus and targeting international export markets through LNG projects. However, there are logistical issues in efficiently transporting natural gas production from the west to demand centers in the southeast, in part due to a lack of natural gas infrastructure. In addition, a tightness in the market from growing LNG exports (as described in Chapter 3), a drop in new upstream investments, and insufficient domestic supplies in the southeast is increasing gas prices for domestic consumers.

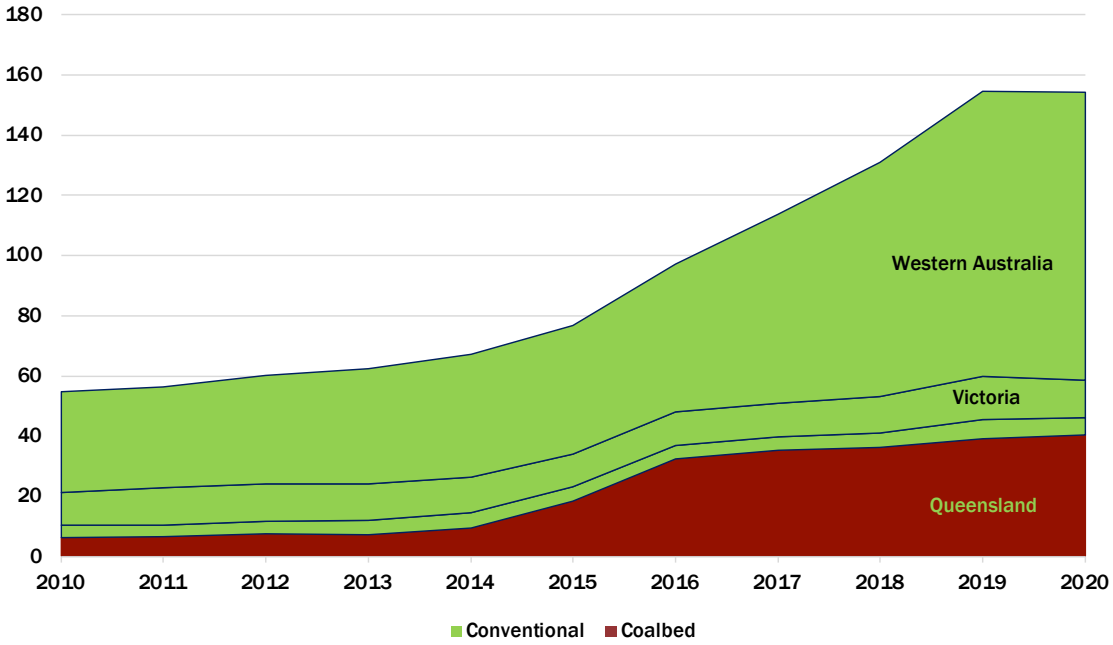
Conventional natural gas is largely produced in the Carnarvon Basin offshore northwestern Australia, which concentrates most mature and prolific fields, many of which are declining in output. The Western Australia offshore region encompasses the largest share of natural gas production (63%) in 2015. While the Victorian state in the southeast region had a production of less than 15%. In addition, Queensland and New South Wales (NSW), represent Australia's main sources of coal bed methane with a share of 19% of total natural gas production. The inland Cooper and Amadeus basins are small offshore fields in the northern Bonaparte basin that account for the remaining share of Australia's natural gas production.

As previously mentioned, the largest share in natural gas production occurs in Western Australia, a region that over the last decade has tripled its production, reaching 96 bcm in 2020. At a smaller scale, Queensland in the east had an increased natural gas production growth of 84% over the last decade. From 2014 to 2015 production doubled in size reaching 18 bcm and has continued to grow up to 40 bcm in 2020 (3% lower than forecast). As a result of the COVID-19 pandemic and a drop on LNG spot prices, Australia's gas supply forecast fell short during 2020. The gas supply levels forecasted for 2020 were 2 044 PJ compared to actual levels of 1 937 PJ. This trend has put additional pressure on already constrained natural gas supply availability in the east.

Australia has increased its LNG export capacity from 2.6 bcf/d (27 bcm/y) in 2011 to more than 11.4 Bcf/d (118 bcm/y) in 2019, becoming the world's largest LNG exporter, with exports averaging 10.2 Bcf/d (105 bcm/y). The total export capacity in northwestern Australia from a total of five LNG export projects that were developed in 2012 is 8.1 Bcf/d (84 bcm/y). On the other hand, eastern Australia has three LNG export projects with a combined nameplate capacity of 3.4 Bcf/d (35 bcm/y). LNG export projects in eastern Australia use natural gas from coalbed methane as a feedstock to produce LNG.

In order to ensure sufficient domestic gas supplies, the Australian Domestic Gas Security Mechanism (ADGSM) instituted by the Australian Government in 2017, regulates the LNG market to prioritize domestic market supply forecast needs over the export market at competitive prices. Moreover, Australia's competition watchdog, ACCC, released a warning in August stating that if LNG producers export all their surplus gas, there is a growing risk of a gas supply shortfall by 2022 of 2 PJ in the east coast gas market, especially affecting the southern states that could see a 6 PJ shortfall. The ACCC also stated that producers are forecast to produce 1 981 PJ in 2022, with a surplus of 101 PJ.

Figure 2-6: Gas production in Australia, 2010-2020 (bcm)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, 2021.

2-1-6 Southeast Asia

APEC's natural gas production in Southeast Asia (SEA) originates in six economies: Brunei, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The region is at a crossroads, as domestic natural gas supplies are insufficient to meet the region's rapidly growing demand.

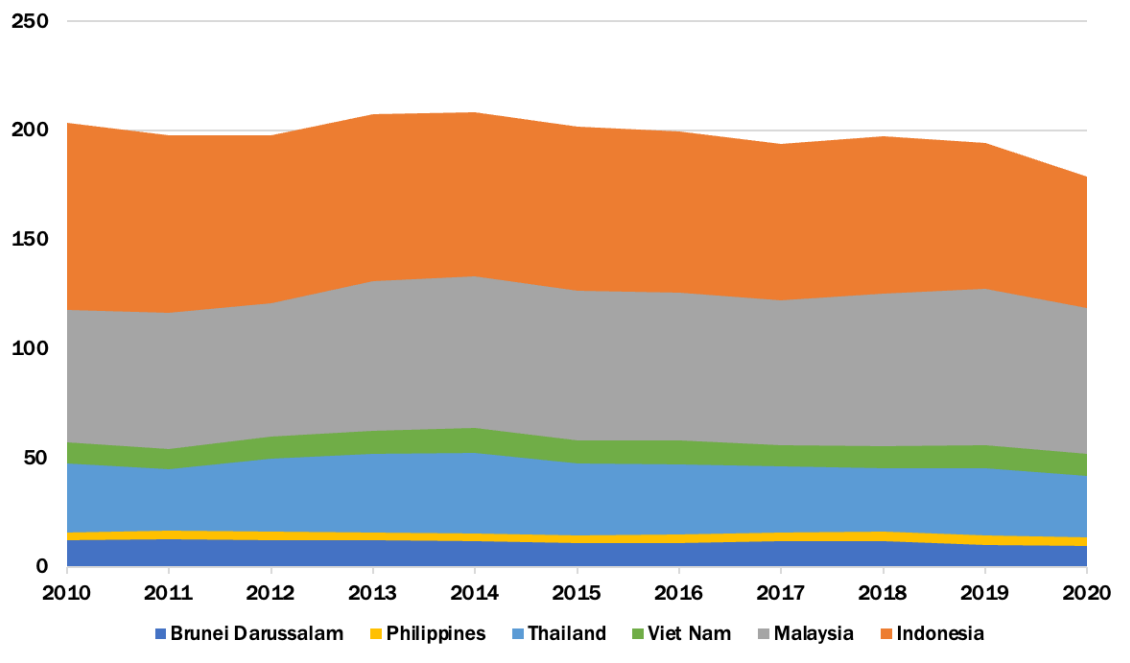
Indonesia's proved natural gas reserves are the third largest in the Asia-Pacific region, after China and Australia, and are estimated to be 49.7 trillion cubic feet (Tcf) in 2021. Over the last decade, Indonesia's natural gas production has declined by 29%, in part due to regulatory hurdles and policies that limit private sector participation. A lack of infrastructure to recover associated natural gas contributes to high volumes of natural gas being flared. In 2019 Indonesia had a production of 66 bcm and was replaced by Malaysia as the top natural gas producer in SEA. In 2020 Indonesia and Malaysia, SEA largest producers, had a production of 60 bcm and 66 bcm respectively. Overall total natural gas production in SEA declined by 15 bcm from 2019 to 2020 largely due to the impacts of COVID-19.

According to the *Oil & Gas Journal* (*OGJ*), Malaysia holds 41.8 Tcf of proved natural gas reserves as of January 2020. Over the last decade, Malaysia has had steady gas production growth that exceeded domestic consumption. Malaysia has pursued a strategy to liberalize the natural gas market, in 2017 the Gas Supply Act came into force to further liberalize the natural gas market, allowing third party access to existing natural gas infrastructure among other measures. A robust natural gas pipeline network in Sabah and Sarawak enables efficient gas transportation from offshore fields to power plants for electricity generation or to LNG terminals for export.

Thailand's natural gas proven reserves accounted for 7.3 Tcf in 2016 and have been on a decline, according to OGJ. Thus, increased exploration investments are required to make new discoveries and replace reserves at a faster rate. Thailand's natural gas production has followed a declining trend since 2014 when it reached its highest production in a decade at 37 bcm. As a result of

insufficient domestic production, Thailand is increasingly reliant on piped gas imports particularly from its SEA neighbor Myanmar, as well as LNG imports.

Figure 2-7: Gas production in Southeast Asia, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ.

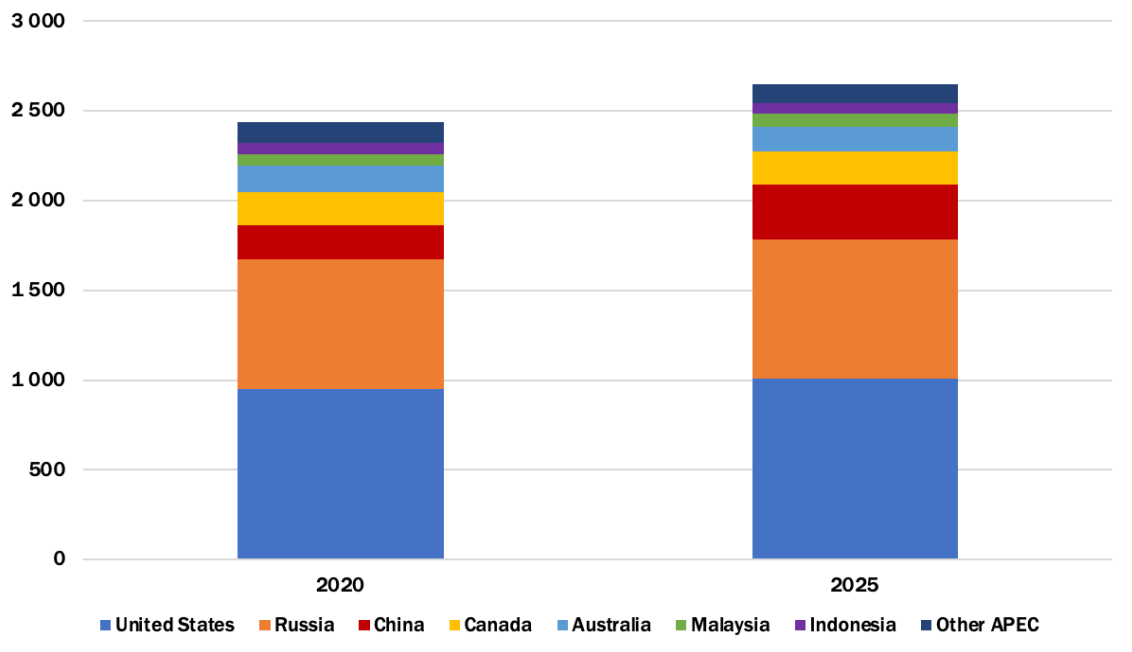
2-2 Gas production outlook

According to the preliminary modelling results of the Reference Scenario for the 8th Edition of the APEC Energy Demand and Supply Outlook, gas production in APEC increases from 2 490 bcm in 2019 to 2 613 bcm in 2025, a 5% increase over six years.

The United States and Russia are expected to continue to be the largest producers of natural gas in APEC reaching a production of 1 008 bcm and 775 bcm, respectively by 2025. China has the largest projected compound annual growth rate (CAGR) of 9.6% from 2019 to 2025. Hence, it is projected to grow its natural gas production from 176 bcm in 2019 to 305 bcm by 2025 (a third of the USA natural gas production). Meanwhile, Canada's gas production declines marginally by an annual average of 0.4% during the projected period, resulting in production of 183 bcm by 2025. Canada's production decline and increasing output from China leaves China on third place in terms of natural gas production in APEC.

Australia has a slight increase in gas production from 137 bcm in 2019 to 141 bcm in 2025. While Malaysia's gas production remains flat at 72 bcm by 2025, and Indonesia has a drop of 7.8 bcm realizing a production of 58 bcm by 2025.

Figure 2-8: Natural gas production outlook in APEC member economies, 2020, 2025 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

Chapter 3: Natural gas trade

With the growth of liquified natural gas (LNG), natural gas trade has evolved from being primarily based on regional transactions executed through pipelines to a global market. LNG allows natural gas to be stored and transported in a liquid state and then regasified and consumed in the destination market, allowing for increased access to markets. In addition, the rise of LNG trade has complemented existing natural gas pipeline transactions and created a dynamic global natural gas market with important implications for the energy transition, energy security and geopolitics.

The energy transition that is underway, will further incentivize and facilitate a switch away from coal and petroleum products to natural gas for electricity generation in rapidly growing economies. Particularly, as new liquified natural gas (LNG) export and import terminals come in service, and stronger inter-regional natural gas value chains are established. New technologies such as carbon-neutral LNG, and carbon capture, utilization, and storage (CCUS), are providing new opportunities to meet growing energy demand while decarbonizing energy systems. In addition, areas beyond the reach of current pipeline systems due to geographic barriers, are now able to access natural gas that contributes to their economic development, by providing lower cost and smaller scale natural gas importing infrastructure. Floating storage, regasification and power generation units (FSRPs), also known as "LNG to power", can be used for importing natural gas and using it for onsite gas-fired power generation.

Chapter 3 of APEC's Natural Gas Report 2021 provides a deep dive into the main trade patterns and development's seen in APEC and non-APEC economies over the last decade.

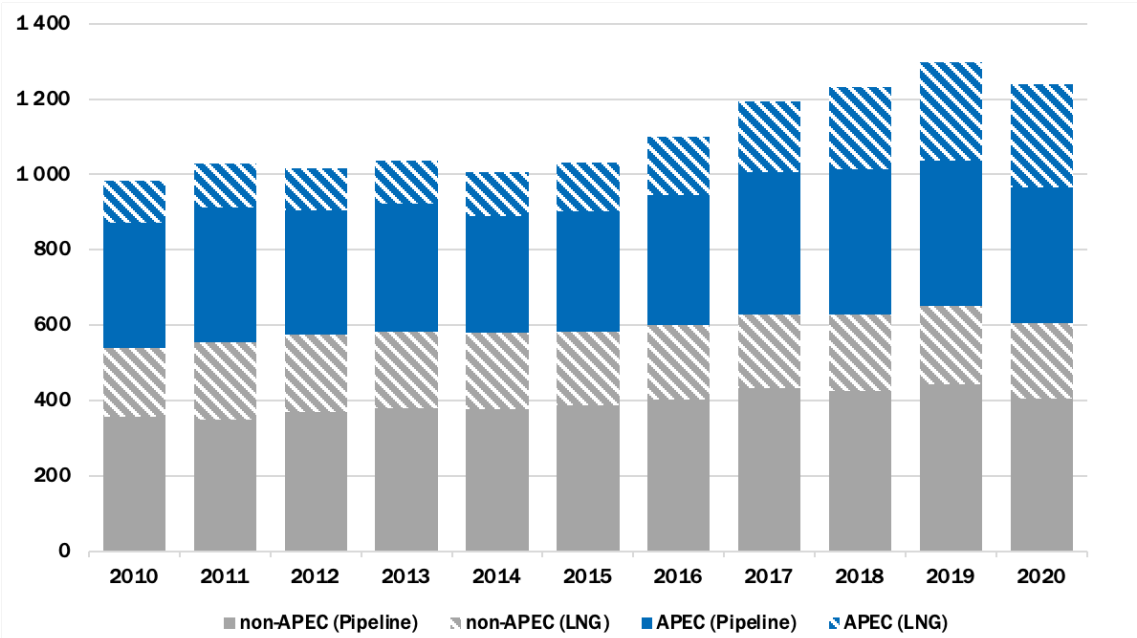
3-1 World and APEC natural gas trade

Over the past decade, the share of natural gas being traded via LNG has increased from 27% to 38%. World LNG exports have grown at a CAGR of 6.3% from 2009 to 2020, while pipeline exports had a CAGR of 1.5% (Figure 3-1). During this same period, APEC LNG exports increased at a CAGR of 10%, going from 96 bcm to 273 bcm, mainly driven by a rise in USA LNG exports. In comparison, non-APEC LNG exports had a CAGR of 2.9%.

World natural gas exports have increased by 28% from 2009 to 2020, as LNG export capacity and new pipeline infrastructure has been built out globally, allowing the distribution of increased volumes of gas across different continents and within countries. Increased gas availability from USA shale, liquefaction projects and a fall of 30 to 50% in the capital cost of LNG liquefaction plants in the second half of the past decade; have made project implementation and gas availability more accessible and efficient for rapidly growing economies with a growing natural gas demand.

APEC plays an essential role in the natural gas market as it has the largest gas importers and exporters in the world. Japan, China, and the USA are three of the five largest natural gas importers in the world. While the USA, Canada and Russia, are three of the five largest natural gas exporters in the world.

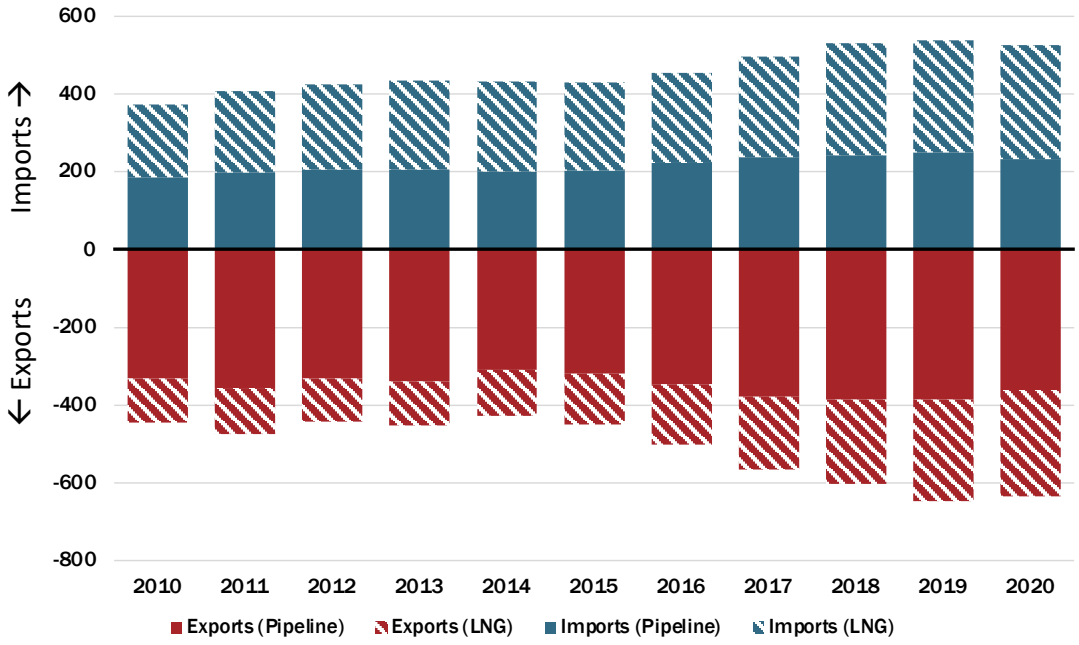
Figure 3-1: Natural gas trade, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

In aggregate, APEC economies export more natural gas than they import, with most of the exports occurring through pipelines (57%). However, the volume of gas traded, and the share of LNG exports are both increasing. Over the last decade, the volume of LNG exports increased by 177 bcm, compared to an increase of pipeline exports of 36 bcm (Figure 3-2). Furthermore, in 2009, there was a total volume of gas traded of 421 bcm, and 77% of exports took place via pipelines. In comparison to 2020, when the volume of traded gas increased to 634 bcm, while the share of pipeline exports fell to 57%, as LNG gained market share.

Figure 3-2: APEC Natural gas net trade, 2010-2020 (bcm)



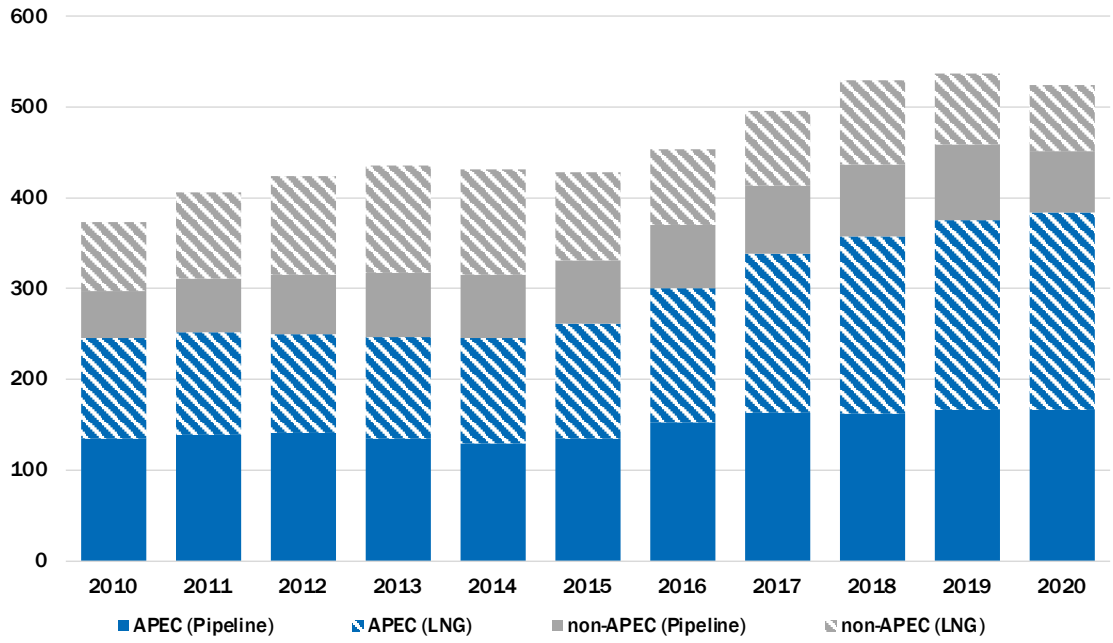
Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC calculations, 2021.

Natural gas imports occur mostly via LNG, representing a share of 55% in 2020. Over the last decade, the volume of LNG imports has increased by 35% from 2009 to 2020. Asia has seen the largest increase in natural gas imports due to several factors including rapid economic growth (particularly in China and Southeast Asia), fuel switching from coal and nuclear energy to natural gas, and a lack of domestic natural gas production.

3-2 Gas Imports in the APEC region

Over the last decade, global gas imports have increased by 35% reaching 524 bcm in 2020 from 338 bcm in 2009 (Figure 3-3). From 2009 to 2020, China has seen the largest increase in natural gas imports with a growth of 106% reaching a total of 136 bcm in 2020 (Figure 3-4). This trend has been largely due to China's "Blue Skies" policy that seeks to switch from coal to gas in the power and industrial sectors in order to improve air quality. China has ranked among the four top customers of USA LNG every year since that trade began in 2016. In 2019, the largest sources for Chinese LNG imports were Australia, Qatar, Malaysia, and Indonesia.

Figure 3-3: APEC Natural gas imports by origin and type, 2010-2020 (bcm)

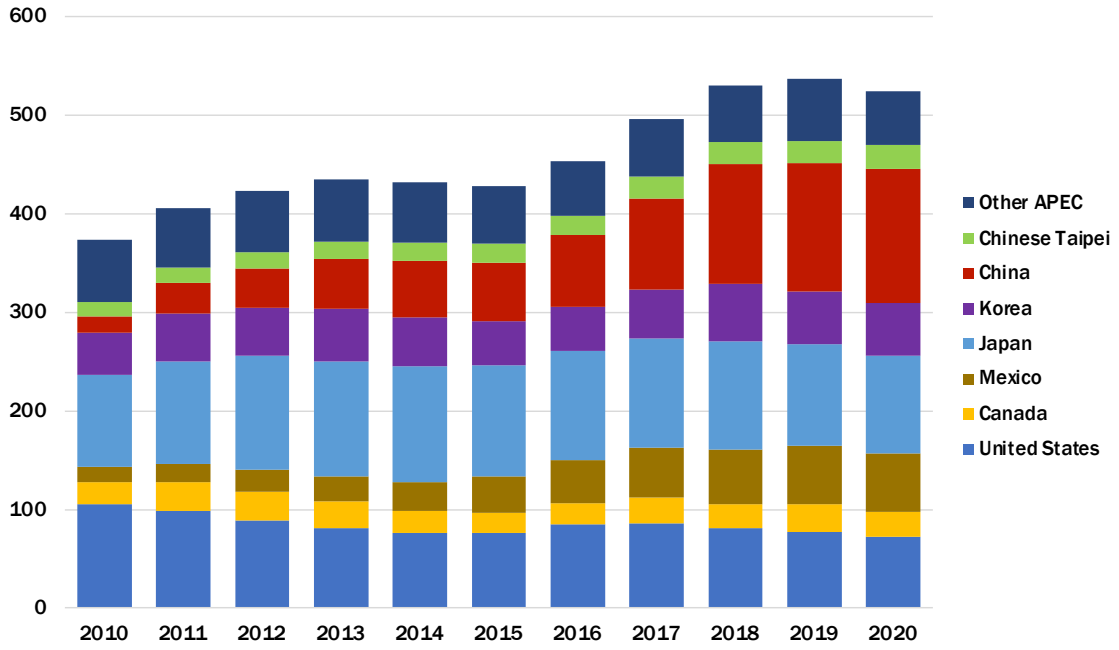


Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

Following China in terms of a rise in gas imports is Mexico, with an increase of 74%, reaching a level of imports of 59 bcm from 15 bcm in 2009 (Figure 3-4). Mexico's gas imports have risen as a result of falling domestic gas production and increased midstream infrastructure build-out. Most of Mexico's imports occur through pipelines from the USA with a smaller share of imports from LNG. In Mexico, LNG imports for domestic consumers serve to balance the market seasonally and have been on a decline as increased pipeline infrastructure came online. An emerging trend in Mexico is importing LNG from the USA and exporting it to the international market, as a re-exporter of LNG, particularly to Asia through the Pacific due to logistical advantages.

APEC economies except for the USA increased their natural gas imports during the last decade. The USA saw a 32% decline in natural gas imports over the last decade and is set to become the largest natural gas exporter by 2022, while it is also the largest natural gas producer in the world (Figure 3-3).

Figure 3-4: Total natural gas imports by APEC economy, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

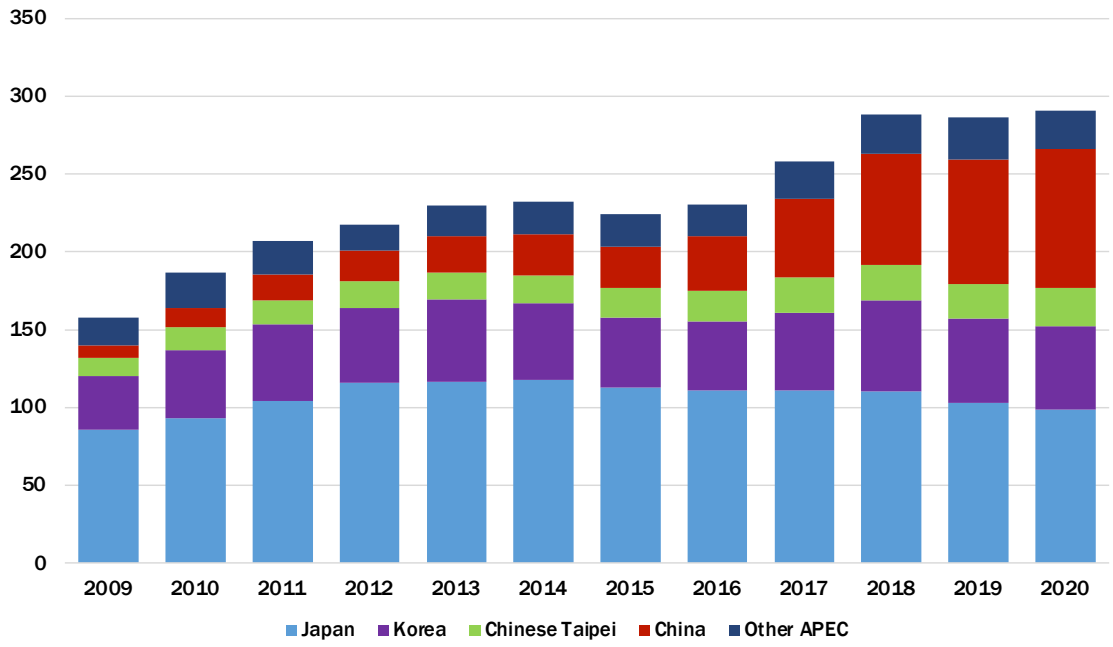
The largest share of imports in 2020 was in the form of LNG, with LNG imports representing a share of 55% in comparison to 45% of pipeline imports in 2020 (Figure 3-3). Over the last decade, APEC LNG imports driven by Japan and China have increased by 57% while non-APEC LNG imports had a growth of 12%. Furthermore, APEC LNG imports represented 217 bcm in 2020, compared to non-APEC imports of 73 bcm. Meanwhile pipeline imports have seen a similar growth in APEC and non-APEC economies during the last decade, representing a growth of 21% and 27% respectively. Pipeline imports in APEC and non-APEC economies represented 167 bcm and 67 bcm respectively in 2020.

3-2-1 APEC LNG Imports

During the last decade, Japan has been the largest LNG importer in the world, a position that is likely to be surpassed by China in 2021. Over the last decade China has seen a CAGR of 25% on its natural gas imports, compared to Japan's CAGR of 1.3%. In 2009, the volume of LNG imports for Japan and China represented 85 bcm and 8 bcm, respectively (Figure 3-5). In contrast to 2020, when the volume of LNG imports for Japan and China were 99 bcm and 89 bcm, respectively. As a result, Japan's share of APEC's total LNG imports has declined from 54% in 2009 to 34% in 2020. While at the same time, China's share of APEC's total LNG imports has increased from 5% to 31% (Figure 3-5). China's increase in LNG imports is largely due to the economic growth it has had over the last decade and fuel switching from coal to gas driven by the industrial and power sectors, as described in Chapter 1.

Korea is the third largest LNG importer in APEC with an import volume of 53 bcm in 2020, its LNG imports are driven by the power sector as the country shifts from coal and nuclear to natural gas and renewable energy for environmental and safety reasons.

Figure 3-5: LNG imports by APEC economy, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

3-2-2 Pipeline imports from APEC economies

Although a net exporter, the United States is APEC's largest natural gas importer through pipelines, mostly from Canada. Nevertheless, USA natural gas imports have been on a downward trend since peaking in 2007, oppositely natural gas exports have been on the rise. From 2009 to 2020, USA natural gas imports via pipelines have reduced by 24%, accounting for a total volume of 71 bcm in 2020 (Figure 3-6).

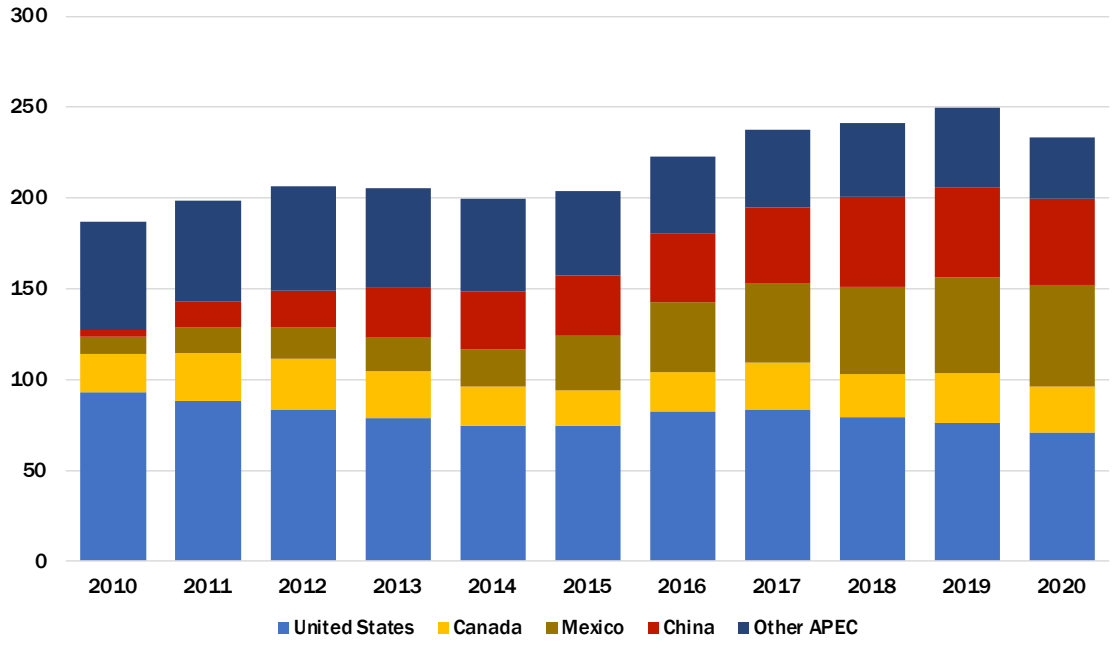
Over the last decade, Mexico has simultaneously seen a demand growth for natural gas and a decline in its domestic natural gas production. Increasing its reliance on pipeline natural gas imports, particularly from its top trading partner, the USA. Thus, taking advantage of its high gas production, competitive prices, and close geographic proximity. Mexico's pipeline capacity expansion has allowed increased volumes of USA gas to flow into Mexico. Mexico's pipeline imports have increased by 83% from 2009 to 2020, reaching a volume of 56 bcm in 2020. An increase in Mexico's natural gas consumption has been largely due to a switch from costly high-carbon emitting fuels like oil to cheaper and cleaner-burning natural gas for power generation and industrial use.

China began importing gas through pipelines in 2010, and since then it has rapidly grown its natural gas intake, becoming the third-largest natural gas pipeline importer with a volume of 47 bcm in 2020. An expansion of its pipeline capacity has in turn increased the volume of natural gas imports. In December 2019, the first natural gas pipeline from Russia to China called Power of Siberia came in service. This pipeline has an initial capacity of 38 bcm per year. In addition, Russia is also planning to build another pipeline, Power of Siberia 2, which will allow it to supply gas from

the Yamal Peninsula fields to China via Mongolia with a planned export capacity of approximately 50 bcm per year. The section of the pipeline that will run through Mongolia is named "Soyuz Vostok". This pipeline will further increase China's natural gas imports from Russia over the next decade.

Other APEC economies have reduced the volume of imported gas via pipelines by 41% over the last decade, representing a total import volume of 34 bcm in 2020. This decline in pipeline imports in other APEC economies is partly due to a displacement of pipeline imports with LNG imports, that result more viable in some cases.

Figure 3-6: Pipeline imports by APEC economy, 2010-2020 (bcm)



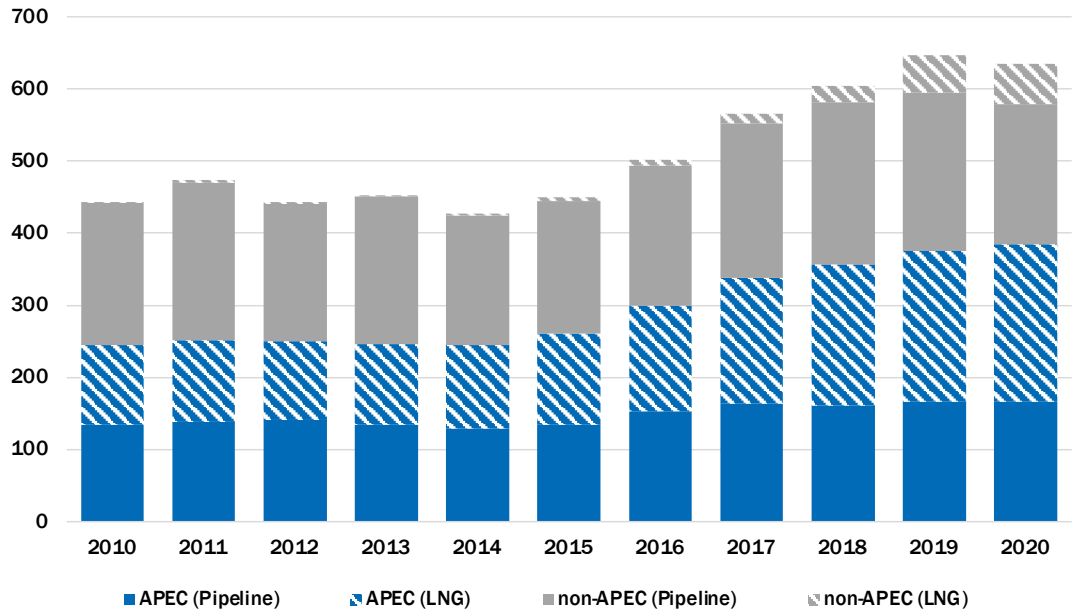
Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

3-3 Gas exports in the world and the APEC region

APEC total natural gas exports represented 384 bcm in 2020, an increase of 41% from 2009 levels (Figure 3-7). The largest share of these exports occurs through LNG, representing a share of 57% in 2020 with a volume of 217 bcm.

Conversely, non-APEC total natural gas exports occur mainly via pipelines representing a share of 78% in 2020 with a volume of 194 bcm (Figure 3-7). Over the last decade, non-APEC economies have increased their volume of natural gas exports by 22%, reaching a total of 249 bcm in 2020.

Figure 3-7: APEC natural gas exports, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

3-3-1 APEC LNG exports

Over the last decade the total volume of APEC's LNG exports has grown from 96 bcm in 2009 to 273 bcm in 2020. Thus, APEC LNG exports as a share of global LNG exports rose from 40% in 2009 to 58% in 2020. This is largely due to two factors: firstly, a rapid growth in global natural gas demand, driven by Europe and Asia and secondly, the development and increased production of unconventional gas resources, particularly shale gas in the USA, that provided an abundance of natural gas in LNG exporting economies. Furthermore, higher margins obtained in the international gas market from the selling of LNG provides a strong economic incentive for LNG exporters.

In 2020, during the unprecedented energy demand shock due to the impacts of COVID-19, the United States had a drop in domestic gas demand, that was offset with increased LNG exports, which grew by 31% y-o-y in 2020. During that same year, Asia became the main export destination for the USA overtaking Europe, with almost half of USA LNG exports reaching Asia.

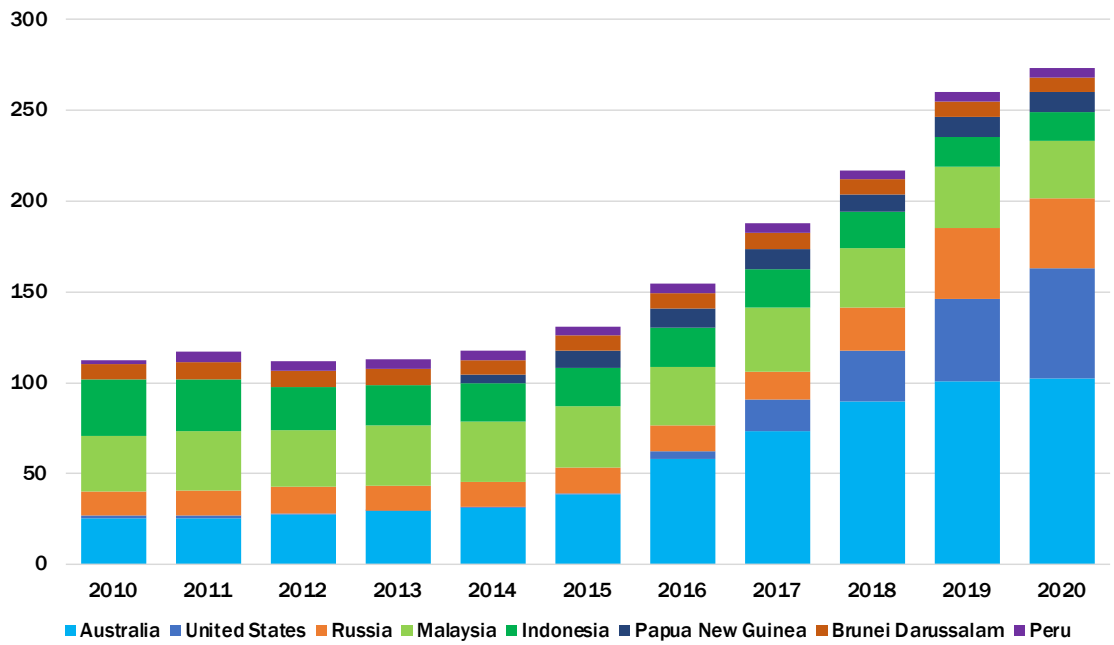
The United States liquified natural gas export capacity is expected to be the world's largest in 2022. LNG liquefaction units under construction in Louisiana, Sabine Pass and Calcasieu Pass, are expected to come in service by the end of 2022. Positioning the USA as the economy with the world's largest LNG export capacity. The USA nominal capacity is projected to increase to 11.4 Bcf/d (118 bcm per year), and peak capacity will increase to 13.9 Bcf/d (144 bcm per year). In comparison, estimated peak LNG production capacity in two of the world's largest LNG exporters: Australia and Qatar is 11.4 Bcf/d (118 bcm per year) and 10.4 Bcf/d (107 bcm per year), respectively. Additionally, Golden Pass LNG, will be the eight USA LNG export facility and will further add to an estimated 16.3 Bcf/d (168 bcm per year) of total LNG export capacity by 2024, when it is expected to come online.

In 2020, overall APEC LNG exports y-o-y growth was 5%. In that year, Australia was the world's leading LNG exporter with an export volume of 102 bcm, followed by the the United States (60 bcm), and Russia (38 bcm). Over the last decade, Australia has increased its LNG exports by 76%, largely targeting a growing Asian market with around 40% of its exports going to Japan in 2019.

Over the last decade there has been a realignment in the global LNG market. In 2020, Southeast Asia's economies Malaysia, Indonesia, and Brunei, had a total export volume of 54 bcm. Together these economies accounted for 20% of APEC's total share of LNG exports compared to 2010 when they accounted for 63% of APEC's total share of LNG exports. Conversely, the United States, Russia, and Australia (Today's main LNG exporters in APEC) have significantly increased their share of APEC's total LNG exports, from 36% in 2010 to 74% in 2020.

A drop in Southeast Asia LNG exports is largely due to falling natural gas production in mature oil and gas fields and underinvestment in the upstream sector. Indonesia's drop in upstream production has reduced the volume of its LNG exports by a half during the last decade, from a peak of 31 bcm in 2010 to 15 bcm in 2020. A declining trend in Southeast Asia and an increase in natural gas demand, is likely to increase the region's reliance on natural gas imports over the next decade while simultaneously reducing its LNG exports.

Figure 3-8: LNG exports in APEC by economy, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

3-3-2 Pipeline exports from APEC economies

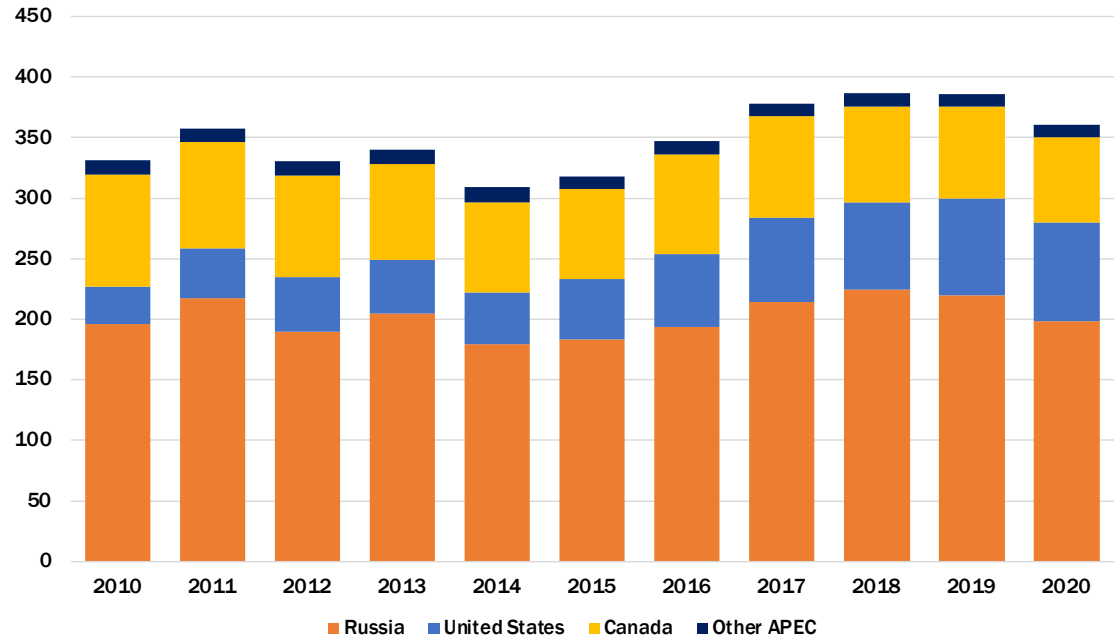
Russia leads APEC economies in terms of natural gas exports via pipelines, having Europe as its main export market, and initiating exports to China in 2019. Over the last decade, its export volumes via pipelines have remained at similar levels, reaching their highest level in 2018 with a volume of 225 bcm, and representing a total of 198 bcm in 2020. Pipeline exports to Europe have been declining while pipeline exports to China have been increasing. This has had an impact on European gas prices, that realized their highest prices on record during 2021, exceeding prices in Asia, as described in Chapter 4.

The contentious construction of Nord Stream 2 gas pipeline, that runs from Russia to Europe across the Baltic Sea, which is pending on Germany's approval, will increase Russia's gas export capacity into Europe by 55 bcm per year. The exact same capacity as already operating Nord Stream pipeline.

North America has a strong energy platform that includes a robust natural gas pipeline network, that runs throughout the continent, particularly from the north to the south, going from Canada to the USA and then from the USA to Mexico. Canada is APEC´s second largest pipeline exporter. Although, over the last decade, Canada's pipeline exports to the USA declined by 23%, a trend that is likely to continue. This is largely due to a rise in Canada's LNG exports, an increase in United States natural gas production and reduced reliance on imports. In 2020, Canada's exports represented a volume of 71 bcm from 92 bcm in 2009.

On the other hand, gas pipeline exports from the USA to Mexico are expected to continue growing over the next decade. Over the last decade, gas pipeline exports from the USA, that have Mexico as a key destination, have increased by 64%, accounting for 82 bcm in 2020. As described in Chapter 1, Mexico's natural gas demand growth has been driven by its electricity sector, as electricity generation shifts from more costly and polluting petroleum-based fuels to natural gas. Mexico's share of electricity generation from natural gas has increased from 21% in 2000 to 60% in 2020 (Figure 3-9). While Mexico's total natural gas imports have increased by 76% from 2010 to 2020, with over 90% of these gas imports coming from the US alone, mainly through pipelines.

Figure 3-9: Pipeline exports in APEC by economy, 2010-2020 (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ; APERC Calculations.

3-4 Gas trade outlook in the APEC region

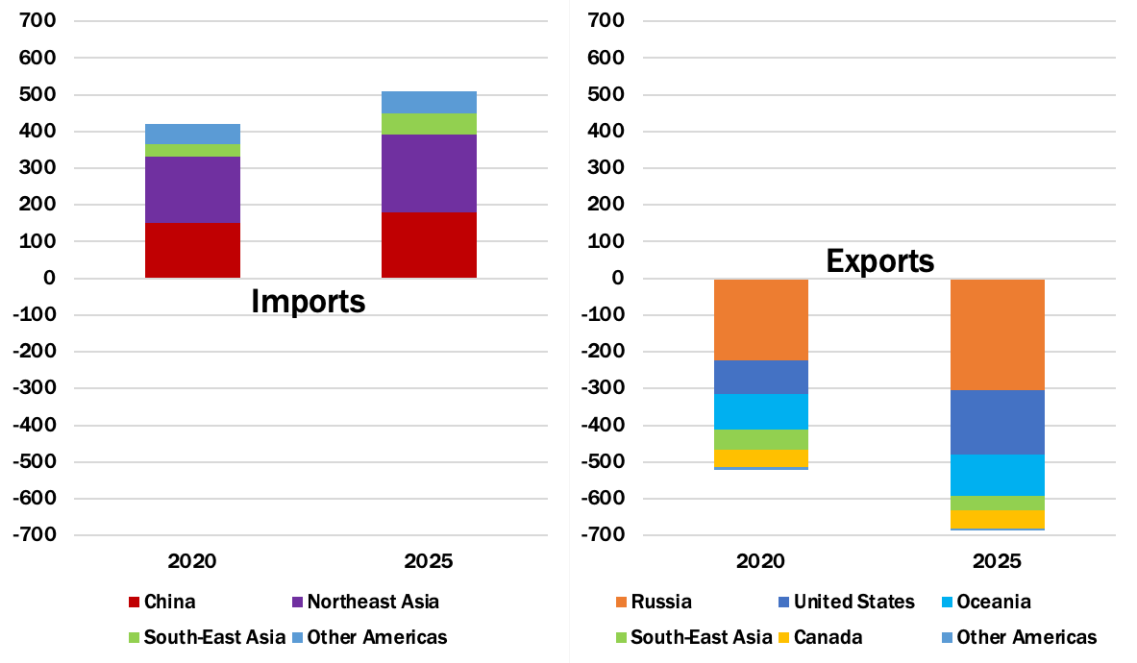
Northeast Asia was the region with the largest imports of natural gas in 2020 with a volume of 182 bcm. It is projected to further expand its imports by 14% reaching a volume of 212 bcm by 2025 (Figure 3-10), thereby maintaining its position as the region with the highest gas import

volumes. In 2020, China was the second largest importer of natural gas, with a volume of 150 bcm and is projected to increase its imports by 16% reaching a volume of 179 bcm by 2025.

Meanwhile, South-East Asia and Other Americas represent a smaller share in terms of imports within APEC. In 2020, SEA imported 34 bcm of natural gas while Other Americas imported a volume of 54 bcm. APEC's projection in its reference scenario shows an increase of 40% for South-East Asia and 14% for Other Americas through 2025, reaching a gas import volume of 57 bcm and 63 bcm, respectively.

As for natural gas exports in APEC, Russia is the main exporter of gas with a volume of 223 bcm in 2020 and is projected to increase by 27% reaching an export volume of 306 bcm by 2025. Meanwhile, in North America the United States exported 90 bcm in 2020 and is projected to increase its exports to 174 bcm by 2025. Canada's exported 46 bcm in 2020 and is projected to increase to 51 bcm by 2025. Oceania had an export volume of 97 bcm in 2020 and is also projected to expand its exports over the next five years, reaching a volume of 112 bcm. Lastly, South-East Asia and Other Americas show a drop in their export volume. SEA goes from a gas export volume of 57 bcm in 2020 to 41 bcm in 2025, while Other Americas are projected to reduce their export volume from 97 bcm in 2020 to 4 bcm in 2025.

Figure 3-10: Imports and exports outlook in APEC (bcm)



Source: IEA, Natural Gas Information 2021; CEDIGAZ, 2021; APERC Calculations.

Chapter 4: Gas prices

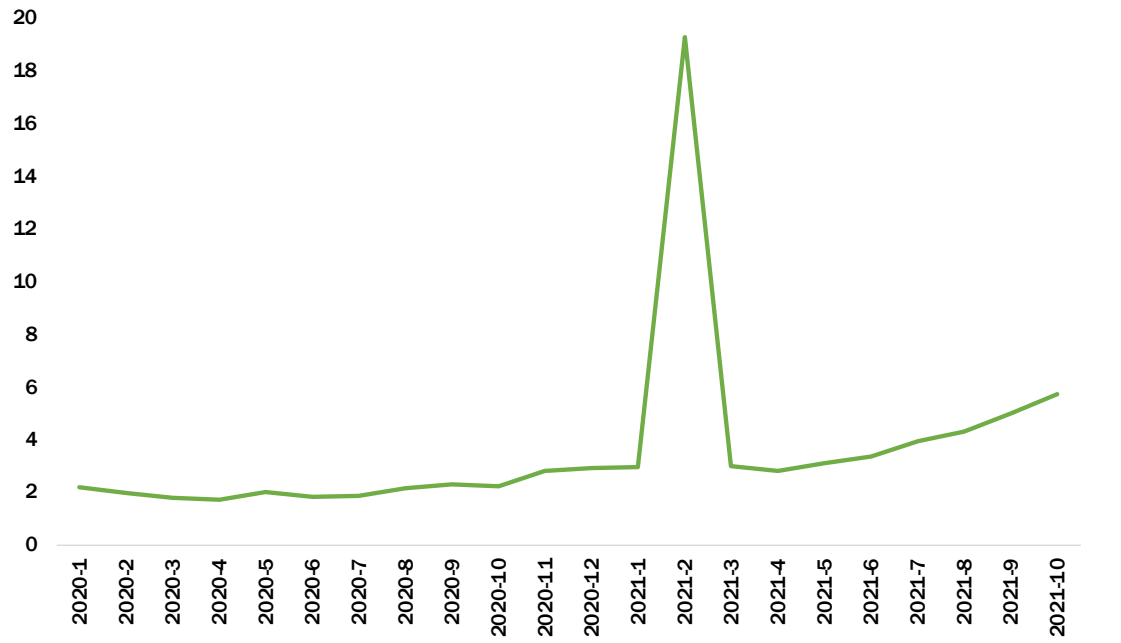
As discussed in APERC's Natural Gas Report 2020, last year the effects of the COVID-19 pandemic saw an unprecedented drop in demand that caused global oil and gas prices to fall sharply. In contrast, 2021 was a year of high gas prices and dramatic price spikes, due in large part to limited supply availability and several extreme weather events in gas consuming regions. North America, Asia, and Europe's primary natural gas price benchmarks: Henry Hub (HH), the Japan-Korea Marker (JKM), and the Title Transfer Facility (TTF) respectively, recorded historically high gas prices during 2021, as discussed below.

In February 2021, a cold snap in Texas, a major natural gas producing and exporting state in the USA that has several local gas hubs, led to skyrocketing gas prices on USA natural gas pricing hubs that averaged USD 19.29/MBtu. In stark contrast to an average price of USD 2.04/MBtu in February 2020 (see Figure 4-1).

However, prices retreated the following month, although remaining at elevated levels throughout the rest of the year. As a result of economic recovery, an increase in demand that outpaced gas supply growth, and low storage inventories. Hence, resulting in an annual average gas price (data available up to October) of USD 5.36/MBtu in 2021, an 62% y-o-y increase.

In addition, strong global demand for natural gas, even at high prices due to an imbalance between supply and demand, drove an increase in USA LNG exports, due to higher margin realization in the international gas market. An increase in USA natural gas prices translated into weaker domestic consumption, and an electricity market merit order that favored cheaper coal-fired power generation. The reduced demand caused a 6% y-o-y decline in natural gas consumption in the electricity sector during the first three quarters of 2021.

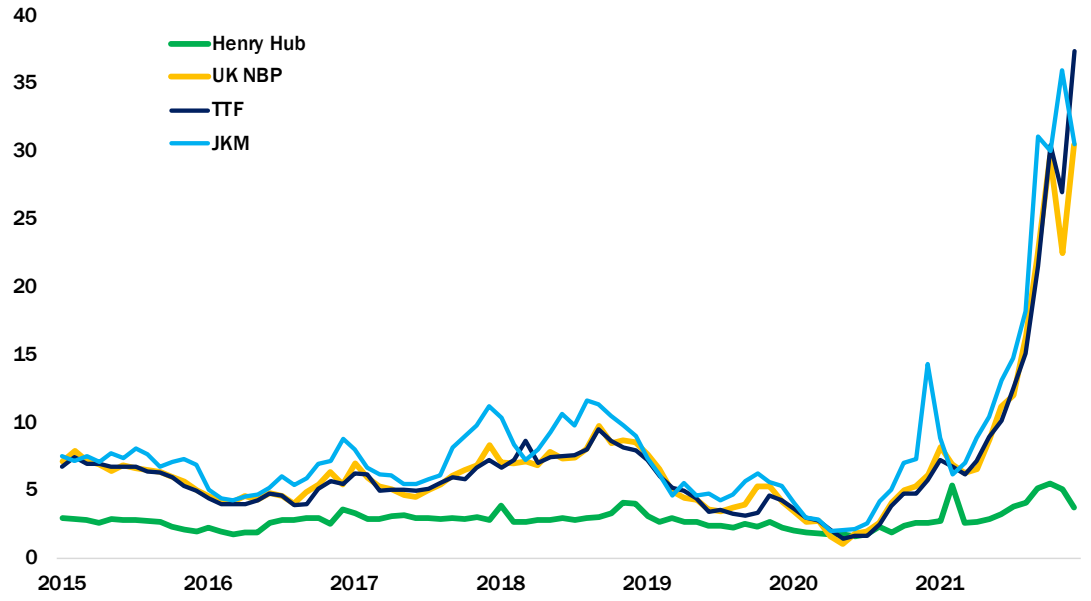
Figure 4-1: USA /North America 2020-2021 Gas Prices (USD per MBtu)



Source: IEA, 2021.

All major gas price benchmarks have climbed to record breaking levels in 2021, an extraordinary rebound in gas prices after a steep drop in 2020 (Figures 4-2 and 4-3). In 2020, HH, JKM, and TTF benchmarks averaged: USD 2.04/Mbtu, USD 4.71/Mbtu, and USD 3.15/Mbtu respectively. In stark contrast to 2021, when HH, JKM, and TTF benchmarks averaged: USD 3.91/Mbtu, USD 17.92/Mbtu, and USD 15.86 /Mbtu respectively.

Figure 4-2: Gas Prices in all Benchmarks 2015-2021 (USD per MBtu)



Source: EIA, Investing.com, Elexys NV, ERCE.

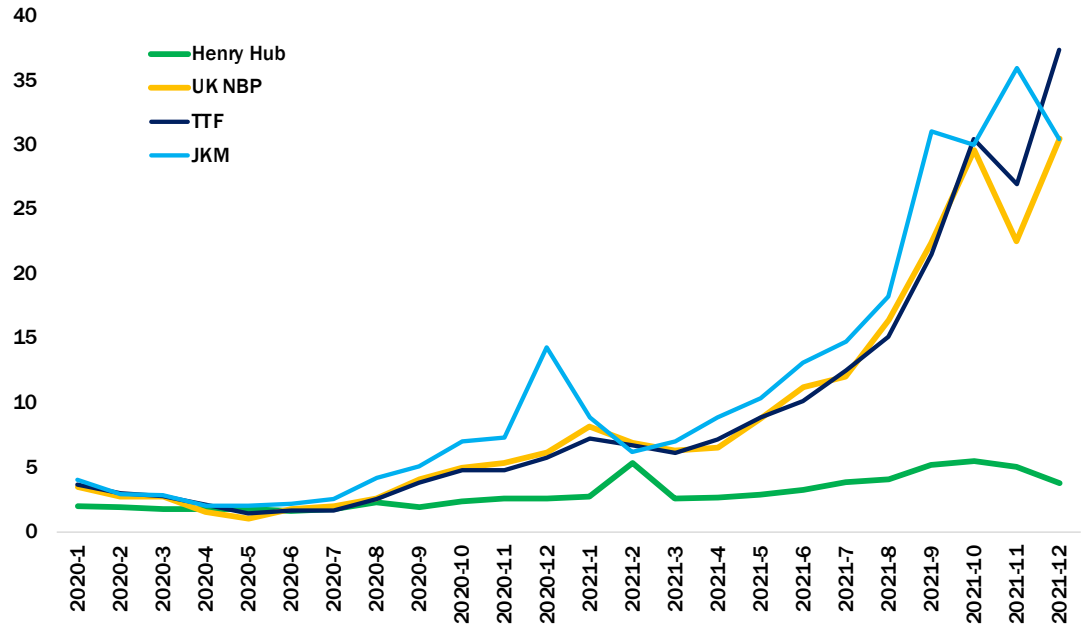
The Asian and European gas markets in particular saw the highest surge in prices during 2021. In December 2020, a cold snap in Northeast Asia drove an increase in heating demand and caused average gas prices to double from the previous month to USD 14.00/Mbtu. Doubling again to a price of USD 30/MBtu by December 2021. Meanwhile, European gas prices went from an average price of USD 5.74/MBtu in December 2020, to a price of USD 37.39/MBtu in December 2021.

From 2015 to 2021, the TTF benchmark monthly prices exceeded those of JKM only on rare occasions, as they usually trade at a discount to Asian spot prices. Highlighting the tightness of the European gas market that started the year with a price of USD 7.00/Mbtu in January and has seen prices increase by an astonishing 81% by the end of the year.

Over this past year, several factors, particularly limited natural gas supply availability, contributed to Europe's natural gas market tightening. First, the economic recovery and extreme weather events increased seasonal gas demand for cooling in the summer and heating during the winter, leading to higher storage withdrawals and lower stock builds due to limited supplies. Second, gas flowing from Russia through the Yamal and Ukraine pipelines was significantly less than the average historical monthly volumes. Third, a decline in domestic oil and gas production, as well as a lower-than-expected energy generation from wind, operational issues at its nuclear plants, and a retirement of coal-fired power plants, put additional upward price pressure on gas used for power generation.

Amid a high global gas price environment in 2021, Southeast Asia, a price-sensitive market, turned to coal during the spot LNG price spikes seen throughout the year to satisfy its domestic demand for power generation (as described in APERC's Coal Report 2021). In addition, for the first time in 2021, high gas prices led Indonesia, Thailand, and Singapore to carry out LNG re-exports, particularly to China. Going forward, APERC projects continued volatility in the global gas market and a high price environment. Especially if supply remains limited while energy demand continues to rise.

Figure 4-3: Gas Prices in all Benchmarks 2020-2021 (USD per MBtu)



Source: EIA, Investing.com, Elexys NV, ERCE.

Going forward, we expect continued volatility in the global gas market and a high price environment. Especially if supply remains limited due to the Organization of Petroleum Exporting Countries' tight production quotas and insufficient upstream investments globally, while energy demand continues to rise.

Chapter 5: Potential of natural gas to reduce CO2 emissions from coal

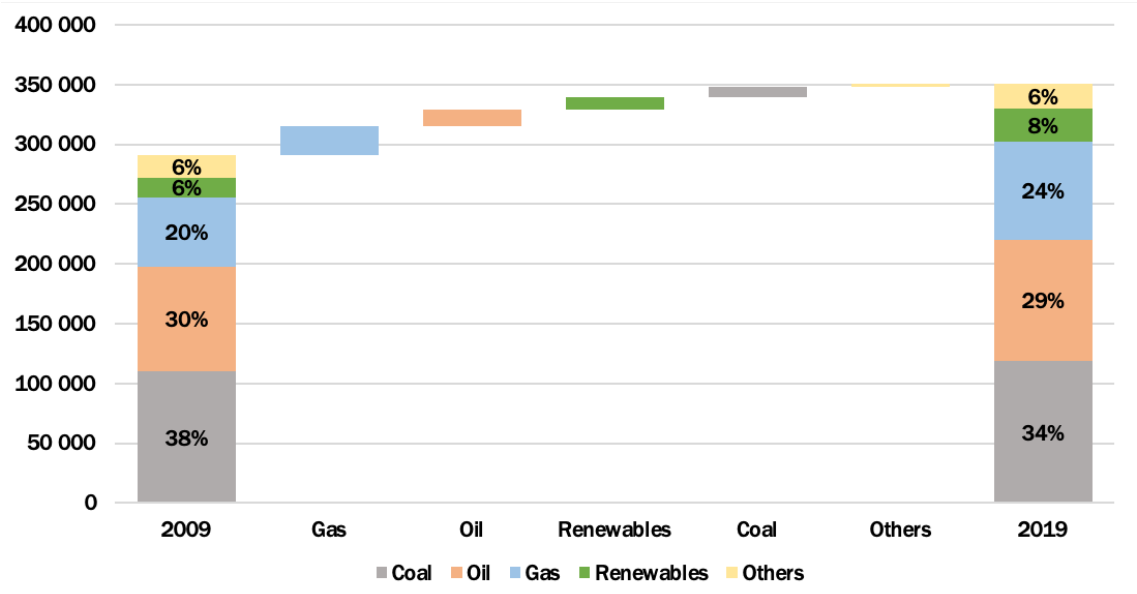
At their 2020 and 2021 Economic Leaders Summits, APEC economies supported the Putrajaya Vision 2040, which among other goals, calls for the promotion of "economic policies, cooperation and growth which support global efforts to comprehensively address all environmental challenges, including climate change, extreme weather, and natural disasters, for a sustainable planet".

For APEC economies, the period from 2009 to 2019 was a period of stable economic development. Primary energy consumption during this period increased by 21%. At the same time, the consumption of fossil fuels increased by only 18%. The result of these changes in the fuel mix was a 16% increase in CO2 emissions, less than the increase in fuel use. A key role in the marginal increase in CO2 emissions was the accelerated growth of natural gas consumption compared to other fossil fuels, especially coal. This chapter examines the transformation of APEC's fuel mix from the perspective of changes in coal and gas consumption and their impact on changes in CO2 emissions.

In 2009, gas accounted for 20% of APEC's total primary energy consumption. Coal dominated with a share of 38%, oil accounted for 30%, and renewable and other energy sources each accounted for about 6% each (Figure 5-1).

In 2019, APEC's total primary energy consumption was up 21% from 2009. The leader of the increase was gas, with a consumption increased of 43%. During the same period, gas's share of total primary energy consumption increased from 20% to 24%. Coal continued to dominate with a corresponding decrease in its share to 34%. The share of oil did not change. The use of renewables grew by 64%, but their share of primary energy consumption increased by only 2%. The share of other energy carriers remained at 6%.

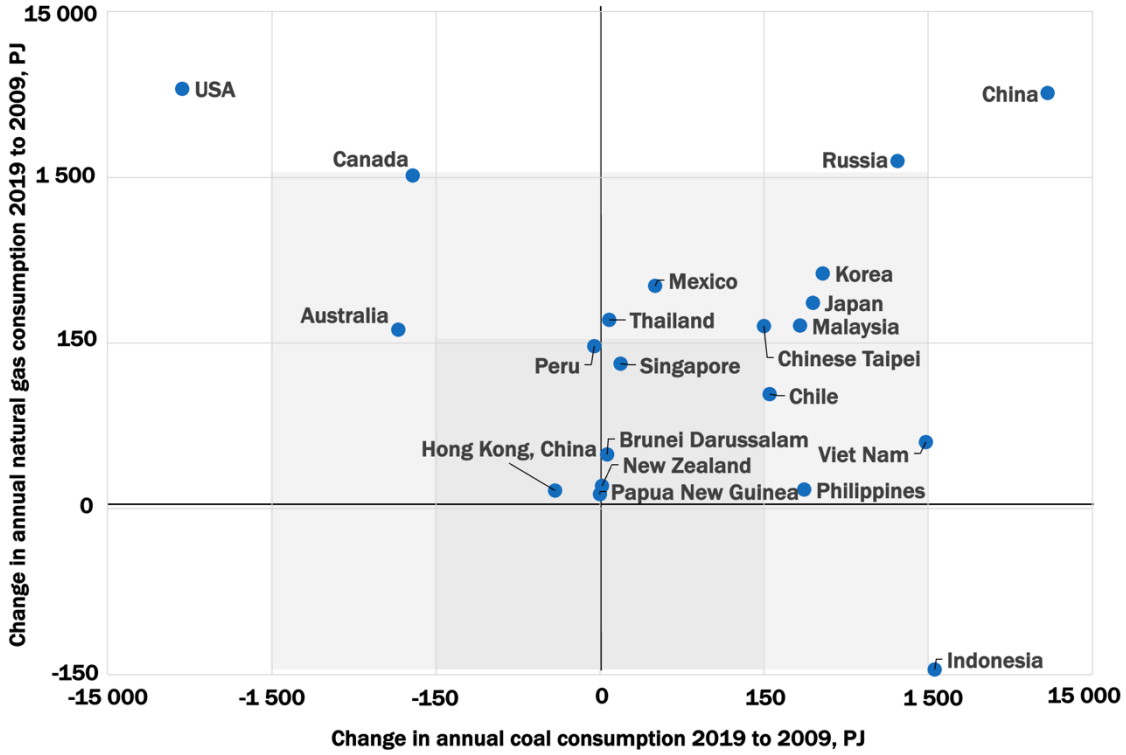
Figure 5-1: Total primary energy consumption change in APEC from 2009 to 2019 (PJ)



Source: EGEDA, 2021; APERC Calculations.

Figure 5-2 shows the change in gas consumption (y-axis) and coal consumption (x-axis) for each of the APEC member economies. All APEC member economies except Indonesia increased their gas consumption. However, only five economies reduced their coal consumption: Australia; Canada; Hong Kong, China; Peru; and the United States. The United States accounted for more than 90% of the region's total reduction in coal consumption (note logarithmic scales). As shown in Figure 5-2, only three of these five - Australia, Canada, and the United States - increased their gas consumption by approximately the same amount that they reduced their coal consumption. It should be noted that they are the largest gas producers in APEC (see Chapter 2). This means that gas consumers in these economies can use gas at lower prices than those that import gas, especially LNG. In this regard, domestic gas production is an essential factor in increasing the use of gas and the potential replacement of other fossil fuels.

Figure 5-2: Change in the gas and coal use from 2009 to 2019



Source: EGEDA, 2021; APERC Calculations.
Note: Logarithmic scales

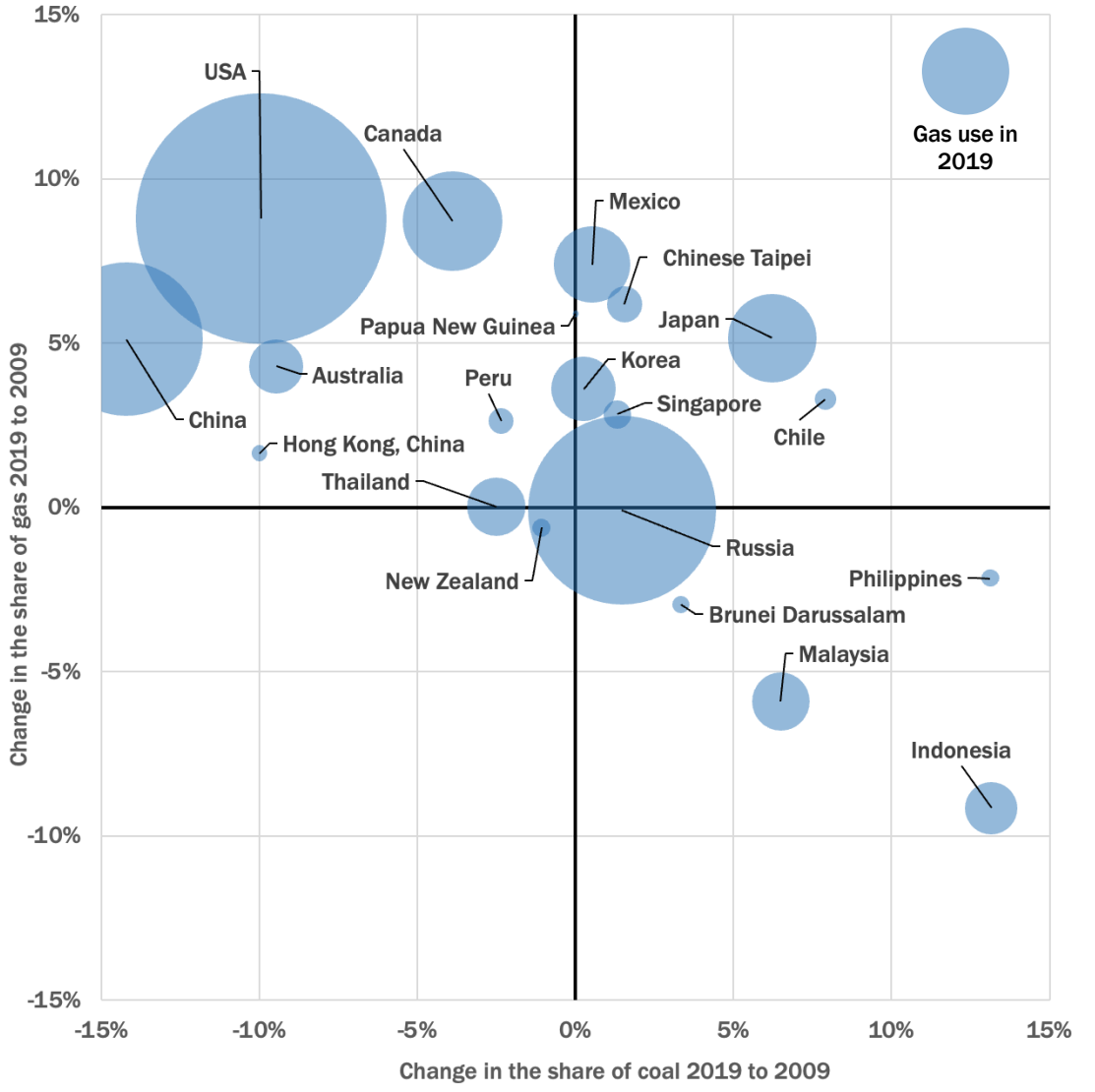
Figure 5-3 also shows the relationship between gas and coal consumption for each APEC member economy but does so in terms of each fuel's share of total primary energy consumption. In addition, the size of each circle is proportional to 2019 gas consumption. The changes in the APEC member economies' fuel mix have been very diverse, as the share of each energy carrier is affected by both the initial mix and the varied shares of increased renewable energy use in each economy.

Only New Zealand (lower left quadrant, Figure 5-3) decreased both the share of coal and gas in primary energy consumption because of a significant 35% increase in the use of renewables. Nine economies (upper left quadrant) increased the share of gas in their fuel mix, with a constant or decreasing share of coal in primary energy consumption. These economies account for 78% of total APEC gas and only 18% of coal consumption increase. China shows the most significant

divergence between the economies in Figures 5-2 and 5-3. Despite comparable increases in gas and coal consumption, coal's share of the fuel mix decreased by 14% and gas's share increased by only 5%. On the one hand, this reflects the low share of gas in 2009 and a significant increase in hydro and nuclear power generation during the period.

Six economies (upper right quadrant) increased the share of coal and gas in their primary energy consumption. These economies account for only 9% of total APEC gas, and 18% of coal consumption increased. The rest five economies (lower right quadrant) increased the share of coal, with a constant or decreasing share of gas in primary energy consumption. These economies account for 12% of total APEC gas consumption, but 64% of coal increased.

Figure 5-3: Change in the share of gas and coal use in 2009-2019

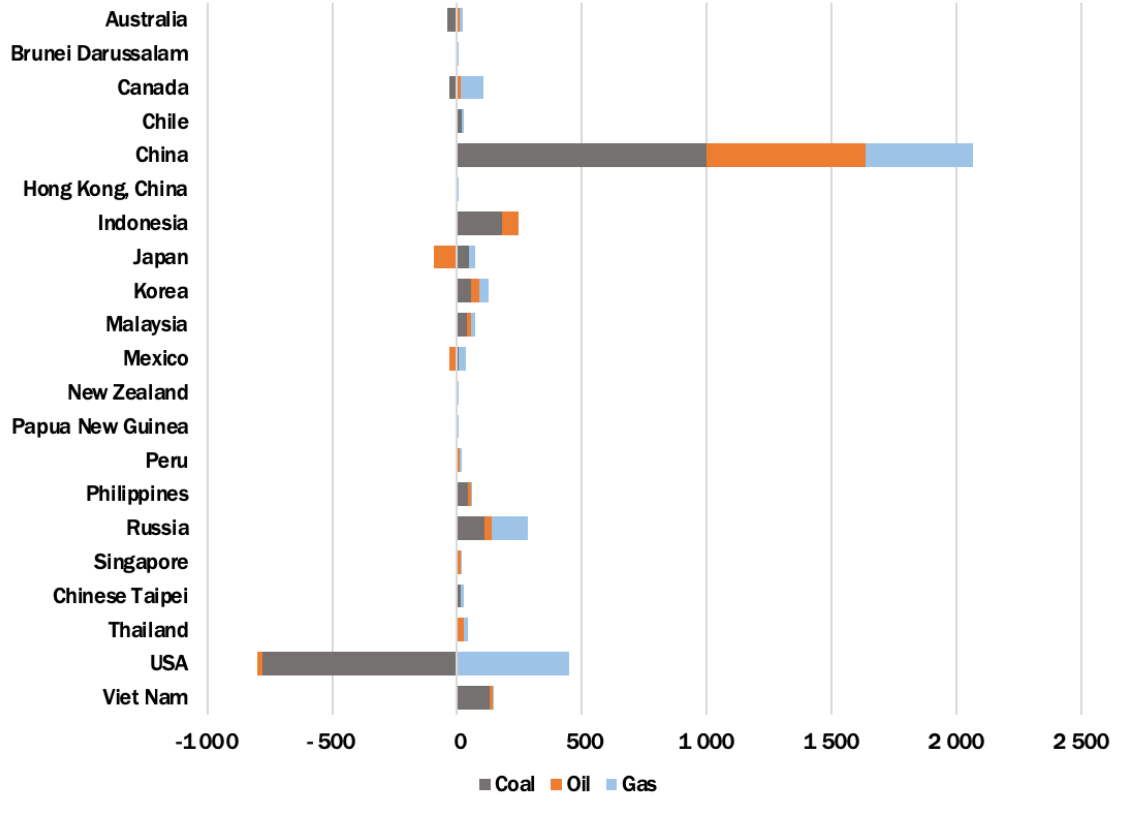


Source: EGEDA, 2021; APERC Calculations.

From 2009 to 2019, only three APEC member economies reduced their CO2 emissions from fossil fuels (Figure 5-4). Two of those did so by reducing their coal consumption while increasing their natural gas consumption. The third economy, Japan, lowered its emissions by reducing oil

consumption. Canada's emissions from coal were reduced by increased use of gas but Canada's total emission increased during the period due to increased oil use.

Figure 5-4: Estimated change in CO2 emissions in APEC by fuel from 2009 to 2019 (MMTCO2)



Source: EGEDA, 2021; APERC Calculations.

Looking forward, the experience of Australia and the United States during the 2009–2019 period demonstrates that substituting gas for coal can substantially reduce carbon emissions using current commercial technologies. A key issue for other APEC economies considering a similar approach to reduce CO2 emissions will be economics. The three economies that grew gas consumption by approximately the same amount that they reduced coal consumption are each major natural gas producers. APEC economies that rely on imported natural gas may find the economics of gas-coal substitution less attractive, depending on the relative prices of the two fuels.

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