



GECF

**ANNUAL GAS
MARKET REPORT**

2023



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Project Leader

- Aydar Shakirov, Head of GMAD

Experts Team (In Alphabetical Order)

- Adrian Sookhan, Gas Market Analyst, GMAD
- Amin Shokri, Energy Analyst, GMAD
- Hossam ElMasry, Research Assistant, GMAD
- Imran Mohammed, Gas Transportation and Storage Analyst, GMAD
- Rafik Amara, Senior Gas Market Analyst, GMAD
- Sandy Singh, Market Research Analyst, GMAD

Administrative Support

- Hadia Bendeddouche, Secretary, GMAD

Peer Review Support

Refinitiv Limited (an LSEG Business)

Design

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GECF Technical and Economic Council (as of March 2023)

Algeria – Mr Sofiane Dakiche | Bolivia – Mr Sergio A. Guzmán Rios | Egypt – Eng. Yaseen Mohamed Yaseen | Equatorial Guinea – Mr Antimo Asumu Obama | Iran – Dr Afshin Javan | Libya – Ms Naima Mohamed Suwani | Nigeria – Mr Salisu Haruna Kwalami | Qatar – Mr Jabor Yaser AL-Mesalam | Russia – Dr Denis Leonov | Trinidad and Tobago – Mr Selwyn Lashley | United Arab Emirates – Ms Amal Al Ali | Venezuela – Mr José Agustín Ruiz



Foreword

I am pleased to present this revamped edition of the GECF Annual Gas Market Report (AGMR) 2023. It presents natural gas-related developments in 2022 and prospects for 2023-2024.

This publication comes at a time when natural gas markets are undergoing fundamental transformations in terms of physical flows, investment, trade, and market functioning. These changes are in response to the compounded effects of the successive shocks of the last three years. In 2020, the coronavirus pandemic became an unprecedented global stress test of the resilience of energy systems. In 2021, the effect of chronic underinvestment since 2014 led to a sharp increase in prices as supply could not keep pace with the post-pandemic strong demand recovery. In 2022, energy security went back to the top of policymakers' priorities list. The crucial role of natural gas in the production of fertilisers and, thus, for food security, gained renewed prominence. At the same time, progress in energy access has been hampered, as well as progress in combating climate change, as many countries switched from gas to coal and even lignite to keep their economies running, lights on, and houses warm.

Against this backdrop, uncertainties have never been higher, and the energy trilemma has never been more evident and complicated at the same time: How to ensure secure, affordable, and sustainable energy systems?

Although natural gas consumption declined slightly in 2022, it is expected to rebound in 2023-2024 and reach an all-time high level. Five new countries will become LNG importers in this period of time, in addition to Ecuador, El Salvador and Germany, which joined the club of LNG importers in 2022. Furthermore, Congo, Mauritania, Senegal, Suriname, and Mexico are expected to become LNG exporters, while Mozambique exported its first LNG cargo in November 2022.

Investment has recovered in the past two years, but remains below pre-pandemic levels despite higher gas prices and EPC costs. Long-term gas contracts have regained prominence on the back of supply security advantages that they provide. LNG trade continues to expand, rising by 6% in 2022 and making gas markets more global and interconnected. Natural gas has also gained further recognition as clean energy and labelled as green in EU taxonomy. Carbon capture, utilisation and storage projects in the development phase have increased, and favourable policies were enacted in many countries. Hydrogen gained further interest, notably for decarbonising hard-to-electrify industrial processes.

These developments are tokens of bright prospects for the expansion of the global gas industry, as natural gas is set to play a pivotal role in socio-economic development and towards just and inclusive energy transitions.

I am also delighted to see the GECF family expanding. Mozambique joined the organisation on the occasion of the 6th GECF Summit of Heads of State and Government in Doha, Qatar. The United Arab Emirates upgraded its membership from observer to become a full member. The GECF is in discussions with potential new members, and I am confident that the Forum will expand further in the near future.

I express my gratitude to the GECF team for preparing the AGMR 2023, and GECF Technical and Economic Council members for their contributions in enriching the report, as well as Refinitiv for peer-reviewing it.

Eng. Mohamed HAMEL
Secretary General

About the **GECF**

The Gas Exporting Countries Forum (GECF or Forum) is an intergovernmental organisation established in May 2001. It became a fully-fledged organisation in 2008, with headquarters in Doha, the State of Qatar.

As of March 2023, the GECF comprises twelve Members and seven Observer Members (hereafter referred to as the GECF Countries) from four continents. The Member Countries of the Forum are Algeria, Bolivia, Egypt, Equatorial Guinea, Iran, Libya, Nigeria, Qatar, Russia, Trinidad and Tobago, the United Arab Emirates and Venezuela (hereafter referred to as Members). Angola, Azerbaijan, Iraq, Malaysia, Mozambique, Norway and Peru have the status of Observer Members (hereafter referred to as Observers).

Cooperation has been extended to technology with the establishment of the Gas Research Institute in 2019, headquartered in Algiers, the People's Democratic Republic of Algeria.

In accordance with the GECF Statute, the organisation aims to support the sovereign rights of its Member Countries over their natural gas resources and their abilities to develop, preserve and use such resources for the benefit of their peoples, through the exchange of experience, views, information and coordination in gas-related matters.

In accordance its Long-Term Strategy, the vision of the GECF is "to make natural gas the pivotal resource for inclusive and sustainable development", and its mission is "to shape the energy future as a global advocate of natural gas and a platform for cooperation and dialogue, with the view to support the sovereign rights of Member Countries over their natural gas resources and to contribute to global sustainable development and energy security".

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Executive Summary

Gas markets in 2022 were characterised by significant turbulence and fundamental changes, mainly driven by geopolitical developments and underinvestment in the industry over the past decade. Spot gas and LNG prices in Europe and Asia skyrocketed to record highs at the end of summer, while experiencing significant volatility throughout the year. This was mainly attributed to a tight LNG market as Europe's LNG demand surged to replace lower pipeline gas imports into the region. Amidst record-high spot prices, various countries around the world had to switch from gas to coal and even lignite, chiefly in the power generation and industrial sectors. Energy security concerns took precedence over climate change mitigation goals, with policymakers focusing on meeting the energy needs of their people, and countries heading to solve the energy trilemma of achieving security, affordability and sustainability.

The global economy encountered significant headwinds in 2022, and the outlook is skewed to the downside, with global GDP growth expected to slow further in 2023

Global GDP growth decelerated to an estimated 3.4% in 2022, driven by soaring energy and commodity prices, rising inflation, tightening financial conditions, supply chain disruptions, extensive lockdowns in China, and geopolitical developments in Europe. In the meantime, global inflation reached 8.8%, the highest level since 2008. In 2023, global GDP growth is expected to slow to 2.9%, while global inflation is likely to remain relatively high, although gradually declining to an estimated 6.6%.

Following a record rebound in 2021, global gas consumption recorded a decline in 2022, but is expected to resume growth in 2023

In 2022, global gas consumption is estimated to have recorded a decline of 0.4% y-o-y to reach 4.03 trillion cubic metres (tcm). Mild winter weather in Q1 and Q4 2022 in the Northern Hemisphere resulted in lower gas consumption in the residential sector, while high gas prices affected gas consumption in the industrial sector, which led to demand decline in various countries of Asia Pacific and Europe. In the meantime, US gas consumption rose by 5% y-o-y driven by a boost in gas use in the power generation sector amidst tightening coal supply and rising coal prices. In 2023, global gas consumption is forecasted to increase by around 1% y-o-y, with US, China, and some emerging countries in Asia Pacific driving the growth.

Power generation remains the largest driver of global gas consumption

The power generation sector is still the largest consumer of gas, with a share of 44% of the global gas consumption in 2022. Gas consumption in the power sector decreased by 0.2% y-o-y to 6,050 terawatt hour (TWh), driven by gas-to-coal switching in various regions amidst high gas prices, which made natural gas less competitive compared to other fuels. Nonetheless, power generation will likely remain the largest driver of global gas consumption, as more countries transition away from coal-fired power plants.

High gas prices led to an increase in production costs for heavily gas-reliant industries

Global gas consumption in the industrial sector is estimated to have declined by 4% y-o-y to 740 billion cubic metres (bcm) in 2022 due to high gas prices, which caused a reduction in production or partial shutdown in some heavy industries such as cement, fertiliser, and steel. However, with the expected lower gas prices, gas consumption in the industrial sector is likely to rise in 2023, as natural gas remains a cost-effective, reliable, and environmentally friendly energy source for many industries.

Global gas production registered a slight decline in 2022, but is on the path to recovery

In 2022, global gas production decreased by 0.1% to 4.04 tcm, primarily due to a drop in global gas demand. The Eurasia and Africa regions experienced the most significant decline, while North America, the Middle East, Latin America and the Caribbean (LAC), Europe, and Asia Pacific recorded an increase in gas output. Global gas production is expected to increase by around 1% in 2023, driven by North America, LAC, the Middle East, and Africa.

Unconventional gas production continues to be the main driver of production growth

Unconventional natural gas production has been growing steadily over recent years, with its share in global production increasing to 31% in 2022. In the meantime, a decline in conventional gas production was the main reason for the overall decrease in gas output in 2022. Associated gas and offshore fields represent 14% and 29% of global gas production, respectively.

Discovered gas volumes made 2022 a significant year for exploration

Over 600 bcm of natural gas was discovered in 2022, a 16% y-o-y increase, representing 39% of the total discovered oil and gas volumes. Nevertheless, the number of exploration wells was less than half the average number of the pre-pandemic levels, highlighting continued underinvestment in exploration. The Middle East and Europe drove the increase in global gas discoveries, while LAC and Africa did so in liquids.

Oil and gas investment continues to increase, possibly exceeding pre-pandemic levels in 2023, but still remains much lower than the level of 2014

Oil and gas investment has increased by 7% y-o-y to reach \$718 billion, partly due to higher petroleum services and EPC costs. In 2023, oil and gas investment is expected to rise further, on the back of greater investment in the upstream industry and LNG import terminals. However, several looming uncertainties, including a slowdown in global economic growth, tight financial conditions, inflation, and high energy price volatility, may deter investment.

CCUS and hydrogen gain momentum, but still a long way to go

The number of announced CCS/CCUS projects and associated abatement capacity has significantly increased, while hydrogen also emerged as a potential pathway for decarbonisation, with a prominent increase in the announced capacity. However, the number of CCS/CCUS and hydrogen projects that have already reached the FID stage is still far from the required scale.

Pipeline gas trade contracted in 2022

The European region, as the world-leading market for pipeline gas trade, accounts for three-fifths of net flows on the global level. Total pipeline gas imports to the EU in 2022 reached 203 bcm, which was 26% or 70 bcm lower y-o-y. The EU's imports from Russia fell sharply, which was only partially offset by increases from Norway and Azerbaijan. Pipeline gas imports in the EU may decline further in 2023. In the meantime, the Asia Pacific markets are likely to record higher pipeline gas trade as Russia pivots strongly towards the region, with its exports to China expected to increase by 40% y-o-y in 2023.

Global LNG flows shifted away from Asia Pacific to Europe in 2022, but a recovery in imports in Asia Pacific is expected in 2023

Global LNG imports expanded by 6% or 21 million tonnes (Mt) y-o-y to 399 Mt in 2022, driven by a surge in LNG imports in Europe, which offset a decline in LNG imports in Asia Pacific and LAC. Europe's LNG imports surged by 62% (49 Mt) to a record high, amidst lower pipeline gas imports. China drove the 7% (20 Mt) decline in Asia Pacific's LNG imports. Unlike previous years, Europe displaced Asia Pacific to become the premium market for LNG. In 2023, global LNG imports are forecasted to increase by 4-4.5% (16-18 Mt) y-o-y to 416 Mt. China and countries in the Indian sub-continent and Southeast Asia are forecasted to account for the bulk of incremental increase in LNG imports with an additional 13-15 Mt of LNG imports.

FIDs in new liquefaction capacities declined in 2022, but an acceleration in FIDs is expected in the short term to meet the strong growth for LNG demand in the medium-term

The liquefaction capacities that reached FID in 2022 declined to 34 million tonnes per annum (Mtpa), from 52 Mtpa in 2021, with 68% of the capacities coming from the US,

followed by Suriname, Congo, Canada, and Malaysia. In 2023 and 2024, almost 160 Mtpa of new liquefaction capacities are targeting FID, led by the US as well as Qatar, Mexico and the UAE. This is supported by strong LNG contracting over the past two years and expectations for a tight LNG market up until the middle of this decade. At the end of 2022, global liquefaction and regasification capacities stood at 486 Mtpa and 1,037 Mtpa, respectively.

LNG shipping market grows to accommodate the increase in global LNG trade

Less than 30 new LNG carriers were commissioned in 2022, representing the slowest increase since 2013, while the global LNG carrier fleet surpassed 670 carriers. Spot charter rates for LNG carriers witnessed record highs in the autumn of 2022. This, along with a rise in the cost of LNG shipping fuels, contributed to increasing LNG shipping costs.

Strong gas storage build during 2022, along with reduced demand over the winter of 2022-23, placed the EU gas stocks at record high levels

The level of underground gas storage in the EU at the start of 2022 was the lowest in the previous five years. Concern for security of supply during the subsequent winter prompted the European Commission to implement legislation for gas storage sites to be filled to 80% capacity by 1 November 2022. Due to the strong storage build and lower than anticipated withdrawals, gas storage at the end of the 2022-23 winter season remains at a much higher level than the 5-year average.

Gas and LNG spot prices surpassed historical highs and recorded extreme volatility in 2022, fuelled by geopolitical developments, growing concerns for security of gas supply, and a tightening global LNG market

In 2022, TTF spot gas prices in Europe averaged \$38/MMBtu, 136% higher y-o-y, while NEA LNG spot prices in Asia averaged \$33/MMBtu, a 79% increase y-o-y. This shift in prices made Europe the premier LNG market for suppliers, as TTF spot prices maintained a high premium over Asian LNG spot prices. In 2023, spot prices are expected to remain volatile. Factors such as a relatively mild winter, high gas storage levels in Europe, and weakened gas demand growth in the midst of a slowdown in global economic growth may exert downward pressure on spot prices. However, there may be some upward pressure on spot prices this year due to the anticipated recovery in China's gas demand, higher imports in price-sensitive countries in Asia Pacific, and a rebound in gas demand in the industrial sector. Additionally, any further supply disruptions or extreme weather conditions during the year may also boost prices.

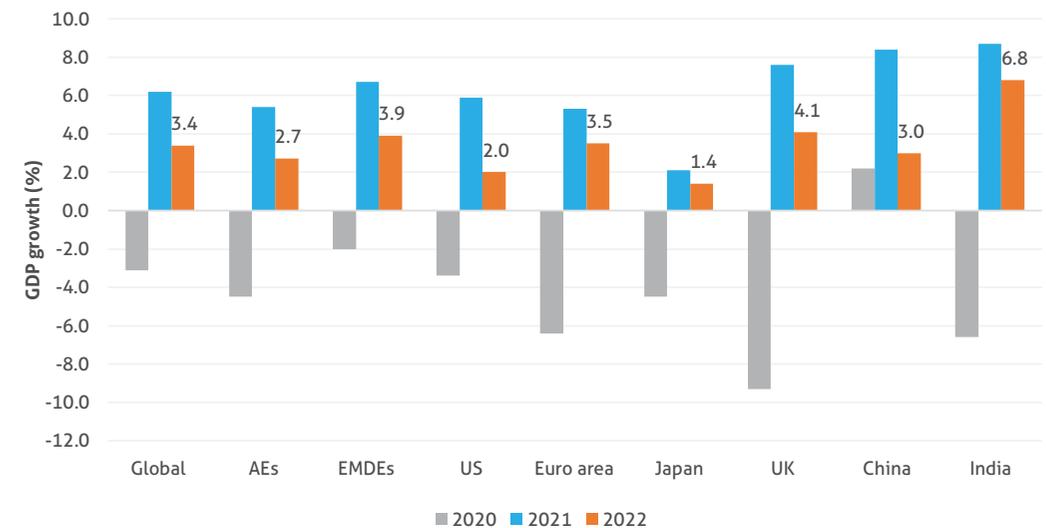
CHAPTER 01

Global Perspectives

1.1 Global Economy

The global economy faced major headwinds in 2022, which resulted in a significant deceleration, following a strong post-pandemic recovery in 2021. Global gross domestic product (GDP) growth in 2022 was estimated at 3.4% (Figure 1), based on IMF's World Economic Outlook (WEO) Update January 2023. It was shaped by a multitude of factors, including soaring energy and commodity prices, rising inflation, tightening financial conditions, supply-chain disruptions, extensive lockdowns in China and the impacts of escalating geopolitical tensions in Europe.

Figure 1: GDP growth 2020-2022



Source: GECF Secretariat based on data from IMF World Economic Outlook Update January 2023

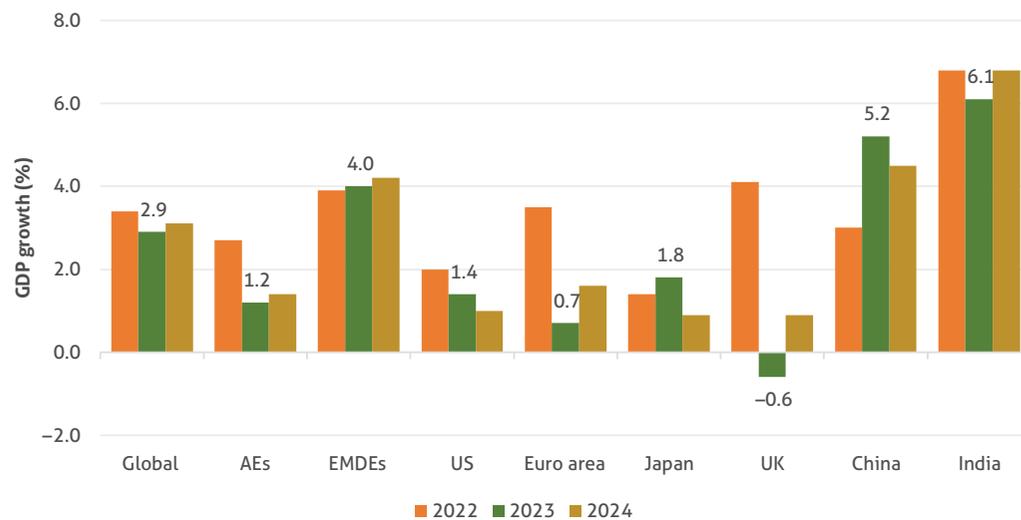
In 2022, advanced economies (AEs) experienced GDP growth of 2.7%, a substantial slowdown from the growth of 5.4% in 2021. GDP growth in the United States (US) was estimated at 2%, largely due to the better-than-expected growth in the third and fourth quarters, following contraction in the first two quarters. Meanwhile, GDP growth

in the euro area and the United Kingdom (UK) was 3.5% and 4.1%, respectively. These relatively strong economic growth rates are essentially a reflection of the impact of easing of COVID-19 restrictions in the second half of 2021, rather than an indication of stronger performance. In the UK, for instance, there was a strong GDP growth in Q1 2022, after which growth was relatively flat for the subsequent quarters.

GDP growth in emerging markets and developing economies (EMDEs) was 3.9% in 2022, compared to growth of 6.7% in 2021. China experienced very weak economic growth, at an estimated 3% due to its zero-COVID policy, weak private consumption and a slump in the real estate sector.

In 2023, the global economy is expected to continue to lose momentum, with global GDP growth expected to slow further to 2.9%, based on the IMF WEO Update January 2023 (Figure 2). There are several factors influencing GDP growth risk to the downside, including the risk of further escalation of geopolitical tensions, the continued battle against inflation, and tight financial conditions. However, several major economies had a stronger-than-expected performance in Q4 2022, which has lifted growth expectations for 2023. Conversely, upside factors include the anticipated economic recovery in China and easing of inflation. In 2024, the global economy is projected to rebound, with global GDP growth reaching 3.1%, driven by a gradual recovery in major economies, subsiding inflation and easing of supply-chain bottlenecks.

Figure 2: GDP growth 2022-2024



Source: GECF Secretariat based on data from IMF World Economic Outlook Update January 2023

The global economic slowdown in 2023 largely reflects the declining growth in advanced economies. GDP growth in AEs is expected to decelerate significantly to 1.2%. In the US,

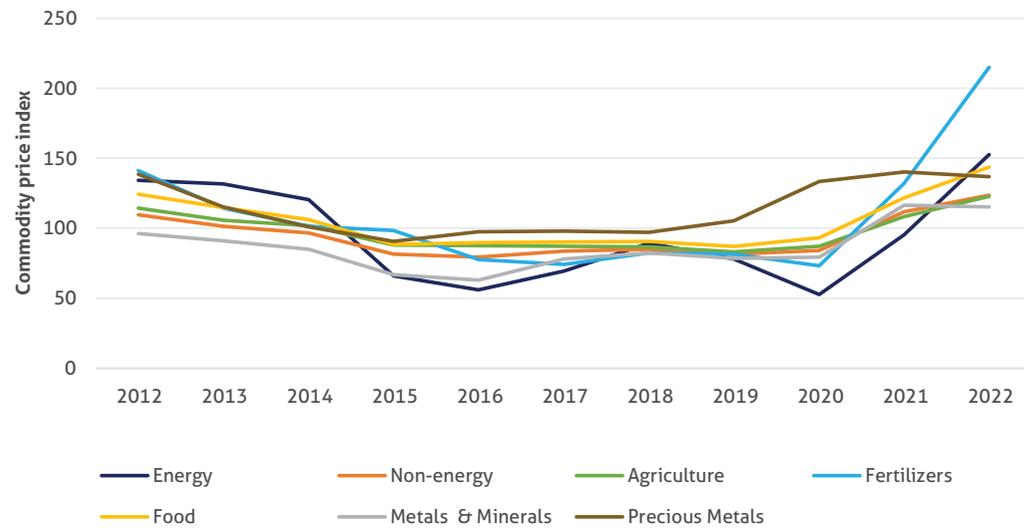
GDP growth is forecast to slow to 1.4%. While the US economy performed better than expected in Q3 and Q4 2022, tight fiscal and monetary policies and high borrowing costs are likely to contribute to sluggish growth. Similarly, in the euro area, GDP growth is expected to slow significantly to 0.7%. Although GDP growth was stronger-than-expected in 2022, the euro area's economy remains fragile and will be subject to lingering risks. GDP growth in AEs is expected to rebound modestly to 1.4% in 2024.

In EMDEs, GDP growth is forecast to rise to 4% in 2023, with China projected to accelerate sharply to 5.2%. The easing of COVID-19 restrictions, recovery in private consumption and industrial activity, rebound in the property sector and accommodative monetary policies will support China's economic growth. Furthermore, GDP growth in EMDEs is expected to pick up further to 4.2% in 2024.

With regard to the global GDP growth, several other key institutions have forecasted a slowdown in GDP growth in 2023, followed by a rebound in 2024. However, some institutions like the World Bank and United Nations are more wary of the downside risk. The World Bank (WB) projects a deeper slowdown in global GDP growth of 1.7% in 2023, after which it rebounds to 2.7% in 2024. Similarly, the United Nations (UN) forecasts global GDP growth of 1.9% in 2023 and 2.7% in 2024. The Organization for Economic Cooperation and Development (OECD) forecasts global GDP growth of 2.6% in 2023 and 2.9% in 2024.

Commodity prices have experienced large swings over the past two years driven by major market shocks caused by chronic underinvestment since 2014, the COVID-19 pandemic and escalating geopolitical and trade tensions. Following a sharp decline in 2020, the energy index rose 81% y-o-y in 2021 due to strong post-pandemic demand recovery and related supply-constraints. Subsequent to this, in early 2022, disruptions to supply and trade of commodities, driven by geopolitical tensions, caused further price escalations. The average energy price index in 2022 increased 60% y-o-y reflecting significantly higher oil, coal and gas prices. Meanwhile, the average non-energy price index was only 11% higher y-o-y. However, the fertilizer price index has increased significantly over the past two years, jumping by 81% y-o-y in 2021 and a further 63% y-o-y in 2022, largely driven by high raw material costs and supply-chain disruptions. (Figure 3).

Figure 3: Commodity price indices



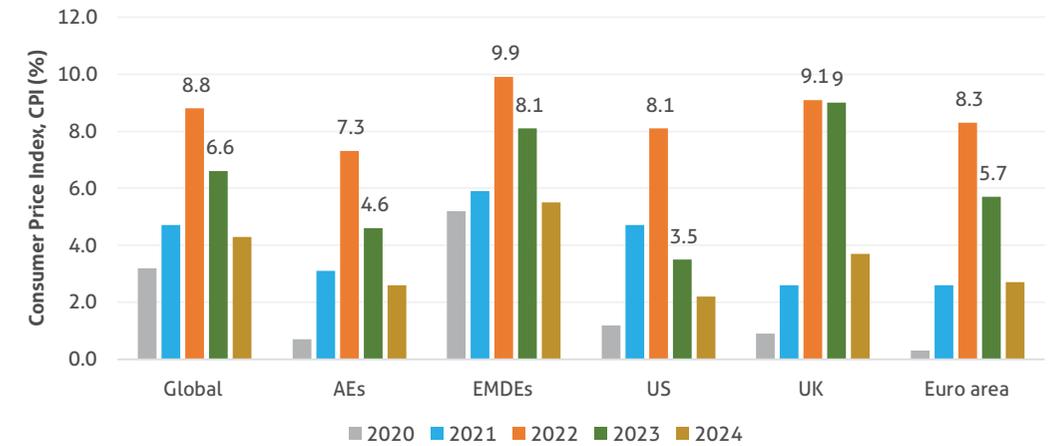
Source: GECF Secretariat based on data from World Bank Commodity Price Data

Note: Annual price indices based on nominal US dollars, 2010=100, 1960 to present. The energy price index is calculated using a weighted average of global crude oil (84.6%), gas (10.8%) and coal (4.7%) prices. The non-energy price index is calculated using a weighted average of agriculture (64.9%), metals & minerals (31.6%) and fertilizers (3.6%).

Global inflation is likely to have peaked in 2022, reaching an average of 8.8%. High energy and food prices since the start of 2021 have been the major drivers of inflation over the past two years. In 2022, supply-chain disruptions, due to escalating geopolitical tensions further exacerbated energy and other commodity prices, resulting in rising inflation. This, in turn triggered rapid monetary policy tightening, particularly in major advanced economies, which has worsened global financial conditions.

In 2023, inflation is expected to remain relatively high; however it is likely to gradually decline as the impact of tightening monetary policies are felt in the system. In addition, major central banks remain focused on bringing inflation back down to the targeted level of around 2%. In this regard, global inflation is expected to average 6.6% in 2023, and to decline further to 4.3% in 2024. Inflation in AEs is expected to decline from 7.3% in 2022 to 4.6% in 2023 and further to 2.6% in 2024. Similarly, in EMDEs, inflation is forecast to fall from 9.9% in 2022 to 8.1% in 2023, and then to 5.5% in 2024 (Figure 4).

Figure 4: Inflation rates – actual and forecast



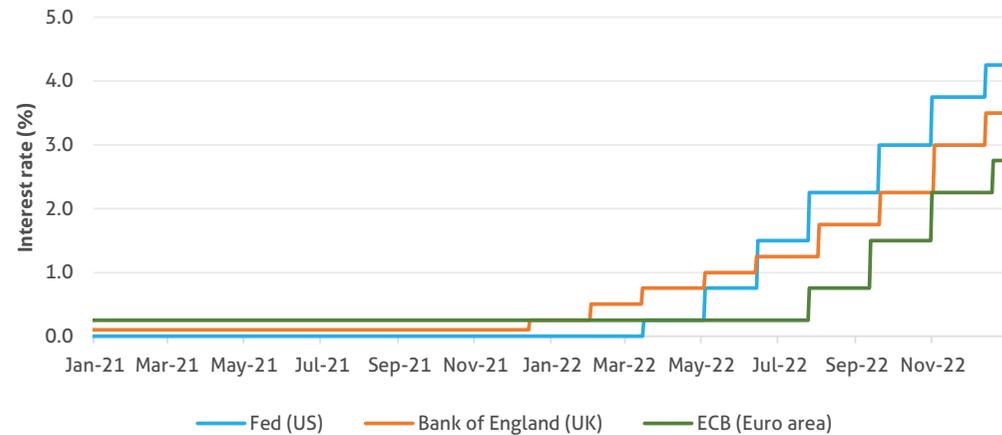
Source: GECF Secretariat based on data from IMF World Economic Outlook January 2023 and October 2022

In 2022, major central banks across the world undertook rapid monetary policy tightening in order to tackle rising inflation as illustrated in Figure 5. The US Federal Reserve (Fed) increased interest rates seven times in the last year. At the end of the year, the Fed’s benchmark interest rates had reached 4.25-4.5%, the highest since December 2007.

In the UK, the Bank of England (BOE) increased interest rates eight times in 2022. At the end of the year, the BOE’s benchmark interest rate was 3.5%, the highest since October 2008.

In the euro area, the European Central Bank (ECB) increased its key interest rates four times last year. At the end of the year, the ECB’s benchmark interest rates on the main refinancing operations, marginal lending facility and deposit facility rose to 2.5%, 2.75% and 2% respectively.

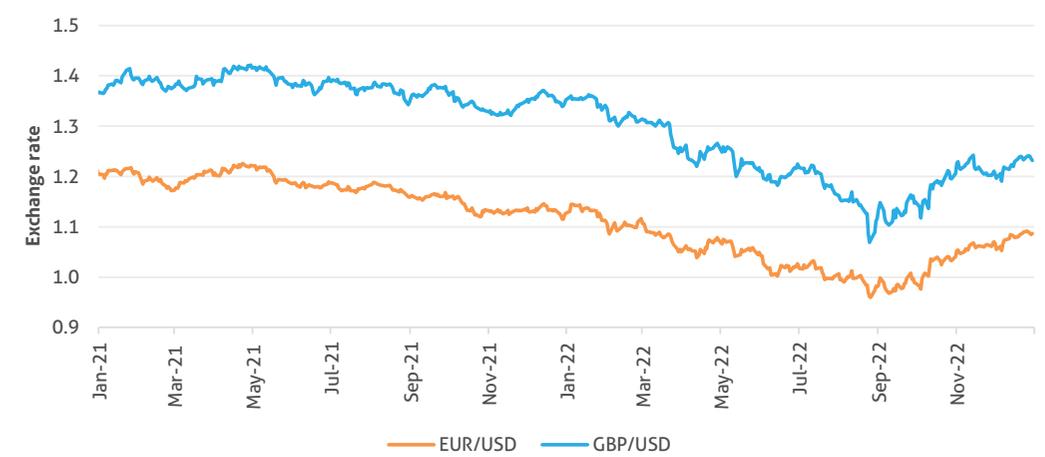
In 2023, interest rates are likely to stay elevated in order to effectively bring down inflation to targeted levels. The first set of hikes was announced by these three central banks in early February 2023. While central banks are likely to be persistent with increases to their benchmark interest rates, less aggressive hikes are expected this year.

Figure 5: Interest rates of selected major central banks

Source: GECF Secretariat based on data from US Federal Reserve, European Central Bank and Bank of England

The US dollar appreciated significantly against the currencies of other advanced economies in 2022 as a consequence of uneven monetary policy tightening and growing interest rate differentials between the Fed and other major central banks. The Fed started increasing its interest rates earlier than the ECB, lending to a higher differential. In September 2022, the euro plummeted to a two-decade low of \$0.9596 and the sterling dropped to a historic low of \$1.0688. The strength of the US dollar and spill-over effects of the energy crisis in Europe, including high energy prices, high inflation, a slowdown in business activity and fears of economic recession, all weighed heavily on European currencies.

In 2022, the euro was valued at an average of \$1.0541, decreasing 11% from the previous year. Similarly, the sterling had an average value of \$1.2377 in 2022, 10% lower than the previous year. Rising inflation in the euro area and the UK, which was estimated at 8.4% and 9.1%, respectively, in 2022 put considerable pressure on European currencies (Figure 6).

Figure 6: Exchange rates

Source: GECF Secretariat based on data from Refinitiv Eikon

1.2 Energy Policies

1.2.1 Global and Regional Developments

Concerns about energy security that contributed to unprecedentedly high energy prices, along with the global movement to reduce carbon emissions and promote the decarbonisation of the energy industry, are considered the main drivers that shaped energy policy in 2022. Countries took action to solve the energy trilemma of achieving energy security, affordability and sustainability. This, in turn, helped shape both gas supply, which is affected by the upstream fiscal regulations and investment policies, and gas demand, which is related to market conditions and policies.

In the meantime, the energy crisis could represent a catalyst for new energy policies and initiatives that focus on the issues of achieving energy security while taking into consideration the environmental pledges. On the demand side, this has been translated into energy regulations that focus on achieving energy affordability by relieving the burden of high energy prices on consumers. Meanwhile, on the supply side, high energy prices created an incentive for companies to decide on new investments in the upstream sector and for governments to encourage these investments to achieve security of supply. Historically high energy prices also saw some governments implement various so-called windfall taxes.

In June 2022, the leaders of the G7 addressed the global energy crisis with some commitments concerning achieving "the security of energy supply, reducing the burden of high energy prices on consumers and expanding the deployment of renewable

energies, renewable hydrogen and enhancing energy efficiency". In addition, the G7 agreed to consider imposing price caps on energy prices for the sake of stabilization of the energy market and confirm a commitment to end direct international public financing of fossil fuels by the end of 2022, with some exceptions to safeguard national security and geostrategic interests. On climate issues, the G7 reached an agreement in concept concerning ambitious climate protection measures, industrial transformation through accelerated decarbonization, and close cooperation and support beyond the G7, in particular with emerging and developing countries.

In November 2022, the Arab Republic of Egypt, a GECF Member Country hosted the 27th UN Climate Change Conference (COP27) under the slogan "Together for Implementation". The Conference concluded with a historic agreement to establish a "Loss and Damage Fund" to help vulnerable countries deal with the climate crisis. However, the operational modalities of this Fund would be determined at COP28, to be hosted by another GECF Member Country, the United Arab Emirates. The UNFCCC Parties reiterated their positions about "the urgent need for deep, rapid and sustained reductions in global GHG emissions" to limit global warming to 1.5°C above pre-industrial levels, the most ambitious goal of the Paris Agreement. Progress was also made with regard to the financial mechanism related to the implementation of Article 6 of the Paris agreement.

In November 2022, the leaders of the G20 countries, meeting in Bali Indonesia, expressed their concerns about volatility in energy prices and disruptions to energy supply and called to strengthen international cooperation and producer-consumer dialogue. The Summit underlined the urgency to rapidly transform and diversify energy systems, advance energy security and resilience, and market stability by accelerating a clean, sustainable, just and affordable energy transition and flow of sustainable investments.

However, it should be noted that despite the ongoing environmental pledges, some countries have increased their coal consumption in recent months, illustrated by an increase in gas-to-coal switching, amidst the current energy crisis.

The following section provides the latest energy policy developments in major regions, reflecting developments during 2022.

1.2.1.1 Europe

2022 witnessed a significant transformation in how EU Member States secure their energy. Concerns over the security of energy supplies saw Member States, together with the European Commission (EC), embark on an unprecedented effort to reduce gas imports from Russia on political background and diversify their supply. Fuel prices experienced a sharp rise in the EU amid the concerns about gas deficit in Europe. At the same time, EU member countries tried to keep their pledges towards decarbonization policies and GHG emission reduction targets by striking a hard balance between energy security and the agreed environmental goals.

In May 2022, the EC introduced the REPowerEU plan, which targeted a reduction in dependence on fossil fuels, diversification of supply and aimed to fast-forward the energy transition, while increasing the resilience and sustainability of the EU energy system. The measures in the REPowerEU plan include energy savings, increasing energy efficiency and storage capacity, and accelerated rollout of renewable energy to replace fossil fuels in homes, industry and power generation. In February 2023, the European Council adopted an amended regulation to include REPowerEU in the Recovery and Resilience Facility. This move will enable the member countries to include the REPowerEU in their national recovery and resilience plans and provide finance for the key investments and reforms required to put REPowerEU objectives into actions.

In June 2022, the EU adopted a regulation on targets for gas storage. The storage facilities were to be 80% full by November 1, 2022 and 90% full by 1 November in the years thereafter.

In June 2022, the EU Parliament approved a plan to label gas and nuclear energy as green projects in EU Taxonomy from 2023 if they meet certain requirements. Gas-fired power plants will be considered as green projects if they produce less than 270g CO₂ per kWh.

In August 2022, the EU adopted a regulation "Save Gas for a Safe Winter" to reduce regional gas demand by 15% from August 2022 to March 2023.

In September 2022, EC proposed the "Emergency Market Intervention on High Electricity Prices" to reduce electricity demand by 10% from October 2022 to March 2023.

In December 2022, addressing the volatility in the energy markets, the EU agreed to establish a "Market Correction Mechanism" aiming to cap energy prices. The mechanism is automatically activated if certain market conditions take place. The regulation includes a suspension mechanism, if risks to security of energy supply, financial stability, intra-EU flows of gas, or risks of increased gas demand are identified. In addition, the EU agreed on regulation improving Member State solidarity in case of emergency and gas supply shortages, a better coordination of joint gas purchases, the setting of a gas price benchmark and exchange of gas across borders. It is worth mentioning that the proposed mechanism triggered many concerns regarding its potential impact on the market. The 24th GECF Ministerial Meeting "expressed great concern with regard to the attempts to alter the price discovery and risk management functions of markets, and to impose politically-driven price caps. It underlined that such artificial intervention in market functioning can only aggravate market tightness, discourage investment, and be detrimental to producers and consumers alike".

In December 2022, the European Parliament approved the Carbon Border Adjustment Mechanism (CBAM), which is one of the main components of the Fit for 55 package. It aims to reduce EU carbon leakage from imported products such as fertilizers, cement and

metals, and prevent the offshoring of carbon emissions by moving production outside the EU. This was accompanied by an agreement to reduce emissions from the EU ETS by 61% by 2030 compared to 2005 levels. The mechanism comes into effect in its transitional phase starting October 1, 2023, with permanent system entering into force in January 2026. However, the mechanism was criticized by various stakeholders as a protectionist measure that is not compatible with WTO rules as well as with the Paris Agreement.

Furthermore, countries have also taken policy measures at a national level. In Germany, the government approved a plan to deal with high energy prices that aims to cap gas and electricity prices in March 2023 retroactively covering prices from January 2023 for private households and small companies until the end of April 2024. In addition, Germany has delayed the retirement of coal-fired power plants to 2023 and activated power plants in its reserve. The temporary increase in coal output will mainly substitute for gas-fired power plants, to free up gas supplies for heating in residences, public buildings and industry. In a similar move, to reduce the impact of high gas prices on consumers, the Italian government passed a new policy package. It includes measures to decrease domestic consumption by trimming 15 days from its winter 2022/23 domestic heating season and a daily reduction in heating time of one hour as part of a drive to save 3.6 bcm of gas. In the UK, following huge profits of upstream companies due to high oil and gas prices in the market, the government is increasing the taxes on the windfall profit, with the Energy Profits Levy on oil and gas companies, increasing from 25% to 35% starting January 2023 and remaining in place until the end of March 2028. In France, the government has approved plans to reduce the total energy consumption by 10% over two years in addition to capping the increase in energy prices in 2023 at 15% to shield consumers against soaring prices. The Netherlands followed the same policy by putting a price cap on gas, electricity and heating for households and other small scale users.

1.2.1.2 Asia Pacific

The policy agenda of most of the countries in the region was driven mainly by measures to ensure the security of energy supply especially with the renewed liquefied natural gas (LNG) market competition with the EU amidst an unprecedented energy crisis and the measures to reduce carbon emissions.

China announced its 14th five-year energy development plan in March 2022, targeting the establishment of the energy sector that strikes a balance between energy security issues, sustainability and the long-term energy transition targets. The plan is built on four main pillars addressing energy security, energy efficiency, energy transition and innovation. This is translated into promising targets of 18% reduction in CO₂ intensity and 13% reduction in energy intensity by 2025 compared to 2020 levels, with a plan to establish a \$63 billion fund for renewable companies allocated subsidies. In addition, China plans to establish a nationwide unified power market by 2025 to avoid provincial energy crises and increase the share of renewables in electricity generation to 33% by 2025.

Japan announced its Green Transformation policy with \$100 billion committed to support the development and adoption of zero-emission fuels, aiming to enhance industrial competitiveness through the energy transition. Moreover, Japan's Ministry of Economy, Trade and Industry (METI) announced its plan to launch a pilot Emission Trading Scheme (ETS) in September 2022, with a view to create a fully operational carbon market in the second quarter of 2023. Japan also updated its GHG emission reduction target to reduce emissions by 46% by 2030 compared to 2013 levels.

Australia, a major player in the LNG market, imposed a 12-month price cap on gas sold to domestic consumers. The move was a part of a legislative package to provide financial relief to households and businesses impacted by high energy prices. Targeting achieving domestic energy security, Australia also imposed a regulatory oversight to divert gas to the domestic market instead of LNG exports in case of a domestic shortage.

Indonesia announced a commitment to ground-breaking climate targets and associated financing to support the Asian country in an ambitious and just energy transition. It includes an accelerated power sector emissions reduction pathway to net zero by 2050, expansion of renewable energies and the phase down of coal-fired electricity. Indonesia worked on prioritizing the domestic consumption over export by diverting LNG cargoes domestically, imposing a ban on coal exports in 2022 and introduction of carbon tax for coal-fired power plants in April 2022.

South Korea announced in July 2022 a new energy policy that includes revisions to the 2021 power generation plan, with a significant increase in nuclear power's share in the energy mix, giving support to LNG as a pathway for decarbonization and prioritizing security of energy supply over the phasing out of coal. This was accompanied by an easing of the tax regime on coal and gas till the end of 2022 to stabilize inflation. India promoted energy policies aimed at ensuring energy security and incentivizing domestic production of gas amidst the price volatility in energy markets. India delayed the retirement of some of its coal-fired power plants. The government also increased the price of locally produced gas to support domestic upstream companies and imposed a windfall tax on oil producers and refiners in 2022.

1.2.1.3 North America and Latin America and the Caribbean (LAC)

In the US, the authorities approved the Inflation Reduction Act (IRA) in August 2022. It includes a landmark \$369 billion fund to fight the climate crisis through incentives for developing clean energy and decarbonization technologies over the next decade. The IRA targets boosting hydrogen production, electric vehicles, CCUS (carbon capture utilization and storage), methane emission reduction and enhancing energy efficiency by providing tax credits like the 45Q tax credit for CCUS and 45V tax credit for hydrogen production. The legislation will also provide tax credits for renewable energy developers, as well as initiatives supporting nuclear energy and fossil fuels. In addition, the US worked on boosting its energy production by proposing easier procedures for

issuing permits that previously delayed fossil fuel and clean energy development. This was accompanied by announcing an approval for resuming oil and gas drilling on federal lands despite the climate pledges, targeted at taming the surging fuel prices and inflation.

In Canada, the government introduced a CAD 2.6 billion CCS tax credit over five years. In Mexico, the government announced a stricter target for reducing GHG emissions by 35% compared to 22% by 2030, with gas-fired power generation to continue dominating in Mexico's power mix.

In Latin America and the Caribbean (LAC), Argentina's government announced a plan to stimulate domestic gas production, mainly from Vaca Muerta shale basin, through a new gas pipeline, easing of foreign exchange limitations for gas producers and passing a regulation to create the "Vaca Muerta" custom corridor to facilitate the custom clearance of related equipment. This was accompanied by plans to build liquefaction plants to enhance exports. In Brazil, the energy policies focused on gas market liberalization. In Trinidad and Tobago, the government announced plans to revamp its tax regime related to energy industry, targeting new investments in oil and gas E&P. In Guyana, the government announced a plan to establish a sovereign wealth fund for oil revenues.

1.2.1.4 Africa

In 2022, the African Union adopted the African common position on Energy Access and Just Energy Transition, which is a comprehensive approach that draws the African short, medium and long-term energy development plans to accelerate energy access and transition without compromising its development imperatives for oil and gas. This aims to be accomplished through striking a critical balance between development of oil and gas resources and a smooth transition towards a clean energy system. Given the continent's considerable discoveries in recent years, the governments' energy policies were focused on boosting investment to develop gas resources in addition to updating the emission reduction targets in some countries.

In Egypt, energy policies were mostly focused on increasing gas production and rationalizing domestic electricity consumption to boost LNG exports to take advantage of the high gas prices. Egypt has emerged as a regional gas hub for the Eastern Mediterranean region based on the relative advantages of existing LNG facilities. In addition, Egypt declared a strategic framework for hydrogen production at COP27, with a number of MoUs signed to establish green hydrogen and ammonia production projects. At COP27, also, South Africa launched its new Just Energy Transition Investment Partnership and announced a five-year investment plan for the \$8.5 billion financing package, which was announced as a part of the country's Just Energy Transition Partnership with France, Germany, UK, US and the EU at COP26. Tunisia also updated its GHG emission reduction target to 27% by 2030 compared to 2010 levels and raised renewable targets in the power mix from 30% to 35% by 2030. Algeria worked on

enhancing its gas output and rationalizing domestic gas consumption for electricity to increase exports. Algeria also has emerged as a reliable gas source for EU in their target to achieve energy security by diversification of supply.

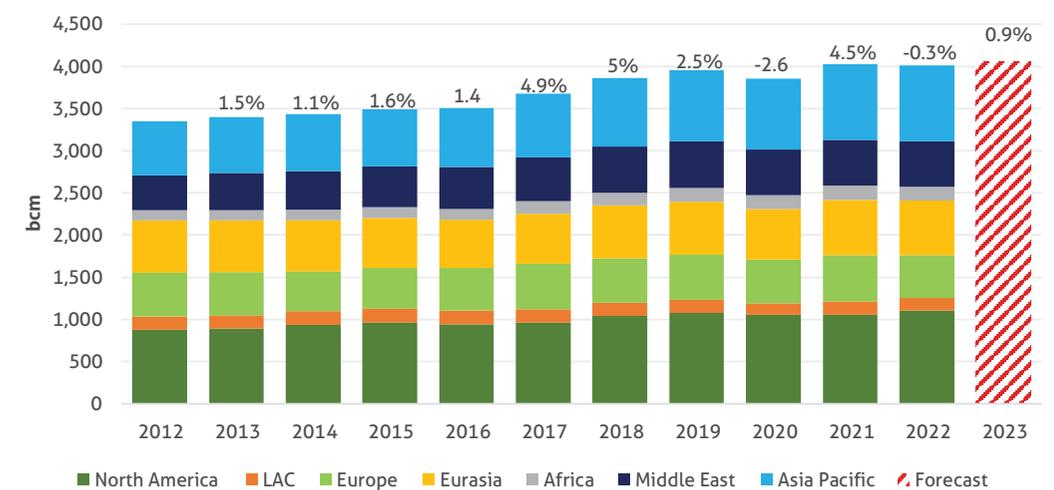
CHAPTER 02

Gas Consumption

2.1 Gas Consumption by Region

After a record rebound in gas consumption in 2021 driven by global economic recovery, as well as abnormal weather conditions, with a very cold winter and a warmer summer, the year 2022 witnessed a decline in global gas consumption by 0.4% compared to 2021 level to 4.01 tcm (Figure 7). Mild weather conditions in Q1 and Q4 2022 impacted gas consumption in the residential sector. High gas prices negatively affected gas consumption from industrial consumers, that either switched to alternative fuels or reduced output which in some cases resulted in demand destruction in Asia Pacific and Europe. In addition, the implementation of the EU regulation 2022/1369 of 5 August 2022 on coordinated demand-reduction measures for gas after the escalation of geopolitical tensions in Europe. This contributed to a drop of 10% y-o-y in regional gas consumption. For the Asia Pacific region, China and India recorded a decline in gas consumption by 1.3% and 4.3% y-o-y, respectively. This was driven by the switching back to coal use in the power generation sector as a consequence of high global LNG prices.

Figure 7: Trend in global gas consumption by region



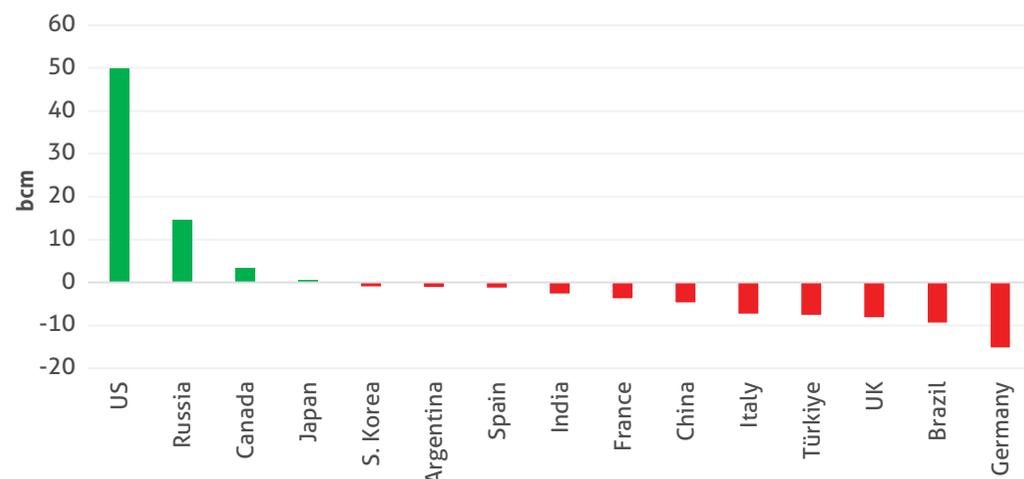
Source: GECF Secretariat based on data from BP Statistical Review 2021, Cedigaz and IEA Monthly Gas Statistics

In addition, the total lockdown that the Chinese authorities imposed in the country heavily affected the industrial sector in China. However, North America recorded a rise in gas consumption despite high gas prices; US gas consumption increased by 5.4% in 2022 driven by a boost in gas use in the power generation sector as a consequence of the tightening coal supply and rising coal prices that have limited the fuel switching ability of power generators.

In 2023, global gas consumption is forecast to rise by 1% y-o-y. The US, China and some emerging countries such as Indonesia, Thailand, and Bangladesh will drive the demand growth.

At a country level, the US, Russia and Canada recorded high growth in gas consumption, driven by a boost in coal to gas switching and colder winter compared to other regions of the globe. In contrast, Germany, Brazil, the UK, Türkiye, Italy and China recorded significant decline in gas consumption (Figure 8).

Figure 8: Y-o-Y Variation in gas consumption in major regions and countries in 2022



Source: GECF Secretariat based on data from Cedigaz, India's PPAC and Refinitiv

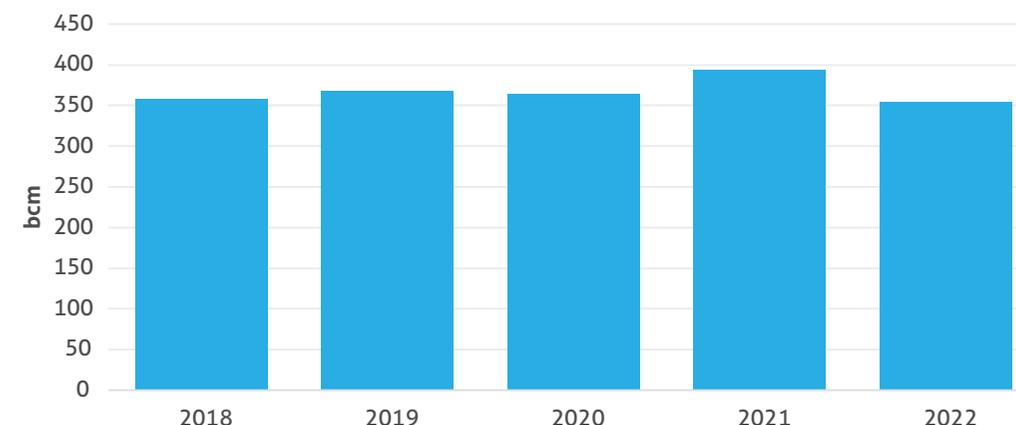
2.1.1 Europe

In 2022, The European Union's gas consumption was down by 10% y-o-y to reach 354 bcm, which represents the highest y-o-y drop recorded in the EU in the last decade. The decline in gas consumption was mainly seen in Germany, the UK, Türkiye, Italy, France and Spain with a decrease of 16%, 11%, 12%, 9.5%, 9% and 3.6% y-o-y, respectively. The decline was mainly attributed to the sustained high gas prices that made the fuel less competitive against coal in the power generation and industrial sectors. In addition to that, the strong expansion of renewables affected gas demand in the power generation sector. Residential sector demand was also affected as the weather conditions were above the norm compared to the previous years. In addition,

the implementation of the EU regulation 2022/1369 of 5 August 2022 on coordinated demand-reduction measures for gas, which contributed to the decline (Figure 9).

In 2023, gas demand in Europe is forecast to record a decline of 3% compared to 2022. This will be driven by the continuing implementation of the EU policy to reduce gas consumption. In addition, the mild weather that is already recorded in Q1 2023 will reduce the gas demand for heating in the EU. Another factor that could harm gas consumption in Europe is the continuous rise of wind and solar installed capacity, which will increase the share of renewables in the electricity mix.

Figure 9: Trend in the EU's annual gas consumption



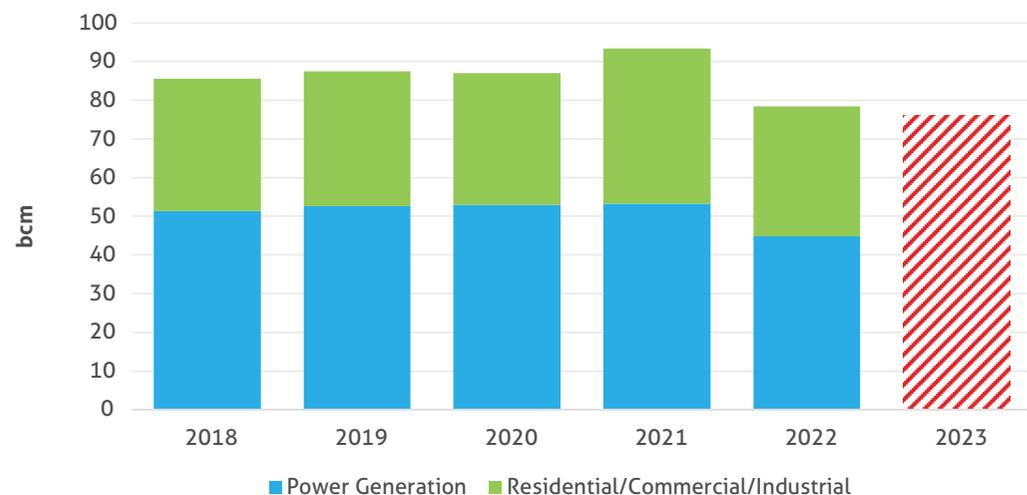
Source: GECF Secretariat based on data from McKinsey

2.1.1.1 Germany

The overall trend in gas consumption in Germany over the recent years was stable, with an average consumption of 88 bcm over the period 2018-2021. However, in 2022 the situation changed drastically mainly due to the escalating geopolitical tensions in Europe. For the year 2022, total gas consumption dropped to 78 bcm, which corresponds to a decline of 16% y-o-y (Figure 10). Both the residential/industrial and power generation sectors were down by 17% and 10% y-o-y, respectively.

The decline in gas consumption was the consequence of many factors. First, the implementation of the EU Regulation 2022/1369 of 5 August 2022 on coordinated demand-reduction measures for gas. Second, mild weather prevailed particularly in Q1 and Q4 of 2022, while the National Meteorological Service (DWD) reported that Germany's hottest year ever recorded was in 2022, with an annual mean temperature of 10.5 degrees Celsius. Temperatures were higher than in 2018, the previous record-holder, and were higher by 2.3 degrees Celsius than during the whole period 1961-1990. Third, the increase in gas prices led to a rise in gas-to-coal switching lifting the usage of coal in the power generation by 10% compared to the preceding year.

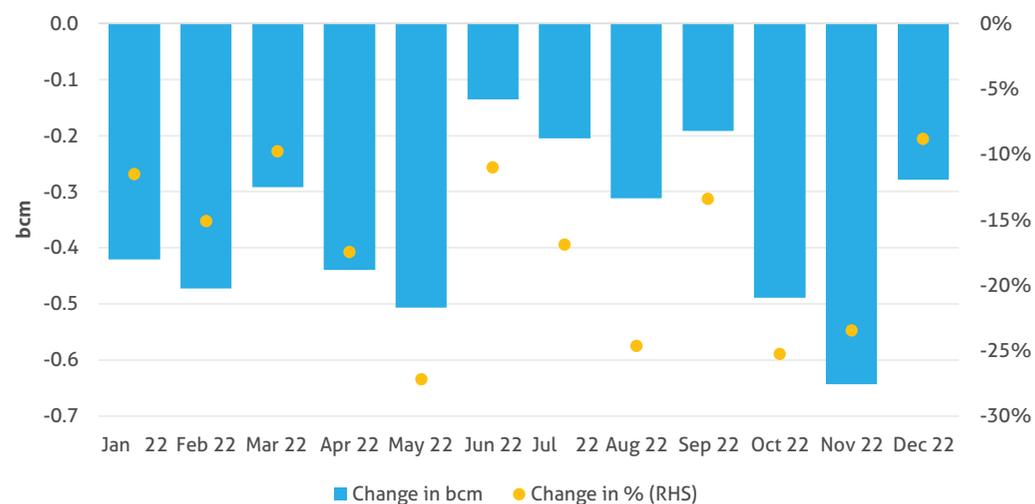
Figure 10: Trend in Germany's annual gas consumption by sector



Source: GECF Secretariat based on data from Refinitiv

Moreover, the high gas prices affected the industrial sector with an estimated decline of 16% y-o-y. Demand destruction was recorded in the industrial sector where manufacturers were obliged to reduce production or partially shut down their production, mainly in heavy industries such as cement, fertilizer and steel. As a result, gas consumption in the industrial sector dropped to 23 bcm (Figure 11).

Figure 11: Monthly y-o-y variation in gas consumption in Germany's industrial sector in 2022

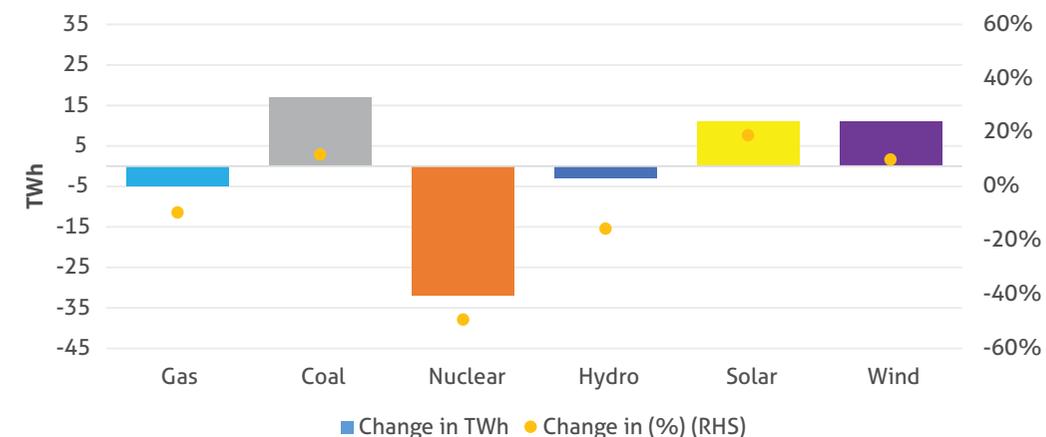


Source: GECF Secretariat based on data from Refinitiv

In 2022, the share of coal in the power generation mix rose from 29% in 2021 to 33%. The main reason is the sharp increase in gas prices during the year, which provided an incentive for power producers to use more coal to produce electricity. Consequently, the share of gas declined from 10% in 2021 to 9% in 2022. In the meantime, the share of renewables (wind and solar) in the German electricity mix rose from 32% in 2021 to 37% in 2022, driven by favourable weather conditions and the increase in wind and solar capacity during the year. For the year 2022, coal, solar and wind consumption in the power generation sector increased by 12%, 19% and 10% y-o-y, respectively. By contrast, nuclear and hydro consumption decreased by 50% and 16% y-o-y respectively (Figure 12).

In 2023, gas consumption in Germany is forecast to decline by 3% to reach 76 bcm driven by the continuous application of the EU measures to reduce gas consumption and mild weather that is already recorded for Q1 2023.

Figure 12: Y-o-Y variation in Germany's electricity generation by fuel in 2022



Source: GECF Secretariat based on data from Refinitiv and Ember

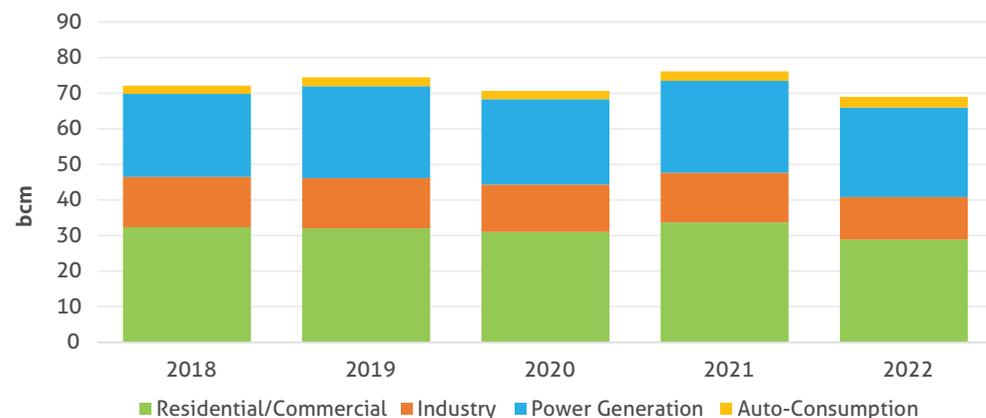
2.1.1.2 Italy

In 2022, gas consumption in Italy decreased by 9% (7 bcm) y-o-y to reach 69 bcm (Figure 13). The residential/commercial, industrial and power generation sectors were down by 14%, 15% and 3% y-o-y, respectively.

The residential sector was impacted by the warm temperatures that were recorded during Q1 and Q4 of 2022. As declared by ISAC-CNR¹, 2022 was the hottest year on record for more than a century. The annual average temperature was up by 1.1 degrees than the average of the period 1991-2020. The overheating tendency has intensified in the last decade with the warmest years of the last century being concentrated between 2014 to 2022.

1. The Italian Institute of Atmospheric Sciences and Climate

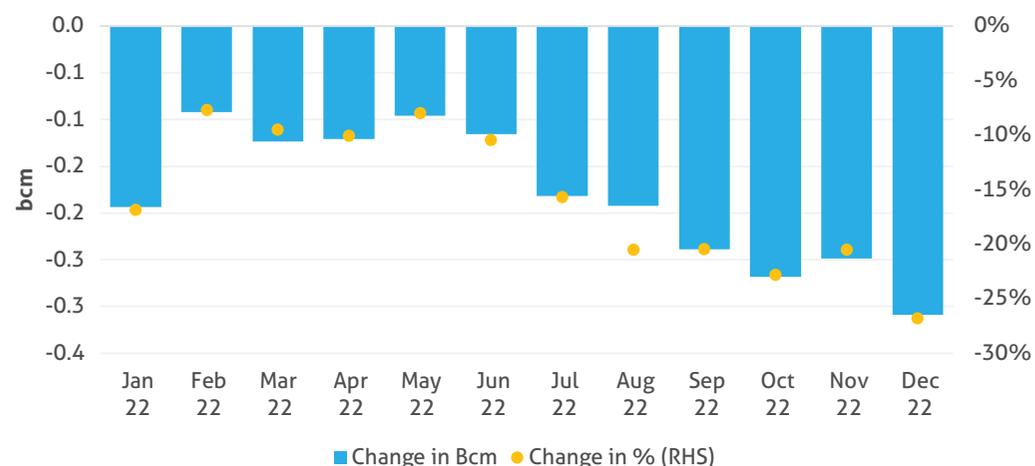
Figure 13: Trend in Italy's annual gas consumption by sector



Source: GECF Secretariat based on data from Snam

The slowdown in industrial activities was driven by soaring gas prices, which led to a temporary closure or reduction in the production of some intensive gas users such as steel, and cement industries as well as in the petrochemicals and refinery sectors (Figure 13). The bulk of the decline occurred during the second half of 2022 as prices were higher on average compared to the first half of 2022. The industrial sector declined by 2.2 bcm y-o-y (Figure 14).

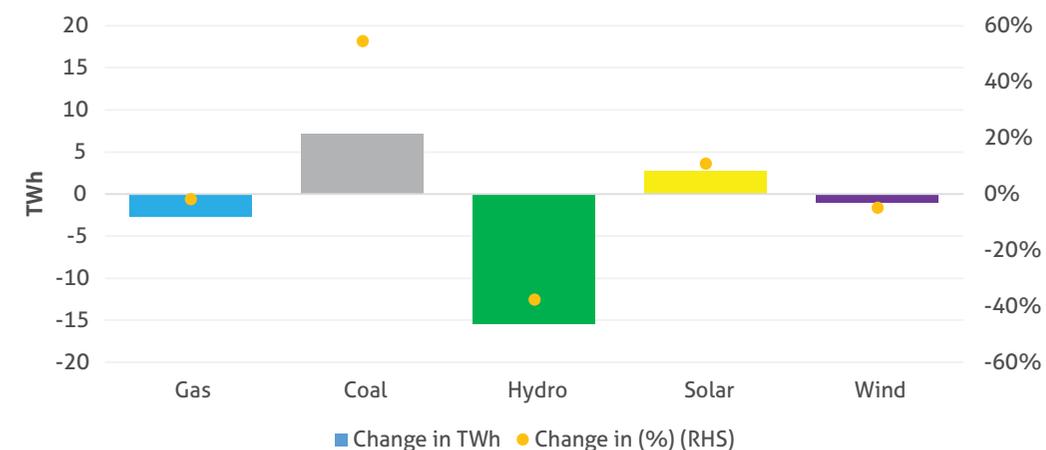
Figure 14: Monthly y-o-y variation in gas consumption in Italy's industrial sector in 2022



Source: GECF Secretariat based on data from Snam

In the power generation sector, total electricity production in Italy decreased by 4% y-o-y to 242 TWh. Despite the huge decline in hydro output in Italy (-38%) due to the high draught during the year, electricity production from gas declined by 2% y-o-y. In the meantime, electricity production from coal and solar increased by 55% and 11% y-o-y, respectively. Gas was the dominant fuel in the power mix with a share of 54% followed by renewables (19%), hydro (11%) and coal (8%) (Figure 15).

Figure 15: Y-o-Y variation in Italy's electricity generation by fuel in 2022



Source: GECF Secretariat based on data from Snam and Ember

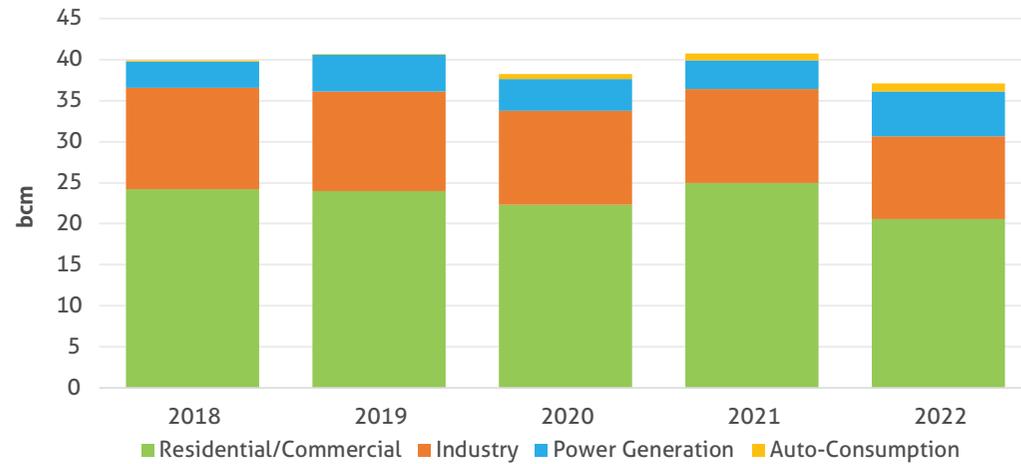
2.1.1.3 France

In 2022, gas consumption in France decreased by 9% (3.7 bcm) y-o-y to 37 bcm (Figure 16) according to the French gas system operator (GRTgas). Gas consumption in the residential sector dropped by 18% y-o-y (4.4 bcm) to 20.6 bcm. The residential sector was affected by warm weather as France recorded the hottest year ever recorded by Météo France², with 1.6 °C (yearly average) up compared to 2021. These warm meteorological conditions combined with a rise in gas prices led to a plunge in gas consumption in the residential sector.

Similarly, gas consumption in the industrial sector recorded a decline of 12% (1.3 bcm) y-o-y to 10.1 bcm. The drop was driven by high gas prices and higher energy efficiency measures implemented by some industrial branches. The decline was mainly visible in gas-intensive activities such as petrochemicals, refineries, metallurgy, and ceramic manufacturing.

2. Météo France is the official meteorological station in France

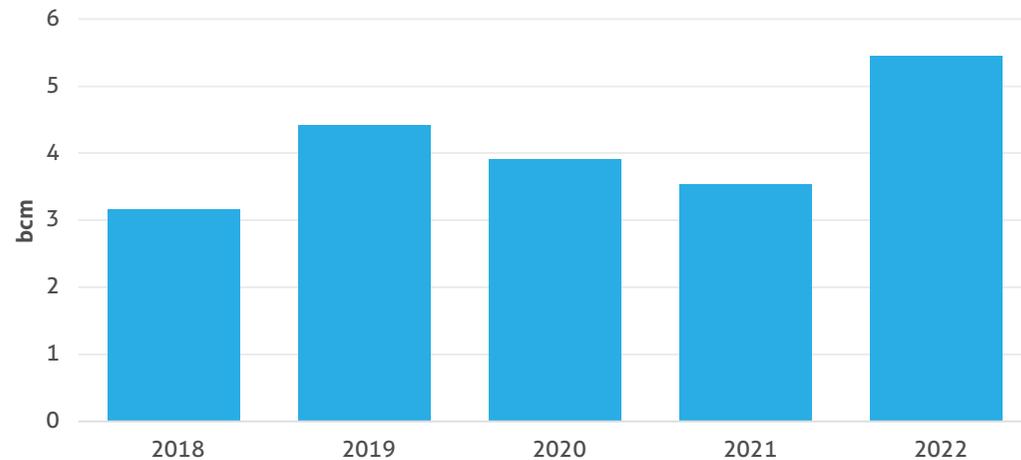
Figure 16: Trend in France’s annual gas consumption by sector



Source: GECF Secretariat based on data from GRTgaz

In contrast, gas consumption in the power generation sector recorded a huge jump of 54% (+2 bcm) y-o-y, reaching 5.5 bcm (Figure 17). That was mainly due to lower nuclear availability and weaker hydro output during the summer period.

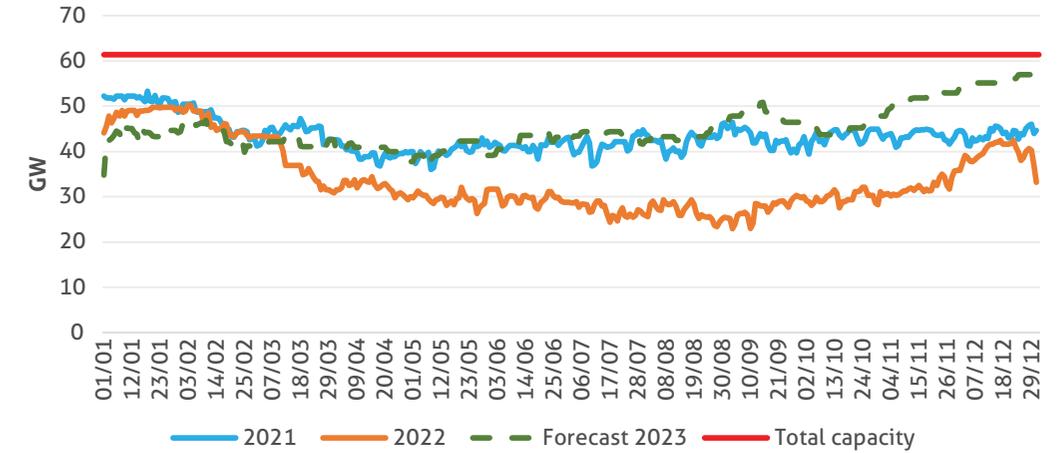
Figure 17: Trend in France’s annual gas consumption in the electricity sector



Source: GECF Secretariat based on data from GRTgaz

The weak nuclear output in the French power generation mix promoted the use of CCGT for electricity production. The French nuclear availability in 2022 was the weakest compared to the last five years. The nuclear output in 2022 reached 297 TWh representing a decline of 84TWh compared to 2021. The main reason for the decline in nuclear availability is the ongoing outages of several nuclear plants because of stress corrosion concerns (Figure 18).

Figure 18: Trend in weekly nuclear availability in France

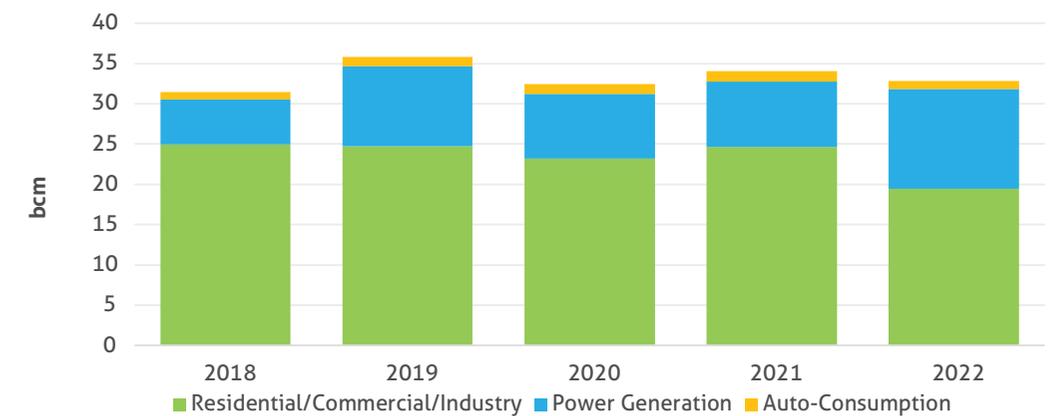


Source: GECF Secretariat based on data from Rte and Refinitiv

2.1.1.4 Spain

In 2022, gas consumption in Spain decreased by 3.6% y-o-y to reach 33 bcm (Figure 19). The residential/commercial/industrial sector represented a major decline in gas consumption during the year, with a drop of 21% (5 bcm) y-o-y. The decline in the residential sector was driven by above-normal temperatures that were recorded during the winter season. In 2022, Spain’s average temperature reached 15.5oC, which is the first time that the country reached that level as stated by the Spanish national meteorology service. In contrast, gas consumption in the power sector jumped by 54% y-o-y to 12.5 bcm, which is the highest level in the last decade.

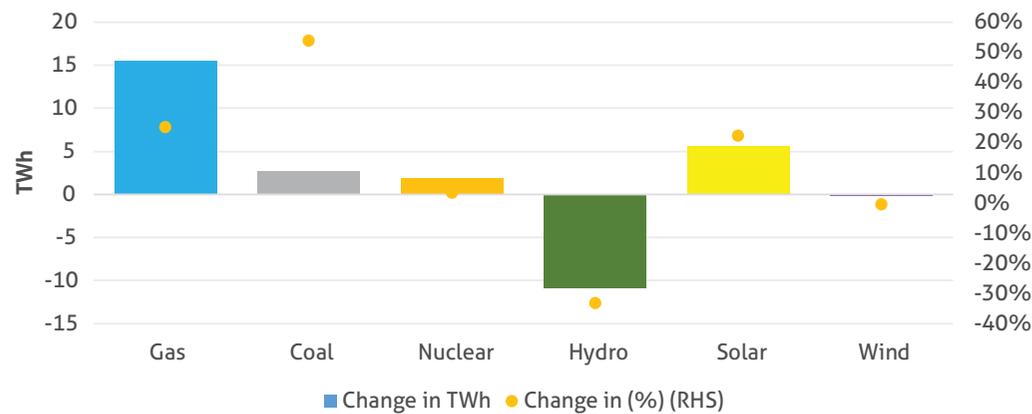
Figure 19: Trend in Spain’s annual gas consumption by sector



Source: GECF Secretariat based on data from Enagas

The surge in gas consumption in Spain's power generation was supported by strong electricity exports to both France and Portugal. Spain played a great role to balance the French electricity market, as several French nuclear plants were offline for maintenance during 2022. In addition, the severe drought that Spain recorded during the year affected the hydro output (-33% y-o-y) which played in favour of gas in the Spanish electricity mix. In 2022, electricity production from wind and solar increased by 0.4% and 22% y-o-y, respectively (Figure 20). Meanwhile, coal consumption in power generation increased by 54% y-o-y. Renewables are still the dominant fuel in the power mix with a share of 35% followed by gas (30%), nuclear (22%), hydro (9%) and coal (3%).

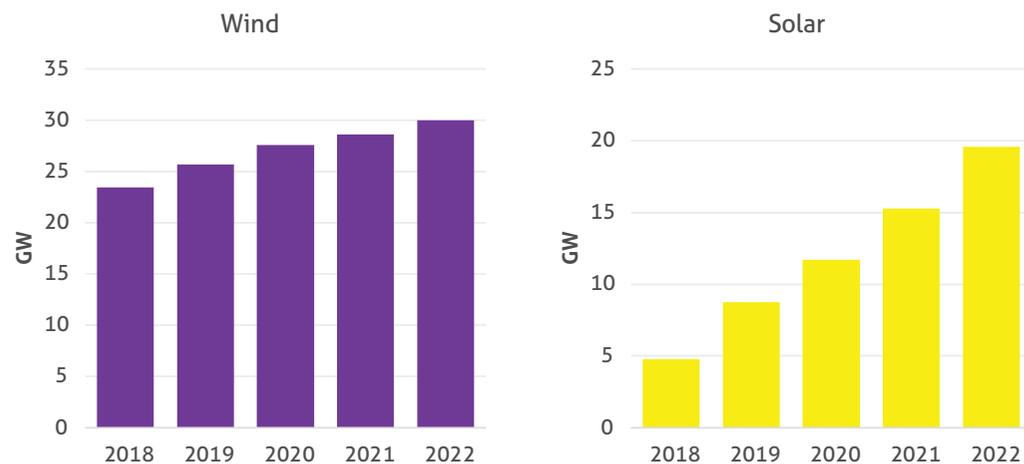
Figure 20: Variation in Spain's electricity generation by fuel in 2022



Source: GECF Secretariat based on data from Ree.es

In terms of the renewables capacity addition in Spain, wind and solar capacity increased by 5% (1.4 GW) and 28% (4.3 GW), respectively (Figure 21).

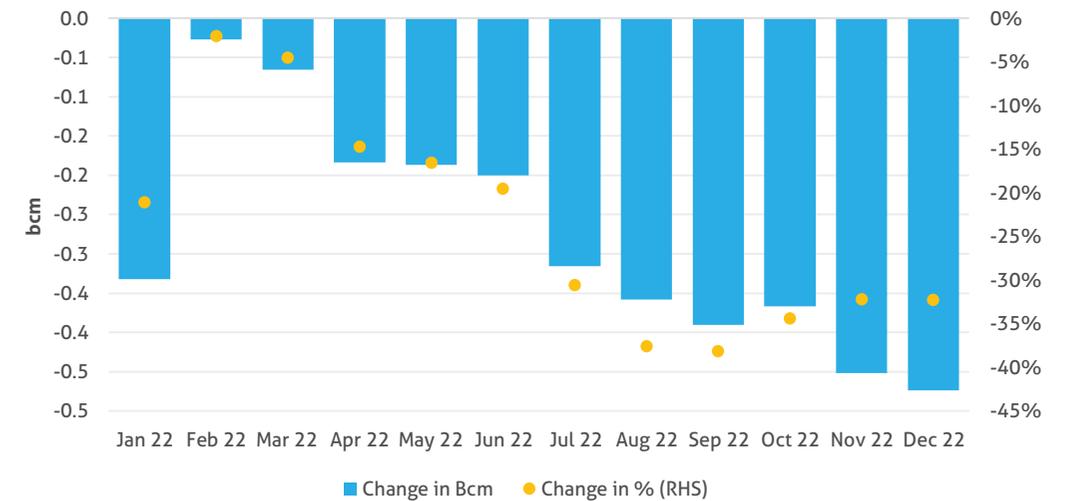
Figure 21: Trend in Installed Wind and Solar Capacity in Spain



Source: GECF Secretariat based on data from Ree.es

Moreover, the high gas prices affected gas consumption in the industrial sector, with a decline of 3.3 bcm compared to 2021. This represents a decline of 21% y-o-y (Figure 22). For example, the ceramic industry with gas costs representing 30% of the total cost of production recorded a huge decline in production in 2022.

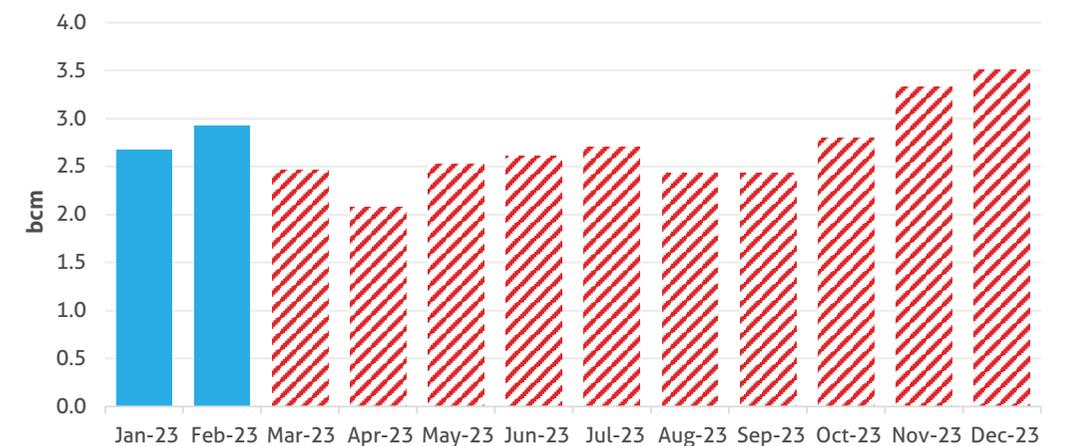
Figure 22: Monthly y-o-y variation in gas consumption in Spain's industrial sector in 2022



Source: GECF Secretariat based on data from Enagas

According to the data published by the Spanish gas transporter Enagas, gas consumption for the full year 2023 is estimated to reach the same level as 2022 – 33 bcm (Figure 23).

Figure 23: Spain's forecasted monthly gas consumption in 2023

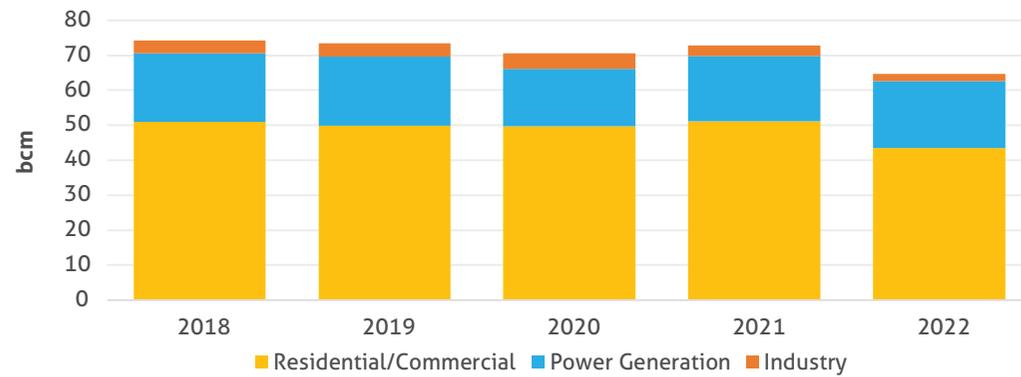


Source: GECF Secretariat based on data from Enagas
Note: Forecast from March to December 2023

2.1.1.5 UK

In 2022, gas consumption in the UK decreased by 11% y-o-y to reach 65 bcm (Figure 24). Gas consumption in the residential and industrial sectors declined by 15% and 29% to 43 bcm and 2 bcm, respectively. The decline in the residential sector was driven by warmer-than-normal weather during Q1 and Q4 of 2022. For the first time on record, the UK recorded a yearly average temperature of above 10oC and above the previous historical high of 9.9oC in 2014. In addition, the strict application of the rationing measures taken by the UK government reduced gas consumption.

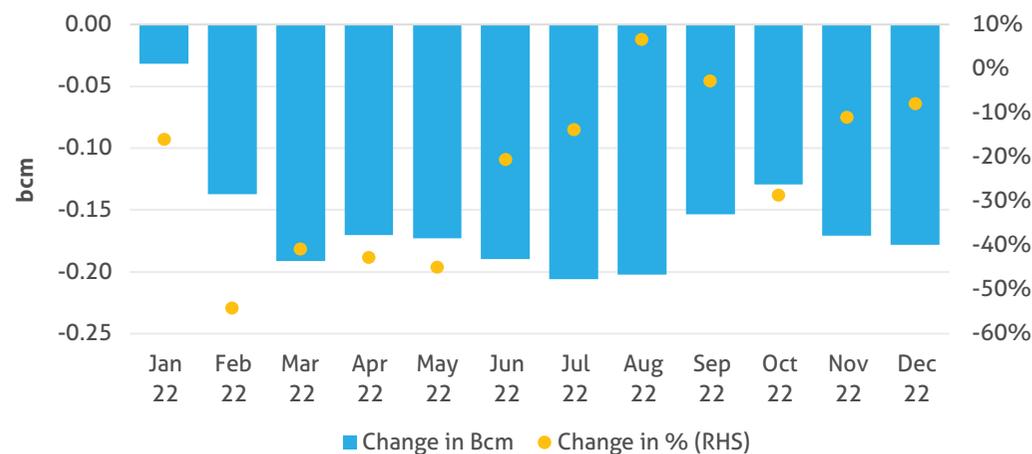
Figure 24: Trend in the UK's annual gas consumption by sector



Source: GECF Secretariat based on data from Refinitiv

Moreover, gas consumption in the industrial sector declined by 1 bcm driven by high gas prices, with industrial users switching to alternative fuels or reducing output. Companies in energy-intensive sectors, such as fertilizers, glass and steel, either reduced or suspended production (Figure 25).

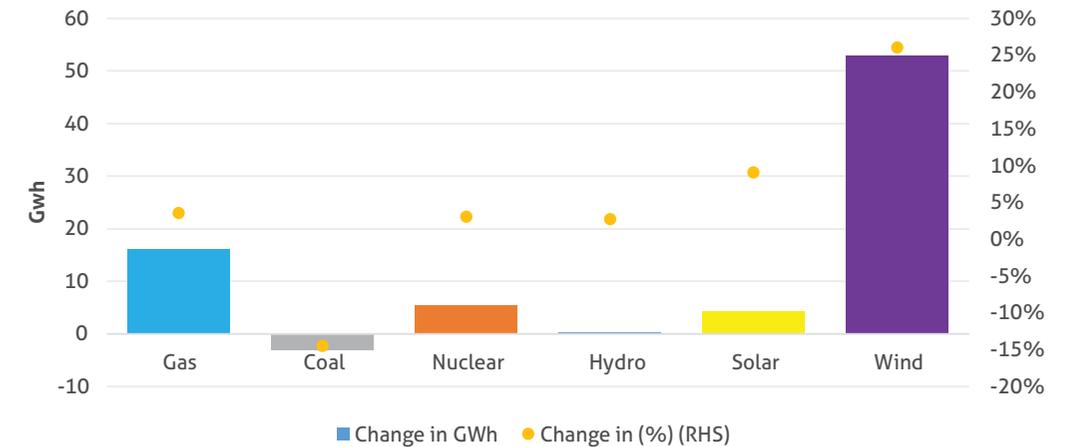
Figure 25: Monthly y-o-y variation in gas consumption in the UK's industrial sector in 2022



Source: GECF Secretariat based on data from Refinitiv

By contrast, electricity production from gas increased by 3.6% y-o-y, while total electricity production rose by 6% y-o-y to 106 TWh. Higher generation from nuclear (3% y-o-y), hydro (3%), solar (9%) and wind (26%) was recorded during the year. However, electricity production from coal declined by 14% y-o-y (Figure 38). Gas became the dominant fuel in the power mix with a share of 44% followed by renewables (29%) and nuclear (18%).

Figure 26: Variation in the UK's electricity generation by fuel in 2022

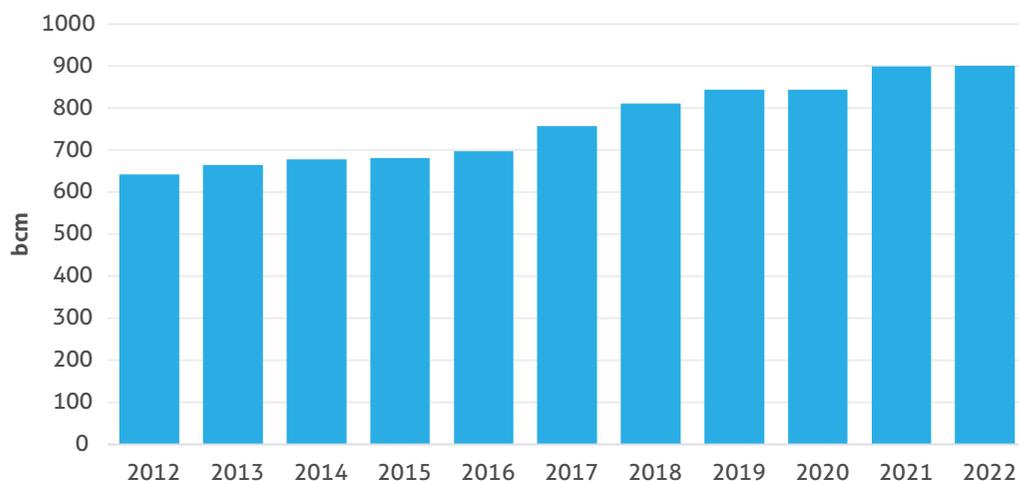


Source: GECF Secretariat based on data from Refinitiv

2.1.2 Asia Pacific

In 2022, gas consumption in the Asia Pacific region recorded the same level as 2021, reaching 900 bcm (Figure 27). Australia led the growth with an increase of 5% y-o-y (5 bcm), followed by Japan with an increase of 0.5% y-o-y. By contrast, China, South Korea, and India recorded a decline of 1.3% (-4 bcm), 1.8% (-1 bcm), and 4.3% (-2.6 bcm) y-o-y, respectively.

Figure 27: Trend in Asia Pacific annual gas consumption



Source: GECF Secretariat based on data from Cedigaz

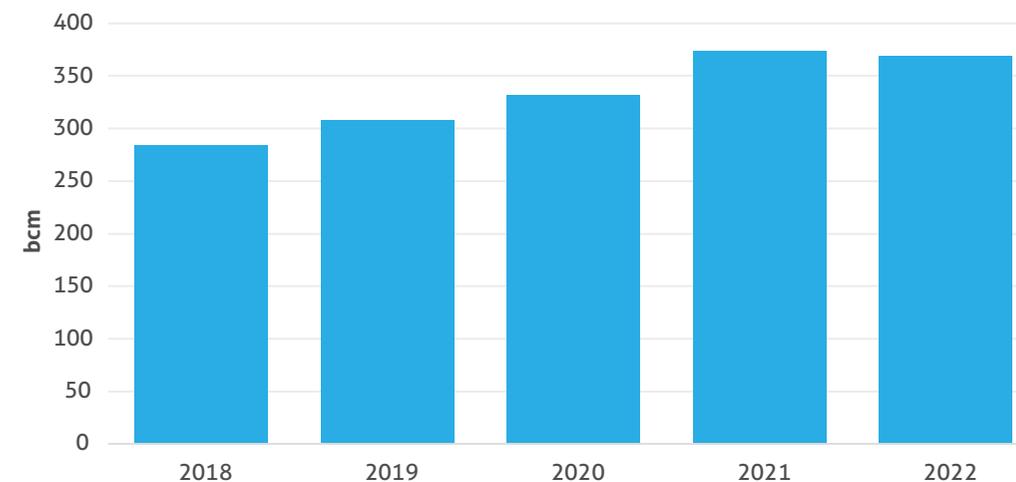
In 2023, gas demand in the region is expected to increase slightly, driven by economic recovery and increased electricity demand. China will drive demand growth after the removal of COVID-19 restrictions. With the decline in gas prices and the entry on stream of some LNG receiving terminals, gas consumption in emerging countries such as Indonesia, Thailand, Philippines and Bangladesh will increase. In addition, higher coal-to-gas switching is forecast in the power generation sector as gas becomes more competitive than other fuels due to the drop in global gas prices.

2.1.2.1 China

In 2022, China recorded its first decline in gas consumption in more than two decades, representing only the second time since 2005 that total gas consumption expanded slower than GDP. China’s apparent gas consumption (production + PNG imports + LNG imports) dropped by 1.3% y-o-y to reach 369 bcm (Figure 28), attributed to the economic decline that the country experienced after a complete lockdown in April-May 2022. An increase in COVID cases also affected gas consumption in the industrial, power generation, public services, and transportation sectors. In addition, the warm weather during the winter season 2022 affected heating demand in the residential sector.

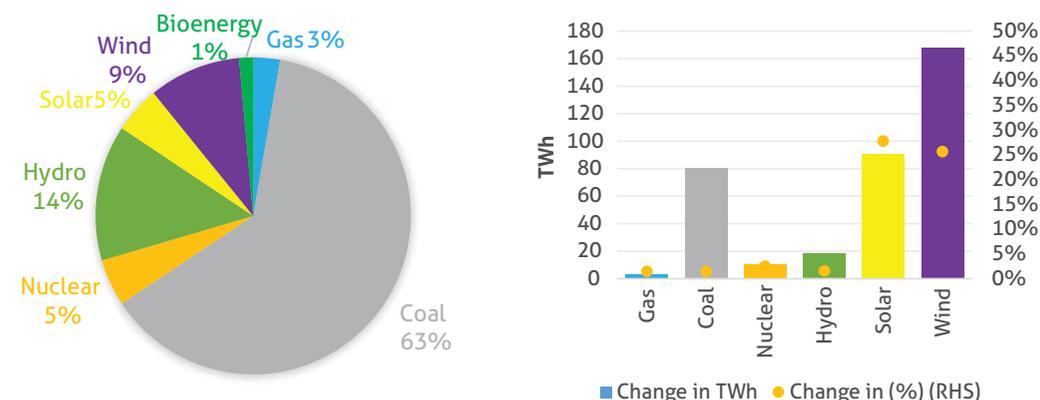
Electricity production from gas rose by 2% y-o-y, while total electricity production increased by 4.5% y-o-y to reach 8722 TWh. Higher generation was recorded from coal (1%), nuclear (3%), hydro (2%), solar (28%) and wind (26%) during the year. Coal remained the dominant fuel in the power mix, with a share of 63%, followed by renewables (15%), hydro (14%), nuclear (5%), and gas (3%) (Figure 29).

Figure 28: Trend in China’s annual gas consumption



Source: GECF Secretariat based on data from Refinitiv

Figure 29: China’s electricity mix and variation in electricity production by source in 2022

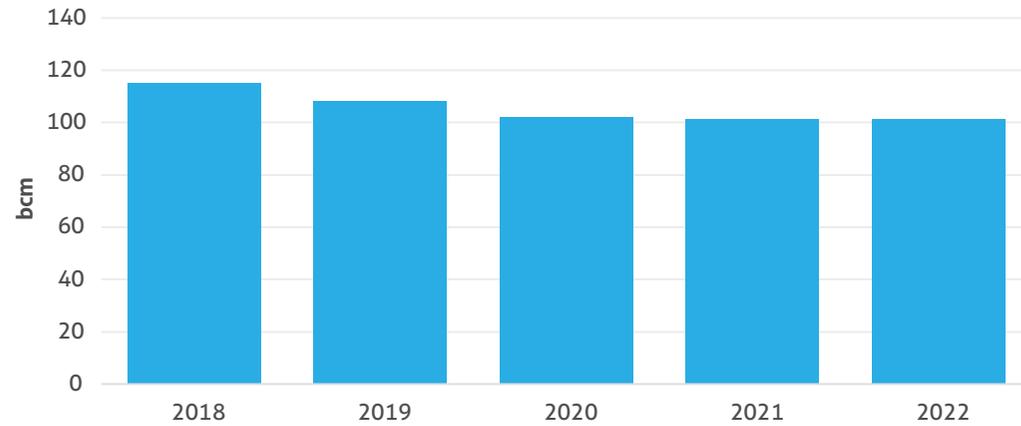


Source: GECF Secretariat based on data from mber and Refinitiv

2.1.2.2 Japan

In 2022, gas consumption in Japan increased 1% y-o-y to reach 102 bcm (Figure 30). Gas consumption in the city gas sector - representing the residential, commercial and industrial sectors - increased 2% y-o-y to 44.5 bcm, driven by a recovery in economic activity. In addition, higher gas for heating usage was recorded during January and February as the country experienced colder than normal weather.

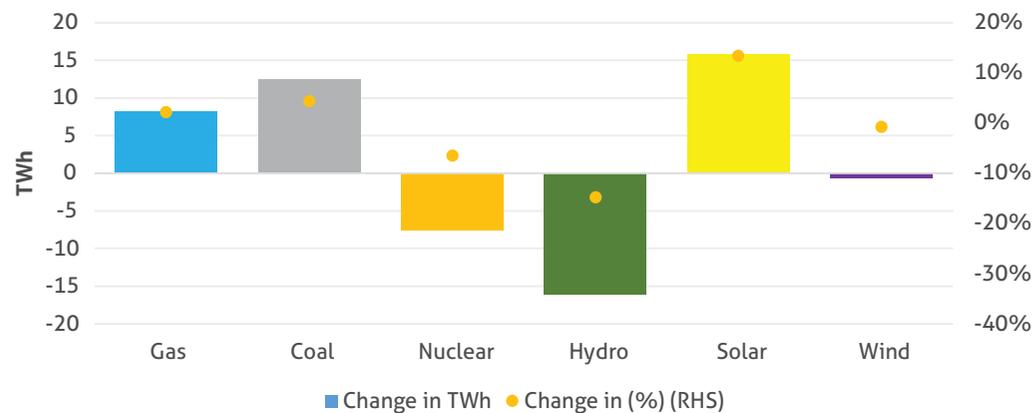
Figure 30: Trend in Japan's annual gas consumption



Source: GECF Secretariat based on data from Refinitiv

Electricity production from gas rose by 2% y-o-y, similar to the total electricity production with a growth of 1.7% y-o-y. Higher y-o-y generation from coal (4%) and solar (13%) was recorded during the year. However, a decline in generation from nuclear and hydro by 7% and 15% respectively contributed to the rise of gas use in the power generation mix (Figure 31). Gas remained the dominant fuel in the power mix with a share of 34%, followed by coal (21%), nuclear (19%), renewables (14%) and hydro (7%).

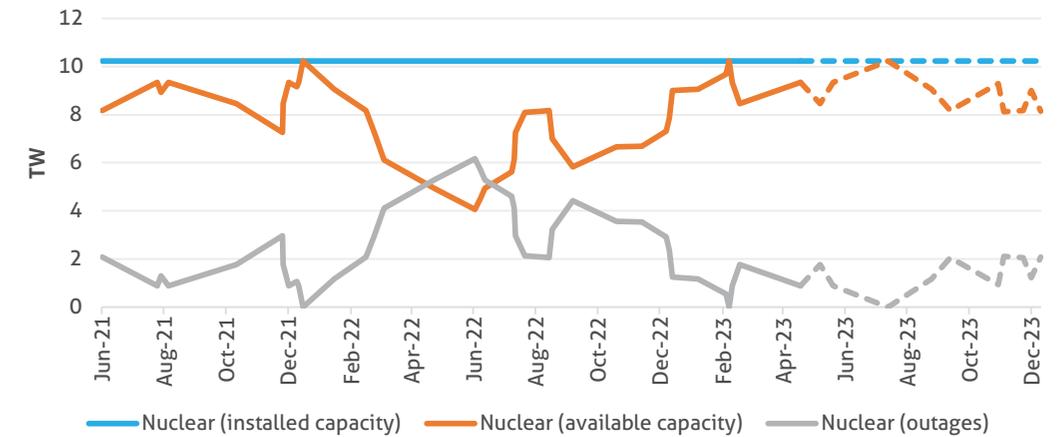
Figure 31: Y-o-Y Variation in the electricity production in Japan in 2022



Source: GECF Secretariat based on data from Refinitiv

In 2022, Japanese nuclear output recorded a decline of 15% to reach 54TWh. The bulk of the reduction was a consequence of scheduled maintenance for anti-terrorism obligations. Kyushu's 2.36GW Genkai 3 and 4 nuclear plants were the most affected in terms of availability, with both offline through most of the year. Genkai 3 restarted at the beginning of December 2022, while Genkai 4 was reactivated on July 13 before going offline on September 12. It returned online once again in February 2023. In addition, there was approximately two months delay to the restart of Kansai Electric's Takahama 3 and Kyushu Electric Sendai 2 with a capacity of 870MW and 890MW, respectively. For 2023, the Japanese regulator forecasts higher output from nuclear plants, which could affect gas demand in the power generation sector.

Figure 32: Japanese nuclear availability

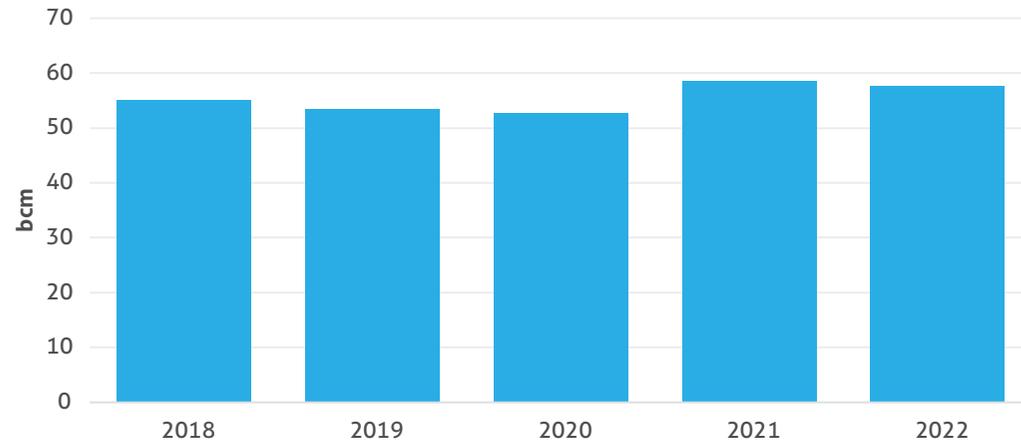


Source: GECF Secretariat based on data from Refinitiv

2.1.2.3 South Korea

In 2022, gas consumption in South Korea decreased by 1.8% y-o-y to reach 58 bcm (Figure 33), driven by robust decline of gas consumption in the power generation mix. This was a result of the country's strategy to reduce LNG usage in the power generation sector during the peak demand and maximize nuclear and coal output. In addition, many nuclear plants restarted after a series of maintenance work during 2021. By contrast, gas consumption in city gas sector, which represents both residential and industrial sectors, grew by 4% y-o-y to reach 27 bcm. However, the rise in city gas sector did not offset the decline recorded in the power generation sector.

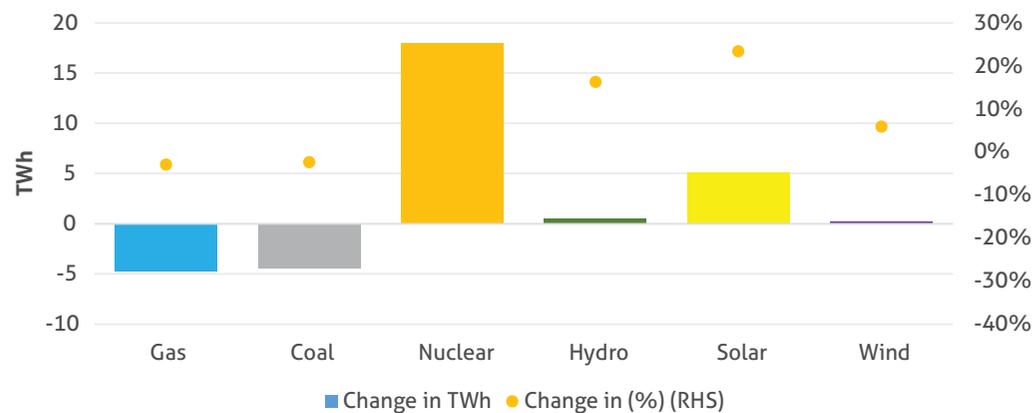
Figure 33: Trend in South Korea's annual gas consumption



Source: GECF Secretariat based on data from Refinitiv

Electricity production from gas declined by 3% y-o-y, while the total electricity production grew by 3.3% y-o-y. Higher generation from nuclear (11%), hydro (16%), solar (24%) and wind (6%) was recorded during the year. However, generation from coal declined by 2% y-o-y (Figure 34). Even with this, coal remained the dominant fuel in the power mix with a share of 33%, followed by nuclear (30%), gas (28%), renewables (6%) and hydro (1%).

Figure 34: Y-o-Y variation in the electricity production in South Korea in 2022

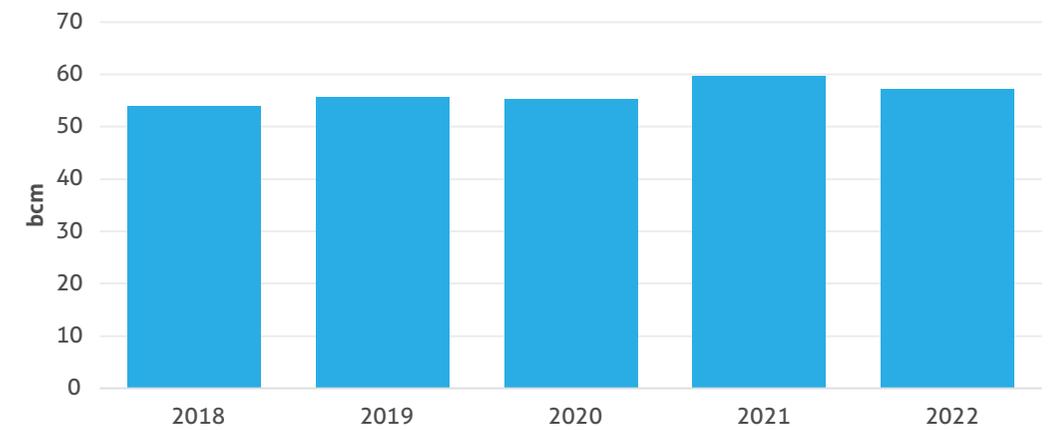


Source: GECF Secretariat based on data from Ember and Refinitiv

2.1.2.4 India

In 2022, gas consumption in India decreased by 4.3% y-o-y to reach 57 bcm (Figure 35), driven by lower gas consumption in the power generation (-2.3 bcm), refinery (-1.6 bcm) and petrochemicals (-0.8 bcm) sectors. In contrast, gas consumption increased in the fertilizer (+1.2 bcm) and city gas (+0.5 bcm) sectors.

Figure 35: Trend in India's annual gas consumption

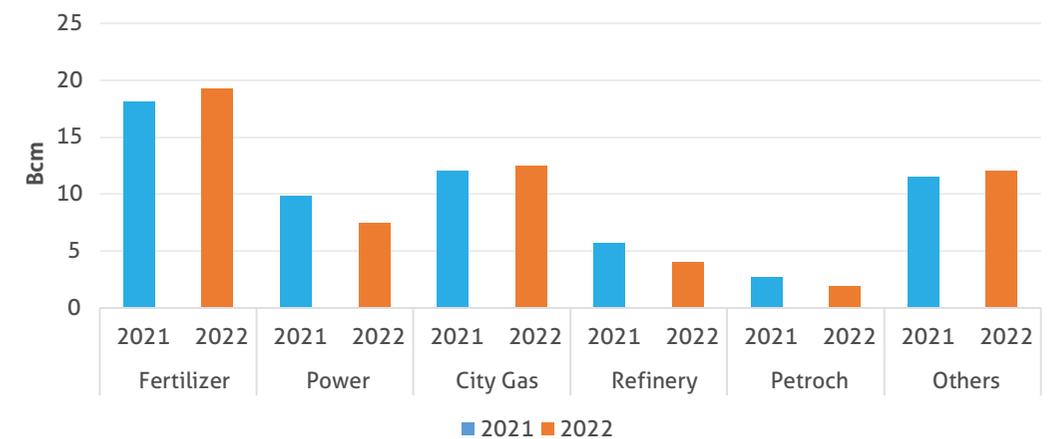


Source: GECF Secretariat based on data from India's PPAC

The fertilizer sector continues to dominate demand with a share of 34%, followed by city gas and power generation sector with shares of 22% and 13%, respectively. The refining and petrochemical sectors represented a share of 7% and 3.3%, respectively (Figure 36).

Regasified LNG (R-LNG) contributed 46% of the gas consumed in the country, down from 54% in 2020. Meanwhile, domestic gas production represented 54% of the national gas supply. The rise in domestic gas production rebounded due to high volatility and LNG prices during the year 2022.

Figure 36: Trend in India's annual gas consumption by sector



Source: GECF Secretariat based on data from India's PPAC

2.1.3 North America

In 2022, gas consumption in North America increased by 4% to reach 1,100 bcm. The US led the growth of gas consumption in the region with an increase of 5.4% y-o-y (+49 bcm), followed by Canada with an increase of 4.1% (+6 bcm) y-o-y. (Figure 37).

Figure 37: Trend in North America's annual gas consumption



Source: GECF Secretariat based on data from Cedigaz and EIA

In 2023, gas demand in the region is forecasted to remain at the same level or slightly decline compared to 2022, driven mainly by the rise of renewables capacity and a reduction in gas's share of power generation as a consequence of lower coal prices.

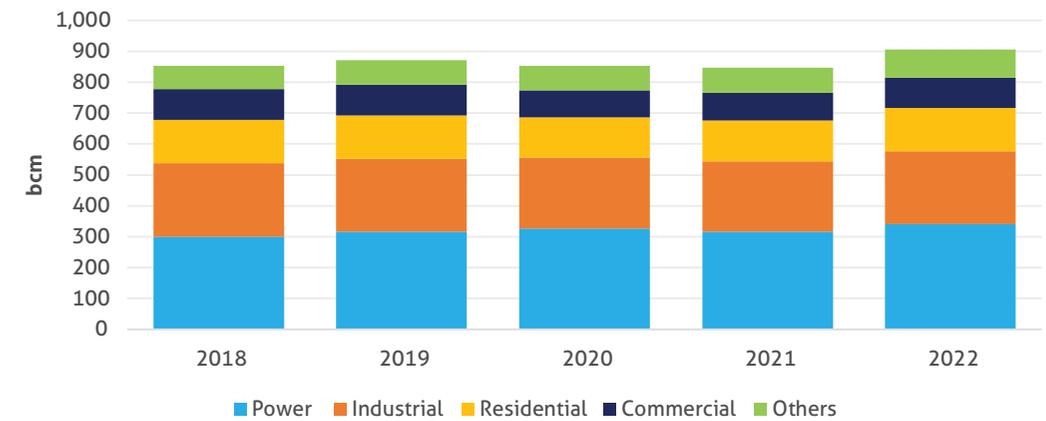
2.1.3.1 US

In 2022, US gas consumption recorded an increase of 5.4% to reach 905 bcm. Robust gas consumption was observed in the power generation sector with an increase of 7.7%, representing a rise of 24 bcm. This rise was driven by switching to gas despite high gas prices as gas-fired generation benefited from tightening coal supply and rising coal prices that limited power generators' switching ability. For the residential sector, the US recorded a very hot summer in the Northeast part of the country, which boosted the demand for air conditioning.

On the other hand, the commercial and residential sectors recorded an increase of 8% (+7.4 bcm) and 7.3% (+9.5 bcm), respectively (Figure 38). The growth in the residential sector was due to cold weather during some periods in the winter season. As an indicator, the total number of Heating Degree Days (HDDs) in Q4 2022 was 1548, up by 21% y-o-y, which led to an increase in gas consumption for heating in the residential sector.

In terms of gas consumption by sector, the power sector consumed the largest amount of gas with a share of 38%, followed by the industrial (26%), residential (16%) and commercial (11%) sectors.

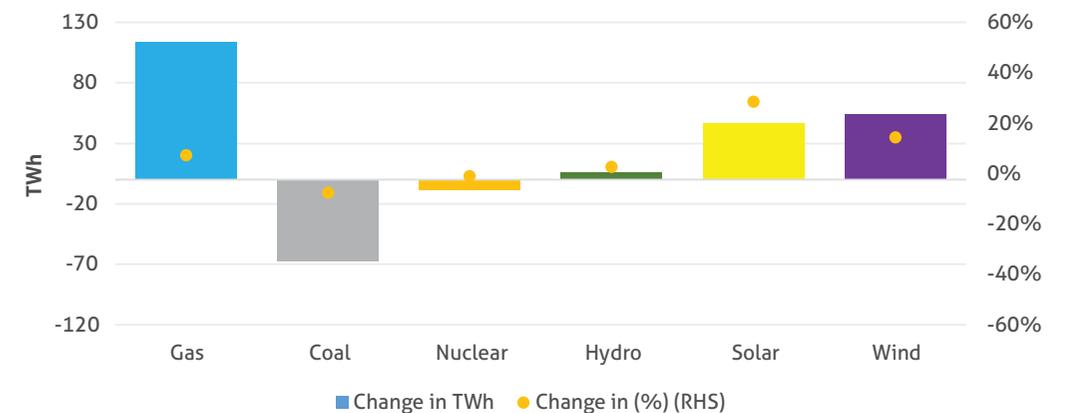
Figure 38: Trend in the US annual gas consumption by sector



Source: GECF Secretariat based on data from EIA

Electricity production in the US increased by 3.5%, with higher generation from gas (+7%), hydro (+3%), solar (+29%) and wind (+14%) offsetting a slump in coal (-8%) and nuclear (-1%). Gas was the leading fuel in the power mix with a share of 40%, followed by coal (20%) nuclear (18%), and renewables (15%) (Figure 39).

Figure 39: Y-o-Y variation in electricity production in the US in 2022



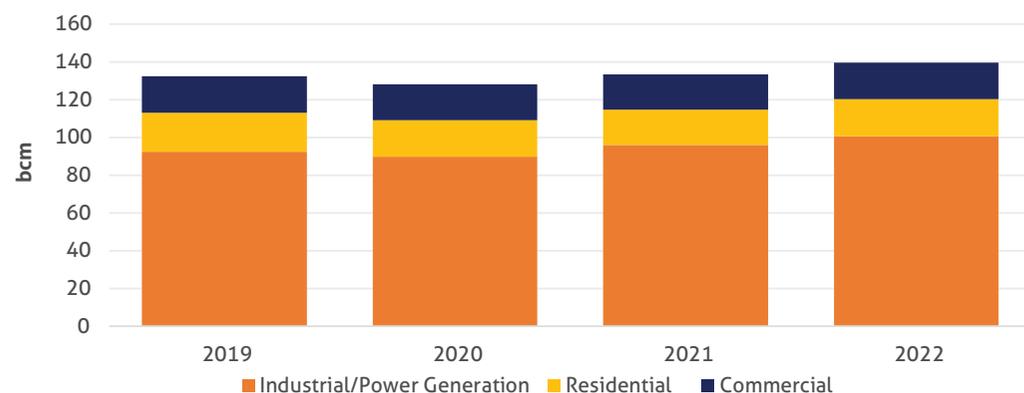
Source: GECF Secretariat based on data from EIA

2.1.3.2 Canada

In 2022, Canada's gas consumption increased by 4% to reach 139 bcm. The growth of gas consumption is attributed to cold weather during Q1 and Q4 2022 and the phase out of some coal power plants which played in favour of gas use in the power generation sector. In terms of consumption by sector, the industrial/power generation sector was

up by 4.7% (+4.5 bcm) y-o-y driven by coal to gas switching in accordance with the country’s policy to phase out coal power plants. Gas consumption in the residential and commercial sectors increased by 6.3% (1.2 bcm) and 3.6% (0.7 bcm), respectively, driven by colder-than-normal temperatures during the winter season (Figure 40). Regarding HDDs in Canada, during the year 2022, Canadian HDDs were up by 4% y-o-y.

Figure 40: Trend in annual gas consumption in Canada by sector

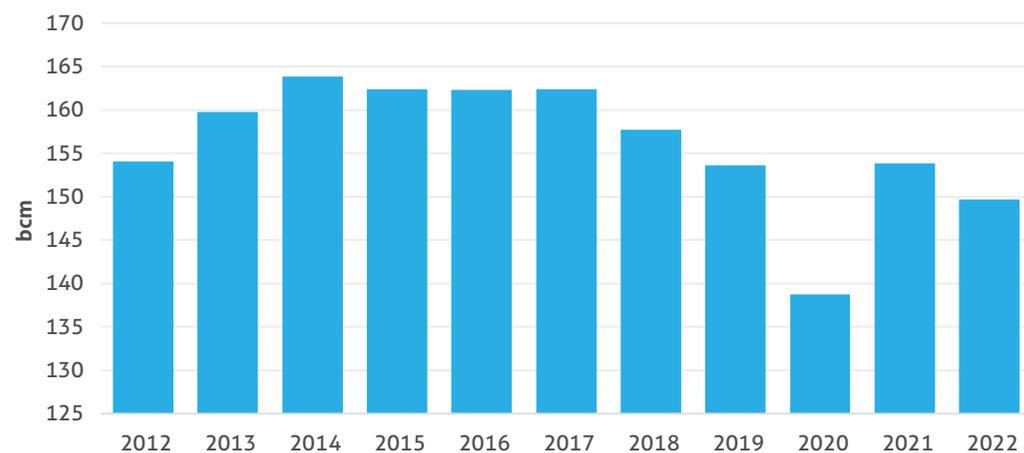


Source: GECF Secretariat based on data from Statistics Canada

2.1.4 Latin America & the Caribbean (LAC)

In 2022, gas consumption in LAC is estimated to record a decline of 2.7% y-o-y to 150 bcm. Brazil led the decline, driven by the reduction of gas use in the power generation sector (Figure 41). In 2023, regional gas demand is forecasted to decline by 1%, driven mainly by the recovery in hydro and renewables output and lower LNG imports as a result of high prices.

Figure 41: Trend in LAC’s annual gas consumption

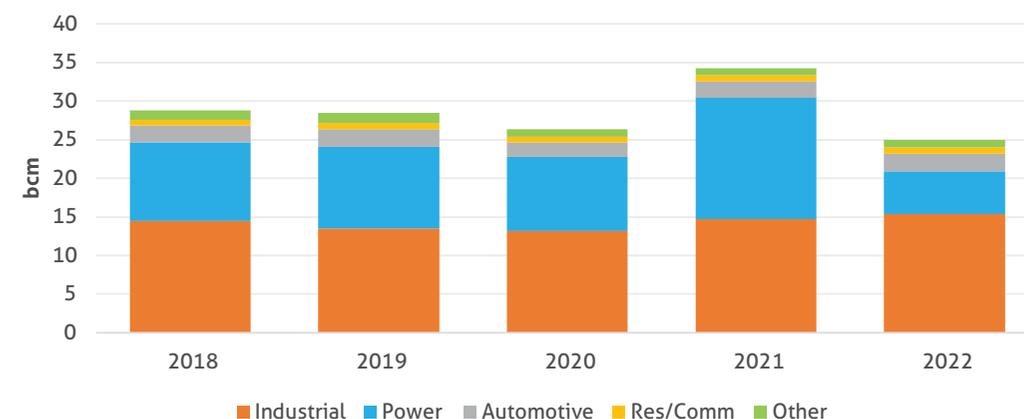


Source GECF Secretariat based on data from Cedigaz

2.1.4.1 Brazil

In 2022, Brazil was a driver of the decline in South America. Brazil recorded a fall in gas consumption of 27%, equivalent to 9.3 bcm compared to 2021. The bulk of drop was observed during Q3 and Q4, with reductions of 3.3 and 3.2 bcm, respectively (Figure 42). In terms of gas consumption by sector, power generation recorded huge decline of 52% (-10 bcm) driven by higher output from hydro following an extraordinary year for droughts in 2021. In contrast, the industrial and automotive sectors increased by 4.3% (0.6 bcm) and 4.4% (0.1 bcm).

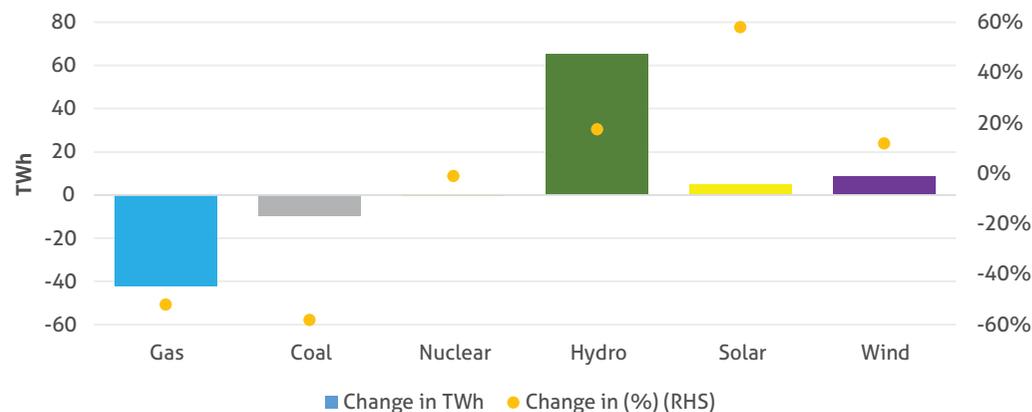
Figure 42: Trend in Brazil’s annual gas consumption by sector



Source GECF Secretariat based on data from MINISTÉRIO DE MINAS E ENERGIA

Electricity production from gas declined by 52% y-o-y, while the total electricity production grew by 4.6% y-o-y. Higher y-o-y generation from hydro (+17%), solar (+58%) and wind (+12%) was recorded during the year. However, generation from coal and nuclear dropped by 58% and 1% y-o-y (Figure 43). Hydro remained the dominant fuel in the Brazilian power mix with a share of 73% followed by renewables (15%), gas (6%), nuclear (2%) and coal (1%).

Figure 43: Y-o-Y variation in electricity production in Brazil in 2022

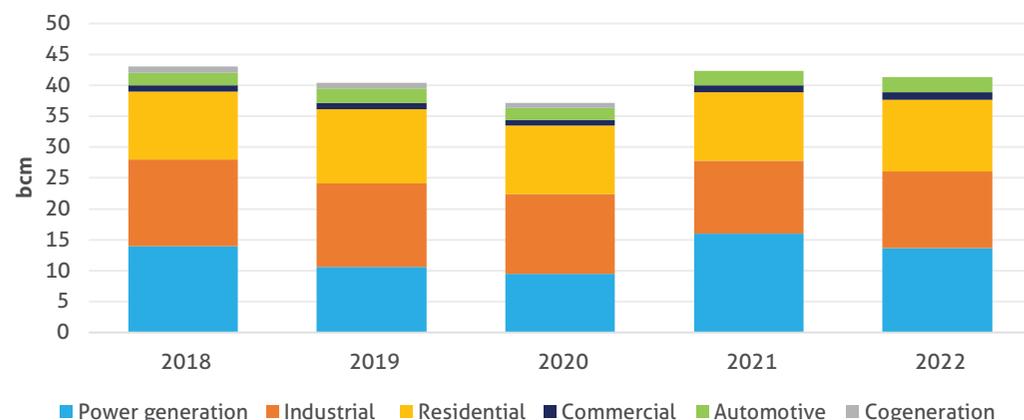


Source GECF Secretariat based on data from MINISTÉRIO DE MINAS E ENERGIA and Ember

2.1.4.2 Argentina

In 2022, gas consumption in Argentina decreased by an estimated 2.6% (-1 bcm) y-o-y to reach 41 bcm (Figure 44). The decline in gas consumption was driven by lower use of gas in the electricity mix, which was down 10% y-o-y. However, the industrial, residential and commercial sectors were up by 4.5% (+0.5 bcm), 6.5% (+0.7 bcm), and 3.4% (+0.4 bcm) y-o-y, respectively, but did not offset the overall decline in gas consumption. The drop occurred due to high hydro output during the year.

Figure 44: Trend in Argentina's annual gas consumption by sector

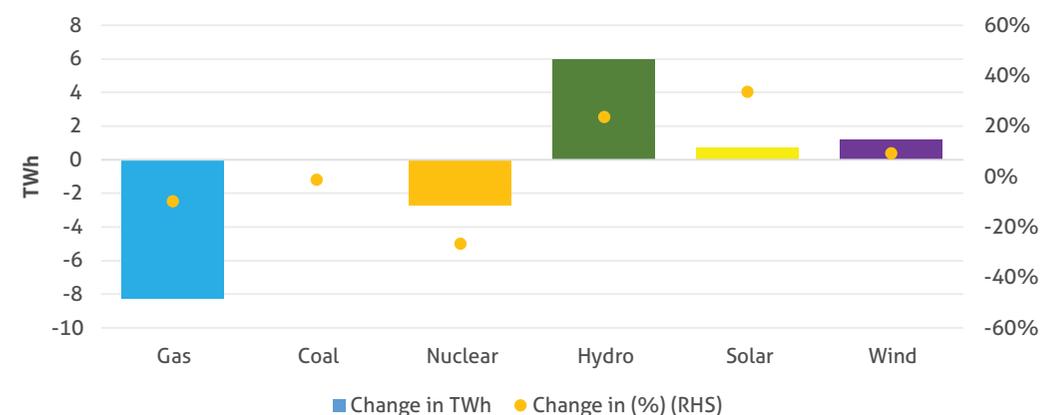


Source GECF Secretariat based on data from MINISTÉRIO DE MINAS E ENERGIA

Electricity production from gas declined by 10% y-o-y, while total electricity production dropped by 2.2% y-o-y. Higher y-o-y generation from hydro (+24%), solar (+34%) and wind (+9%) was recorded during the year. However, generation from coal and nuclear

dropped by 1% and 27% y-o-y (Figure 45). Gas remained the dominant fuel in the Argentinian power mix with a share of 56% followed by hydro (23%), renewables (12%), nuclear (5%) and coal (2%).

Figure 45: Y-o-Y variation in the electricity production in Argentina in 2022



Source GECF Secretariat based on data from MINISTÉRIO DE MINAS E ENERGIA

2.2 Gas Consumption by Sector

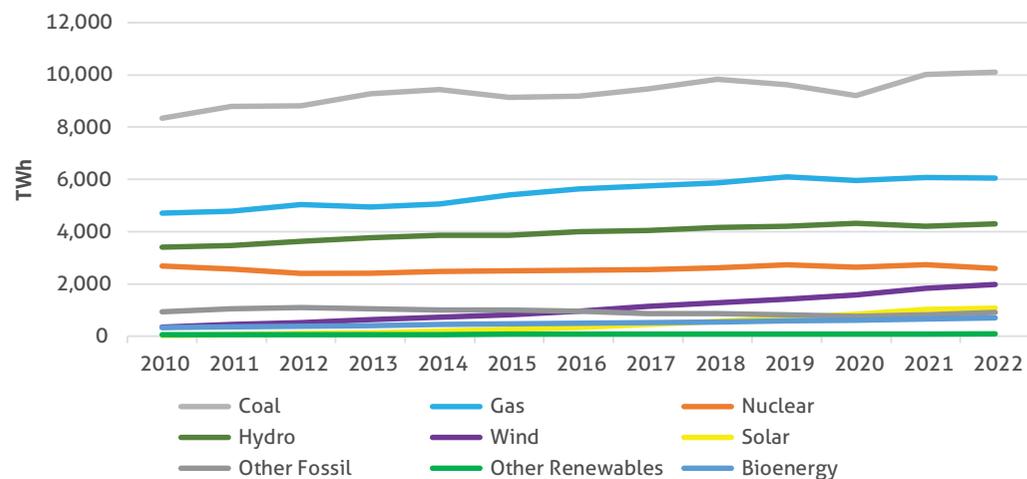
2.2.1 Power generation

In 2022, energy consumption in global power generation sector rose by 1.8% y-o-y, reaching 27,927 TWh, driven by the economic recovery and expansion of the grid in many countries.

The power generation sector is still the larger consumer of gas with a share of 44% of the global gas consumption in 2022. Gas consumption in the power sector was 6,050 TWh (Figure 46), down by 0.2% y-o-y. The decline was due to the gas-to-coal switching in many regions as a consequence of high gas prices which made gas less competitive compared to other fuels.

In the meantime, global renewable power generation continued growing with an increase of 7% compared to 2021 (+200 TWh). Over the past five years, renewables output has more than doubled, driven by increasing policy support. Coal power generation recorded a growth of 1% y-o-y (+102 TWh), with coal power plants benefiting from the high gas prices and rising gas-to-coal switching. Coal still maintains the largest share in the power generation mix at 36% in 2022. Hydropower production increased by 15% y-o-y to reach 4,294 TWh.

Figure 46: Trend in the Global Power Generation Mix

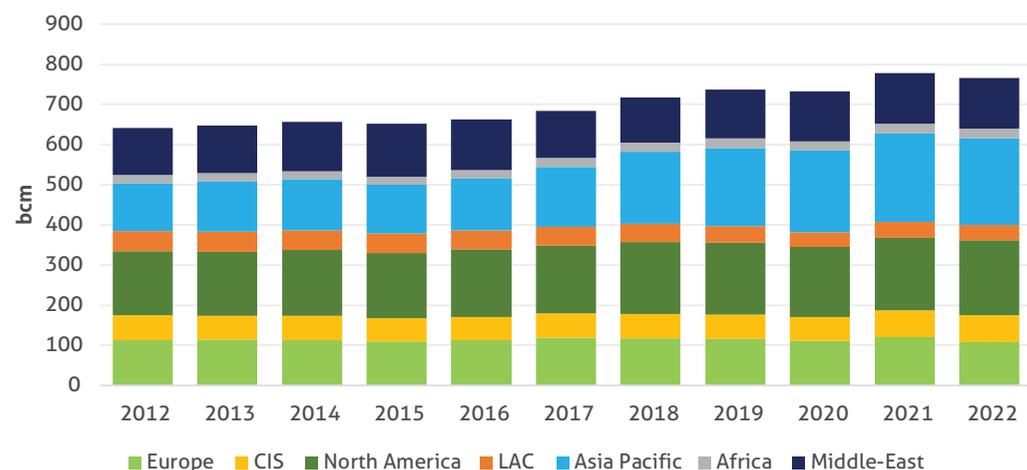


Source: GECF Secretariat based on data from Ember, BP Statistical Review 2021

2.2.2 Industrial Sector

Global gas consumption in the industrial sector is estimated to have declined by 4.4% y-o-y in 2022 to 740 bcm, which corresponds to a decline of 35 bcm (Figure 47). However, gas consumption in the industrial sector was slightly higher than the pre-pandemic level. The key drivers of the decline were demand destruction in some industrial sectors and reduction or partial shutdown in some heavy industries such as cement, fertilizer and steel because of high gas prices. At a regional level, Europe, Asia Pacific and Eurasia recorded a decline of 9%, 2.4% and 3% y-o-y, respectively. However, North America recorded a growth of 4.4% compared to last year, representing an increase of 8 bcm compared to 2021.

Figure 47: Trend in annual gas consumption in the industrial sector by region

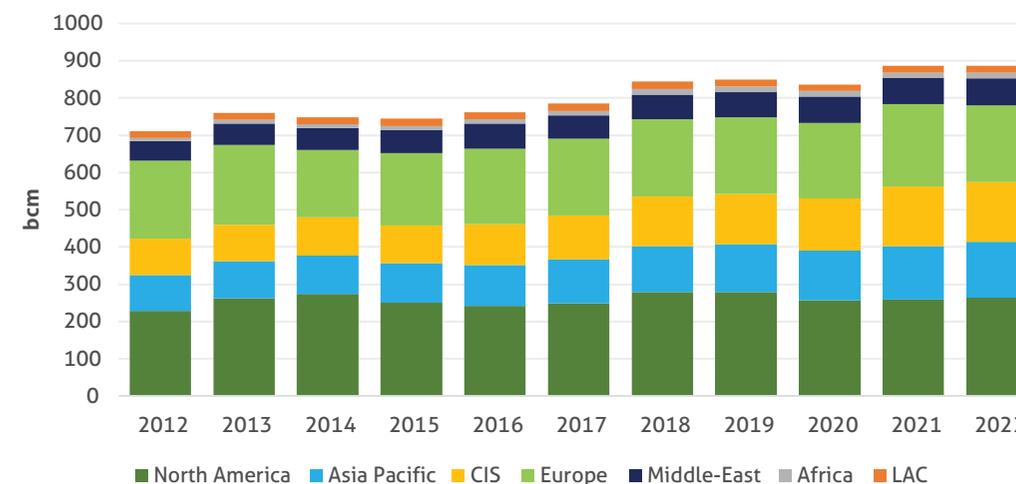


Source: GECF Secretariat based on data from Enerdata, Cedigaz and IEA Monthly Gas Statistics

2.2.3 Residential and Commercial Sector

The global gas consumption in the residential and commercial sector for the year 2022 recorded a decline of 0.1% y-o-y to 886 bcm (Figure 48). This corresponds to a decline of 1 bcm compared to 2021. However, gas consumption was higher than the pre-pandemic level by 4%. The key drivers of the decline were the warm weather conditions witnessed in 2022, with record high temperatures in the winter season, which reduced gas demand for heating during the year. At a regional level, Europe recorded a drop of 7%, representing a decline of 16 bcm compared to 2021. However, North America and Asia Pacific recorded a growth of 2% (6 bcm) and 4% (6 bcm), respectively. Africa recorded a growth of 6% compared to last year, representing an increase of 1 bcm compared to 2021.

Figure 48: Trend in annual gas consumption in the residential/commercial sector by region



Source: GECF Secretariat based on data from Enerdata, Cedigaz and IEA Monthly Gas Statistics

2.2.4 Transportation Sector

Gas utilization within the transportation sector continues to be low, in recent years accounting for just 1% to 2% of total gas consumption on the global level. As such, it remains a niche market for gas penetration, although the prospects are dissimilar in the different transportation modes.

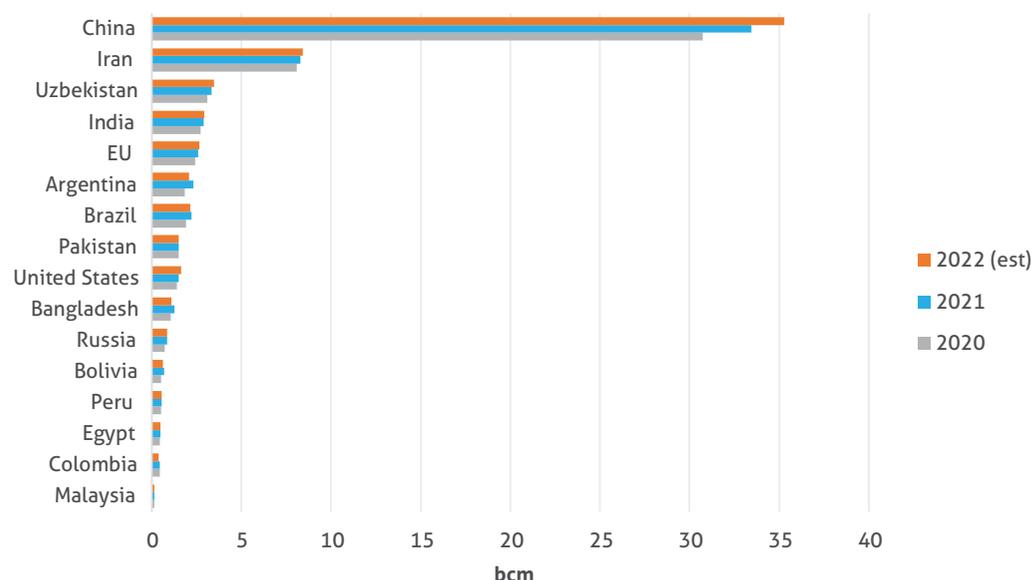
2.2.4.1 Automotive Industry

In the automotive industry, the most popular applications for gas as a vehicular fuel are compressed natural gas (CNG) and LNG. CNG-fuelled engines are particularly useful for the passenger vehicle segment, requiring only minor modifications to contemporary gasoline-fuelled engines. However, CNG solutions are faced with the downside of

needing space to house the large fuel tanks. On the other hand, LNG-fuelled engines are more suitable for the commercial trucking sector, typically for long-range hauling. In recent years, there has been substantial growth in this specific application, backed by significant investments in China. Both gas and conventional gasoline-powered vehicles face increased competition from electric and hybrid electric vehicles while other alternative fuels continue to be explored.

The Asia Pacific dominates the global market for gas vehicles, propelled by large-scale implementation in countries such as China and India, with growing appeal in others such as Pakistan and Bangladesh (Figure 49). China in particular, accounts for more than four times the volume of gas consumed by this industry compared with the next country on the global list.

Figure 49: Gas consumption in the automotive industry of selected countries



Source: GECF Secretariat based on data from Enerdata

Gas vehicles have become well established in Iran, with particular focus being placed on the utilization of CNG fuel. Through a government initiative to declare CNG as the national fuel, Iran may benefit from lower fuel cost and reduced atmospheric smog. In 2022, the National Iranian Oil Products Distribution Company reported that over 200,000 public transportation vehicles have been converted for dual-fuel (gasoline and gas) use, with the ultimate target being 1.2 million vehicles by 2026. It is estimated that thus far, the quantity of gasoline saved in the country as a result of this measure has reached 370 million litres.

As part of a memorandum of understanding signed between Iran and Nigeria, both countries agreed to cooperate in the area of gas utilisation as a vehicular fuel. A seven-year programme will involve Iranian firms constructing 1,000 CNG refuelling stations, as well as 70 conversion sites, targeting one million vehicles. The metropolis of Lagos has launched a fleet of CNG-powered buses that will provide high-capacity public transit in the city.

India continues to represent a major market for gas utilization in the transportation sector. The government has invested heavily in a nationwide CNG initiative, and has increased the construction of adequate refuelling stations to facilitate this. Over 4,700 CNG stations are in operation across the country. That number is expected to rise to 8,000 by 2024, which would mark a significant growth of almost 800% within only ten years. It was reported that there were over 200,000 CNG vehicles sold in India in 2022, an increase of 70% from 2021. CNG vehicles now account for around 10% of all car sales in the country. However, the sector in the country was challenged by skyrocketing gas prices observed throughout 2022; it has been estimated that growth in the CNG market may be limited to just around 10% during the current fiscal year. In response, the government is investigating solutions such as bio-CNG to supplement gas.

Gas penetration in the automotive industry has been limited in Europe. Currently, of the fleets of passenger vehicles and trucks, less than 1% are fuelled by gas. The market share is much more favourable for buses, accounting for almost 4% of the region's fleet. The EU has implemented several policies aimed at reducing carbon and particulate emissions from the transportation sector. Firstly, the Fit For 55 initiative targets the reduction of carbon emissions in new vehicles in the region by 15% by 2025, 55% by 2030 and 100% by 2035, compared with the base year of 2021. Further, in November 2022, the European Commission introduced the Euro 7 proposal, which aims to reduce emissions of particulates and NOx in cars and vans by 13% and 35% by 2035. Both of these serve as complementary drivers promoting the shift away from gasoline engines in Europe and may increase the penetration of gas as a fuel in the region. In this regard, there is continuing investment in the necessary refuelling infrastructure to accommodate this shift, with Europe currently at 4160 CNG stations and 635 LNG vehicle-refuelling stations in operation.

Bolivia's government department responsible for overseeing the conversion of vehicles to gas fuels has reported over 200,000 conversions of state, public and private vehicles since the inception of the programme in 2010 until 2022.

In Peru, the Ministry of Energy and Mines has implemented a system of subsidies on vehicle conversions from petrol engines to alternative fuels such as CNG. The government expects this incentive to spur the conversion of at least 50,000 vehicles in 2023. Additionally, the country recently commissioned the first LNG refuelling station in Peru, which will support the heavy-duty transportation industry.

Egypt has also been making great strides in gas penetration in the road transportation sector, particularly through the conversion to CNG vehicles and expanding the national CNG refuelling capacity. In fact, in 2022 alone, the country targeted a doubling of CNG stations to reach 1,000 by the end of the year. Moreover, over 350 diesel-powered buses were converted to operate on gas in 2022; this is part of an overall plan to revamp the entire 2,200 public bus fleet over a five-year period. Added to this is the recent initiative to launch a light four-wheeled gas vehicle to replace the current 3.5 million three-wheeled taxis that are commonplace in the country.

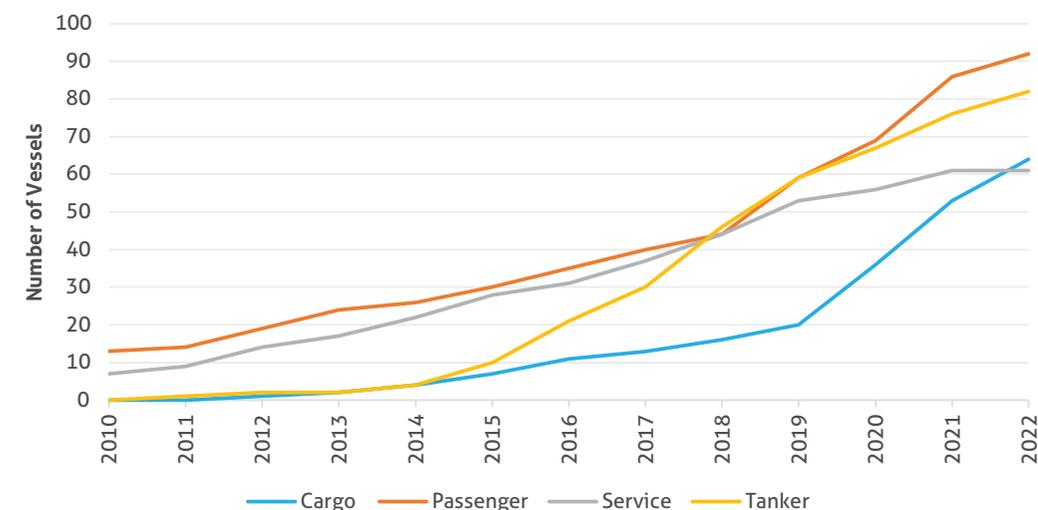
One key drawback the industry faces is the volatility of gas prices widely observed throughout 2022. The industry is also challenged by the growing climate agenda, which may not only shift market share away from gasoline fuels to gas, but might reduce market share of CNG vehicles in the long term. Options such as electric vehicles are growing rapidly in popularity, while alternative fuels such as hydrogen are still in the nascent state, and may not soon be ready for large-scale deployment.

2.2.4.2 Maritime Industry

The maritime industry has more positive prospects for the utilisation of gas as fuel than in the automotive industry. This is clearly demonstrated by the steady growth in new orders for alternatively fuelled marine vessels, which slowly increase market share as older vessels are retired. The most widely utilised of these alternatives is LNG, with an industry of purpose-built bunkering vessels growing in magnitude over recent years. LNG fuel offers significant impact with regard to the reduction of carbon emissions by up to 20%. In addition, compared with traditional fuel oils, LNG-fuelled vessels present the possibility for an 80% reduction in NOx compounds and little to zero SOx compounds and particulates. Similar to the automotive industry, other fuel options do exist, such as methanol, ammonia and hydrogen, but the scale of deployment of these are yet to be comparable with LNG.

The switching from conventional fuel oils to LNG as a marine fuel is further encouraged with the implementation of global regulations from the International Maritime Organisation (IMO). Details of these regulations are explored in detail in the section on LNG Shipping. On the regional level, these are further complemented by specific regulations and policies put into place by individual governments, some of which may even be more stringent, as in the case of the EU.

Figure 50: Global LNG-fuelled vessels by type



Source: GECF Secretariat based on data from Argus

There was a slowdown in the growth rate of the global LNG-fuelled fleet in 2022, rising by 8% compared to the previous year, to reach 300 vessels (Figure 50). Passenger vessels, which include cruise ships and ferries, account for the largest share of the LNG-fuelled fleet. On the other hand, 11 LNG-fuelled cargo ships were commissioned in 2022, continuing the trend in recent years as the fastest growing segment in the overall LNG-fuelled fleet. Cargo and service vessels each account for one-fifth of the global LNG-fuelled fleet.

Looking ahead, the expectation is that the total number of LNG-powered vessels will continue to grow, driven by the IMO and regional regulations. There may continue to be further penetration into the global cargo trade industry, particularly through new entries of container ships but also new vehicle carriers.

The global LNG refuelling capability has also been growing to keep pace with this rising demand. Over the course of 2022, there was a 12% increase in the total capacity of LNG bunkering vessels brought online globally. As shown in Figure 51, a sizeable capacity was also placed on order prior to 2022 but has not yet made it to market, further adding to the global LNG bunkering potential. In fact, when considering the planned projects, the global LNG bunkering capacity is expected to double by 2024, reaching over 300,000 cubic metres.

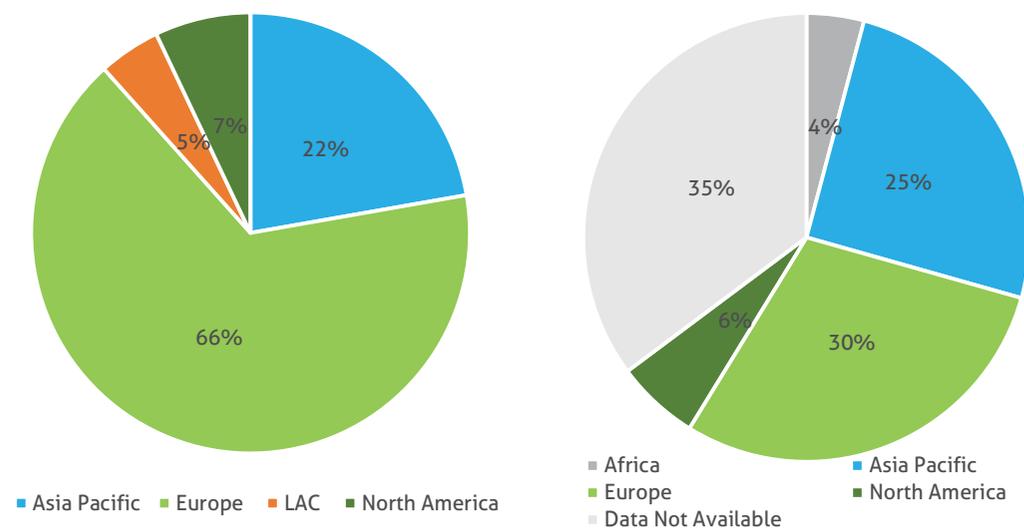
Figure 51: Cumulative global LNG bunkering vessels capacity



Source: GECF Secretariat based on data from Argus

Currently, two-thirds of the operational global LNG bunkering capacity is located around the European region, notably the Northwest area and Mediterranean Sea (Figure 52).

Figure 52: Regional distribution of LNG bunkering capacity by 2022: operational (left), and ordered or planned (right)



Source: GECF Secretariat based on data from Argus

However, the Asia Pacific region is growing in significance, representing 22% of the current global operational capacity and accounting for at least a quarter of capacity on order or in the planning stage.

Collectively, bunkering firms from hubs around the globe have been collaborating in an effort to create a global LNG bunkering network. According to Pavilion LNG, which operates out of Singapore, the initial members of this network also include Gasum from Finland and CNOOC of China, thereby covering the key hubs of the Baltic and northwest Europe, along with the Far East Asia Pacific region. In fact, China is making huge investments into constructing the LNG bunkering hub at Shenzhen into the largest such facility in Asia Pacific. There are future plans to expand the global LNG bunkering alliance to firms and ports operating in the Mediterranean and the Americas.



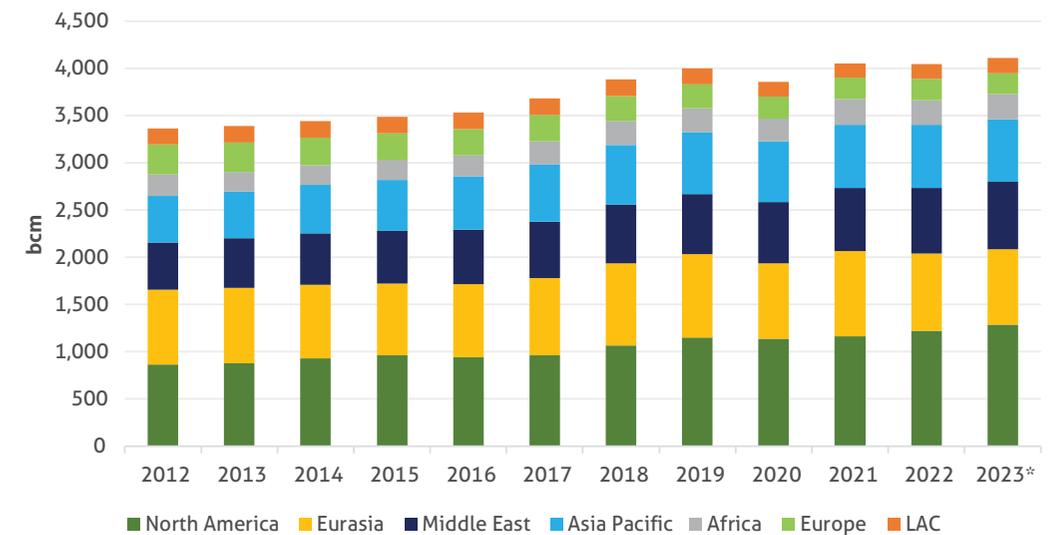
CHAPTER
03

Gas Production

3.1 Gas Production by Region

Based on preliminary estimations, global gas production declined by 0.1% to 4.04 tcm in 2022 (Figure 53). Several factors, including decreased gas demand and geopolitical tensions, exerted downward pressure on gas production in 2022. Moreover, increased upstream costs and high inflation hampered upstream activities while affecting companies' profit margins. Therefore, many companies followed strict financial discipline to increase their cash flow and balance their financial statements.

Figure 53: Gas production on a regional basis



Source: GECF Secretariat based on data from Rystad Energy Ucube
*Forecast for 2023

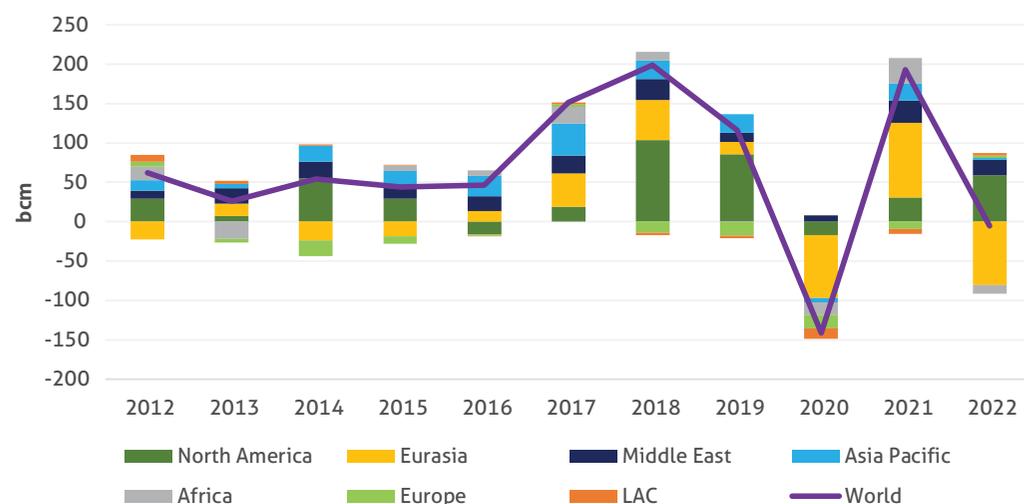
Among the regions, Eurasia and Africa experienced the highest levels of decline (9% and 4%, respectively) as shown in Figure 54. Conversely, the gas output of North America, the Middle East, LAC, Europe, and Asia Pacific increased by 59 bcm, 20 bcm, 3 bcm, 3 bcm, and 2 bcm respectively. On a country basis, the US, Canada, and Saudi

Arabia experienced the highest levels of production increase in 2022. Non-GECF gas output is estimated to have increased by 3.8% to reach 2,443 bcm in 2022, mainly due to a production increase of 46 bcm in the US.

The volume of gas resources linked to new projects declined in 2022 compared to 2021. These projects are estimated to recover 1,748 bcm of gas during their lifetime from 155 fields (compared with 1,818 bcm from 2021 projects). The fields that started production in 2022 added 14 bcm to the global gas supply and are expected to contribute 60 bcm to 2023 gas output. The top 3 upstream project startups in 2022 were the Kharampurskoye (phase 1, Cenomanian) and Semakovskoye (phase 1) gas fields in Russia and the Gorgon/Jansz (stage 2) field in Australia.

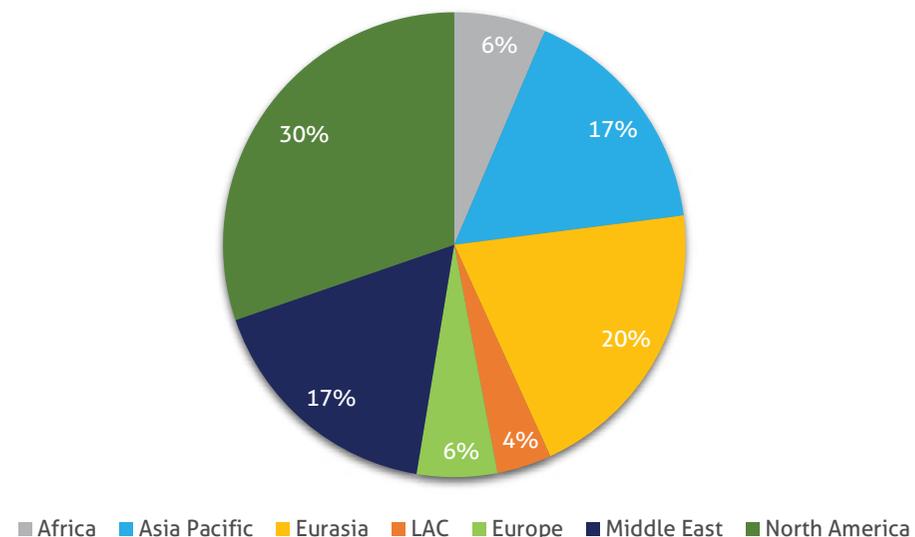
For 2023, with demand recovering, gas production is also expected to increase by 1% driven by production increase in North America, LAC, the Middle East, and Africa (5%, 4%, 3%, and 2%, respectively). Unconventional gas output is expected to increase by 6% followed by offshore production (1%). In the medium term, North America and the Middle East will be the main sources of global gas output increase, followed by Eurasia and Africa. Gas output from unconventional sources will be the main driver of gas production growth in the medium term.

Figure 54: Incremental gas production variation by region



Source: GECF Secretariat based on data from Rystad Energy Ucube

Figure 55: Shares of regions in global gas production (2022)



Source: GECF Secretariat based on data from Rystad Energy Ucube

3.1.1 North America

The US gas output increased by 4.7% y-o-y to reach 1,013 bcm in 2022 (Figure 56). The increased supply met the higher demand for feedgas by liquefaction plants. The majority of US gas is produced from the main shale gas/oil regions, including Anadarko, Marcellus, Utica, Bakken, Eagle Ford, Haynesville, Niobrara, and Permian. The rise in US gas production in 2022 was attributed to a surge in drilling operations in the Permian and Haynesville basins, according to EIA’s Short-term Energy Outlook, and due to the recent expansion of pipeline infrastructure in both regions.

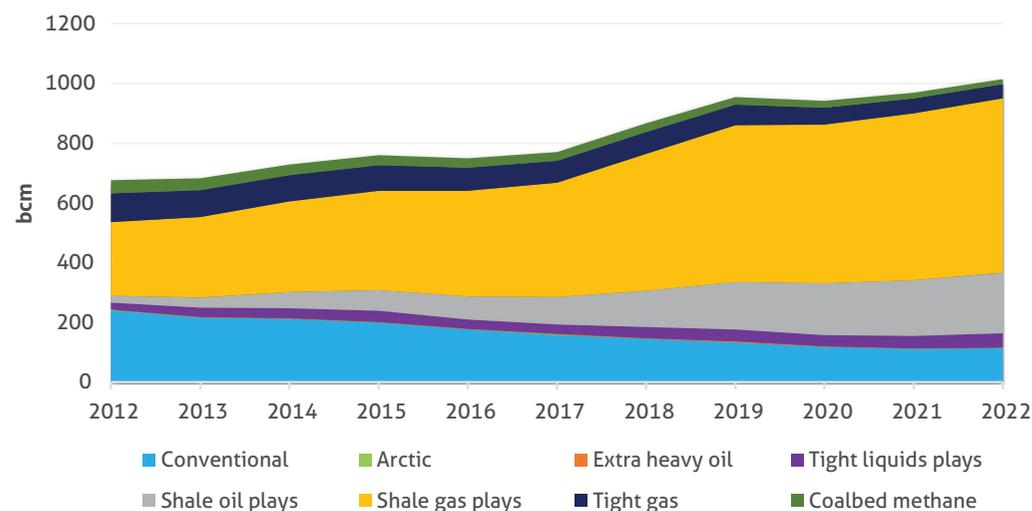
As a result, US unconventional gas production increased by 5% to reach 902 bcm in 2022, representing 72% of the global unconventional gas output, according to Rystad Energy’s Ucube. The Permian region (associated gas) and the Appalachian region, consisting of Marcellus and Utica, were the leading shale gas producers, accounting for 20% and 37% of total production from the seven key regions, respectively.

Increased upstream costs, high inflation, and the declining number of high-quality DUCs (Drilled but Uncompleted Wells) were the primary headwinds to the US gas production in 2022, affecting companies’ profit margins. For instance, according to Bloomberg, producers in the Permian region have experienced a significant increase in the cost of proppant, with prices rising by 150%. Therefore, many companies followed strict financial discipline to increase their free cash flow.

The number of drilled but uncompleted (DUC) wells in 7 key US shale oil and gas-producing regions of the US stood at 4,577 at the end of 2022. This is 498 wells below the number of DUCs in December 2021. The high price of natural gas and the rising costs of drilling new wells have incentivized drillers to complete previously drilled wells and make them operational.

US gas production is expected to rise by 5% (51 bcm) to 1,064 bcm in 2023.

Figure 56: US gas production by type



Source: GECF Secretariat based on data from Rystad Energy Ucube

3.1.2 Asia Pacific

In 2022, gas production in the Asia Pacific increased by 2 bcm to reach 671 bcm, representing a 17% share of global gas production. The increase in Asia Pacific production was driven by China (7.2 bcm), Australia (3.4 bcm), and India (2.7 bcm).

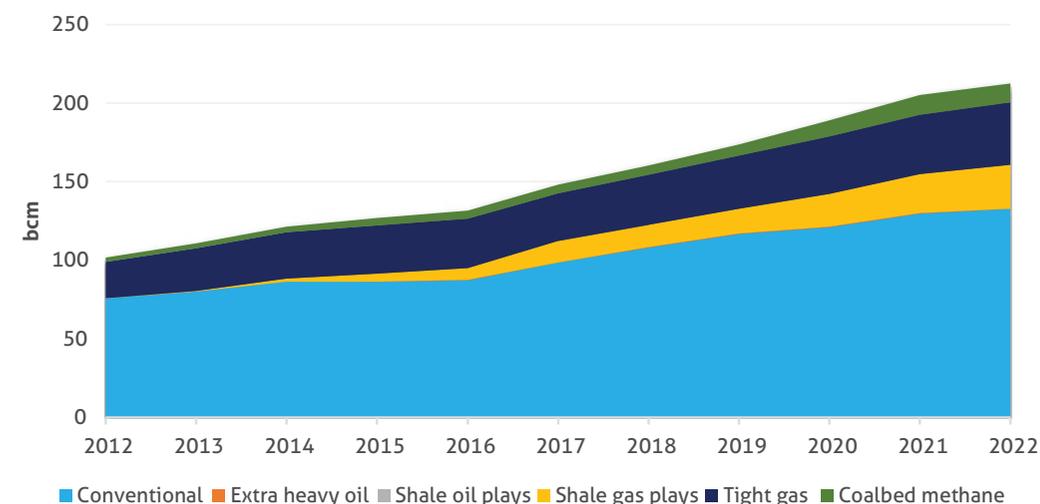
China’s gas production increased by 4% y-o-y to reach 212.5 bcm in 2022 (Figure 57). The country’s gas production has seen a steady increase in recent years and has the potential to continue its upward trend while recording an all-time high in December 2022.

Meanwhile, total unconventional gas production in China increased from 40 bcm in 2015 to 79 bcm in 2022, accounting for 37% of total gas output. Gas production from unconventional sources in China has become crucial in responding to the country’s energy needs. Over the years, numerous exploration and development projects have been launched to enhance unconventional production capability. In recent years, state-owned companies in China have successfully developed unconventional basins like the Sichuan basin without any assistance from international companies. These companies

serve as the primary developers of China’s shale plays. The shale formations in China are situated in regions that are both densely populated and mountainous, making the process of fracking and commercializing these resources more challenging. The geological structure of these shale formations in China is more complicated than those in the US.

In July 2022, state-run oil giant, CNOOC, claimed to have made a breakthrough in Chinese offshore shale with its commercial discovery of oil and gas in the Beibu Gulf in the South China Sea. This marks the first time that China has successfully discovered offshore shale. Moreover, Argus reported that China’s Ministry of Natural Resources has officially recognized Sinopec’s Qijiang shale gas field in southwest China as a shale gas field with proven reserves of 146 bcm located in the Sichuan Basin.

Figure 57: China’s gas production by type

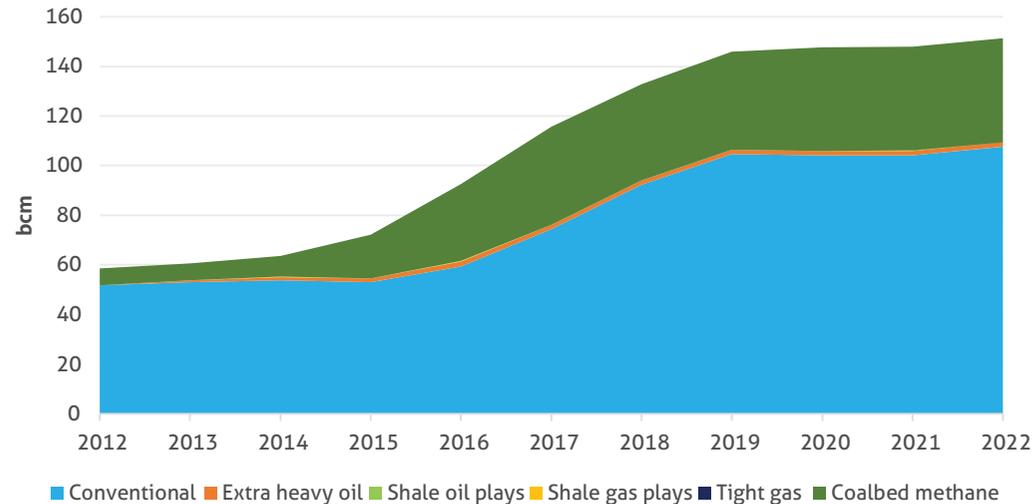


Source: GECF Secretariat based on data from Rystad Energy Ucube

The other major producer in the region, Australia, has recently seen a significant increase in investment in unconventional energy sources, particularly in developing Coal Bed Methane (CBM) production. This boost supports the country’s LNG liquefaction plants. The government aims to attract even more investment by easing regulations that hinder gas project growth. The ultimate goal is to maximize production from Australia’s abundant unconventional gas resources. However, the main concern of the Australian government amidst the expansion of the country’s LNG export facilities is the domestic gas shortage. Even though LNG export is one of the main pillars of the country’s economy, the government attempts to secure a sufficient gas supply to domestic consumers.

As indicated in Figure 58, total gas production in Australia increased by 2% in 2022 to stand at 151.3 bcm. Conventional gas production dominates Australia’s gas output followed by coal-bed methane. Unconventional gas production in Australia increased dramatically in recent years by commissioning new liquefaction projects fed by gas production from CBM. Australia’s unconventional gas production reached 42 bcm in 2022.

Figure 58: Australia’s gas production by type

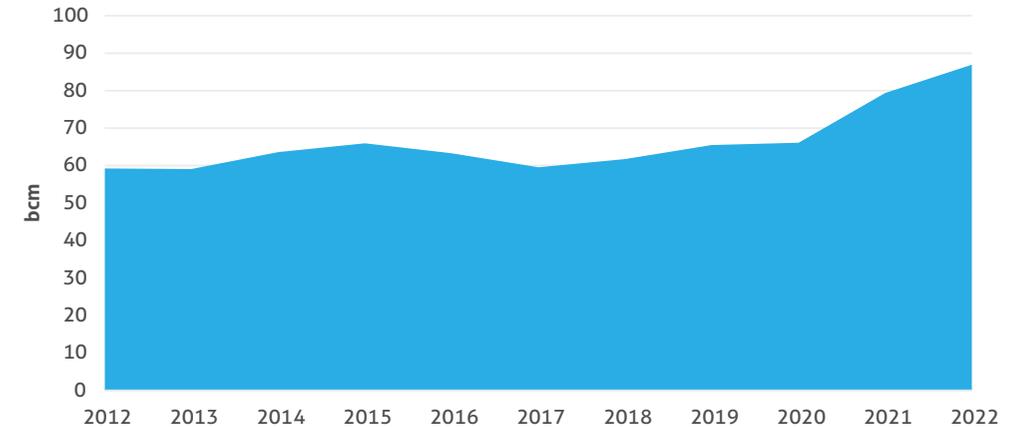


Source: GECF Secretariat based on data from Rystad Energy Ucube

3.1.3 Eurasia

In 2022, Eurasia gas production is estimated at 817 bcm, representing a 9% decrease compared to the previous year. Russia dominates the region’s gas production, followed by Turkmenistan, Uzbekistan, Azerbaijan, and Kazakhstan. In 2022, the Euraisa region represented 20% of global gas production. Gas production in Azerbaijan increased by 5% y-o-y to reach 32 bcm. Growth was driven by the development of the Shah Deniz field, which supported gas exports to Türkiye through the TANAP pipeline. Turkmenistan’s gas production increased by 9% to stand at 87 bcm representing 11% of the region’s gas output (Figure 59).

Figure 59: Turkmenistan gas production



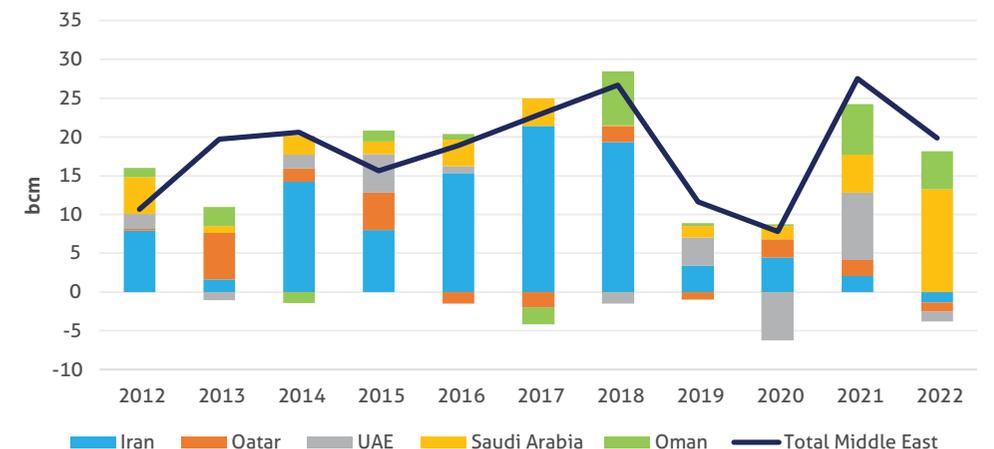
Source: GECF Secretariat based on data from Rystad Energy Ucube

3.1.4 The Middle East

Gas production in the Middle East increased by 3% (20 bcm) to stand at 693 bcm in 2022. While the Middle East’s gas output was resilient during the pandemic in 2020 and 2021, escalating production in 2022 increased the region’s share in global gas production to 17%. Saudi Arabia, Oman, and Iraq were the primary sources of production increase in the region, with 13 bcm, 5 bcm, and 2 bcm, respectively (Figure 60). Meanwhile, the Middle East is driving the rising demand for jack-up rigs in 2022 and 2023.

In the Middle East, Qatar and the UAE have been actively utilizing their gas resources to increase LNG export capacity with a series of projects. Both countries are advancing rapidly with their respective LNG expansion projects, which are highly cost-competitive.

Figure 60: Y-o-Y variation in the Middle East’s gas production



Source: GECF Secretariat based on data from Rystad Energy Ucube

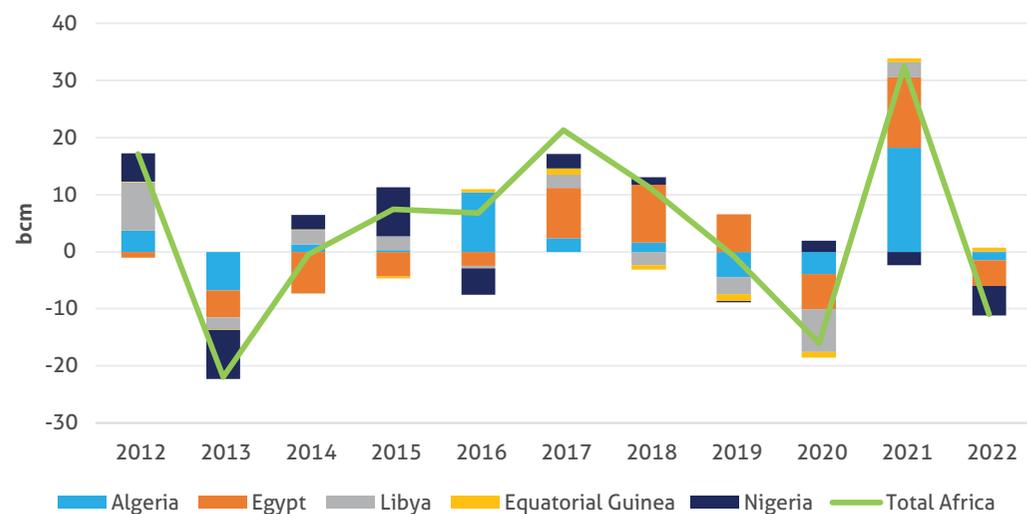
3.1.5 Africa

In 2022, gas production in Africa decreased by an estimated 11 bcm to 259 bcm, representing 6% of global gas output. While gas production from countries such as Mozambique and Tanzania increased by 0.3 bcm and 0.2 bcm, respectively, the output from other major producers in the continent slightly decreased, as indicated in Figure 61.

Rystad Energy reports that Eni and its joint venture have reached a significant milestone in Africa in 2022 by finalizing the investment decision to develop the Quiluma and Maboqueiro gas fields in Angola. The project is crucial in ensuring a steady supply of feedgas for Angola LNG Train 1 and is expected to commence operations in 2026. Additionally, Eni has commenced production at two gas fields located in the Berkine area in Algeria.

The upcoming years will witness a boost in Sub-Saharan Africa’s production due to offshore deepwater resource development. However, significant investment will be required for the development of the discoveries. To increase their output, gas resource holders in the region are significantly increasing their licensing rounds.

Figure 61: Y-o-Y variation in Africa’s gas production



Source: GECF Secretariat based on data from Rystad Energy Ucube

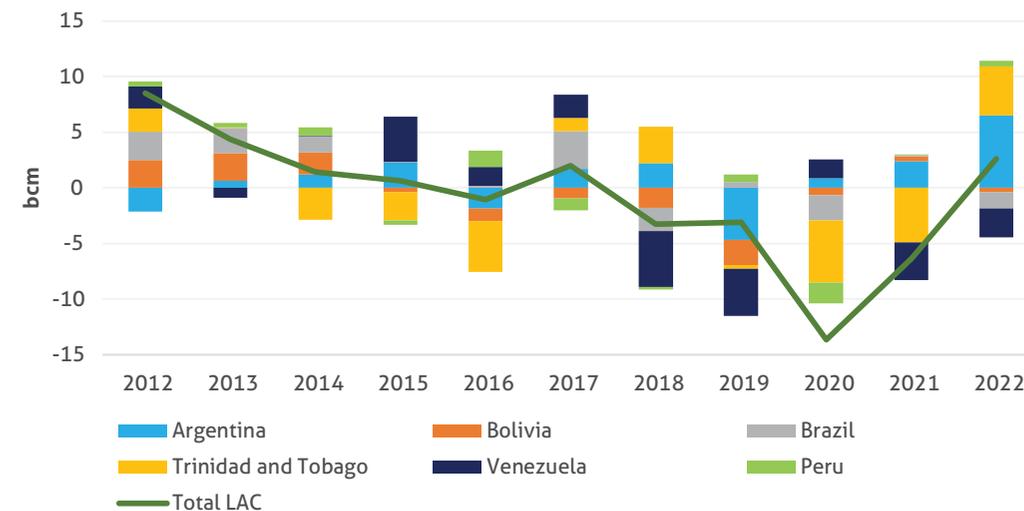
3.1.6 Latin America and the Caribbean (LAC)

In 2022, gas production in LAC increased by 3 bcm to 154 bcm, driven by production increase in Trinidad and Tobago and Argentina (Figure 62).

In Trinidad and Tobago, gas production increased by 17% (4.4 bcm) to reach 30.8 bcm in 2022. Gas output from other major producers of the region, Venezuela and Bolivia, stood at 17.0 bcm and 15.7 bcm, respectively. In addition, Peru’s gas production increased from 11.6 bcm in 2021 to 12.1 bcm in 2022.

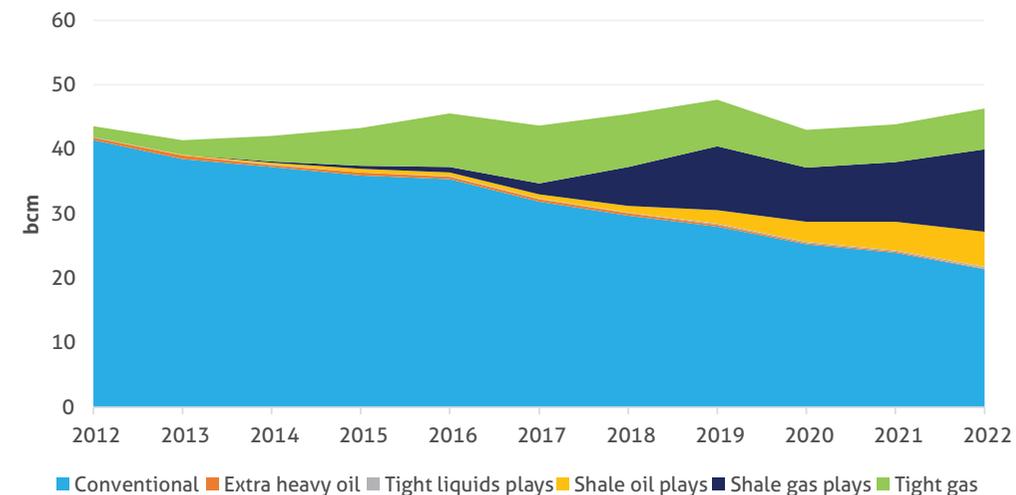
In Argentina, the Vaca Muerta shale basin is the country’s main source of gas production. Argentina’s energy policy mainly focuses on developing the Vaca Muerta basin to increase domestic production and reverse the declining trend observed in recent years. From 46 bcm in 2010, total gas production decreased to 41 bcm in 2013, but since then, the trend has been reversed, with production reaching 47 bcm in 2022 (Figure 63). Unconventional gas production accounted for 54% of Argentina’s total gas production in 2022.

Figure 62: Y-o-Y variation in LAC’s gas production



Source: GECF Secretariat based on data from Rystad Energy Ucube

Figure 63: Argentina’s gas production by type

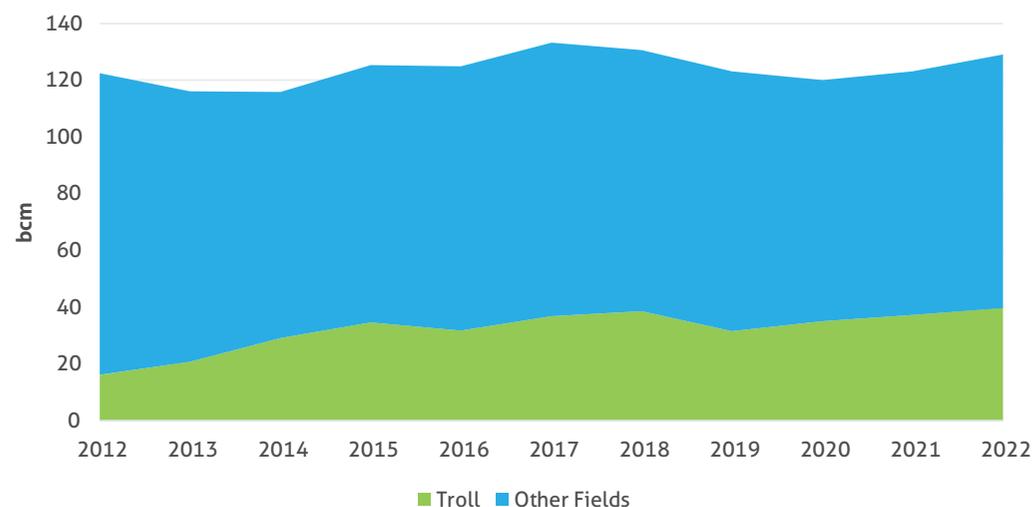


Source: GECF Secretariat based on data from Rystad Energy Ucube

3.1.7 Europe

Europe’s gas production increased by 1.4% to stand at 227 bcm in 2022. The increase was driven by the rise in output by Norway and the UK, whose production stood at 129 bcm (Figure 64) and 35 bcm, respectively. Norway secured the top spot as Europe’s leading gas supplier in 2022. The Norwegian Petroleum Directorate reports that the country’s gas production is forecasted to stay steady in 2023, while upstream investment is predicted to increase by 10%, reaching 189 billion crowns (\$18 billion).

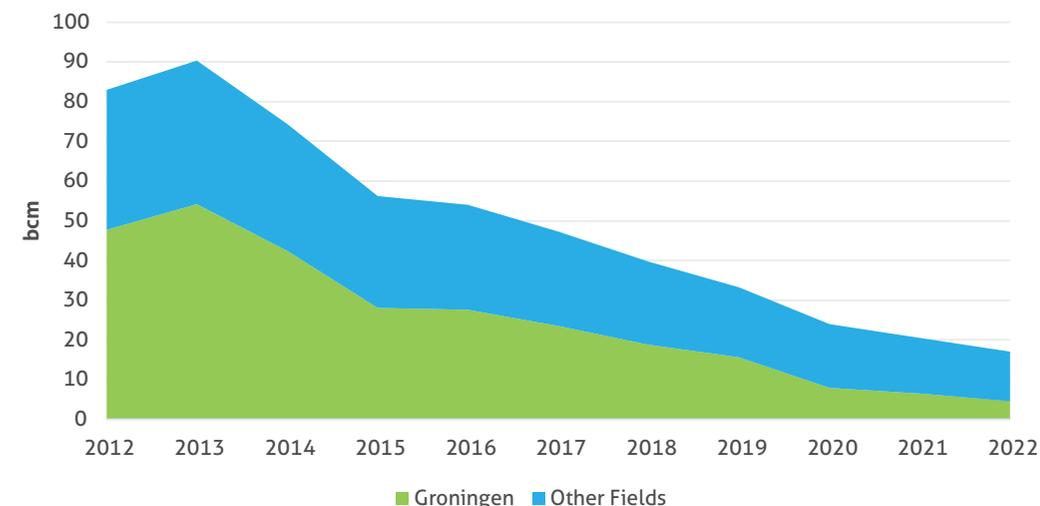
Figure 64: Norway’s gas production by field



Source: GECF Secretariat based on data from Refinitiv

Meanwhile, the Netherlands’ government plans to stick to its timeline for the closure of the Groningen gas field by October 2023, with the option of extending its operation by one more year in case of a gas shortage in Europe in winter. While the field has been one of the main sources of European gas supply in the past, the production cap has been gradually reduced since 2014 (Figure 65), with the aim of its eventual closure.

Figure 65: Netherlands’ gas production by field



Source: GECF Secretariat based on data from Refinitiv

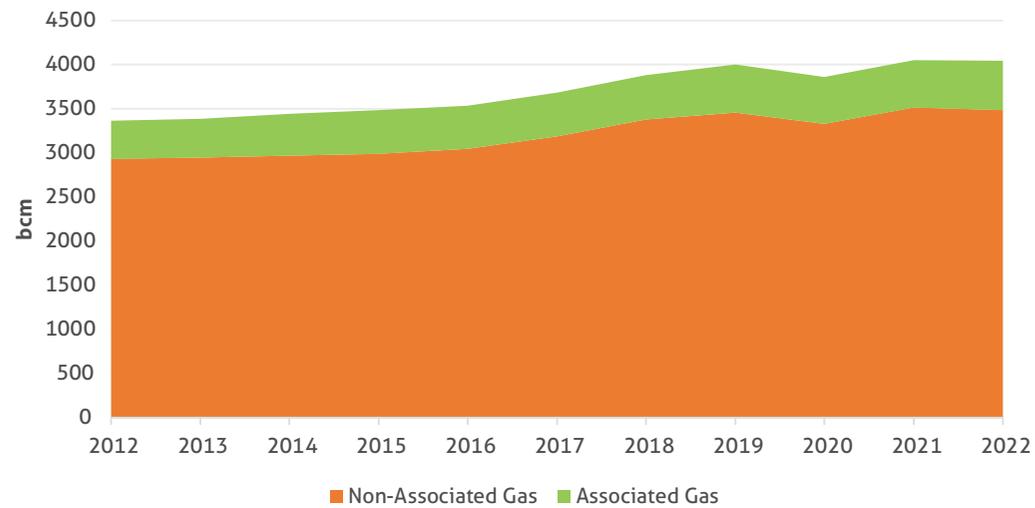
3.2 Gas Production by Type

In 2022, 14% of global gas production (562 bcm) came from associated-gas sources, compared to 13% (536 bcm) in 2021, as indicated in Figure 66. Meanwhile, non-associated gas production stood at 3,484 bcm accounting for 86% of global gas output in 2022. Associated gas production is expected to reach 598 bcm in 2023.

The share of gas production from onshore sources stood at 71% (2,880 bcm) of the global gas output in 2022, while 29% (1,166 bcm) of the global gas output was produced from offshore sources such as shelf, mid-water, and deep-water sources as can be seen in Figure 67. Regarding the supply segments, the decline in onshore production was the main reason for the decrease in 2022 output, followed by the offshore shelf.

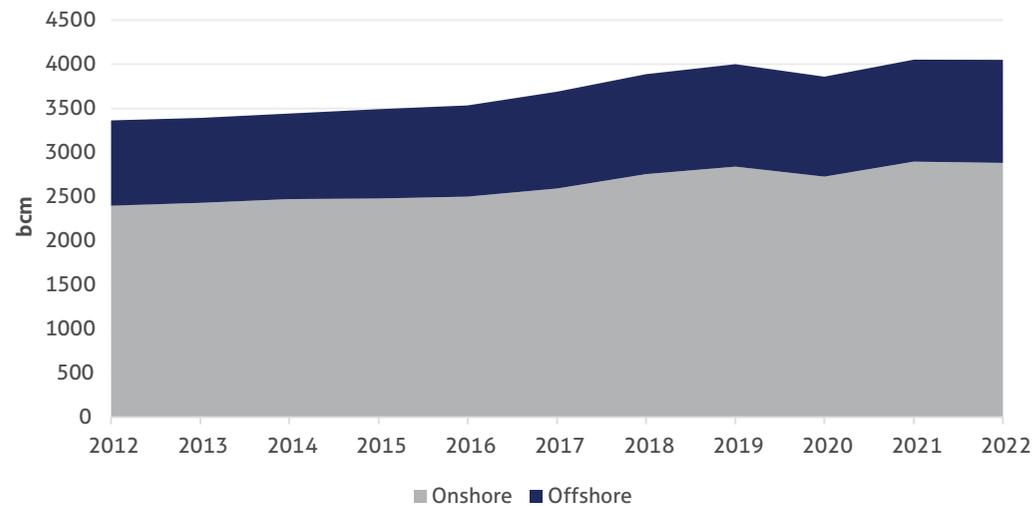
The share of gas production from unconventional sources was 31% in 2022, compared to 21% in 2015, as seen in Figure 68. As mentioned previously, total global gas production declined in 2022, driven by the decline in conventional gas production, while gas production from unconventional sources increased. Shale gas is the dominant source of unconventional gas production, followed by the associated gas production from shale oil plays.

Figure 66: Global gas production by field type (associated vs. non-associated)



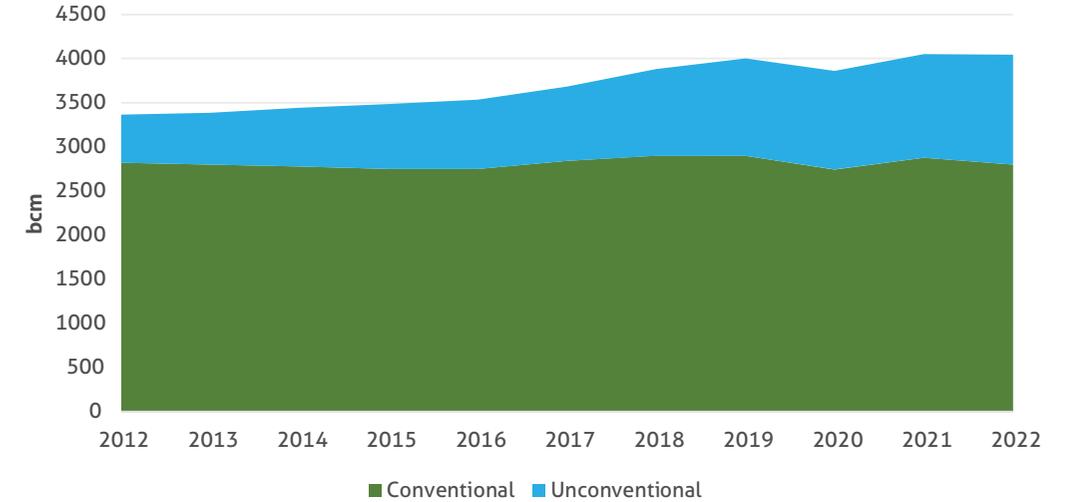
Source: GECF Secretariat based on data from Rystad Energy Ucube

Figure 67: Global gas production by supply segment (onshore vs. offshore)



Source: GECF Secretariat based on data from Rystad Energy Ucube

Figure 68: Global gas production by field type (conventional vs. unconventional)



Source: GECF Secretariat based on data from Rystad Energy Ucube

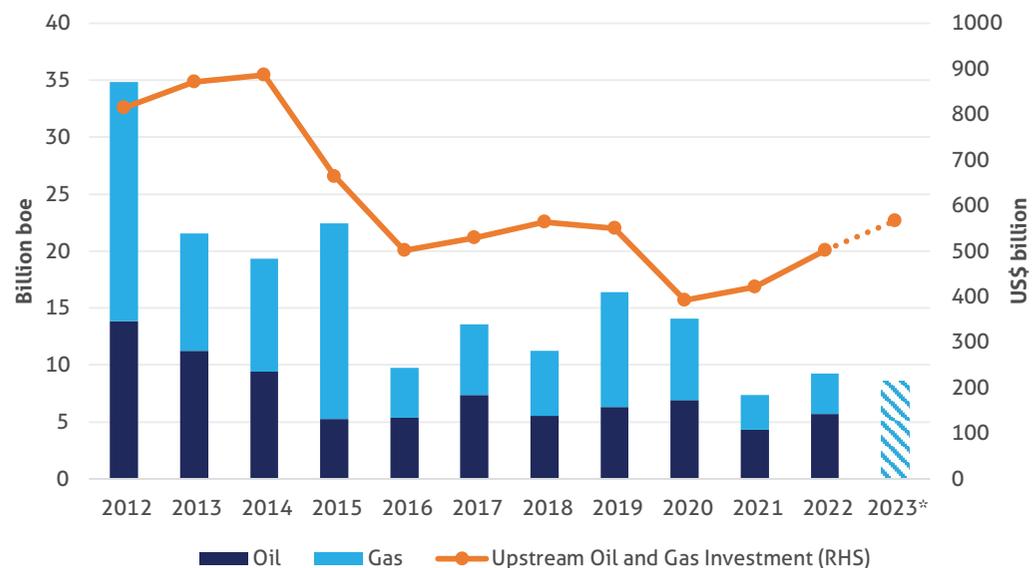
3.3 Global Upstream Developments

3.3.1 Discoveries

The total discovered volumes (liquids and gas) in 2022 stood at 9.2 billion barrels of oil equivalent (boe) according to Rystad Energy, which compares to discoveries of 7.35 billion boe in 2021 with more than a 25% increase in the discovered volumes y-o-y. 39% of the newly discovered volumes represent gas (610 bcm), while the rest is oil (Figure 69).

Offshore discoveries continue to dominate the new explorations' success in terms of newly discovered volumes, representing about 90% of the new volumes, with ultra-deep offshore acquiring the major stake with about 40%.

Figure 69: Global annual oil and gas discovered volumes vs upstream investments



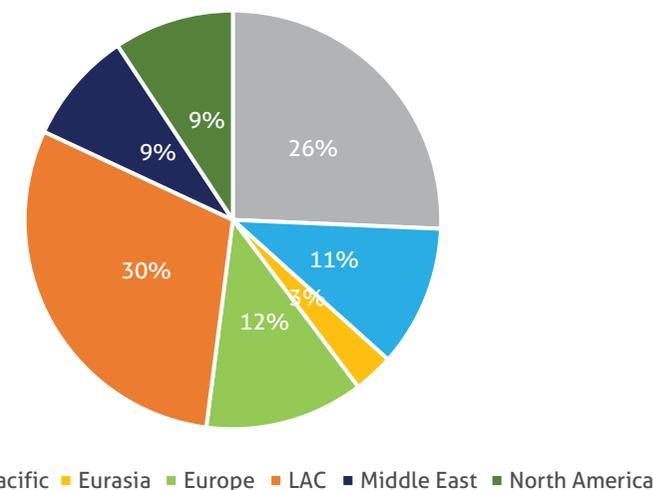
Source: GECF Secretariat based on data from Rystad Energy Ucube
*Forecast for 2023

On a regional basis, LAC acquired the highest stake in the global oil and gas discovered volumes with about 30% of the total volumes discovered, with Africa following in the second rank with about 26%, followed by Europe, Asia Pacific, Middle East, North America and Eurasia holding shares of 12%, 11%, 9%, 9% and 3% respectively (Figure 70).

The Middle East and Europe topped the global new discoveries of gas thanks to the gas discoveries in the UAE and Cyprus, while Africa and LAC topped the global new discoveries of liquid volumes thanks to the great oil discoveries in Namibia and Guyana.

On a country level, the gas discoveries in offshore block 2 in the UAE and the new Cypriot gas fields Coronos and Zeus in the Eastern Mediterranean basin stood as the most significant gas discoveries in 2022. For liquid oil, the new oil discoveries offshore Guyana and the Namibian Venus and Graff offshore fields were the most significant in 2022.

Figure 70: Distribution of discovered volumes by region



Source: GECF Secretariat based on data from Rystad Energy Ucube

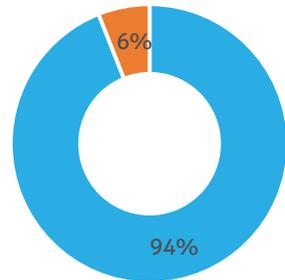
In spite of the downward trend in the upstream investment since 2014, with the bottom reached in the pandemic year of 2020 with only \$390 billion, 2022 can be considered a “standout year for exploration” with significant volumes discovered, even though exploration well numbers were less than half the numbers during pre-pandemic years. In 2022, upstream oil and gas investment was estimated at \$501 billion, with exploration capex accounting for only around 10%. In 2023, the discovered volumes are expected to decrease by 6% driven by the relatively high discovered volumes in the base year 2022 accompanied by a minor share of the exploration capex.

3.3.2 Gas Reserves and Resources

The global gas reserves were estimated at 202 tcm as of 2022, according to Enerdata and Cedigaz, with unconventional gas reserves, including shale gas and CBM, accounting for 6% of the total gas reserves (Figure 71). Shale gas reserves are the largest source of unconventional gas reserves in all regions and basins, with their share reaching 86%. Shale gas reserves support gas production in North America and Asia Pacific regions due to abundant resources in US and China, while coalbed methane supports gas production for the LNG plants in Australia.

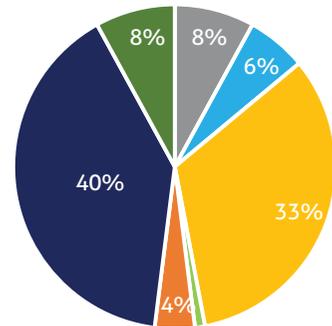
The Middle East holds the world’s highest volume of gas reserves accounting for 40% of global reserves. Other regions, in particular, Eurasia, North America, Africa, Asia Pacific, LAC, and Europe, each hold 33%, 8%, 8%, 6%, 4%, and 1% of global reserves, respectively (Figure 72).

Figure 71: Shares of conventional and unconventional gas reserves



■ Conventional Gas Reserves
■ Unconventional Gas Reserves

Figure 72: Regional shares of gas reserves

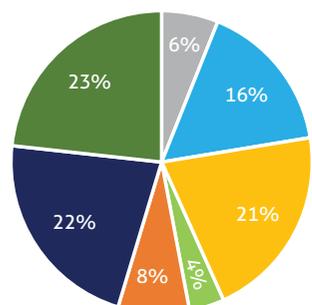


■ Africa ■ Asia Pacific ■ Eurasia
■ Europe ■ LAC ■ Middle East
■ North America

Source: GECF Secretariat based on data from Enerdata and Cedigaz

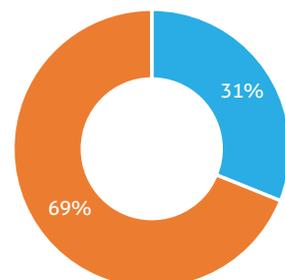
In 2022, the global technically recoverable gas resources were estimated at 325 tcm, according to Rystad Energy, with North America, the Middle East and Eurasia holding the highest shares with 23%, 22% and 21%, respectively. Asia Pacific, LAC, Africa and Europe trail behind with 16%, 8%, 6% and 4%, respectively (Figure 73). Meanwhile, conventional gas resources account for 224 tcm and unconventional gas resources account for 101 tcm. Shale gas dominates the global unconventional gas resources, and the remaining volume belongs to tight gas and coal bed methane (Figure 74).

Figure 73: Technically recoverable gas resources by region



■ Africa ■ Asia Pacific ■ Eurasia
■ Europe ■ LAC ■ Middle East
■ North America

Figure 74: Technically recoverable gas resources by type



■ Unconventional gas recoverable resources
■ Conventional gas recoverable resources

Source: GECF Secretariat based on data from Rystad Energy Ucube

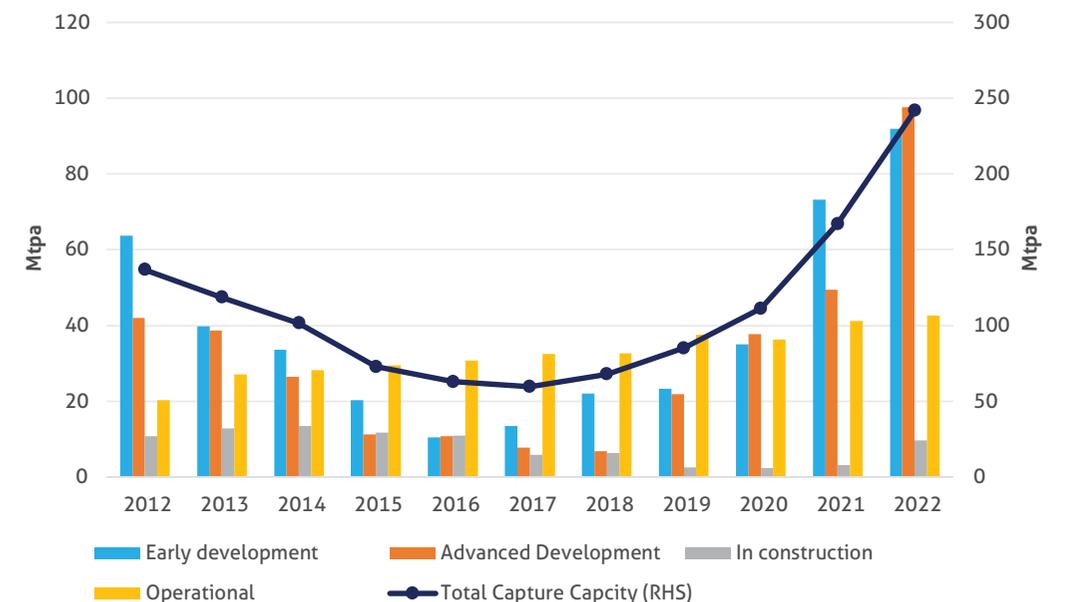
3.3.3 Developments in Decarbonization Projects

The movement to reduce GHG emissions and promote decarbonization as a pathway to achieve net-zero goals is gaining remarkable momentum globally. It is also considered one of the main drivers that shaped energy policy in 2022. Countries have announced significant environmental pledges that still need to be translated into decarbonization projects with allocated funds. This section tracks some of the developments in decarbonization projects in 2022 that could have an impact on gas markets, including developments in CCS/CCUS, hydrogen, carbon dioxide and methane emissions reduction projects.

3.3.3.1 Carbon Capture and Storage Projects

The past few years have witnessed an escalation in the language of climate change and CCS projects are at the heart of it as part of a reliable decarbonization pathway. Since the start of 2018, momentum behind CCS has been growing which is translated into a significant rise in announced CCS projects and the associated carbon abatement capacity (Figure 75). As of 2022, about 200 new carbon capture projects have been announced under different stages of development, with aggregated capturing capacity of around 240 Mt CO₂ per year. This represents a 44% increase compared to the number of projects in 2021 and evidence of the increased interest in CCS as a pathway for achieving emissions reduction, while supporting at the same time economic growth and a just transition.

Figure 75: CCS projects capacity



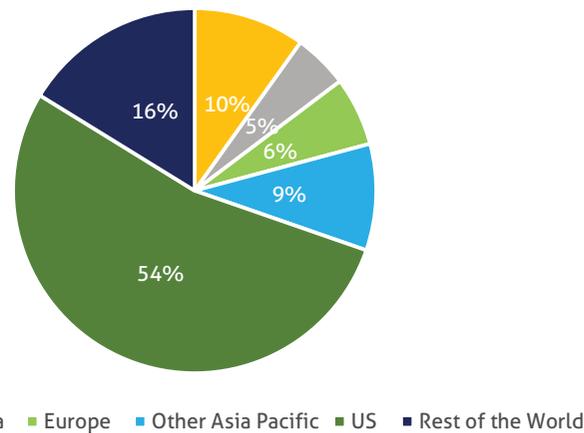
Source: GECF Secretariat based on data from Global CCS Institute 2022 Status Report

Currently, there are around 30 operational facilities applying CCS on commercial scale to industrial operations, power generation and fuel transformation, with a capturing capacity of around 43 Mt CO₂ per year. On the other hand, there are CCS projects that are in different phases of developments, with 75 projects in early development phase, 78 projects in advanced development phase and 11 projects under construction.

However, in 2022 only 19 commercial CCS projects under development have taken FID, including the FID for the development of Petronas’s Kasawari CCS project off the coast of Sarawak, Malaysia, which is considered the world largest offshore CCS project, with capturing capacity around 3.3 Mt CO₂ per year. Over 100 projects may be sanctioned in 2023, which would be considered a significant rise in the CCS portfolio. These projects aim to provide around 100 Mtpa of capturing capacity.

On a regional basis, the major share of capturing capacity for operational CCS in 2022 belongs to the US with more than 50%, followed by Canada and Asia Pacific (Figure 76).

Figure 76: Regional shares of 2022 operating capture capacity



Source: GECF Secretariat based on data from IEA CCUS Report 2022

The CCS projects under development are distributed over 30 countries with some projects in different phases of progress.

According to the IEA’s Carbon Capture, Utilisation and Storage 2022 report, the US has about 80 projects that are under development through to 2030, with total capturing capacity of 100 Mtpa. This would increase the US capacity in CCS five times. Also in North America, Canada is working on enhancing its CCS deployment, with about 15 projects under development.

China’s Sinopec finished the construction of a CCS project in Qilu petrochemical complex, with capture capacity of 1.7 Mt CO₂ per year, in addition to the first offshore

CCS deployment project by CNOOC which has sequestering capacity of 1.46 million tonnes of CO₂.

In Europe, net-zero goals and other environmental pledges have given a significant boost for CCS projects that take the form of CO₂ storage hubs connected to clusters of emission sources. The IEA reports a capturing capacity of 70 Mtpa to be commissioned by 2030 from North Sea projects in the UK, Norway and the Netherlands.

In the Middle East, Qatar has made progress at the North Field East LNG liquefaction project, which is expected to capture and store 2.9 Mt CO₂ per year, with the UAE, Saudi Arabia and Bahrain announcing CCS hubs projects.

The IEA estimates CCUS investments reach \$1.8 billion in 2022, followed by a sharp increase over the next two years to reach \$40 billion by 2024.

3.3.3.2 Hydrogen Projects

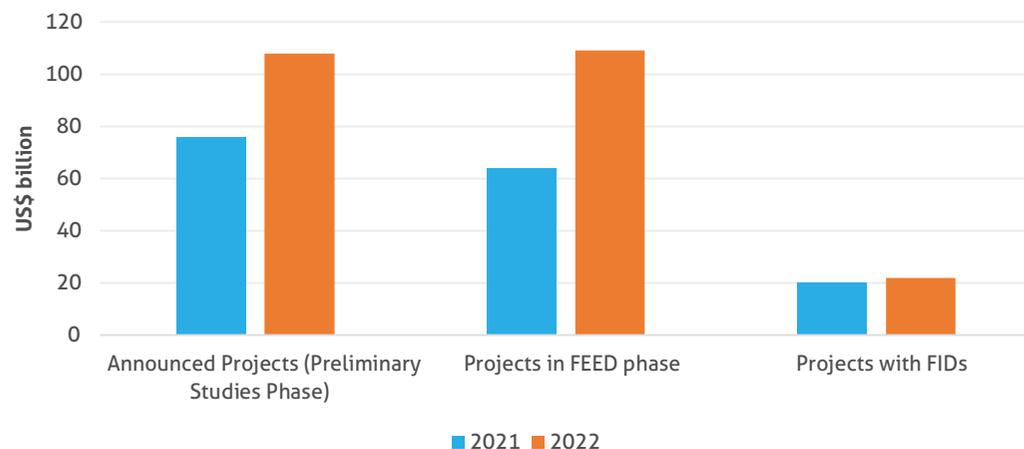
Hydrogen has been widely considered a potential game changer when it comes to the decarbonization of hard-to-abate industries and heavy transportation thanks to the absence of GHG emissions at the end-user point. However, the stages of hydrogen production might include different levels of GHG emissions.

With the recent development of environmental pledges and the race for net-zero in 2050, the hydrogen economy is gaining momentum, while a remarkable rise in the number of proposed hydrogen projects is noticed globally. However, the number of projects, which reached FID stage in 2022, did not exceed 10% of the proposed projects.

According to the Hydrogen Council 2022 Hydrogen Insights Report, around 680 large-scale projects were proposed in 2022 compared to 520 in 2021 – an increase of 30% y-o-y. Over 530 of these projects may be commissioned by 2030, with total direct investment of \$240 billion in the hydrogen value chain and 26 Mtpa of hydrogen capacity.

Around 165 projects are in the phase of executing feasibility or FEED studies, with total investments around \$109 billion. Only 10% of the proposed investments have secured the required FID, with total investments of \$22 billion, \$2 billion up from 2021, which shows a significant gap between the announced projects and the ones which are put into action (Figure 77).

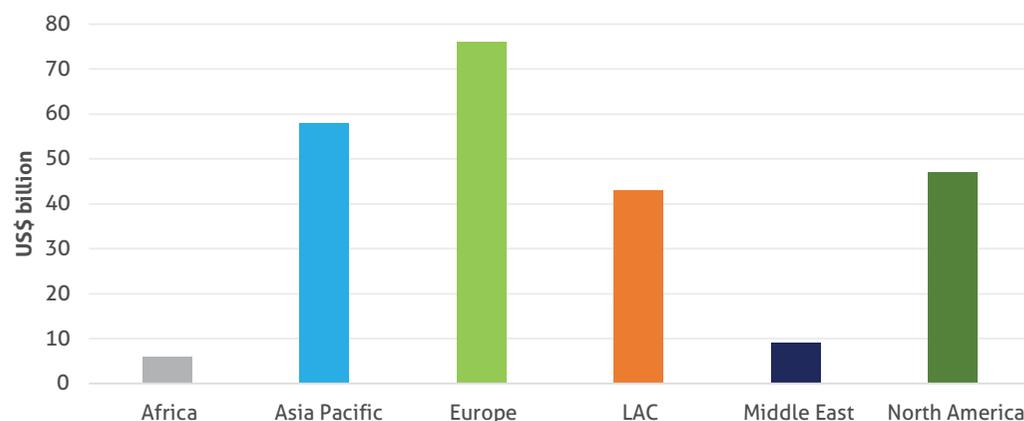
Figure 77: Investments in hydrogen projects



Source: GECF Secretariat based on data from Hydrogen Council 2022 Hydrogen Insights Report

Europe is leading the way in the share of proposed hydrogen investment, with 30% followed by Asia Pacific with 24%, then North American and LAC, each with 20%, while Middle East and Africa have minor shares of 4% and 2%, respectively (Figure 78).

Figure 78: Hydrogen investments by region



Source: GECF Secretariat based on data from Hydrogen Council 2022 Hydrogen Insights Report

In terms of supply, the announced projects in 2022 are expected to provide 26 Mtpa of hydrogen by 2030, with Europe accounting for the highest volume – around 8 Mtpa, followed by LAC and North America, with 4.8 Mtpa and 4.7 Mtpa of hydrogen, respectively.

However, in order to develop the hydrogen economy further, a number of obstacles has to be addressed and solved, including access to financial support in terms of funds,

loans or tax credits to avail the required investments, as well as the credibility of the outlook for hydrogen demand.

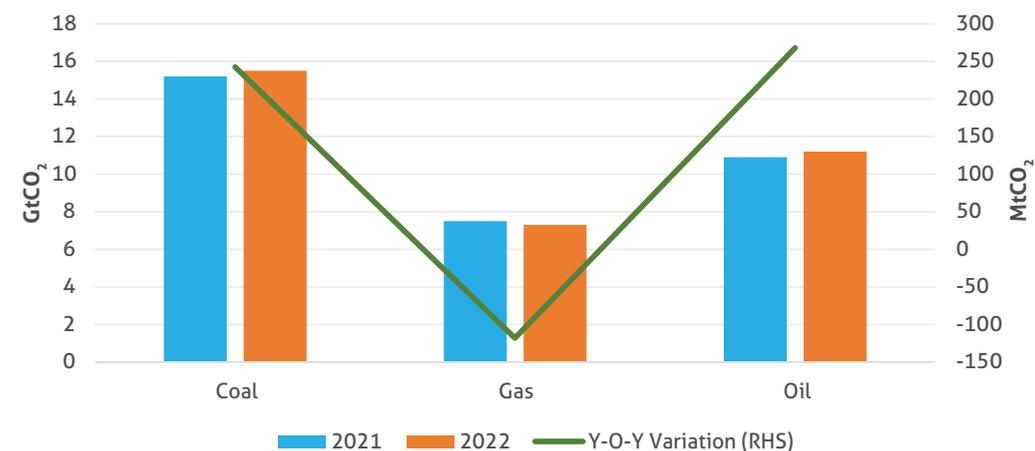
3.3.3.3 Change in CO₂ Emissions

CO₂ represents the greatest contributor to the global warming problem, and one of the main drivers that shaped the energy policies last year was the global movement to reduce carbon emission and promoting decarbonization. According to the 2022 Global Carbon Budget report, the global CO₂ emissions rose by around 0.8% to stand at the level of 40.5 Gt, which remain relatively high, but still lower than their peak in 2019 with a level of 40.9 Gt. This increase was driven by a combination of an increase in the fossil-fuel emission and a steady level of industrial emissions. With regards to the energy-related CO₂ emissions which represents about 90% of the global CO₂ emissions, the IEA CO₂ emissions in 2022 report estimates that the total emission (including oil, gas and coal) recorded an increase by 0.9% compared to 2021 levels, representing an increase of 321 Mt of CO₂, to reach a new record of 36.8 Gt.

The emissions from natural gas witnessed a decrease by 1.6% (118Mt) compared to 2021 level to reach 7.3 Gt, driven by the rise in the gas-to-coal switching and disruption in the gas markets that followed the unprecedentedly high gas prices. Europe reported the greatest decline in gas related emissions about 13.5% y-o-y driven by the decline in gas consumption in Europe amid the energy crisis. On the other hand, the coal-related emissions recorded an increase by 1.6% (243 Mt) compared to 2021 level to reach 15.3 Gt. This increase offset the reduction that natural gas emissions witnessed.

In 2022, Oil-related emissions recorded an increase by 2.5% (268 Mt) to reach 11.2 Gt. This increase was driven the strong rebound in the aviation industry (Figure 79).

Figure 79: Energy related CO₂ emissions



Source: GECF Secretariat based on data from IEA CO₂ emissions in 2022 report

3.3.3.4 Change in Methane Emissions

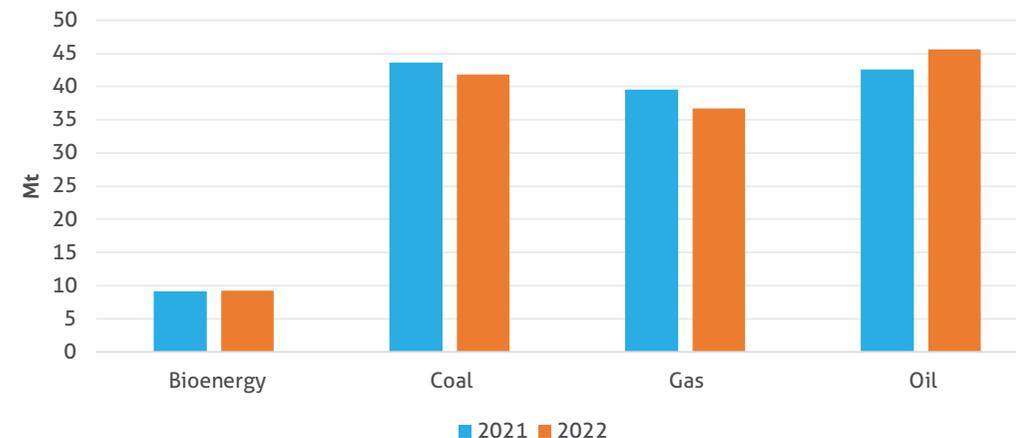
The oil and gas industry has a good potential for a significant reduction in methane emissions by preventing unnecessary flaring and venting. In addition, the value of saved gas could play a significant role in minimizing the cost of abatement. The IEA estimates that about 260 bcm of gas is wasted annually through gas leaks and flaring. Retrieving these amounts is a huge cost advantage towards minimizing the environmental footprint of the upstream industry. The oil and gas methane abatement market size is estimated to reach \$918 million by 2025 according to Bloomberg. Upstream activities are expected to attract around 85% of this market, where the major share of emissions is produced.

Methane emissions are considered the second greatest contributor to the global warming problem among GHGs after carbon dioxide. Although methane stays in the atmosphere for a shorter time compared to CO₂, it is more potent when it comes to the greenhouse effect. It is estimated that methane accounts for 30% of the increase in the Earth’s temperature. This section sheds light on the estimations for the global methane emissions with regional and source classifications.

According to the IEA’s 2023 Methane Tracker, about 580 Mt of methane is emitted annually, with 40% from natural sources and 60% being anthropogenic (resulting from human activities). The human-related sources include agriculture which accounts for 40% of the anthropogenic emissions, followed by the energy industry – including oil and gas industries – with a total of 135 Mt of methane emissions, representing 37% and waste with about 20%.

For oil and gas industry, the main sources of methane emissions are attributed to either venting, flaring or fugitive emissions. In 2022, the gas industry was estimated to emit 36.7 Mt of methane with about a 3 Mt reduction compared to 2021 levels, however the oil industry was estimated to emit 45.6 Mt of methane with about a 3 Mt increase compared to 2021 levels. Venting and flaring accounted for 63% and 9% of the total oil and gas industry’s methane emissions, respectively, in 2022. The remainder came from fugitive emissions. For the coal industry, about 42 Mt of methane was emitted in 2022 – half was attributed to China’s coal industry (Figure 80).

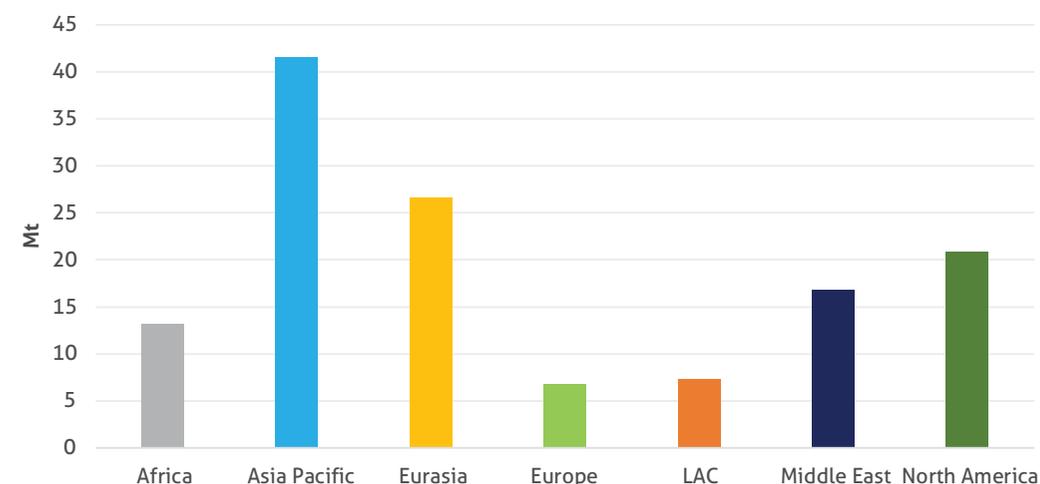
Figure 80: Energy related methane emissions



Source: GECF Secretariat based on data from IEA 2023 Methane Tracker Database

On a regional basis, the Asia Pacific region was responsible for the highest share of energy-related methane emissions in 2022, with about 31% of the total emissions, with China as the largest emitter on a country level. Eurasia, North America and the Middle East – as the main energy producing regions – is each responsible for 20%, 16% and 13% of the total emissions in 2022, respectively. Africa, LAC and Europe each hold smaller shares of 10%, 5% and 5%, respectively (Figure 81).

Figure 81: Regional distribution of energy related methane emissions in 2022



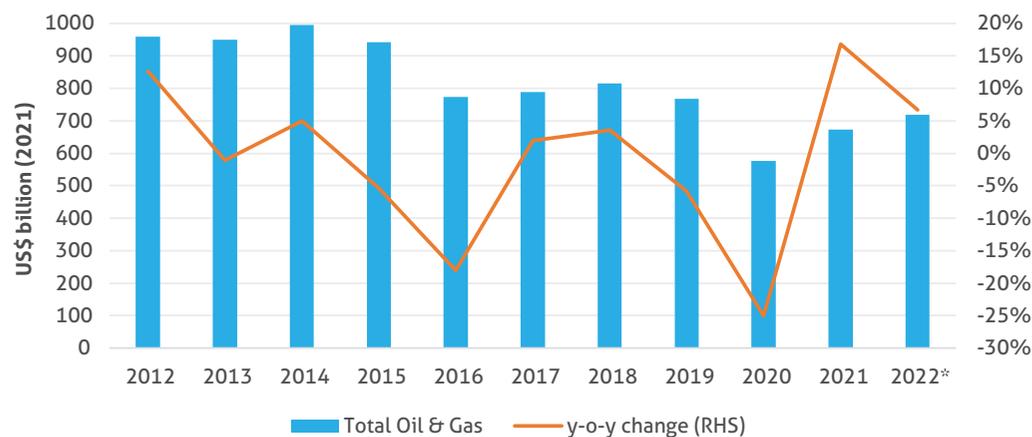
Source: GECF Secretariat based on data from IEA 2023 Methane Tracker Database

3.3.4 Investment in the Oil and Gas Industry

3.3.4.1 Global Investment

In 2022, total investment in the global oil and gas industry was estimated at \$718 billion, an increase of 7% compared to 2021. While there was a substantial recovery in oil and gas investment over the past two years, total investment has not yet recovered to pre-pandemic levels, and was still approximately \$50 billion or 7% lower than the level of 2019 (Figure 82).

Figure 82: Global oil and gas investment



Source: GECF Secretariat based on data from IEA World Energy Investment 2022

Note: Estimate for 2022 is as of June 2022

The investment landscape in 2022 was characterized by extremely high and volatile energy prices, energy security concerns and escalating geopolitical tensions. Investment was mainly directed to short-cycle projects that could deliver volumes relatively quickly, through maximizing existing capacities and brownfield expansions. Revival of LNG projects, US shale gas production and recovery in deep-water oil investments were also some of the key advances in 2022. However, cost escalations due to rising global inflation, as well as supply-chain bottlenecks diminished the effect of higher spending. This has affected the upstream sector in particular, with costs surging by more than 25% since 2020, largely due to the higher cost of materials such as steel, aluminium, nickel and copper. Thus, increased upstream investment may not be proportionately reflected on the supply side.

Moreover, the high price environment in 2022 led to staggering profits for oil and gas companies, with five of the largest IOCs, namely TotalEnergies, ExxonMobil, Chevron, BP and Shell together earning nearly \$200 billion. A large proportion of these profits, approximately \$110 billion, was returned to shareholders, while around \$70 billion was directed towards debt repayment, with only a small portion being reinvested into

the industry. According to Rystad Energy, the investment ratio, which is the ratio of upstream spending relative to cash flow generated from operations, was around 25% in 2022, the lowest value observed in decades. Thus, the issue of short-term investment has become a matter of capital allocation rather than availability. This has prompted many governments to consider the implementation of tougher windfall taxes, to seek higher returns for their natural resources and greater re-investment in the industry.

In 2023, global oil and gas investment is expected to rise further, largely due to higher investment in the upstream sector, as well as a marked increase in LNG import terminals particularly in Europe. The current shift of government interventions from energy transition to energy security can also provide some opportunities for increased investment in gas and LNG projects. However, while investment is expected to remain high this year, there are several looming uncertainties that may deter investment in the industry. A deceleration of global economic growth, tight monetary policies, high energy price volatility and geopolitical tensions may challenge investment decisions. In addition, long-term demand uncertainty, changes to environmental policies and government regulations, and competition with renewables and other low-carbon energy sources for capital will add some challenges to securing investment in the longer term.

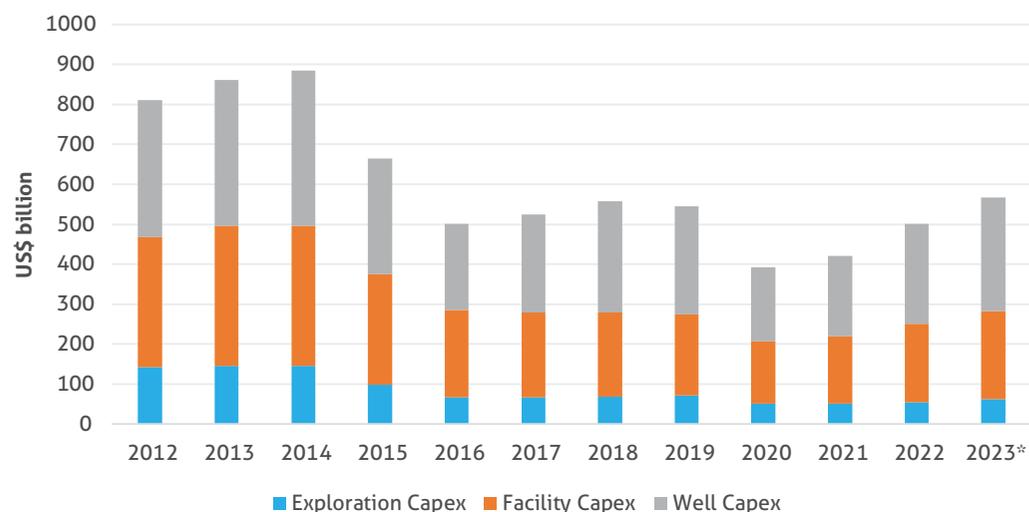
Investors may seek to mitigate these evolving risks by increasing return thresholds and accelerating payback periods. In this regard, small-scale projects with access to existing infrastructure and modular projects that can be operational in a shorter timeframe may be preferred by investors, as opposed to traditional large-scale projects. These projects are likely to be favoured in an investment climate of great uncertainties as they require less capital, have shorter payback periods and have lower risk exposure.

The underlying fact is that adequate investment is crucial for the stability of the global gas market and longevity of the gas industry. Moreover, continued underinvestment can have detrimental effects, including more frequent energy price shocks, increased price volatility and supply shortages. This not only negatively impacts the sustainability and stability of the gas industry, but it can have long-lasting effects on global economic growth and sustainable development.

3.3.4.2 Upstream Investment

Upstream oil and gas investment in 2022 was estimated at \$501 billion, which was 19% higher y-o-y. The major share of upstream capital spending was concentrated on production from existing fields, with costs related to development of infrastructure, drilling and completion of wells, and modification and maintenance on installed infrastructures accounting for almost 90% of upstream investment. Meanwhile, exploration activities only accounted for around 10% (Figure 83).

Figure 83: Upstream oil and gas investment by spending type



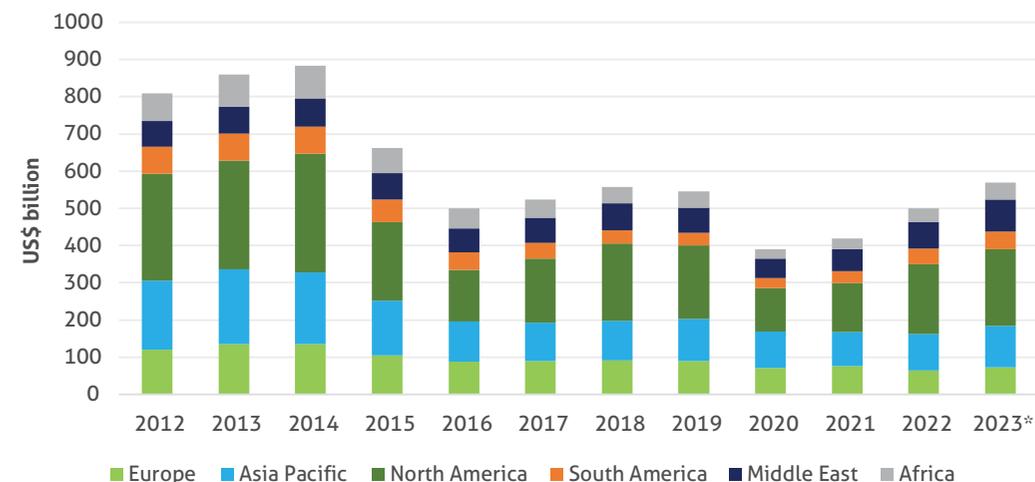
Source: GECF Secretariat based on data from Rystad Energy
 Note: Forecast for 2023 is as of January 2023

Furthermore, in 2023, upstream oil and gas investment is expected to increase by 13% y-o-y, to around \$567 billion. In this regard, upstream investment is likely to exceed the pre-pandemic levels. A large proportion of capital is expected to be allotted to production from existing fields, rather than exploration of new fields.

On a regional level, North America accounted for the lion’s share of upstream investment in 2022, which exceeded \$185 billion, up by 42% y-o-y (Figure 84). This was followed by Asia Pacific and Middle East in which upstream oil and gas investment reached \$98 billion and \$71 billion respectively. While Africa accounted for the lowest regional upstream investment, the region experienced the second largest growth, increasing 32% y-o-y to reach \$38 billion. Europe was the only region that exhibited a decline in upstream oil and gas investment in 2022, decreasing by 14% compared to the previous year to reach \$65 billion. This was largely due to Europe’s invigorated push for energy transition and the consequential aggressive climate change policies and regulations.

In 2023, all regions are likely to experience double-digit growth in upstream capital spending. North America will continue to account for the largest share of investment with an estimated \$205 billion driven by the US, followed by Asia Pacific with \$111 billion. The Middle East and Africa regions are expected to register the largest annual growth rates with 20% and 18%, respectively. In Europe, upstream oil and gas investment is expected to rebound by 13% to approximately \$73 billion, with energy security coming back to the forefront.

Figure 84: Upstream oil and gas investment by region

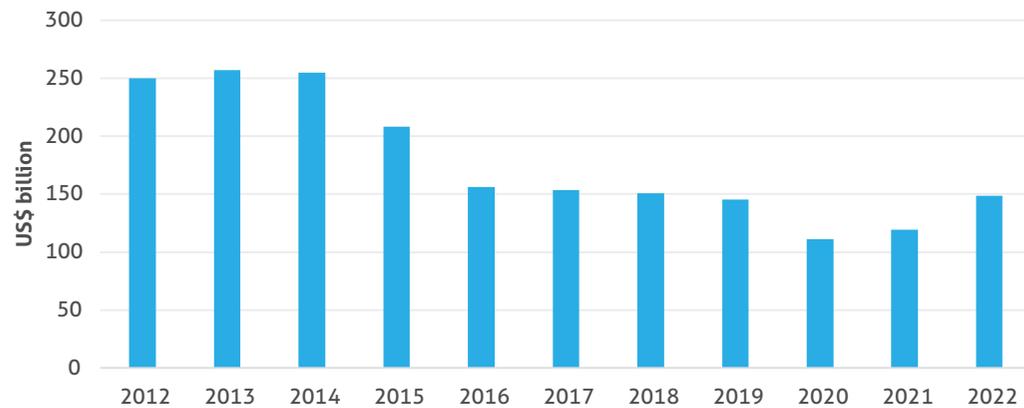


Source: GECF Secretariat based on data from Rystad Energy
 Note: Forecast for 2023 is as of January 2023

Furthermore, total investment in the upstream gas industry was estimated at \$149 billion in 2022 (Figure 85), of which \$47 billion was invested in unconventional gas fields, compared to \$33 billion in 2021, according to Rystad Energy.

In 2022, companies increased spending and investments in gas fields, however a portion of this increase covered rising costs due to inflation. Inflation has hit every corner of the oil and gas industry. Particularly, upstream companies in unconventional fields reported rising costs on everything from rigs and workers to diesel fuel and proppant.

While there was a rebound in upstream gas investment in 2022, it was below the investment level of 2014. In the medium term, investment in unconventional gas in countries such as the US, Australia, China, and Argentina will be the main growth engine of gas production. The investment in gas upstream is expected to increase to \$170 billion in 2023.

Figure 85: Investment in upstream gas sector

Source: GECF Secretariat based on data from Rystad Energy

3.3.4.3 Developments in Financing of Oil and Gas Projects

The landscape for financing of oil and gas projects has undergone several changes over the past two years driven by the effects of the major market shocks, with the focus shifting from energy transition to energy security. The extremely low-price environment in 2020 and the accelerated energy transition put additional pressure on financing of oil and gas projects as banks and financial institutions opted for more strict conditions. Meanwhile, the high price environment in 2021 and the energy crisis in Europe in 2022 have put a slightly different spin on considerations for financing of oil and gas projects, with the recognition that gas will be an integral part of ensuring energy security.

In February 2023, the EU approved the REPowerEU plan, which added new objectives to the €800 billion recovery fund, which will be used to diversify energy supplies. While a large proportion of the fund will be channelled into investment in renewables, it will also provide funding for oil and gas projects. The fund includes an allocation of €10 billion for the financing of gas infrastructure and up to €2 billion for oil infrastructure. However, there are some stipulations for accessing the funds, such as the funding of fossil fuel infrastructure being limited to 30% of the overall REPowerEU spending. In addition, in order to ensure such funding contributes to regional energy security, it is required that gas infrastructure projects should be in operation by 2026.

The EU Taxonomy Regulation aims to define economic activities that are considered as sustainable in order to provide clarity to investors and policymakers. In particular, the Complementary Climate Delegated Act, which entered into force on January 1, 2023, outlines the criteria for specific gas and nuclear projects to be considered sustainable. One such criteria for gas projects is that they must contribute to the transition from coal to renewables.

With regard to financing from banks, one of the world's largest banks, HSBC, announced in December 2022, that it would end financing for new oil and gas fields and related infrastructure, with FIDs taken after 31 December 2021. Furthermore, the bank will not consider any prospective clients with more than 10% of its planned oil and gas capital expenditure in exploration. Prospective clients are also required to have clear plans for eliminating flaring by 2030, and reducing methane emissions by 2025 in EU and OECD countries, and by 2030 for the rest of the world. However, HSBC remains committed to financing existing oil and gas fields to meet current and future demand.

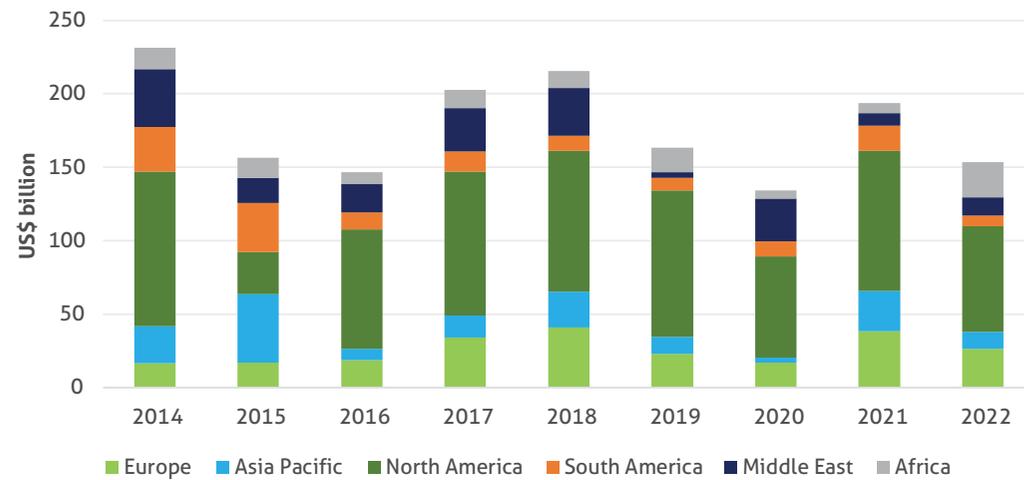
At a global level, the pressure on restrictions for funding of oil and gas projects are still prevalent. According to the deal reached at the UN COP 26 conference in Glasgow regarding fossil fuel funding, from the end of 2022 more than 20 countries and institutions will no longer provide funding for unabated coal, oil and gas projects. Some of the signatories to this deal include US, Canada and the UK, as well as the European Investment Bank (EIB). While this is the overarching deal, some signatories have considered certain hydrocarbon projects that may be repurposed in the future. For instance, the EIB is considering funding of the Iberian gas pipeline that will connect Portugal, Spain and France, with the justification that it will be used for the distribution of hydrogen and other low-carbon gases in the future.

In terms of the global financial sector, the Glasgow Financial Alliance for Net Zero (GFANZ), which was established in April 2021, is the largest coalition of financial institutions that have committed to net-zero emissions by 2050. It provides a forum to support and coordinate efforts across all segments of the global financial system with the common goal of a net-zero global economy. Furthermore, the Net-Zero Banking Alliance (NZBA) is the banking element of the GFANZ, which comprises 125 banks from 41 countries that represent over 40% of global bank assets. These banks have committed to aligning their lending and investment portfolios with net-zero emissions, and will set their decarbonization targets with prioritization of funding based on greenhouse gas emissions, intensity and financial exposure. Based on a progress report from November 2022, 53 banks have a policy in place for oil and gas financing and/or have set an emissions reduction target.

3.3.4.4 Upstream M&A Activity

Merger and acquisition (M&A) activity in the upstream sector declined to \$154 billion in 2022, 21% lower y-o-y, and below pre-pandemic levels. This decline was essentially driven by the continued impact of COVID-related lockdowns particularly in China, high oil and gas price volatility and escalating geopolitical tensions in Europe. Most regions experienced a sharp decline except for the Middle East and Africa. In the Middle East, M&A activity increased by 46% y-o-y, while in Africa the deal value more than tripled compared to the previous year to reach a record \$24 billion (Figure 86).

Figure 86: Upstream M&A activity by region



Source: GECF Secretariat based on data from Rystad Energy

North America accounted for almost 50% of asset and corporate acquisitions in 2022 amounting to \$72 billion, with private companies responsible for a large share of divestment as they opted to maximise their assets amidst the high price environment. Europe and Africa accounted for 17% and 16% of M&A activity respectively, where high commodity prices increased the value of traded producing resources and spurred buying and selling activity.

In addition, a significant increase in demand for gas and LNG assets was observed in the midst of heightened concerns about energy security. The deal value of LNG assets in 2022 climbed by 15% compared to the previous year, to reach \$23 billion. Over 43% of this was attributed to Qatar's North Field expansion project with contracts awarded to five companies, namely Shell, TotalEnergies, ExxonMobil, Eni and ConocoPhillips. Meanwhile, EIG Global Energy Partners accounted for 28% of LNG asset acquisition, with all assets located in Australia.

In 2023, upstream M&A activity is likely to remain around 2022 levels or increase. Furthermore, global energy security concerns are likely to drive investment for gas and LNG assets, and more so, increase acquisitions by European majors in Africa and the Middle East to secure production assets. Additionally, net-zero emission targets may also support demand for gas and LNG assets as the cleanest burning fossil fuel.



CHAPTER
04

Gas Trade

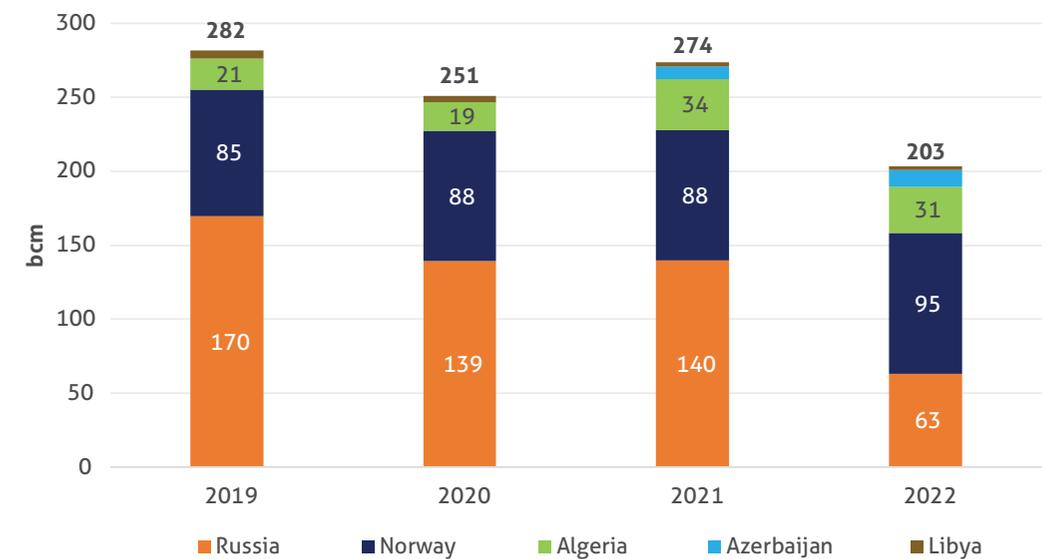
4.1 Pipeline Gas Trade

4.1.1 Europe

On the global level, Europe is the most prominent market with respect to pipeline gas trade. In each of the previous five years, the region has on average accounted for around 60% of the worldwide volume of net imports of pipeline gas. Even with the diversification of energy supply on the continent, as well as the investments into new pipeline projects around the globe, the European region is expected to remain the premier market for pipeline gas trade in the medium-term.

The EU imports its pipeline gas supply from five gas producers: Algeria, Azerbaijan, Libya, Norway, and Russia (Figure 87). During a certain period, pipeline gas supplies also flow to or from the region via the interconnectors with the UK.

Figure 87: Pipeline gas imports to the EU by supplier



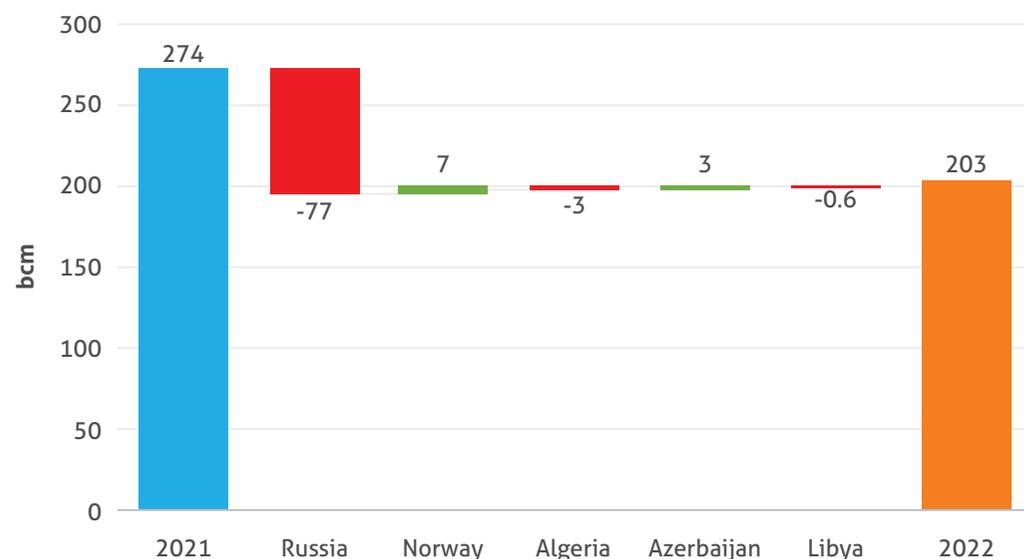
Source: GECF Secretariat based on data from McKinsey and Refinitiv

Pipeline gas trade in the EU in 2022 was greatly impacted by the geopolitical events, which occurred during the year. These centred around the EU political decision to reduce pipeline imports from the Russian Federation. In response, there were marginal supply increases from Norway and Azerbaijan, however, the quantum of these was not sufficient to offset the total falloff in supply.

In 2022, the EU imported a total of 203 bcm of pipeline gas, which was the lowest total in the last four years (Figure 87). The 2022 import quantity was 71 bcm less than in 2021, which represents a decline of 26%.

Overall, the supply decline from 2021 to 2022 was driven by a reduction of around 80 bcm of supply from Russia and Algeria, alongside an increase in gas supply of just about 10 bcm from Norway and Azerbaijan (Figure 88). The bulk of the shortfall was attributed to a loss of 77 bcm of pipeline gas imports from Russia. In comparison, in Q1 2022, Norway committed to ramping up its domestic production, thereby increasing the quantity of gas available for LNG and pipeline gas exports. This was consequentially reflected in an increase of around 7 bcm in total over the year. Similarly, intending to diversify their energy supply, EU countries signed agreements for the increase of imports from Algeria and Azerbaijan. In 2022, Azerbaijan increased pipeline gas exports to the EU by 3 bcm. In the case of Algeria, there were some gas production challenges, along with the switching of market focus from Spain to Italy, which both contributed to a small decline of 3 bcm in 2022.

Figure 88: Breakdown of pipeline gas supply to EU from 2021 to 2022

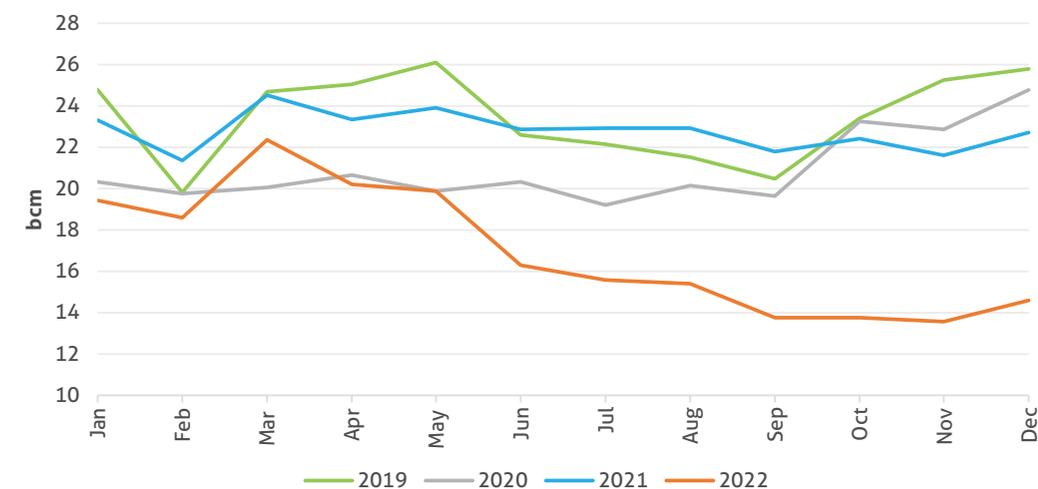


Source: GECF Secretariat based on data from McKinsey and Refinitiv

The overall reduction in EU pipeline imports was immediately noticeable from the start of 2022. The reduction of Russian pipeline imports was attributed to Russia’s response to financial sanctions with a special payment scheme for gas in roubles. This measure was refused by some EU Member States and companies, and thus gas exports to them as a result of no payment were discontinued. Furthermore, technological sanctions imposed by the EU prompted maintenance disruptions on Nord Stream’s Siemens turbines, eventually leading to a complete shutdown of the pipeline by September 2022.

Total imports averaged around 20.1 bcm for the first five months of the year, which soon decreased over the subsequent months to a low of 13.8 bcm in November. On a monthly basis, the volume imported by the region in 2022 was, apart from in March 2020, the lowest in the four years since 2019 (Figure 89). The monthly volume of pipeline gas imports averaged 17.0 bcm in 2022, compared with 22.8 bcm in 2021.

Figure 89: Monthly pipeline gas imports to the EU

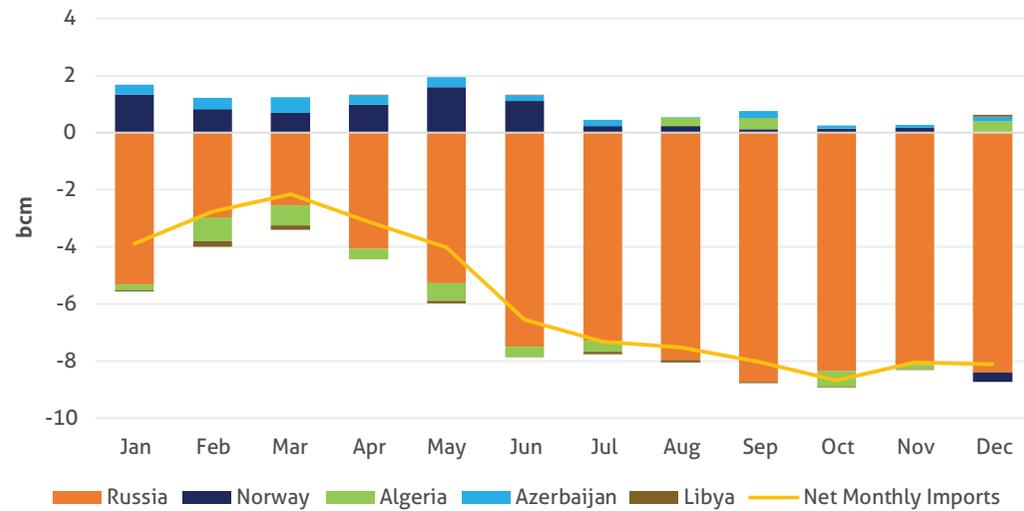


Source: GECF Secretariat based on data from McKinsey and Refinitiv

The period from June to September 2022 was particularly eventful with respect to pipeline imports from Russia, specifically via Nord Stream 1 to Germany. In June, there was a disruption in flow via the line, as a result of sanctions which affected the maintenance to key gas turbines. The unprecedented deliberate sabotage of Nord Stream pipelines on September 26, 2022 then disrupted 82.5 bcma out of a total of 110 bcma capacity of gas supply to Europe, further deteriorating the supply situation for the EU.

Every month, Russian imports to the EU were lower throughout the entire 2022, when compared with the previous year (Figure 90). For Norway and Azerbaijan, there was an improved gas supply during the first half of 2022, coinciding with the supply increase observed starting from H2 2021. The variation in imports from Algeria generally balanced out over the year, even with the effect of the realignment of focus from the Spanish to the Italian market.

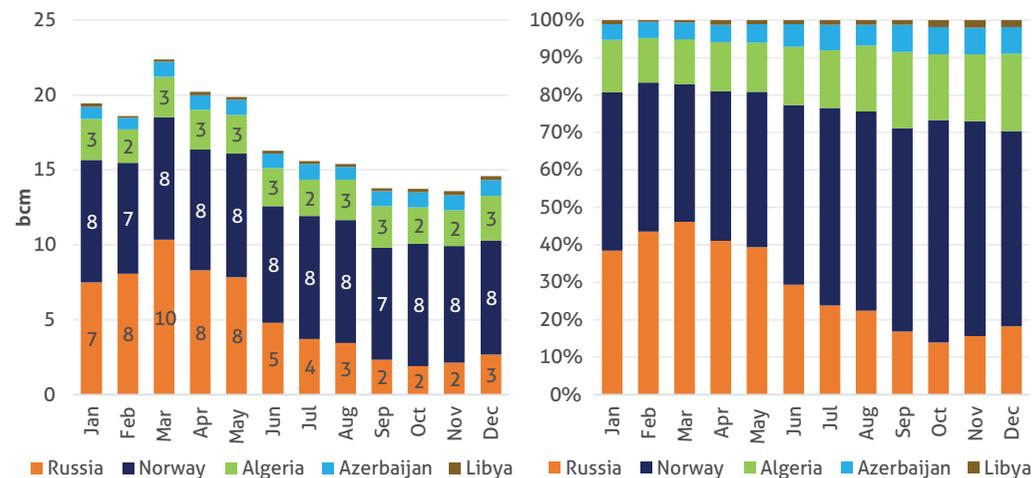
Figure 90: Y-o-Y variation in pipeline gas imports to the EU by supplier (2022 v 2021)



Source: GECF Secretariat based on data from McKinsey and Refinitiv

The supply percentage in the region also shifted during 2022 (Figure 91). Previously, Russia had been the top exporter to the EU, accounting for as much as three-fifths of the supply in 2019. Subsequent diversification of imports altered this breakdown by 2021, to 51% from Russia versus 32% from Norway. The supply dynamic shifted between the two countries during the first half of 2022, until Norway overtook Russia as the top supplier from May onwards, against the backdrop of political pressure on Russian pipeline gas supply to the EU.

Figure 91: Monthly pipeline gas imports to the EU in 2022

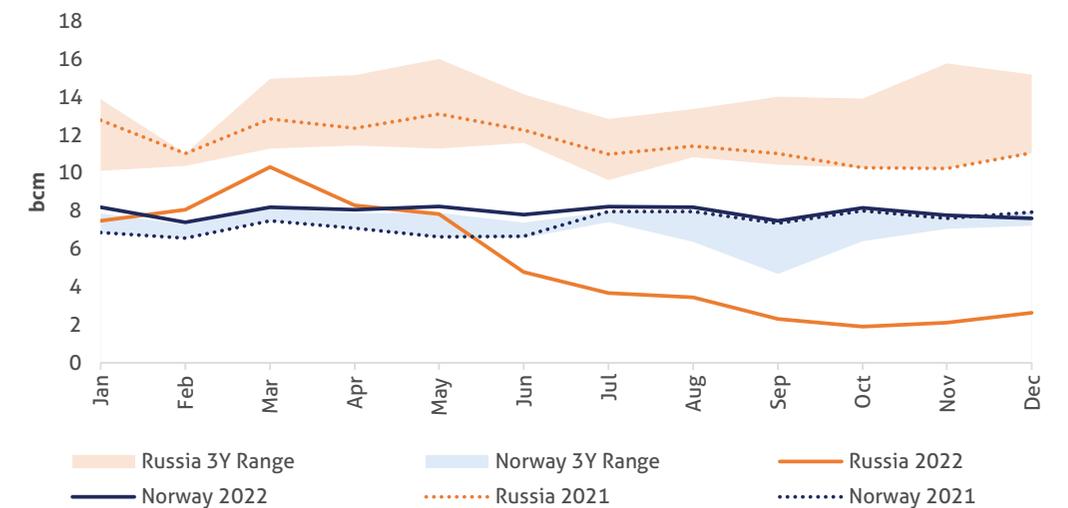


Source: GECF Secretariat based on data from McKinsey and Refinitiv

Focusing even closer on Russia and Norway, Figure 92 shows the monthly pipeline gas supply from both exporters. In response to the gas crisis in Europe, in 2022, Norway committed to ramping up its gas exports, from both LNG and pipeline gas. The effect of this increased gas supply is reflected in the chart: From 2019 to 2021, Norway's pipeline gas exports to the EU have averaged 7.3 bcm per month, while in 2022, this average increased by 9% to 7.9 bcm per month.

While Norway is currently exporting pipeline gas at levels higher than the historical three-year range, the opposite is true for Russia, which is exporting the least amount of gas to the EU since 2019. For comparison, from 2019 to 2021, Russia's pipeline gas exports to the EU had averaged 12.5 bcm per month, while in 2022, this average fell by 58% to 5.2 bcm per month.

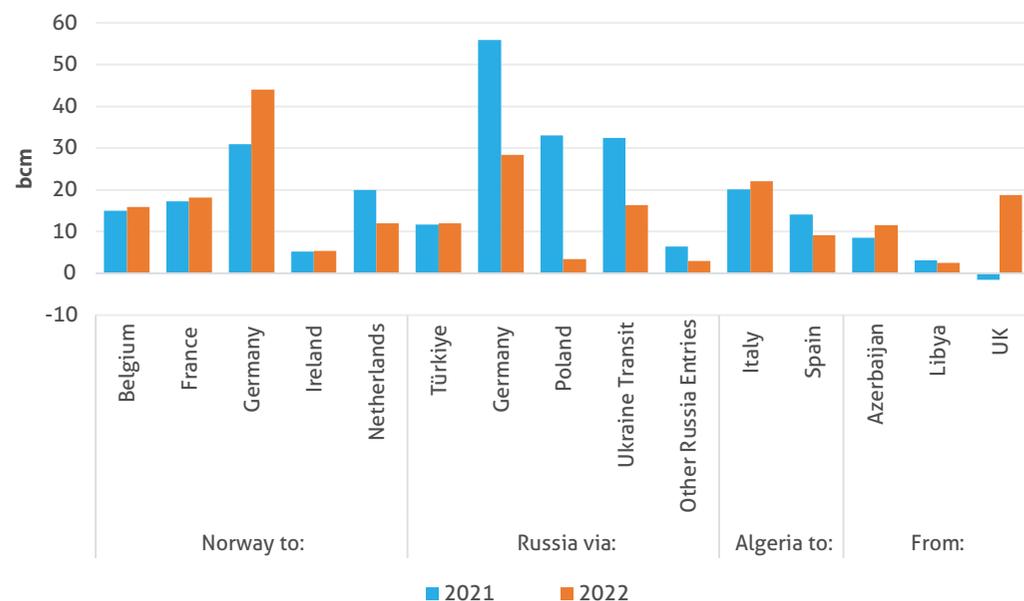
Figure 92: Pipeline gas supply to the EU from Russia and Norway



Source: GECF Secretariat based on data from McKinsey and Refinitiv

Considering the EU pipeline gas trade on a more granular level, there are multiple transmission routes bringing supply from the three top exporters (Figure 93). Norway has five active supply routes, and exports most of its volume to Germany. In 2022, there was a realignment of volumes to the continent: Exports to Germany accounted for 46%, at the expense of the Netherlands, which reduced to 13%, due to an increase in gas imports from alternative sources.

Figure 93: Pipeline gas imports to the EU by supply route



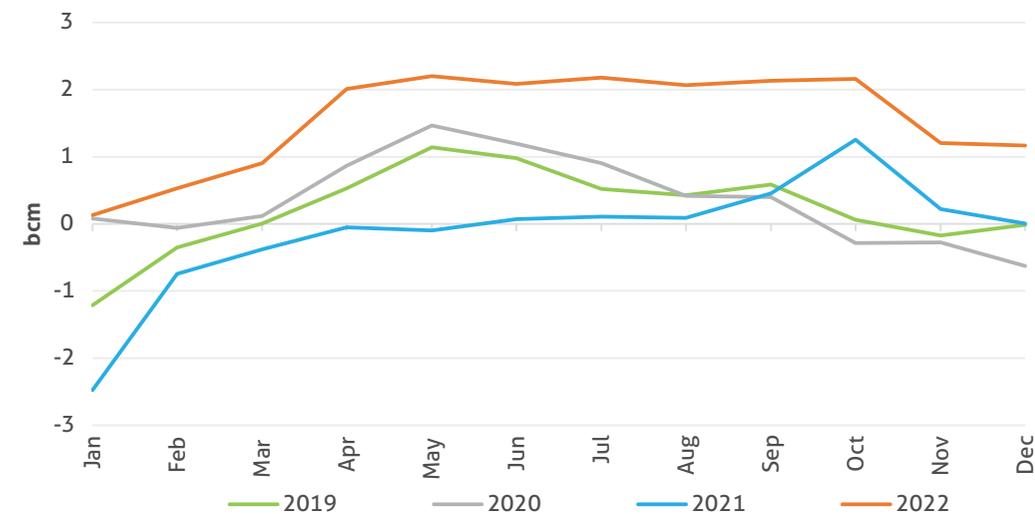
Source: GECF Secretariat based on data from McKinsey and Refinitiv

Russia has several transmission pipelines traversing the continent, which can be broadly simplified into four main routes. In recent years, the major supply for Russian pipeline gas had been to Germany via Nord Stream 1, followed by the Yamal Pipeline via Poland, and the Ukraine transit pipelines. In 2022, Russia supplied 45% of its pipeline gas via Nord Stream 1, followed by 26% via the Ukrainian lines, while 19% entered the EU via the Turkstream pipeline.

Algeria exported 71% of its volumes to Italy in 2022, which was an increase from the 59% supply share to this market in 2021.

An interesting dynamic to consider for the EU is the pipeline gas supply it receives from the UK. There are two bidirectional interconnectors from the UK to Belgium and the Netherlands, which bring supply from within the British grid. Usually, the trend is for flows in the direction from the UK to the continent during the summer, and in the reverse direction in winter. However, in 2022, the increased demand for gas for storage in Europe, as well as the ramp-up of LNG imports in the UK, both contributed to continuous pipeline flow from the UK to the EU throughout the entire year (Figure 94).

Figure 94: Net pipeline gas imports to the EU from the UK



Source: GECF Secretariat based on data from Refinitiv

The comparison between the total quantities imported along each of these major supply routes in 2022, versus the previous year, is shown in Figure 95. In the case of Norway, a supply increase was observed in most routes, most notably a 42% rise in German imports. Volumes to the Netherlands fell by 40% in 2022, as attributed to the increase in gas imports via pipeline from the UK, as well as in the form of LNG cargoes.

Russian pipeline flows declined in most routes, notwithstanding an increase of 2% in quantities delivered via Turkstream. Elsewhere, Algeria’s exports to Spain fell by 35%, while at the same time ramping up supply to Italy by 9%.

In 2023, pipeline gas trade in Europe will continue to be influenced by the quantity of volumes imported from Russia. In total, the volume of pipeline gas that will be delivered will be less than in 2022, since flows along the major route, Nord Stream 1, will not resume in the short term. Nevertheless, Russia may continue to increase flows via Turkstream, which has the potential to supply around 4.5 bcm more volumes than in 2022.

Norwegian pipeline exports, having already ramped up in 2022, are not expected to demonstrate further significant gains in 2023. In October 2022, the 10 bcma Baltic Pipe from Norway to Poland via Denmark was commissioned. With regular flows from 2023, this new supply route is expected to redistribute some of the volumes currently imported by Germany, rather than an overall increase in quantity to the region.

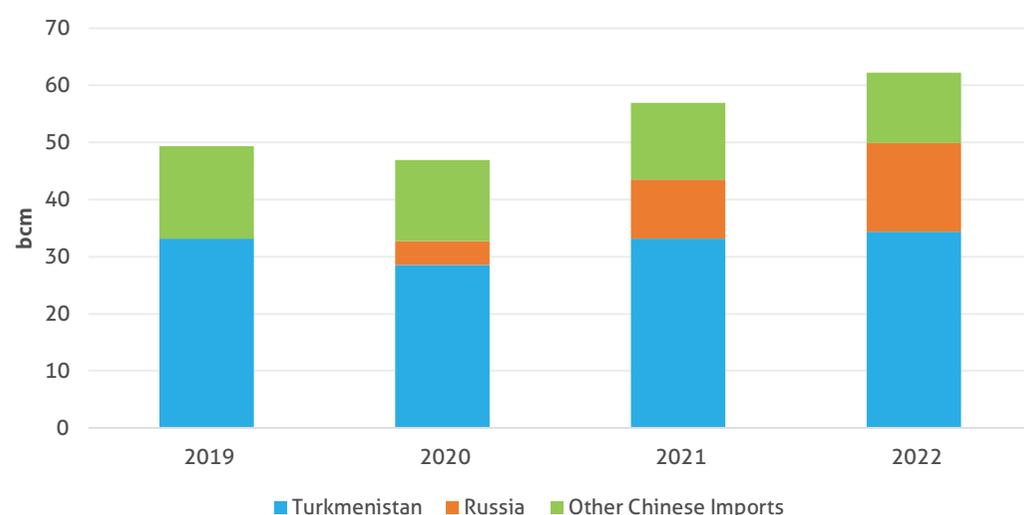
With respect to the other suppliers to the region, Algerian exports to Italy are expected to grow marginally, as per agreements signed between the two countries in 2022. The

The pipeline gas market in North America will be boosted in 2023 by the increase in LNG export output from the continent. With all three North American countries either increasing production from existing liquefaction terminals or investing in new facilities, the pipeline network in the region will continue to grow in significance. One such project is the Coastal GasLink pipeline in western Canada, which after numerous delays and cost overruns, is nearing completion. This line will facilitate LNG exports from the west coast of British Columbia. Other new gas links are in consideration in the south of the region, which will increase quantities exported from the US to Mexico, and then further enhance interconnectivity amongst the Mexican demand centres.

4.1.3 Asia Pacific

Globally, countries in the Asia Pacific region account for around 14% of net imports of pipeline gas. Specifically, China is by far the dominant player, accounting for around 70% of the total quantity of regional pipeline gas imports. This ratio has become even more pronounced as China has massively stepped up its gas imports in recent years. To demonstrate this fact, in 2022, China imported 62 bcm of pipeline gas, which was three times the quantity imported in 2012. However, the rate of increase in 2022 was just 9% compared with the 21% rise in 2021 (Figure 98). The reasons are pandemic-related: In 2021, gas imports rebounded significantly, following the contraction of consumption during the first wave of Covid-19. Then in 2022, Chinese authorities implemented lockdowns for long periods due to another breakout of the virus, leading to gas demand being slightly muted.

Figure 98: Pipeline gas imports to China by supplier

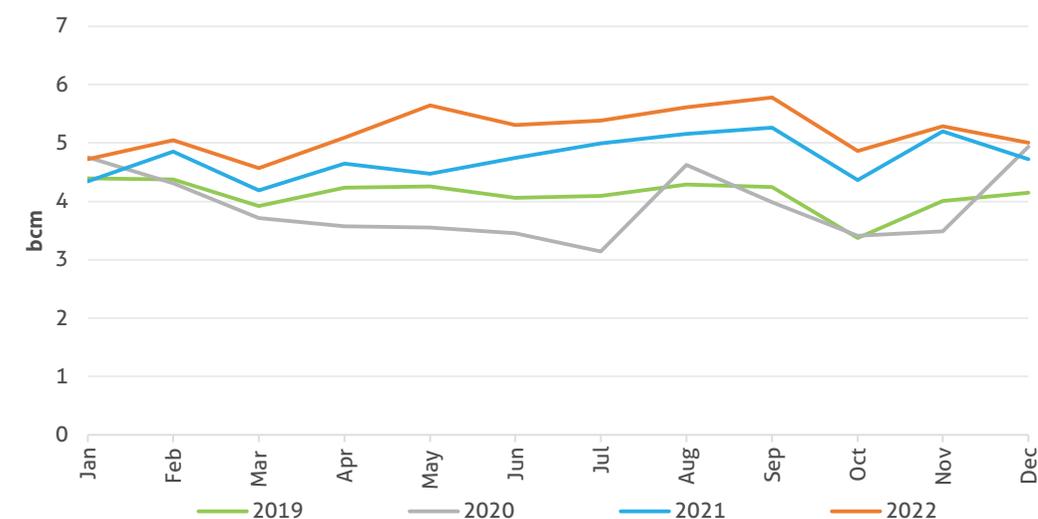


Source: GECF Secretariat based on data from Argus, ICIS and Refinitiv

The rise in China’s imports of pipeline gas has been bolstered by supply from Russia since the start-up of the Power of Siberia (PoS) pipeline in December 2019. In fact, the events of 2022 encouraged some EU countries to announce plans to diversify their sources of energy supply; in turn, Russia’s focus concerning pipeline gas exports has become directed towards China instead. Thus, Russia’s total pipeline gas exports to China in 2022 increased by a significant 49% compared with the total for 2021. In 2022, Russia supplied 15.5 bcm of pipeline gas to China, which represented 25% of Chinese pipeline gas imports. Turkmenistan remains the top supplier to China, accounting for 34 bcm of pipeline gas in 2022. China’s other pipeline gas supply originates from Kazakhstan and Uzbekistan via the central Asia route, as well as from Myanmar.

Further detail on China’s pipeline gas demand is shown through the disaggregation of the imports on a monthly basis (Figure 99). Although the monthly volume of imports was higher in 2022 than in 2021, the difference between the two levels was much closer than comparing 2021 versus 2020. During 2022, the average level of pipeline gas imports was 5.2 bcm per month, compared with 4.7 bcm per month in 2021 and just 3.9 bcm per month in 2020.

Figure 99: Monthly pipeline gas imports to China



Source: GECF Secretariat based on data from Refinitiv

Looking forward, pipeline gas imports into China is expected to increase, driven by an overall rebound in gas demand as the country emerges from lockdowns. This will be aided by more volumes from the north, as Russia ramps up flows via the PoS pipeline to the design maximum of 38 bcm per year by 2025. The Chinese operator PipeChina believes that volumes from Russia along PoS will reach 22 bcm in 2023. To bolster this trade, new connections to the PoS pipeline were commissioned in December 2022. On

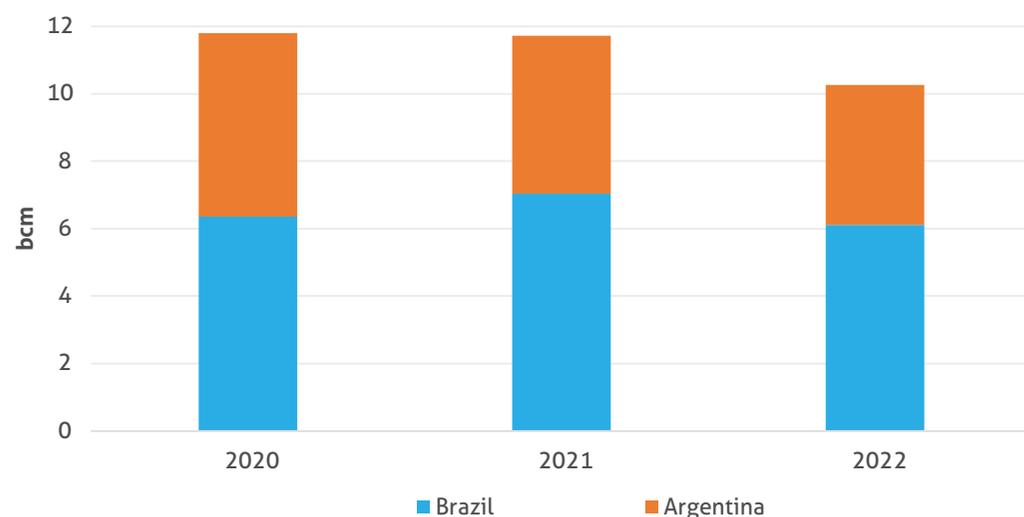
the supply side, flows commenced via a new entry route from the Eastern Siberia field Kovykta; on the demand side, a new segment of the PoS inside southern China began operation, connecting to the critical west-to-east gas corridor in the country. In 2022, a second pipeline gas supply agreement was reached between Russia and China. This 10 bcma contract will bring gas via the Far East route, specifically from fields in Sakhalin. Future increases in pipeline gas trade between both nations - by means of a new supply route to northern China - have been tabled. This Power of Siberia 2 project would have a capacity of up to 50 bcma, and may be expected to be operational by 2030.

China is also accelerating its gas supply plans from Central Asia. Turkmenistan is the top pipeline gas exporter to the country, accounting for 55% of China’s pipeline imports in 2022. Currently, supply is facilitated via the A, B and C lines of the Central Asia-China Gas Pipeline corridor, which has a total capacity of 55 bcma. A fourth connection, the Central Asia-China Gas Pipeline D, is nearing completion and will bring an additional 30 bcma of supply to western China.

4.1.4 Latin America and the Caribbean (LAC)

The LAC region has potential to increase its pipeline gas trade, currently accounting for a mere 2% of the global total of net pipeline gas imports. In this region, the major pipeline gas exporter is Bolivia, which has connections providing supply to southern Brazil and northern Argentina. Pipeline exports from Bolivia have been on the decline in recent years. In 2022, the volume of exports dipped by 13% to reach 10.2 bcm (Figure 100). The quantity of exports to Brazil peaked in 2021, but subsequently fell by 15% in 2022. Exports to Argentina have declined over the past three years, falling by 14% in 2021, then by another 11% in 2022.

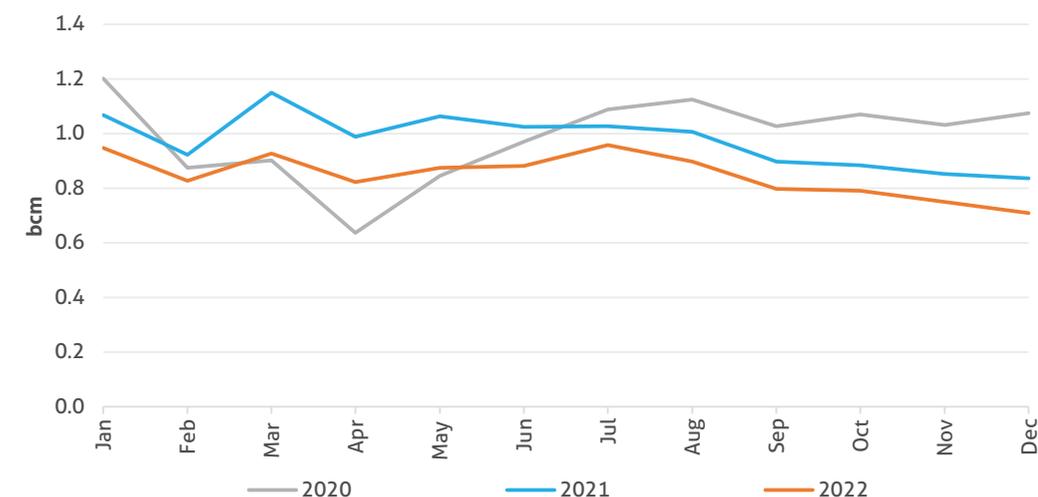
Figure 100: Pipeline gas exports from Bolivia by importing country



Source: GECF Secretariat based on data from Ministério de Minas e Energia (Brasil)

The decline of Bolivia’s pipeline gas exports is also reflected on a monthly basis, as quantities delivered throughout 2022 were consistently lower than in the corresponding month in 2021. Exports in 2022 averaged 0.85 bcm per month, when compared with 0.98 bcm per month and 0.99 bcm per month recorded in 2021 and 2020 respectively (Figure 101).

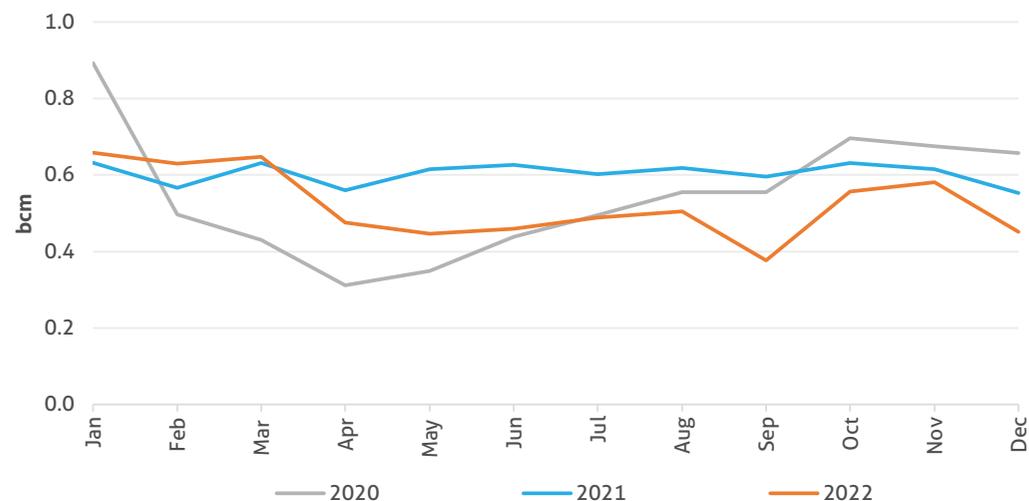
Figure 101: Monthly pipeline gas exports from Bolivia



Source: GECF Secretariat based on data from Ministério de Minas e Energia (Brasil)

Brazil is the largest importer of pipeline gas in South America, with all of its supply originating from Bolivia. When observing monthly pipeline imports, the flows in Q1 2022 were actually on par with the corresponding period in 2021, but the levels then fell away for the remainder of the year (Figure 102). This can be attributed to the recovery of water levels in Brazilian hydroelectric power plants, following a severe drought in 2021, which necessitated an increase in gas imports for power during that period.

Figure 102: Monthly pipeline gas imports in Brazil



Source: GECF Secretariat based on data from Ministério de Minas e Energia (Brasil)

Brazil’s new government is focusing heavily on gas imports in 2023, having already initiated discussions on the matter with counterparts in Bolivia and Argentina. Regarding Bolivia, the new administration’s policies may encourage Bolivia’s state-owned hydrocarbon company Yacimientos Petrolíferos Fiscales Bolivianos to negotiate trade agreements with other Brazilian customers, apart from the current buyer Petrobras. With respect to Argentina, Brazilian banks have provided financing for the Nestor Kirchner pipeline project, which will bring gas supply to southern Brazil from the Vaca Muerta shale fields.

Another development which may promote further pipeline gas trade in South America, is the potential restart of the Antonio Ricaurte gas pipeline between GECF Member Country Venezuela and neighbouring Colombia. This 5 bcma pipeline link between the two nations was initially utilised since 2007 to flow gas from Colombia to Venezuelan oilfields, but this trade came to a halt in 2015. In recent months, however, there have been discussions between government authorities on the possibility of resuming flows from Venezuela to Colombia at some point in the future.

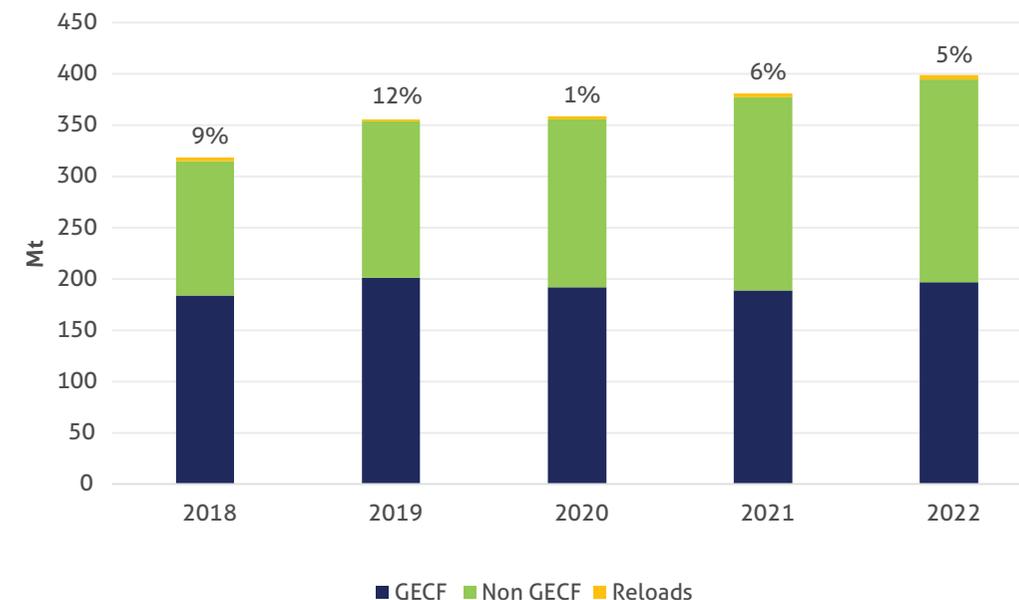
4.2 LNG Trade

4.2.1 LNG Exports

In this report, LNG exports refer to LNG volumes delivered to importing countries, excluding deliveries via ISO containers, and do not reflect the LNG volumes loaded at the LNG export facility. As such, the LNG volumes exclude the boil-off and losses during unloading, shipping and offloading. Global LNG exports include exports from LNG producing countries as well as LNG reloads.

In 2022, global LNG exports increased by 5% (18 Mt) y-o-y to 399 Mt (Figure 103). This represents a slowdown in the pace of growth in LNG exports, which expanded by 6% (22 Mt) y-o-y in 2021. The higher LNG exports last year came from GECF and non-GECF countries as well as higher LNG reloads. GECF’s share in global LNG exports averaged 50% in 2022, relatively unchanged from a year earlier. The start-up and ramp-up of new liquefaction projects, higher feedgas availability, lower unplanned maintenance, and LNG production above the nameplate capacity in some countries, drove the increase in global LNG exports.

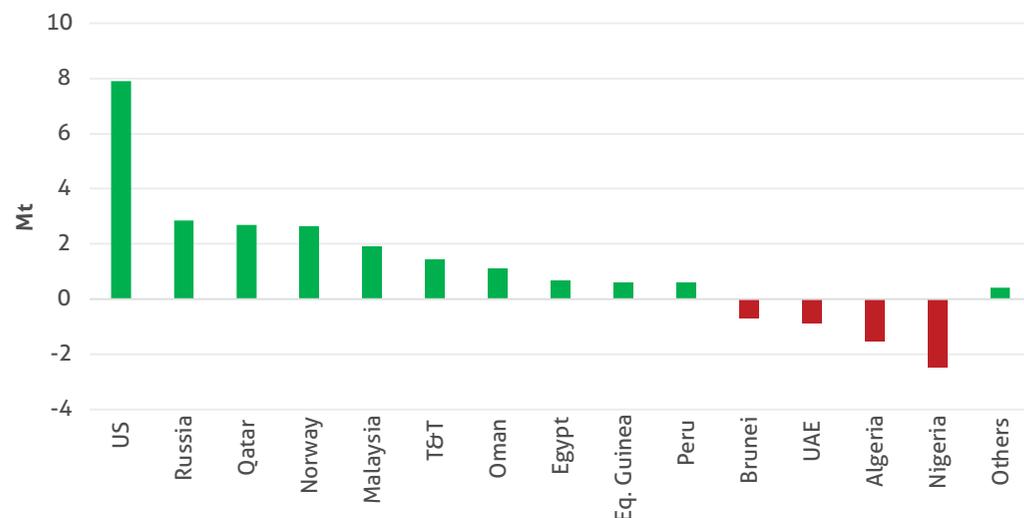
Figure 103: Trend in global LNG exports by supplier



Source: GECF Secretariat based on data from ICIS LNG Edge

At a country level, Qatar reclaimed its position as the largest LNG exporter in 2022 with 80 Mt of LNG exports, followed by Australia (79 Mt), the US (78 Mt), Russia (32 Mt) and Malaysia (27 Mt) respectively. In terms of the variation in global LNG exports at a country level, the US continued to drive the increase in global LNG exports while Russia, Qatar, Norway, Malaysia and Trinidad and Tobago contributed to a lesser extent (Figure 104). In contrast, LNG exports were down significantly in Nigeria and Algeria.

Figure 104: Variation in LNG exports by country in 2022



Source: GECF Secretariat based on data from ICIS LNG Edge

In 2023, assuming LNG reloads remain at the same level as 2022; global LNG exports including LNG reloads are forecasted to grow by 4-4.5% (16-18 Mt) y-o-y to 416 Mt (Figure 105). This represents a slight slowdown in the pace of growth in LNG exports from the previous year. Non-GECF countries are forecasted to account for bulk incremental LNG exports with an additional 11 Mt, while LNG exports from GECF member countries are forecasted to rise by 6 Mt.

Assumptions for global LNG exports in 2023:

Upside

- Start-up and ramp-up of new liquefaction facilities in Congo, Indonesia, Mexico, Mozambique, Russia and the US: 10-11 Mt
- Ramp up of the Hammerfest LNG facility in Norway: 1.5-2 Mt
- Restart of the Freeport LNG facility in the US: 5-6 Mt
- Higher feedgas availability in Algeria and Trinidad and Tobago: 1-2 Mt
- Lower maintenance activity at Prelude FLNG in Australia: 1-2 Mt

Downside

- Lower feedgas availability in Brunei and Nigeria: 1-2 Mt
- Lower feedgas availability for the Darwin LNG facility in Australia: 0.5-1 Mt

Stable

- LNG exports from all other countries are assumed to be at the same level as 2022

In 2024, also assuming LNG reloads remain at the same level as 2023, the pace of growth in global LNG exports is forecasted to accelerate slightly by 4.5-5% (18-20 Mt) y-o-y to 435 Mt (Figure 105). Both GECF member countries and non-GECF countries are forecasted to boost global LNG exports with additional 10 Mt and 9 Mt of LNG respectively.

Assumptions for global LNG exports in 2024:

Upside

- Start-up and ramp-up of new liquefaction facilities in Congo, Indonesia, Mauritania/Senegal, Mexico, Mozambique, Russia, Suriname and the US: 13-14 Mt
- Ramp-up in production from the Freeport LNG facility in the US: 2-3 Mt
- Higher feedgas availability in Algeria, Nigeria and Trinidad and Tobago: 3-4 Mt

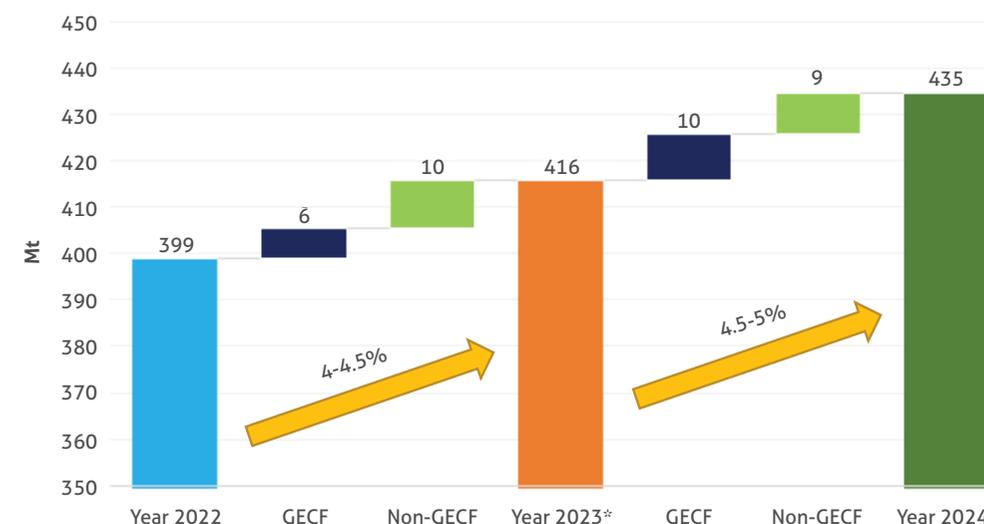
Downside

- Shutdown of the Darwin LNG facility in Australia for refurbishment: 0-0.5 Mt

Stable

- LNG exports from all other countries are assumed to be at the same level as 2023

Figure 105: Short-term outlook for global LNG exports by supplier (2022-2024)

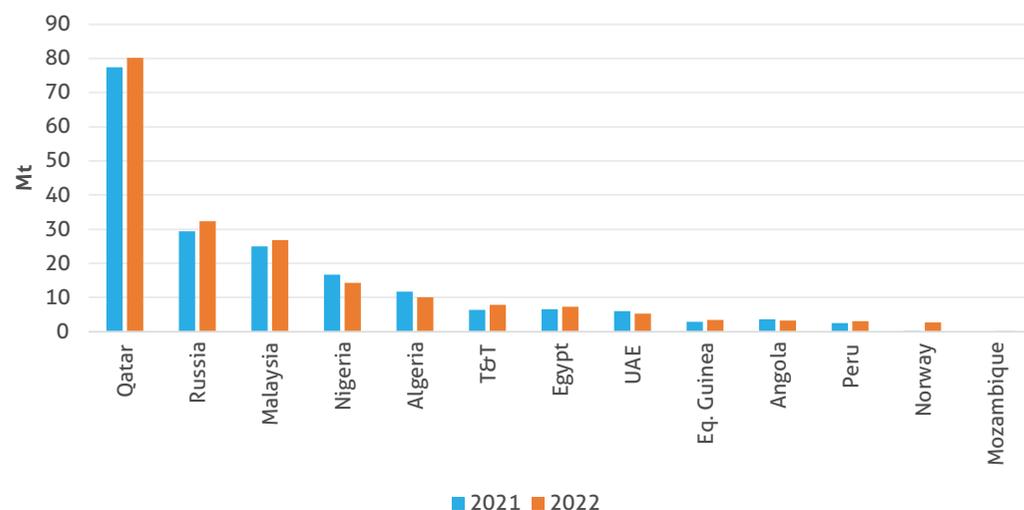


Source: GECF Secretariat based on data from ICIS LNG Edge for Year 2022
 (*): GECF Secretariat's Forecast for Years 2023 and 2024

4.2.1.1 GECF Member Countries

In 2022, GECF’s (members and observers) LNG exports grew by 4% (8 Mt) y-o-y to 197 Mt. The uptick in LNG exports was supported by the start-up and ramp-up of new liquefaction projects, higher feedgas availability, LNG production above the nameplate capacity and lower unplanned maintenance in some GECF Member Countries. Russia, Qatar, Norway, Malaysia, Trinidad and Tobago, Egypt, Equatorial Guinea, Peru and Mozambique accounted for the bulk incremental growth in GECF’s LNG exports and offset lower exports from Nigeria, Algeria, the UAE and Angola (Figure 106).

Figure 106: GECF’s LNG exports by country (2021 & 2022)



Source: GECF Secretariat based on data from ICIS LNG Edge

In Russia, LNG production above the nameplate capacity at the Sakhalin 2 and Yamal LNG facilities, as well as the start-up of the Portovaya LNG facility boosted the country’s LNG exports. Similarly, LNG production above the nameplate capacity in Qatar supported higher LNG exports. Meanwhile, the restart of the Hammerfest LNG facility in June 2022 drove Norway’s LNG exports higher. In Malaysia, the increase in LNG exports was attributed to the ramp-up of the PFLNG 2 facility and higher feedgas availability. Likewise, stronger feedgas availability contributed to the rise in Equatorial Guinea and Trinidad and Tobago’s LNG exports. In Peru, lower maintenance activity supported the uptick in LNG exports from the country. It is also worth mentioning that Mozambique joined the club of LNG exporters last year with the start-up of the Coral South FLNG facility.

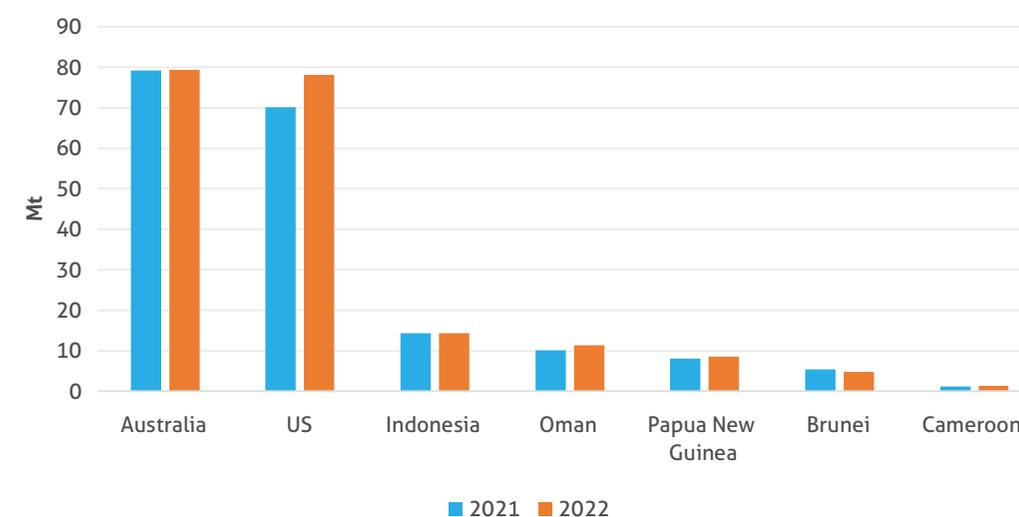
In contrast, the drop in Nigeria’s LNG exports was due to weaker feedgas availability, which was partially affected by widespread flooding in the country in October 2022. In Algeria, an unplanned outage at the Arzew GL 3Z train 1 facility between March

and October 2022, due to a damaged gas turbine compressor, led to a decline in LNG exports from the country. Furthermore, higher maintenance activity at the Das Island LNG facility contributed to the decline in UAE’s LNG exports.

4.2.1.2 Non-GECF Countries

In 2022, non-GECF’s LNG exports rose by 5% (9 Mt) y-o-y to a record high of 197 Mt. This was driven by the start-up and ramp-up of new liquefaction projects, debottlenecking activity, and lower maintenance activity at some liquefaction plants. The US led the growth in non-GECF’s LNG exports, followed by Oman, Papua New Guinea, Australia and Cameroon, which offset the decline in exports from Brunei and Indonesia (Figure 107).

Figure 107: Non-GECF’s LNG exports by country (2021 & 2022)



Source: GECF Secretariat based on data from ICIS LNG Edge

Stronger LNG exports from the US were supported by the start-up of the Calcasieu Pass LNG facility, the ramp-up of Corpus Christi Train 3 and Sabine Pass Train 6 LNG facilities, and higher production from the Elba Island LNG facility. Higher LNG exports from these facilities offset the lower exports from the Freeport LNG facility. To recall, Freeport LNG shut down in June 2022 following an explosion. The facility resumed partial operations in February 2023 but is not expected to be fully operational until the middle of 2023. In Oman, the completion of debottlenecking work to increase the capacity at the Qalhat LNG facility boosted the country’s LNG exports. Meanwhile, lower maintenance activity at the PNG LNG facility drove Papua New Guinea’s LNG exports higher. On the other hand, the weaker feedgas availability in Brunei, due to declining domestic gas production, led to a drop in LNG exports from the country.

In Australia, LNG exports were relatively unchanged in 2022. At a project level, higher LNG exports from the Gorgon and North West Shelf LNG facilities offset weaker exports from the Darwin and Prelude LNG facilities. The stronger LNG production at Gorgon LNG was driven by lower maintenance activity, while higher feedgas availability boosted exports from the North West Shelf LNG facility. Meanwhile, lower feedgas availability to the Darwin LNG facility, as a result of declining gas production from the gas field feeding the LNG facility, led to a decline in LNG exports. Furthermore, strike actions by workers of the facility and higher maintenance activity led to the decline in Prelude’s LNG exports.

4.2.2 New LNG exporting capacity

4.2.2.1 Start-up of New Liquefaction Capacity

Global liquefaction capacity grew by 16 Mtpa y-o-y to 486 Mtpa in 2022, which represents a significant increase from the 7 Mtpa liquefaction capacity added in 2021 (Figure 108). In terms of capacity utilisation of global liquefaction capacity, it averaged 81% last year, the same as in 2021. The US accounted for the largest capacity addition with the start-up of the 11.3 Mtpa Calcasieu Pass LNG facility, followed by Mozambique with the 3.4 Mtpa Coral South FLNG and Russia with the 1.5 Mtpa Portovaya LNG facility.

In 2023, global liquefaction capacity addition is expected to decline to 14 Mtpa, with contributions mainly from Russia and Indonesia. Five projects are expected to start operations, including Arctic LNG train 1 (6.6 Mtpa), Tangguh LNG train 3 (3.8 Mtpa), Altamira FLNG (1.4 Mtpa), Louisiana FLNG (1.4 Mtpa) and Congo FLNG (0.6 Mtpa).

Figure 108: Trend in new liquefaction capacity addition by country



Source: GECF Secretariat based on data from Argus, ICIS LNG Edge, Refinitiv, Rystad Energy and Project Updates
 (*): Forecast for the start-up of new liquefaction capacity

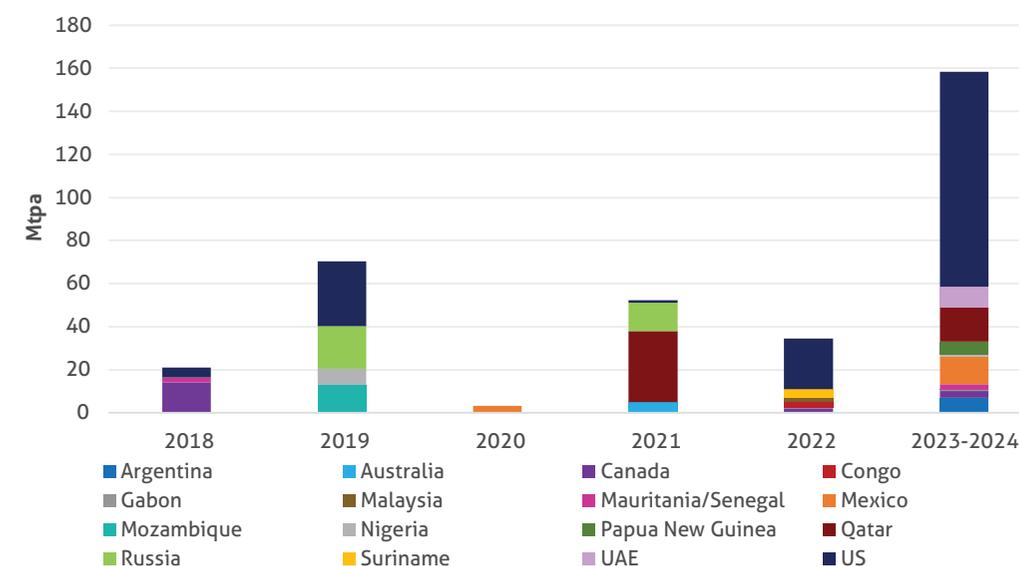
Looking further ahead into 2024, the start-up of new liquefaction capacity is expected to reach the highest level since 2019, with capacity addition of 22 Mtpa. New liquefaction capacity will mainly come from the US, Russia and Suriname. The new liquefaction projects include Arctic LNG train 2 (6.6 Mtpa), Golden Pass LNG train 1 (5.2 Mtpa), Firebird LNG (4 Mtpa), trains 1-6 from Plaquemines LNG Phase 1 (3.76 Mtpa) and Tortue FLNG 1 (2.5 Mtpa).

4.2.2.2 FIDs on New LNG Export Projects

In 2022, final investment decisions (FIDs) on new liquefaction capacity declined to 34 Mtpa from 52 Mtpa in 2021 (Figure 109). The decline in liquefaction capacity that took FID last year was attributed to rising inflation, which led to higher costs for the development of new projects, as well as a slowdown in long-term LNG contracting. Most of the projects that took FID last year came from the US, including the Plaquemines LNG Phase 1 (13.3 Mtpa) and Corpus Christi LNG Stage 3 (10 Mtpa). Other projects that took FID include the Firebird LNG (4 Mtpa) in Suriname, Congo FLNG 1 (0.6 Mtpa) and Congo FLNG 2 (2.4 Mtpa) in Congo, Woodfibre LNG (2.1 Mtpa) in Canada and ZLNG (2 Mtpa) in Malaysia.

In 2023 and 2024, almost 160 Mtpa of new liquefaction capacity could take FID. The strong LNG contracting over the past two years and expectations for a tight LNG market through the middle of this decade are expected to support more FIDs. The US accounts for 63% of the liquefaction capacity targeting FID in the short-term, followed by Qatar (10%), Mexico (8%) and the UAE (6%). In the first three months of 2023, three project reached FID, Port Arthur LNG Phase 1 (13 Mtpa) and Plaquemines LNG Phase 2 (8.77 Mtpa) in the US and the Gabon LNG terminal (0.7 Mtpa).

Figure 109: Trend in FIDs on new liquefaction capacity by country

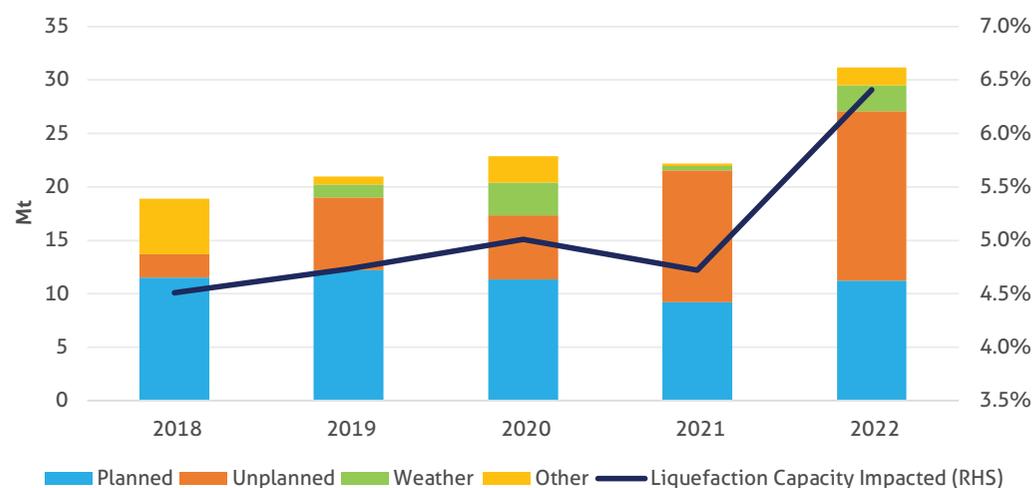


Source: GECF Secretariat based on data from Argus, ICIS LNG Edge, Refinitiv and Project Updates
 (*): projects targeting FID in 2023 and 2024

4.2.3 Liquefaction Plant Outages

Global liquefaction plant outages in 2022, at 31 Mtpa, represented 6% of global liquefaction capacity and the highest level in the last five years (Figure 110). Furthermore, liquefaction plant outages due to unplanned events were the highest in five years and stood at 16 Mtpa. The major unplanned outages in 2022 were at the Freeport LNG facility in the US, Arzew LNG facility in Algeria and the Hammerfest LNG facility in Norway. In 2023, unplanned maintenance is expected to decline, supported by the end of unplanned maintenance at the Arzew and Hammerfest LNG facilities and restart of production at the Freeport LNG facility.

Figure 110: Trend in global liquefaction plant outages



Source: GECF Secretariat based on data from Argus, ICIS LNG Edge and Refinitiv
 Note: Other refers to activities not associated with the LNG facility such as pipeline and upstream maintenance

4.2.4 LNG Reloads

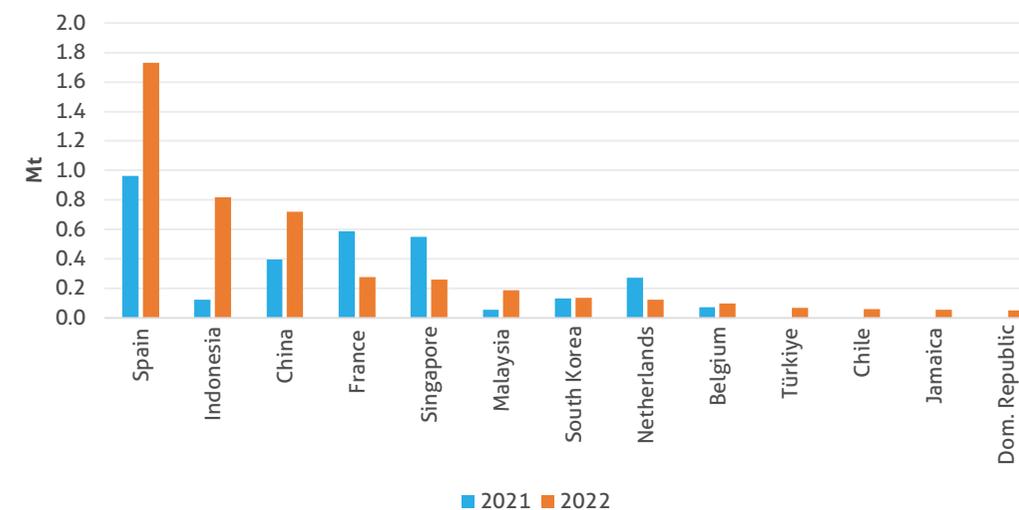
In 2022, global LNG reloads jumped by 39% (1.3 Mt) y-o-y to 4.6 Mt, representing the highest annual LNG reloads since 2014 and driven mainly by an increase in intra-regional LNG trade among EU countries and utilisation of the Arun LNG terminal in Indonesia as an LNG hub. At a country level, Spain, Indonesia and China drove the rise in global LNG reloads, which offset lower LNG reloads from France, Singapore and Netherlands (Figure 111).

Spain has the largest LNG import capacity in Europe and received record volumes of LNG imports in 2022. However, the lack of interconnectivity between the Spanish gas infrastructure and the rest of Europe, coupled with weaker gas demand in the country, supported LNG reloads and exports to other EU countries impacted by lower pipeline gas imports. Spain's LNG reloads surged to 1.7 Mt in 2022, the highest level since 2014.

In Indonesia, TotalEnergies has an agreement with Pertamina to utilise two storage tanks at the Arun LNG terminal for LNG delivery and storage of LNG from its global portfolio before it is reloaded and exported to its customers in Asia Pacific. Similarly, Kyushu Electric also utilises one storage tank at the Arun LNG terminal for LNG delivery, storage and reloading activity. Meanwhile, weak LNG demand in China resulted in several LNG sell tenders from market players, thereby boosting LNG reloads.

In contrast, lower LNG reloads from France and Netherlands was attributed to higher LNG demand to offset the decline in pipeline gas imports in both countries as well as neighbouring countries. In Singapore, weaker spot LNG demand in Asia Pacific drove the decrease in LNG reloading activity in the country.

Figure 111: LNG reloads by country (2021 & 2022)



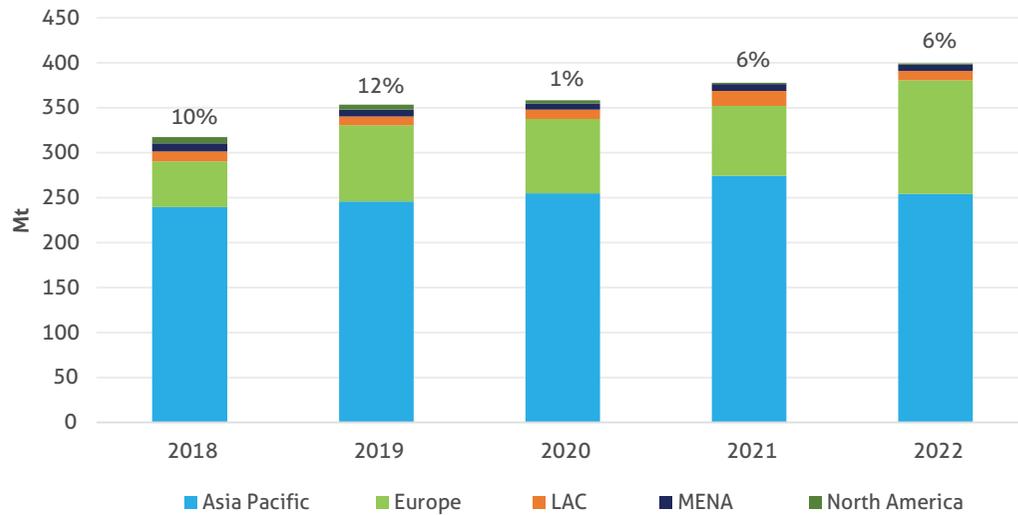
Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.5 LNG Imports

In 2022, global LNG imports jumped by 6% (21 Mt) y-o-y to 399 Mt, driven by robust European demand, which offset weaker imports in all other regions (Figure 112). The weaker imports in other regions were due to their inability to outcompete Europe, which led to demand destruction. The pace of growth in global LNG imports was similar to that of 2021 but lower than the annual growth rates between 2017 and 2019.

Unlike previous years when Europe was the market of last resort for LNG, Europe displaced Asia Pacific to become the premium market due to its strong appetite for LNG to compensate for declining pipeline gas imports. The TTF gas price held a premium over the spot LNG prices in Asia Pacific, attracting significant spot and flexible LNG cargoes from the Atlantic basin that would have previously landed in Asia Pacific.

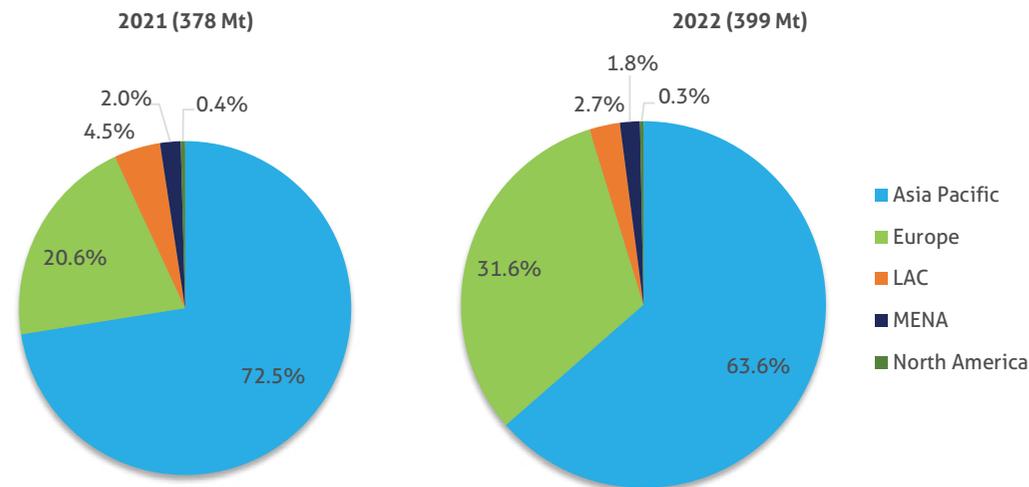
Figure 112: Trend in global LNG imports by region



Source: GECF Secretariat based on data from ICIS LNG Edge

Looking at the regional share of LNG imports in 2022, there has been a significant increase in Europe to the detriment of Asia Pacific and LAC from a year earlier (Figure 113). Europe’s share of global LNG imports jumped from 20.6% in 2021 to 31.6% in 2022. In contrast, Asia Pacific and LAC’s shares in global LNG imports declined from 72.5% and 4.5% to 63.6% and 2.7%, respectively, during the same period. Despite the decline in Asia Pacific’s share in global LNG imports, the region was still the largest LNG importer globally.

Figure 113: Shares of global LNG imports by region (2021 & 2022)

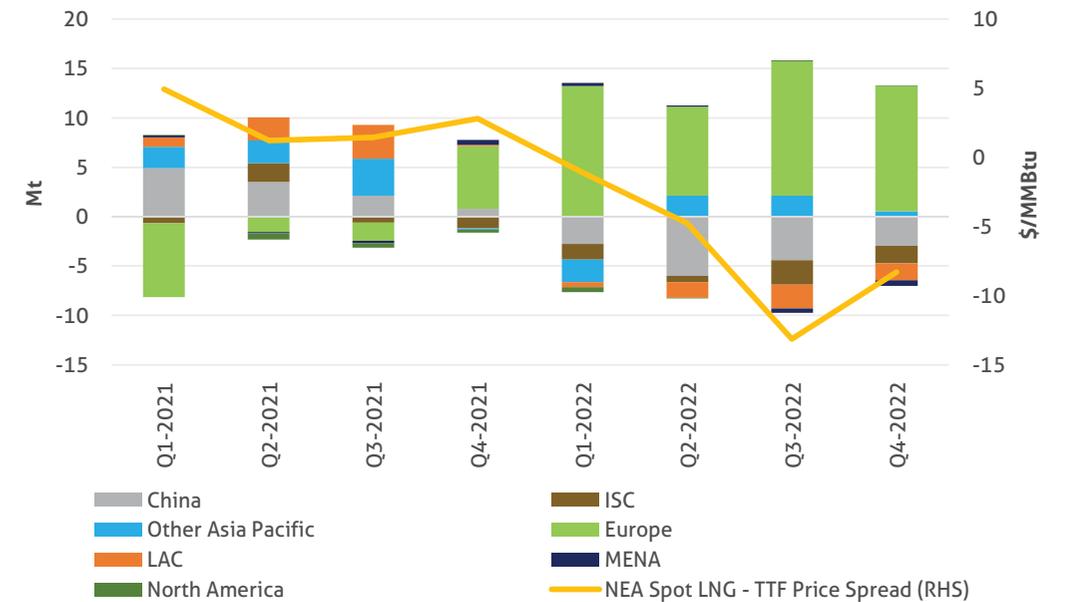


Source: GECF Secretariat based on data from ICIS LNG Edge

In 2022, there was a reconfiguration in global LNG flows, with significant volumes of LNG shifting away from Asia Pacific to Europe. This shifting started in Q4 2021 and continued into 2022 (Figure 114), driven by Asia Pacific’s weakening spot LNG demand and spot LNG prices in Asia Pacific trading at a discount to the TTF gas price. The weaker spot LNG demand in Asia Pacific in 2022 came mainly from China and countries in the Indian sub-continent (ISC). Furthermore, the negative gas/LNG price spread between Asia Pacific and Europe resulted in a higher netback for cargoes from the Atlantic basin exported to Europe compared to Asia Pacific.

The continued shift in LNG flows away from Asia Pacific to Europe is unlikely in 2023 since the increase in LNG imports in both regions may be satisfied by new LNG supply coming to the market. Although Europe is expected to rely on higher LNG imports to offset the decline in pipeline gas imports this year, the forecasted decline in gas consumption and higher gas storage levels at the end of winter will limit the increase in LNG imports to the region.

Figure 114: Quarterly y-o-y variation in LNG imports in major markets



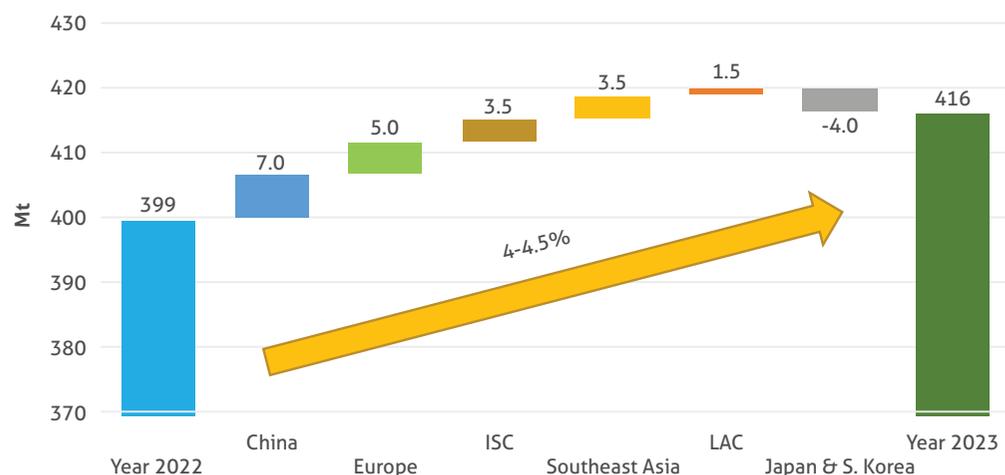
Source: GECF Secretariat based on data from Argus and ICIS LNG Edge

Note: ISC – Indian sub-continent

In 2023, global LNG imports are forecasted to increase by 4-4.5% (16-18 Mt) to absorb the new LNG supply coming to the market (Figure 115). China’s LNG imports could increase by 10% (6-8 Mt), driven by the recovery in gas consumption as economic and industrial activity picks up. However, China’s LNG imports are not expected to return

to the 2021 high this year due to forecasted increases in domestic gas production and pipeline gas imports. In addition, Europe’s LNG imports are forecasted to expand by around 4% (4-6 Mt) to compensate for a further decline in pipeline gas imports. This represents a significant slowdown in the pace of growth in LNG imports from 2022 since the region is expected to end the winter season with significantly higher gas in storage, and gas consumption is forecasted to decrease for the second consecutive year. In Japan and South Korea, LNG imports are forecasted to decline by 4% (2-3 Mt) and 3% (1-2 Mt), respectively, due to higher nuclear availability in both countries. Meanwhile, the cooling of spot LNG prices in Asia Pacific is expected to drive a recovery in LNG imports in the Indian sub-continent by 11% (3-4 Mt). Furthermore, the start of LNG imports and higher LNG demand in Southeast Asian countries, upon declining gas production and increasing gas consumption, are expected to contribute to a jump in LNG imports in the sub-continent by 18% (3-4 Mt). Finally, LAC’s LNG imports are forecasted to grow by 14% (1-2 Mt), while LNG imports in MENA and North America are forecasted to remain flat.

Figure 115: Short-term outlook for global LNG imports by market

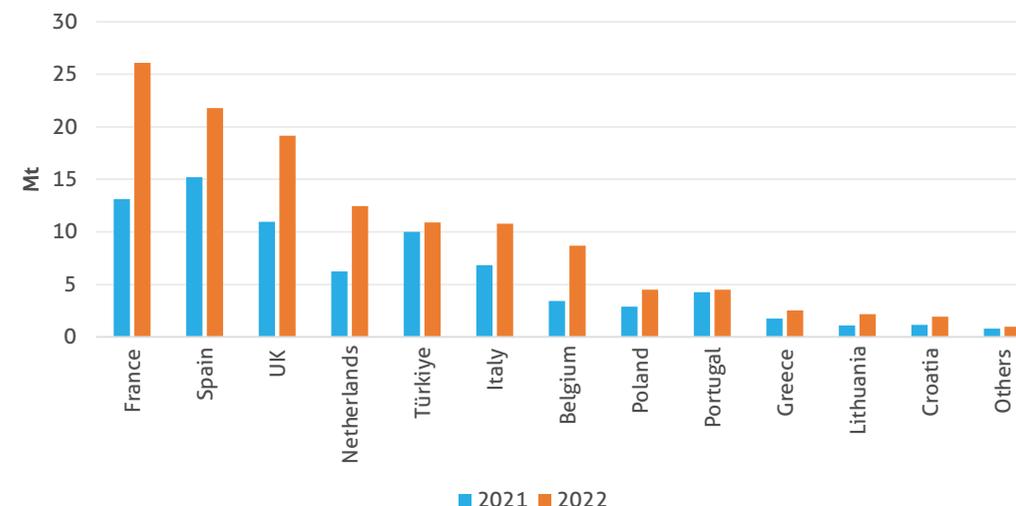


Source: GECF Secretariat based on data from ICIS LNG Edge for Year 2022 and GECF’s Forecast for 2023

4.2.5.1 Europe

In 2022, Europe’s LNG imports surged by 62% (49 Mt) y-o-y to a record high of 126 Mt, helping to partially offset lower pipeline gas imports in the EU amidst ongoing geopolitical tensions. At a country level, France, the UK, Spain, the Netherlands, Belgium, Italy, Poland and Lithuania accounted for the bulk incremental increase in LNG imports (Figure 116). It is also worth mentioning that Germany joined the club of LNG importers in 2022 following the start-up of its first FSRU in December 2022.

Figure 116: Europe’s LNG imports by country (2021 & 2022)



Source: GECF Secretariat based on data from ICIS LNG Edge

French LNG imports increased by a whopping 13 Mt in 2022, driven by lower pipeline gas imports and strong pipeline gas exports to Belgium, Germany and Switzerland, which were also impacted by the drop in pipeline gas imports. It is worth mentioning that Belgium utilises capacity at the Dunkerque LNG import terminal in France for LNG imports. The UK’s LNG imports also rose by a staggering 8 Mt last year, mainly attributed to lower pipeline gas imports from Norway and strong pipeline gas exports to continental Europe via the IUK and BBL gas pipelines. Meanwhile, a drop in pipeline gas imports from Algeria, stronger LNG reloads for re-export to EU countries and an increase in pipeline gas exports to France boosted Spain’s LNG imports.

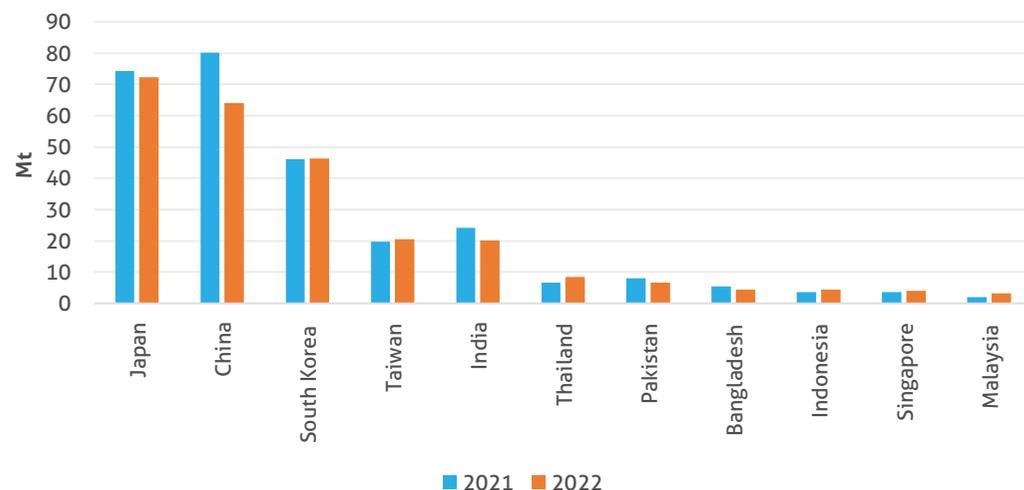
The higher LNG imports in the Netherlands were supported by weaker pipeline gas imports, lower domestic gas production and higher pipeline gas exports to Germany. In Belgium, LNG imports surged by more than 150% in 2022, driven by an increase in pipeline gas exports to Germany and the Netherlands. The Netherlands has traditionally been a net gas exporter to Belgium but switched to becoming a net gas importer with Belgium last year. Furthermore, lower pipeline gas imports contributed to the jump in LNG imports in Italy, Lithuania and Poland. LNG imports in Lithuania also supported increased pipeline gas exports to neighbouring Latvia.

4.2.5.2 Asia Pacific

In 2022, Asia Pacific’s LNG imports fell 7.3% (20 Mt) y-o-y to 254 Mt (Figure 117). This level is slightly lower than the total LNG imports in 2020 and represents the first annual decline since 2015. Weaker LNG imports were mainly due to record-high spot LNG prices and available alternative gas supply sources. On a country level, China led the

decline, followed by India, Japan, Pakistan, and Bangladesh. In contrast, LNG imports were up significantly in Thailand and Malaysia.

Figure 117: Asia Pacific's LNG imports by country (2021 & 2022)



Source: GECF Secretariat based on data from ICIS LNG Edge

China lost its position as the world's largest LNG importer in 2022 and fell to the second position due to the slump in its LNG imports. Weaker gas demand and record high spot LNG prices coupled with elevated domestic gas production and pipeline gas imports led to a 20% drop in LNG imports in the country. This represents the first-ever annual decline in China's LNG imports. In India, the record high spot LNG prices and higher domestic gas production curbed LNG imports. Following the German government's move to eventually nationalise Gazprom's assets, Germany's Securing Energy for Europe (Sefe) took over the Gazprom subsidiary that has a long-term LNG SPA with GAIL. PJSC Gazprom fulfilled its obligations in full to Sefe, however, the LNG was exported to Germany instead of India. As such, Sefe failed to deliver contractual LNG cargoes to India, which contributed to weaker Indian imports.

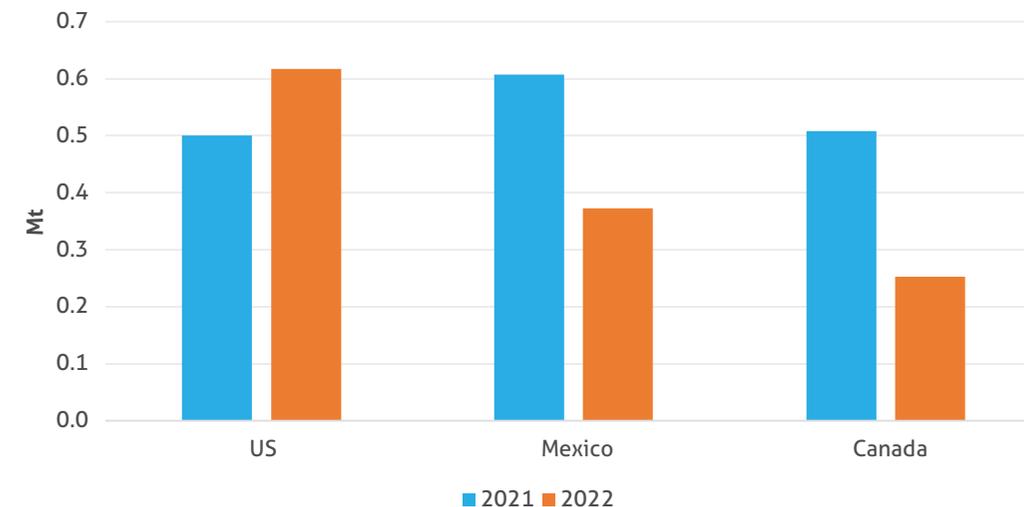
Meanwhile, the weaker LNG imports in Bangladesh and Pakistan were mainly attributed to the record high spot LNG prices last year. Countries in the Indian sub-continent (ISC) are price-sensitive LNG buyers, and European LNG buyers priced them out of the spot market last year, which led to gas and electricity shortages in the countries. In Japan, the gas-saving measures proposed by the Ministry of Energy Trade and Industry (METI), coupled with stronger coal and oil consumption in the electricity sector, led to a decline in the country's LNG imports. Despite the decline in LNG imports, Japan reclaimed its position as the largest LNG importer globally.

On the other hand, LNG imports grew strongly in Thailand to offset lower domestic gas production. In Malaysia, majority gas fields and the liquefaction plants are located close to Borneo Island. The lack of pipeline infrastructure to transport gas from these fields to the Malay Peninsula has supported the growing LNG imports to meet the increasing gas demand in the country.

4.2.5.3 North America

In 2022, North America's LNG imports fell by 23% (0.4 Mt) y-o-y to an all-time low of 1.2 Mt. Weaker LNG imports were attributed to stronger intra-regional pipeline gas trade. On a country level, Canada and Mexico drove the decline in the region's LNG imports but were partially offset by an uptick in LNG imports in the US (Figure 118). Higher gas production in Canada and Mexico led to a decline in LNG imports in both countries in 2022.

Figure 118: North America's LNG imports by country (2021 & 2022)



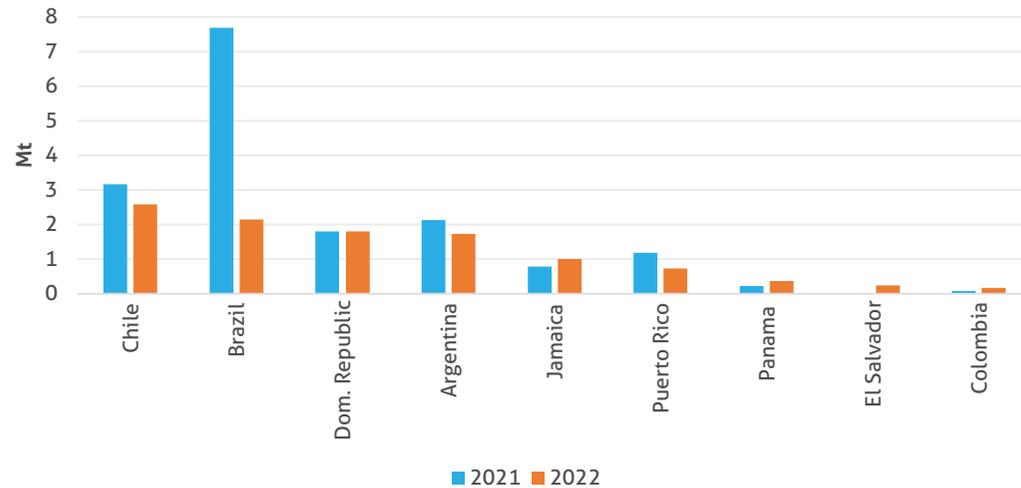
Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.5.4 Latin America and the Caribbean (LAC)

In 2022, LAC's LNG imports plunged by 37% (6 Mt) y-o-y to 11 Mt, in line with the historical average. South America faced one of the worst droughts in a century in 2021, which resulted in Brazil and Chile boosting their LNG imports to increase electricity production from gas to offset lower hydro output. The weaker LNG imports last year were mainly driven by a recovery in hydro levels in South America and an increase in gas production in some countries in the region. Brazil accounted for the bulk incremental decline, falling by 72% y-o-y, while exports in Chile, Puerto Rico and Argentina were down sharply (Figure 119). In contrast, LNG imports were up significantly in El Salvador and Jamaica. El Salvador joined the club of LNG importers in 2022.

In Argentina, stronger domestic gas production curbed LNG imports in the country. Meanwhile, the fall in Puerto Rico's LNG imports was due to the failure of some suppliers to deliver contractual LNG cargoes to the country amidst the energy crisis in Europe. On the other hand, higher gas demand in Jamaica's electricity sector supported the jump in LNG exports. Finally, the start-up of the Acajutla FSRU in El Salvador supported the start of LNG imports in the country.

Figure 119: LAC's LNG imports by country (2021 & 2022)

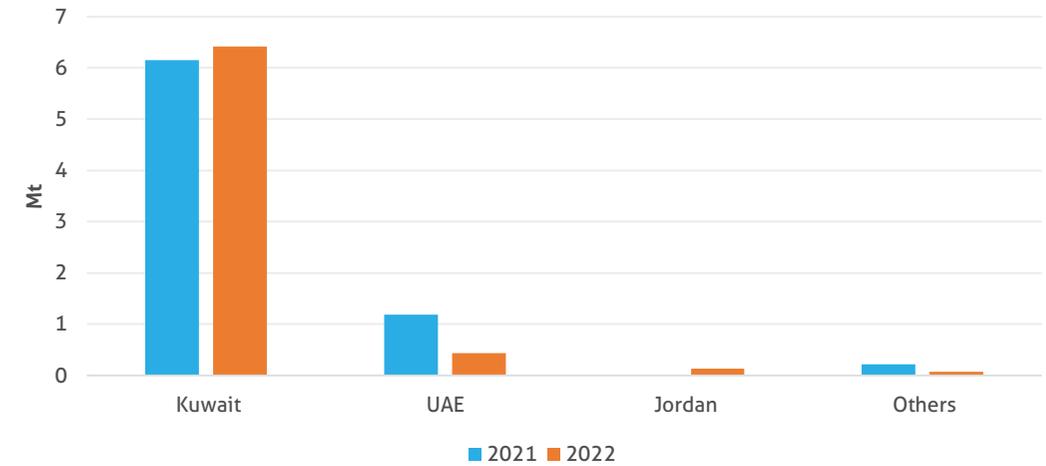


Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.5.5 Middle East and North Africa (MENA)

In 2022, MENA's LNG imports were down slightly by 7% (0.5 Mt) y-o-y to 7 Mt due to increased gas production and higher nuclear availability. The UAE led the decline, with Kuwait partially offsetting this (Figure 120). Following the start-up of the Al Zour regasification terminal in 2021, Kuwait increased its LNG imports last year to meet the higher gas demand in the electricity sector. In other MENA countries, stronger gas production from the Eastern Mediterranean curbed LNG imports.

Figure 120: MENA's LNG imports by country (2021 & 2022)

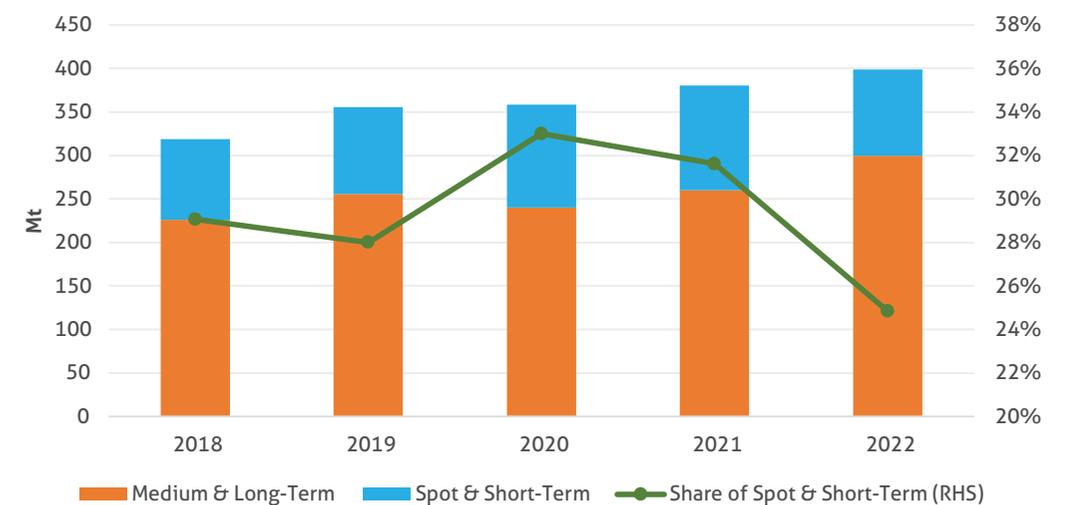


Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.5.6 Trend in Global LNG Trade by Duration

Spot and short-term LNG trade refers to LNG cargoes that are traded under contracts of two years or less. In 2022, global spot LNG trade fell by 18% (21 Mt) y-o-y to 100 Mt, which was the same level as 2019. The decline in global spot and short-term LNG trade was mainly due to the weaker spot LNG demand in Asia Pacific amidst the record high spot LNG prices in 2022 and the start of long-term Sales and Purchase Agreements (SPAs). The share of spot and short-term LNG trade in global LNG trade fell from 32% in 2021 to 25% in 2022 (Figure 121).

Figure 121: Trend in global LNG trade by duration

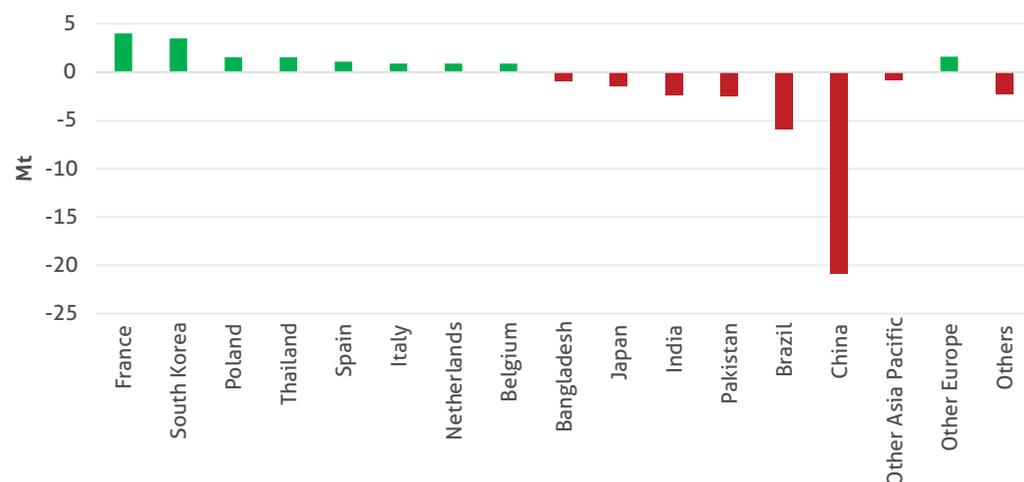


Source: GECF Secretariat based on data from ICIS LNG Edge

Weaker spot and short-term LNG imports in Asia Pacific and LAC, which offset higher spot and short-term LNG imports in Europe, drove the drop in global spot and short-term LNG imports. China by far led the decline, while Brazil, Pakistan, India, Japan and Bangladesh contributed to a lesser extent (Figure 122). In contrast, spot and short-term LNG imports rose sharply in France, South Korea, Poland, Thailand, Spain, Italy, Netherlands and Belgium. On the export side, Malaysia and Oman contributed an additional 0.8 Mt each of spot and short-term LNG exports while it declined in the US (-9.0 Mt), Russia (-3.9 Mt), Qatar (-3.4 Mt), Australia (-2.8 Mt), Nigeria (-2.0 Mt) and Angola (-1.4 Mt).

The lower spot and short-term LNG imports in China were driven by weaker spot LNG demand and the start of long-term SPAs in 2022. Meanwhile, Brazil has high exposure to the spot market, and the drop in LNG demand weighed on spot and short-term LNG imports last year. As mentioned, record-high spot LNG prices curbed spot and short-term LNG imports in the Indian sub-continent. On the other hand, European countries imported more spot LNG to compensate for the decline in pipeline gas imports.

Figure 122: Variation in global spot & short-term LNG imports by country in 2022

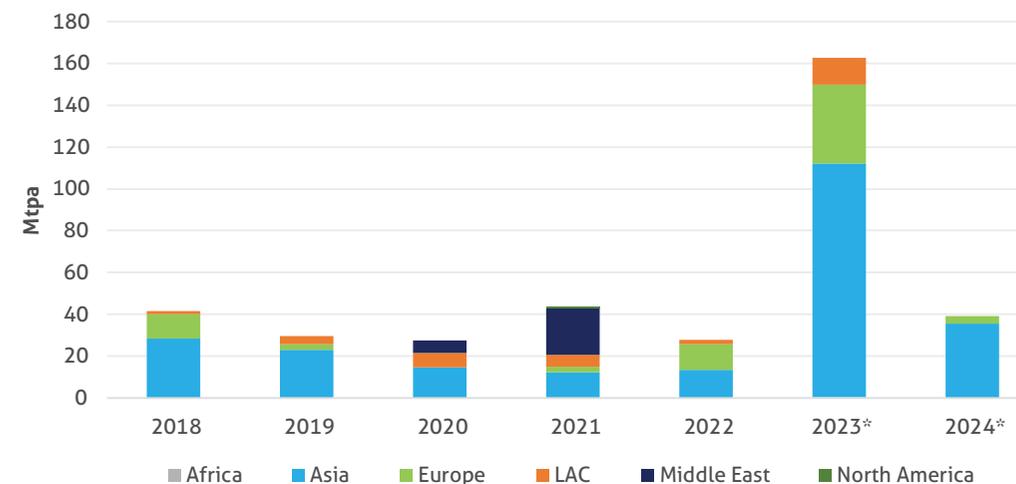


Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.6 New LNG Importing Capacity

Global regasification capacity in 2022 increased by 28 Mtpa y-o-y (Figure 123) to 1,037 Mtpa, representing a decline in capacity addition from 2021. At a regional level, Asia Pacific has the largest regasification capacity of 573 Mtpa, followed by Europe (195 Mtpa), North America (155 Mtpa), LAC (55 Mtpa), MENA (54 Mtpa) and Africa (6 Mtpa). In terms of the capacity utilisation of global regasification capacity, it averaged 39% in 2022, slightly higher than 38% in 2021. Asia Pacific accounted for 48% of the regasification capacity addition last year, followed by Europe (44%) and LAC 8%.

Figure 123: Trend in new regasification capacity addition by region



Source: GECF Secretariat based on data from Argus, ICIS LNG Edge, Refinitiv, Rystad Energy and Project Updates (*): Forecast for the start-up of new regasification capacity

At a country level, Thailand led the start-up of new regasification capacity with its 7.5 Mtpa terminal, followed by the Netherlands (6 Mtpa), Germany (5.5 Mtpa), China (5 Mtpa), Finland (4.1 Mtpa), El Salvador (2.25 Mtpa) and Japan (1 Mtpa). Looking specifically at the major regasification terminals that started operations last year, these include: Nong Fab (7.5 Mtpa) in Thailand, Wilhelmshaven FSRU 1 (5.5 Mtpa) in Germany, Eemshaven (6 Mtpa) in the Netherlands, Jiangsu Binhai LNG Phase 1 (3 Mtpa) in China and Acajutla (2.3 Mtpa) in El Salvador.

Germany and El Salvador joined the club of LNG importers in 2022 with the start-up of regasification terminals in both countries. In addition, Ecuador started small-scale LNG imports via ISO containers in 2022. European governments fast-tracked the development of FSRUs in the region for alternative gas supply amidst the lower pipeline gas imports from Russia. In China and India, several regasification terminals were delayed from 2022 into 2023 due to the weak LNG demand in both countries.

In 2023, global regasification capacity could reach a record high with 163 Mtpa of capacity targeting to start operations. Asia Pacific drives the regasification capacity addition this year with 69%, followed by Europe (23%) and LAC (8%). At a country level, China alone accounts for 66 Mtpa of the new regasification capacity this year, followed by India (19 Mtpa), Germany (18 Mtpa), Philippines (18 Mtpa), Brazil (12 Mtpa) and Türkiye (6 Mtpa). Estonia, Philippines and Vietnam are expected to join the club of LNG importers this year. Between January and March 2023, Germany added 11 Mtpa of new regasification capacity via three FSRUs while, Estonia started LNG imports from the Inkoo FSRU (3.7 Mtpa) in Finland, which is a joint project between Estonia and Finland.

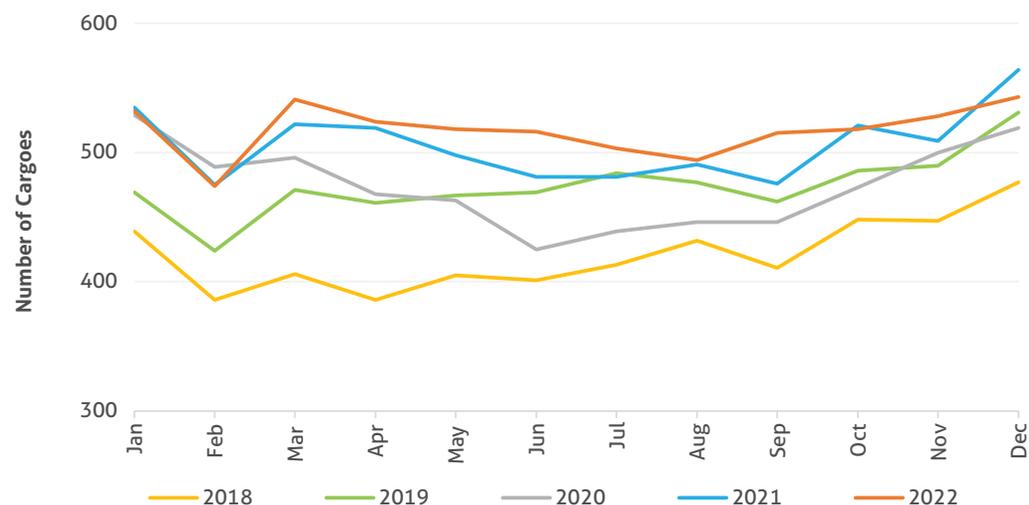
Further ahead in 2024, the addition of new regasification capacity is forecasted to decline sharply to 39 Mtpa. The new regasification capacity is expected to come from China (18 Mtpa), India (5 Mtpa), Vietnam (5 Mtpa), Philippines (4.2 Mtpa), Italy (3.7 Mtpa) and Taiwan (Province of China) (3 Mtpa).

4.2.7 LNG Shipping

4.2.7.1 LNG Shipments

In 2022, the number of LNG cargoes traded globally reached 6,210, increasing 2% over the total number of shipments in 2021. This continued the trend of more cargoes being traded annually in each of the past five years, except during the initial breakout of the pandemic in 2020. Compared with 2021, the number of LNG shipments per month was greater for most of 2022; over the year, the monthly average number of cargoes was 518 compared with 506 in 2021 (Figure 124).

Figure 124: Number of monthly LNG cargo exports

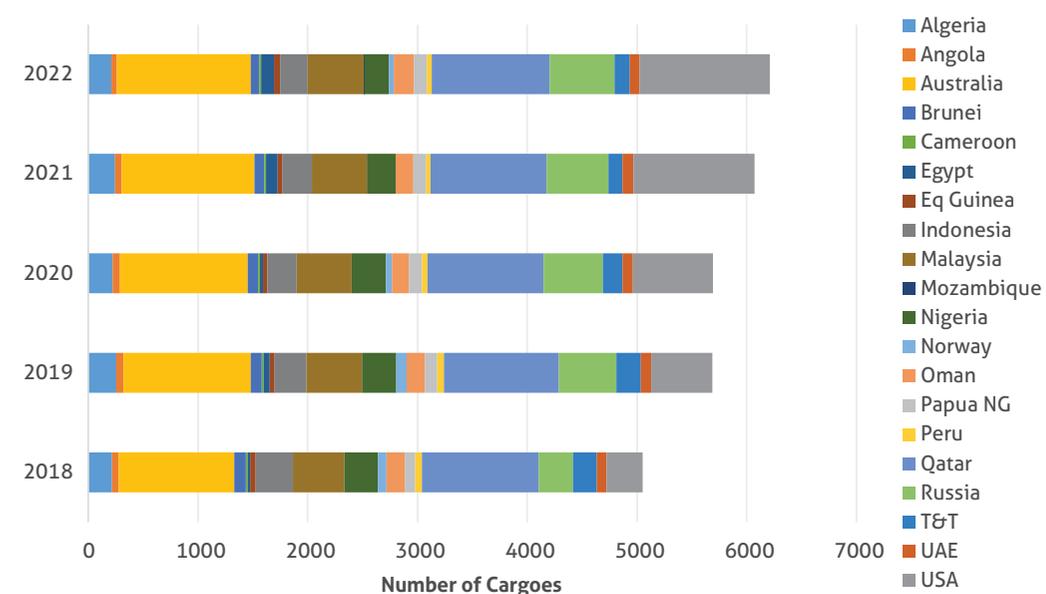


Source: GECF Secretariat based on data from ICIS LNG Edge

For the fourth consecutive year, Australia delivered the highest number of LNG cargoes (Figure 125). In 2022, just as in 2021, the US, Qatar, Russia, and Malaysia completed the top five exporters by number of shipments. The US also had the highest increase in number of cargoes, recording an additional 81 more shipments in 2022 than in 2021. The second highest increase was attributed to Norway, which loaded 49 cargoes from the restarted Hammerfest LNG terminal since June 2022. GECF Countries Equatorial Guinea and Peru registered the largest percentage increases in cargo exports in 2022, with 32% and 21%, respectively. In addition, another GECF Country, Mozambique, joined the league of LNG exporters with three loadings from the Coral South FLNG terminal at the end of 2022.

The increasing trend in global LNG shipments is expected to continue in 2023 as per the overall growth in LNG demand. Furthermore, LNG shipping would be boosted by the restart of the Freeport LNG plant in the US, and increased cargo imports in Europe and Asia Pacific. However, the LNG shipping market may experience tightness due to new IMO regulations in 2023 and further ahead.

Figure 125: Annual number of LNG cargoes by exporting country



Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.7.2 LNG Carrier Fleet

At the end of 2022, the global LNG carrier fleet stood at 677 vessels (Figure 126). Although the total has gradually increased, only 28 new vessels were commissioned in 2022. This represented growth of 4%, which was the lowest increase since 2013.

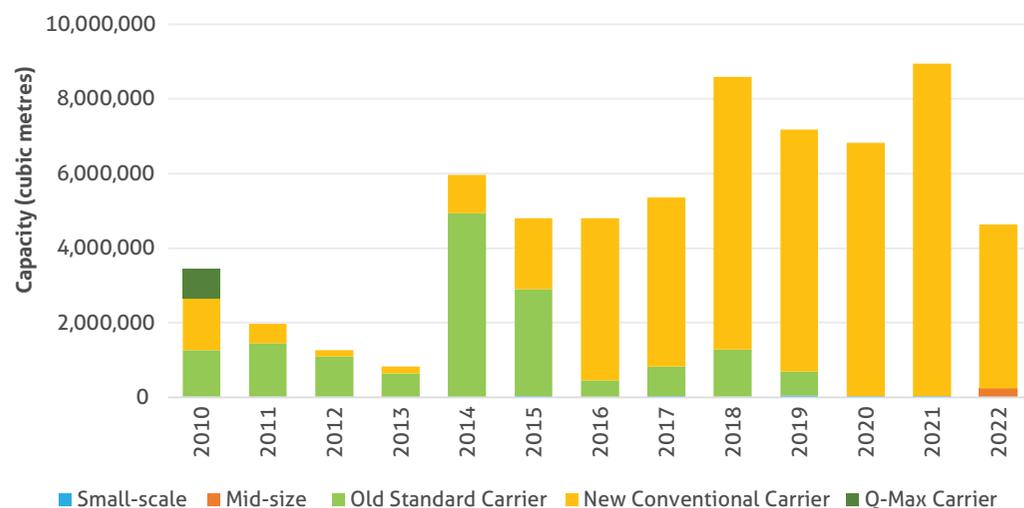
Figure 126: Growth in the global LNG carrier fleet



Source: GECF Secretariat based on data from ICIS LNG Edge

As observed in the recent historical trend since 2010, the years in which there is a sharp increase in the fleet growth rate are typically followed by a drop in the subsequent year. Accordingly, this was repeated in 2022, with just over 4,600,000 cubic metres of LNG carrier capacity entering into service, merely half of the capacity commissioned in 2021 (Figure 127).

Figure 127: Annual capacity additions to the global LNG fleet



Source: GECF Secretariat based on data from ICIS LNG Edge

Nevertheless, most of these new builds were of the capacity range between 170,000 and 200,000 cubic metres; in recent years, this new conventional class of carriers has been phasing out the previous standard range of 125,000 to 170,000 cubic metres (Table 1).

Table 1: Capacity classifications for LNG carriers

Size Class	Capacity (cubic metres)
Small-scale	Less than 60,000
Mid-size	Between 60,000 and 90,000
Old Standard Carrier	Between 125,000 and 170,000
New Conventional Carrier	Between 170,000 and 200,000
Q-Flex Carrier	Between 200,000 and 220,000
Q-Max Carrier	Between 260,000 and 270,000

Source: GECF Secretariat

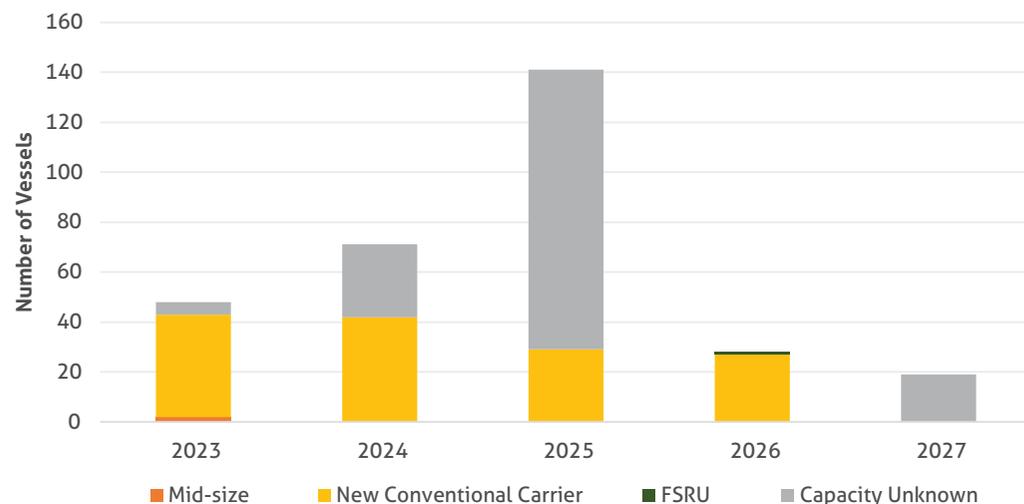
Additionally, around 240,000 cubic metres of “mid-sized” LNG carriers were brought online in 2022. This is an important growing niche market for LNG transportation, demonstrated by a further 320,000 cubic metres of capacity already confirmed on the global LNG carrier orderbook (Figure 128). Of the vessels for which the technical specifications are known, around 170 of the New Conventional sized carriers are on order for delivery between 2023 and 2026.

Qatar is embarking on another significant wave of fleet expansion, to underpin its domestic expansion of the North Field project, as well as investments in the Golden Pass LNG terminal in the US Gulf Coast region. To accomplish this, it has been reported that Qatar has secured booking slots at all of the major South Korean shipbuilding yards over the next five years, for orders of around 100 new carriers.

The cost of newbuild LNG carriers has increased in excess of US\$250 million, which is around US\$20 million more than the average price during 2021. This increasing cost in recent years has been attributed to rising expenses related to construction materials, mainly steel, as well as shortages in the number of available shipyards.

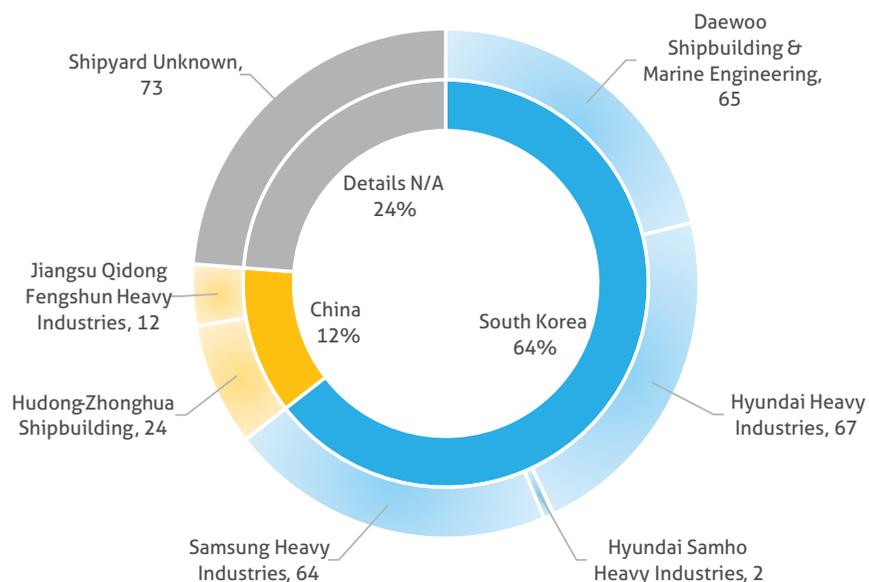
Concerning this point, it has led to vessel owners exploring other options outside the traditional world-leading shipyards for newbuild orders. In particular, with the Hyundai, Daewoo, and Samsung shipyards of South Korea becoming fully booked until after 2025, manufacturers in China are growing in importance, already securing at least 36 of the vessels on the orderbook for orders, which the ownership details are already known (Figure 129).

Figure 128: Global orderbook for LNG carriers



Source: GECF Secretariat based on data from ICIS LNG Edge

Figure 129: LNG carrier orderbook by major shipyard



Source: GECF Secretariat based on data from ICIS LNG Edge

4.2.7.3 IMO Regulations

The International Maritime Organisation (IMO) continues to impose ever more stringent regulations in its efforts to curb the impact of the maritime sector on the environment and climate. In particular, these policies include limits on the emissions of greenhouse gases (GHGs) for the impact of global warming, as well as limits on the emissions of particulates for the impact on air quality. The organisation has targeted a reduction of the carbon intensity attributed to the global maritime sector, from the baseline level measured in 2008, of 40% by the year 2030, and then 70% by 2050.

In January 2020, there was the implementation of IMO 2020, which aims to reduce the emissions of sulphur compounds from marine vessels, through the setting of a cap on the level of sulphur in shipping fuels. The most recent suite of regulations, collectively termed IMO 2023, came into force in January 2023, and will focus on the “technical and operational measures to reduce carbon intensity of international shipping” (Table 2).

Table 2: IMO shipping regulations

	Effective Date	Regulation
IMO 2020	Jan 2020	0.5% sulphur cap in shipping fuels
	Jan 2023	Efficiency Existing Ship Index (EEXI)
IMO 2023	Jan 2023	Carbon Intensity Indicator (CII)
	Jan 2023	Ship Energy Efficiency Management Plan (SEEMP)*

Source: GECF Secretariat

IMO 2023 introduces two new protocols – the Efficiency Existing Ship Index (EEXI) and the Carbon Intensity Indicator (CII), as well as an enhancement to the existing Ship Energy Efficiency Management Plan (SEEMP).

The EEXI for a vessel is calculated based on the ship’s technical specifications, whereas the CII rating is determined based on the actual operational performance. EEXI essentially compares the ship’s energy efficiency level against an established baseline.

The CII rating system is based on the ship's voyages, factoring in the distance between the ports on the route, as well as the quantity and type of cargo being transported. Grades will be assigned to each vessel, with A, B and C being considered acceptable, while those earning grades D or E for three consecutive years will be required to undertake the appropriate remedial actions. Since these new regulations only came into effect in January, it is anticipated that these EEXI and CII appraisals will occur throughout 2023, and the initial vessel ratings will be determined in 2024.

SEEMP was first adopted in January 2013, requiring all vessels to have an energy efficiency plan. This was amended in 2016 to include a fuel oil consumption plan, and now as part of IMO 2023, all ships must also establish their carbon intensity plan.

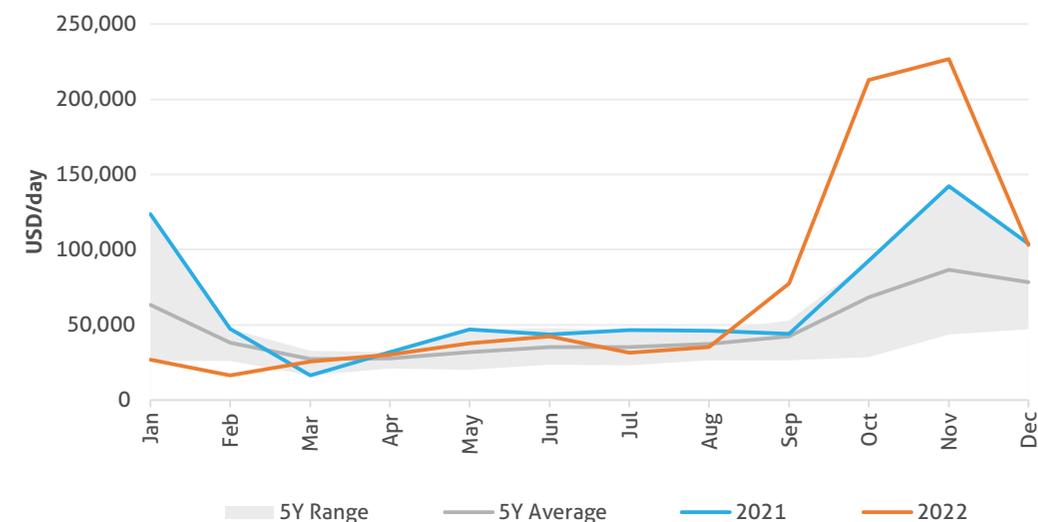
The LNG shipping industry can expect to be impacted by these new measures in the short to medium term. The cost of shipping globally may be expected to rise due to the investments which may be needed by shipowners to make their vessels compatible. Many market observers have indicated that the old steam-powered vessels are most likely to be affected by IMO 2023. While this class of vessel is gradually being phased out or utilised as floating storage, the ones still in operation are expected to reduce their sailing speeds by around 5 knots to meet the new engine power guidelines. Steam-powered vessels currently represent the majority (30% by capacity) of the global LNG carrier fleet.

4.2.7.4 LNG Shipping Cost

The cost of shipping a cargo of LNG is dependent on the cost of chartering the LNG carrier, as well as the cost of the shipping fuel for the voyage.

The spot charter rate for steam turbine LNG carriers generally follows a seasonal trend, where there is a lull in activity during the northern hemisphere summer period, followed by a spike in prices during the winter months (Figure 130). The year 2022, however, was characterised by extreme tightness in the market at a critical period, which was reflected in record increases and elevated prices in the last third of the year.

Figure 130: Monthly average spot charter rate for steam turbine LNG carriers



Source: GECF Secretariat based on data from ICIS LNG Edge and Argus

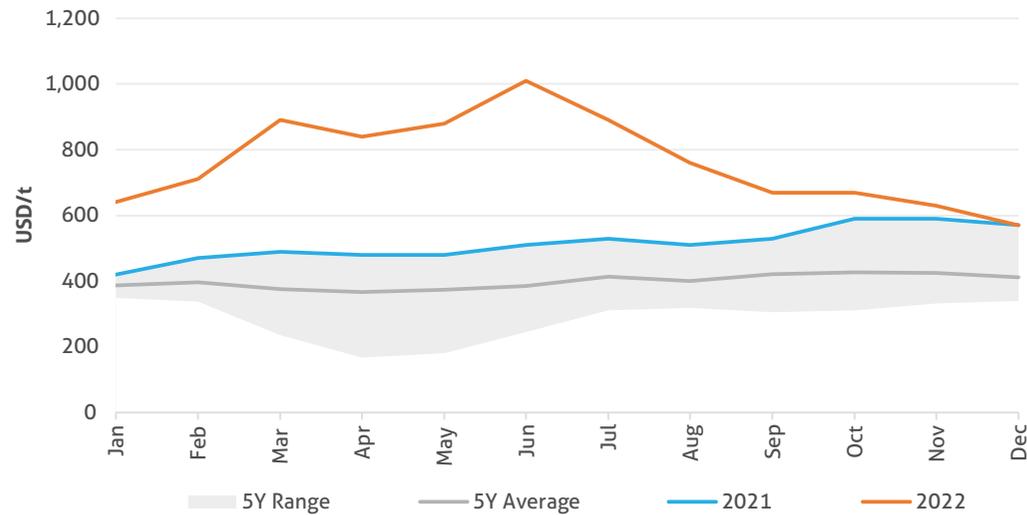
Charter rates commenced the year at just \$26,900/day, which was a 74% decline from December 2021. This came about largely as a result of a redirection of Atlantic basin cargo flows from the longer voyages of the Far East markets towards Europe instead. This dynamic held steady for the first eight months of 2022, driven by the increased price differential in Europe, as that region focused on filling gas storage amidst reduced pipeline imports. Sharp increases in the spot charter rate were observed thereafter, as the European region crept closer to the winter months. In anticipation, buyers began purchasing cargoes to be used as floating storage, taking available carriers off the market.

Further tightness was induced due to the shortcomings of the receiving infrastructure in Europe, and the spot charter rate crossed \$200,000/day by mid-October. Critically, most of the LNG importing capacity is located in the Iberian Peninsula, with insufficient pipeline capacity to quickly transfer the volumes to the entire European grid. As such, and with the region's gas storage sites approaching maximum capacity, numerous carriers were observed to be floating around many European ports for many days, awaiting the opportunity to discharge their cargoes. By November into December, however, the winter season had started, which marks the period of net gas withdrawals from underground storage. This helped to clear the backlog of these floating cargoes and contributed to a softening of charter rates as the year ended.

Regarding the cost of leading shipping fuels, the year 2022 was also exemplified by extremely elevated prices (Figure 131). The monthly average of shipping fuel prices was higher in 2022 than in any year since 2017, averaging \$760/t, compared with

\$510/t in 2021 and just \$400/t for the five-year historical average. Fuel Oil prices generally track the global oil price indices; the fuel oil price averaged \$850/t between February and August 2022 due to oil prices rebounding, in line with continued global economic recovery.

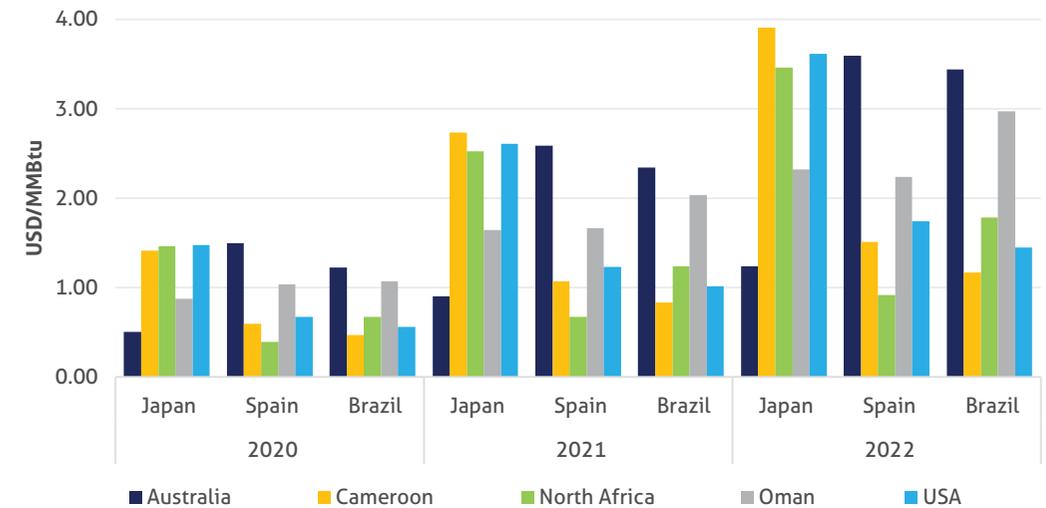
Figure 131: Monthly average price of leading shipping fuels



Source: GECF Secretariat based on data from Bunker Ports News Worldwide and Argus

Both of these factors were key to the spot LNG shipping cost for steam turbine carriers increasing each year. Figure 132 shows the cost of shipping cargoes to Japan, Spain and Brazil (representative of the key demand regions), from popular production hubs worldwide. Shipping costs in 2022 were further influenced by the relatively high delivered LNG spot prices globally, particularly in Europe. The LNG shipping cost in 2022 was observed to have increased for all voyages by up to \$1.20/MMBtu higher than in 2021. This rise is comparable to the increase in shipping cost in 2021 by up to \$1.30/MMBtu higher than in 2020.

Figure 132: Spot shipping costs for steam turbine LNG carriers



Source: GECF Secretariat based on the GECF Shipping Cost Model

Looking forward, the shipping cost would continue to be directly influenced by the factors mentioned previously, with charter rates rising and falling with the corresponding movement in market tightness. Another element that would be taken into consideration is the increase in tariffs for transiting the Suez and Panama Canals. Authorities for both had previously announced a hike in the canal transit fees of 15%; for voyages that utilise routes through these canals, the overall impact is expected to be an increase in shipping cost of between 1% to 1.5%.

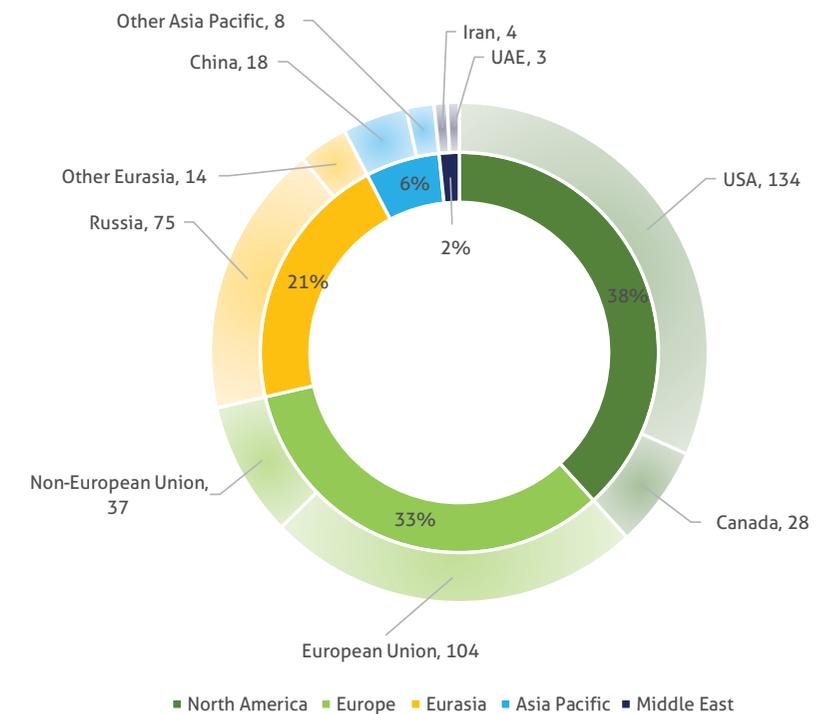
CHAPTER
05

Gas Storage

5.1 Underground Gas Storage

On the global level, the total working gas capacity of underground gas storage (UGS) sites increased by 0.2% to reach 424 bcm. North America remained the region with the highest capacity for underground gas storage at 38%, and is followed by Europe and Eurasia (Figure 133). At a country level, the US retained the top ranking, despite reducing its working gas capacity to 134 bcm. The Russian Federation holds 75 bcm of underground gas storage capacity, followed by Ukraine (31 bcm), Canada (28 bcm), and Germany (23 bcm). The EU as a bloc controls underground gas storage sites across the continent to a total of 104 bcm.

Figure 133: UGS working capacity (in bcm) by region and country

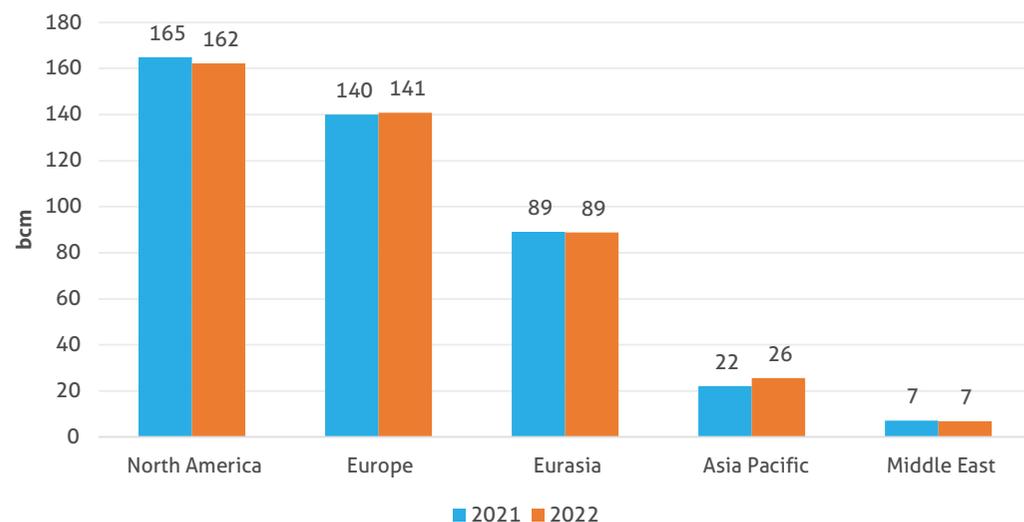


Source: GECF Secretariat based on data from Cedigaz



The Asia Pacific region demonstrated the largest capacity growth in 2022, driven by the commissioning of new underground gas storage sites in China (Figure 134). Working gas capacity in Europe, specifically in the EU, increased by 1 bcm. On the other hand, North America lost 3 bcm of working gas capacity, attributed to the US. The capacity for underground gas storage was unchanged in the other regions.

Figure 134: Change in UGS working capacity by region in 2021 and 2022

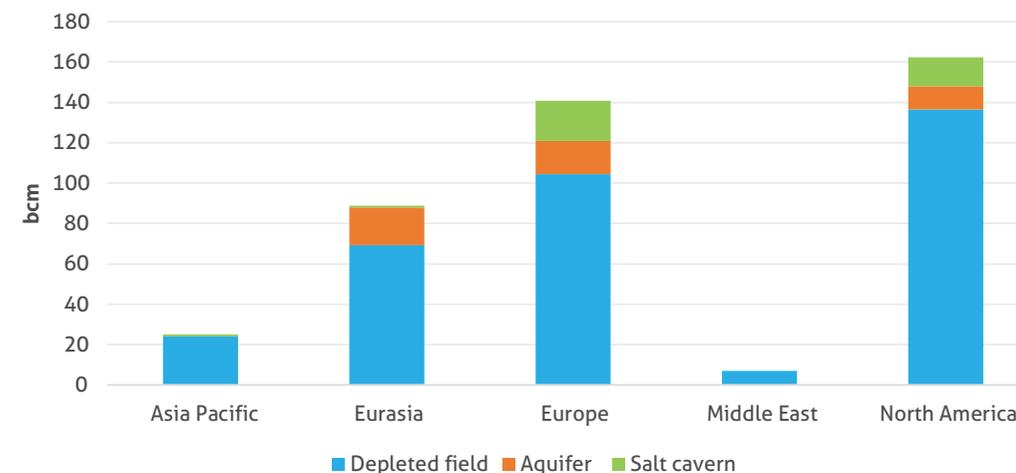


Source: GECF Secretariat based on data from Cedigaz

Underground gas storage sites fall into three general technical classifications. The most popular category has always been the injection of gas into a depleted oil or gas field, due to two main factors. Firstly, these rock formations, having previously borne hydrocarbons, are known to have the porosity and permeability required for gas storage. Additionally, depleted fields are already outfitted with wells, pipelines and other necessary infrastructure to commence operations. Worldwide, this method accounts for 80% of all underground gas storage sites by working gas capacity and is also the most widely-utilised in all regions (Figure 135). There are over 560 such sites around the globe, with 360 located in North America.

The remaining underground gas storage facilities utilise either depleted aquifers (11% by working gas capacity) or salt caverns (9%).

Figure 135: UGS working capacity by technical classification



Source: GECF Secretariat based on data from Cedigaz and GIE

Aquifers are underground water reservoirs, and depleted aquifers can be used in the same way to store gas instead. This is provided that the target formation has the required geological characteristics, and is sealed with a cap rock layer. Depleted aquifers are in use in over 80 sites across Eurasia, Europe and North America.

Salt caverns are the third category of underground gas storage. In the techniques mentioned previously, gas is stored in the pores between grains of rock. Conversely, in this method, gas is stored in open cavern spaces, which have been created by the action of water in salt rock formations. There are over 100 such storage sites globally, with over half of these located in Europe.

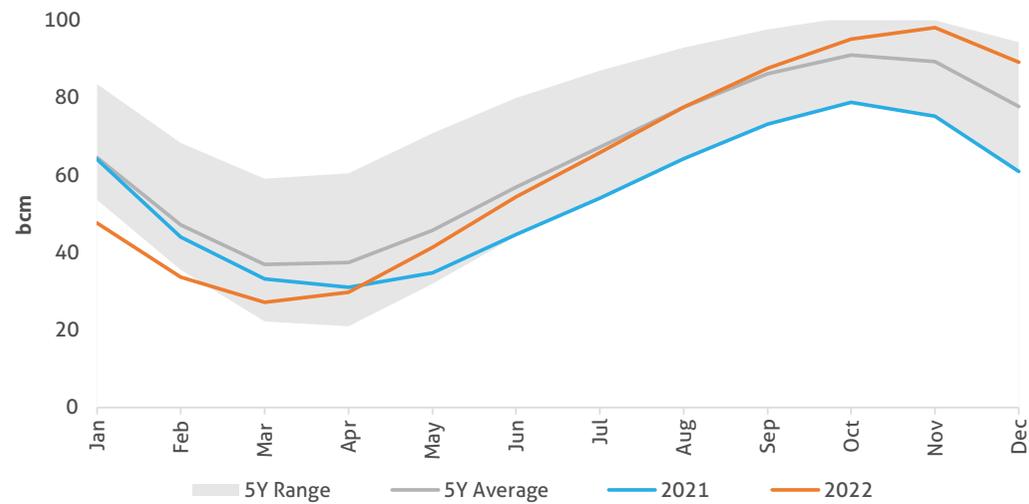
5.1.1 Europe

5.1.1.1 Underground Gas Storage in the EU

During 2022, the level of gas storage in underground sites across the EU was heavily influenced by political decisions at the EU level, and which also directly impacted gas trade and gas prices within the bloc.

Recalling the events of the previous year, in 2021, gas injections into underground storage sites were muted, due to the post-pandemic rebound in gas consumption. Further downward pressure was induced as a result of the gas prices during the summer, which were at the time unusually high. This delta below the level of the five-year average widened progressively, to reach 16.9 bcm at the start of 2022 (Figure 136).

Figure 136: UGS in the EU



Source: GECF Secretariat based on data from AGSI+

The amount of gas in underground storage in January 2022 was therefore the lowest on record at the start of any year since 2017. The storage level then reached a minimum of 27.2 bcm in March 2022, at the end of the winter season. It was within this context of very low gas storage levels, coupled with the reduction of pipeline gas imports from Russia, which compelled the European Commission to implement legislative measures concerning gas storage (Figure 137). These measures were firstly proposed as early as March 2022, and officially entered into force on June 30, 2022, via Regulation 2022/1032.

Figure 137: European Commission’s gas storage regulations

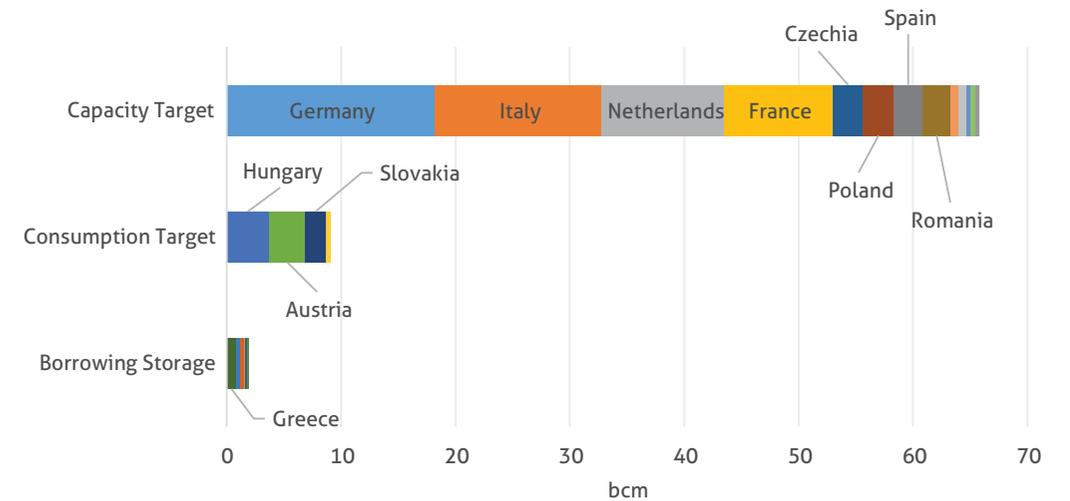


Source: GECF Secretariat based on the European Commission

Within its Member States, it was firstly mandated that underground gas storage sites were to be filled to a minimum of 80% of capacity by November 1, 2022. Secondly, the filling level would be limited by a “Consumption Target” equating to 35% of the individual country’s annual gas consumption over the previous five years. This specific measure effectively reduces the burden on particular Member States, which have smaller gas consumption relative to the capacity of underground storage within the country, such as Austria. Thirdly, with respect to Member States having no underground

gas storage sites of their own, such as Greece, these countries will be able to access storage sites in other Member States, up to a capacity of 15% of their annual gas consumption over the previous five years (Figure 138).

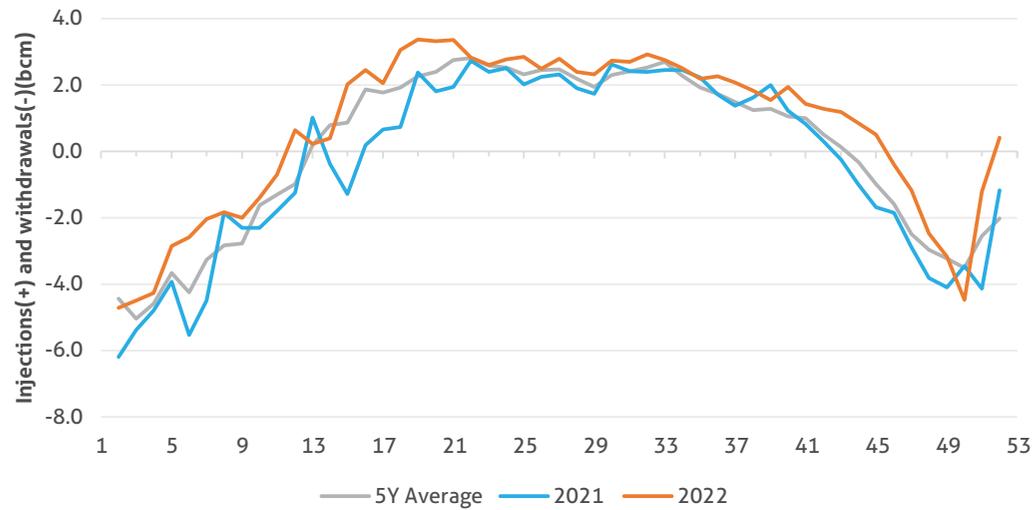
Figure 138: EU countries UGS filling obligations in 2022



Source: GECF Secretariat based on data from the European Commission and Eurostat

As a consequence of these legislative regulations, as well as the supply-side pressure from declining pipeline gas imports, EU Member States were assiduously filling underground storage sites across the region during the net gas injection season. In fact, the rate of the storage build from April to October was observed to be significantly higher in 2022, at an average of 2.3 bcm/week, as compared with 1.6 bcm/week in 2021, and 1.8 bcm/week for the five-year average (Figure 139).

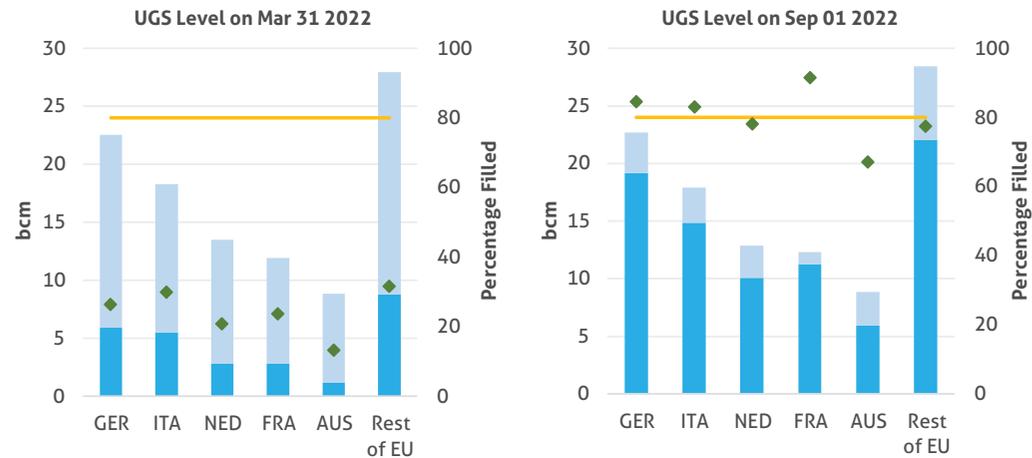
Figure 139: Weekly rate of UGS level changes in the EU



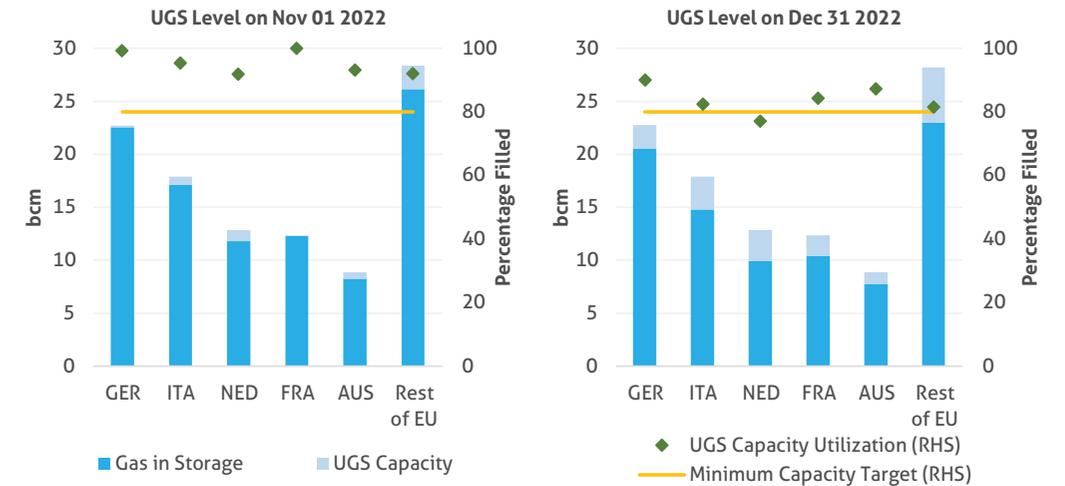
Source: GECF Secretariat based on data from AGSI+

Moreover, despite the unprecedented volatility in gas prices, many EU countries not only attained the 80% mark long before the targeted date of November 1, 2022, but went further ahead to almost full capacity by the start of the winter season (Figure 140).

Figure 140: UGS level in the EU at different points throughout 2022



Source: GECF Secretariat based on data from the European Commission and Cedigaz



Source: GECF Secretariat based on data from AGSI+

From 2023, the EU’s gas storage regulations are even more stringent, since Member States now have adequate time to prepare for the filling season. As such, the minimum storage target will now rise to 90% of capacity by November 1. Furthermore, Regulation 2022/2301 of November 23, 2022, set forth the intermediate targets throughout 2023 for each Member State, as a filling trajectory towards the November objective. The minimum gas storage targets, for the EU collectively, are shown in Table 3.

Table 3: Gas storage targets in the EU in 2023

2023 Date	Minimum Storage Target	
	Percentage	Volume (bcm)
February 1	46%	48
May 1	27%	28
July 1	46%	48
September 1	73%	76
November 1	90%	94

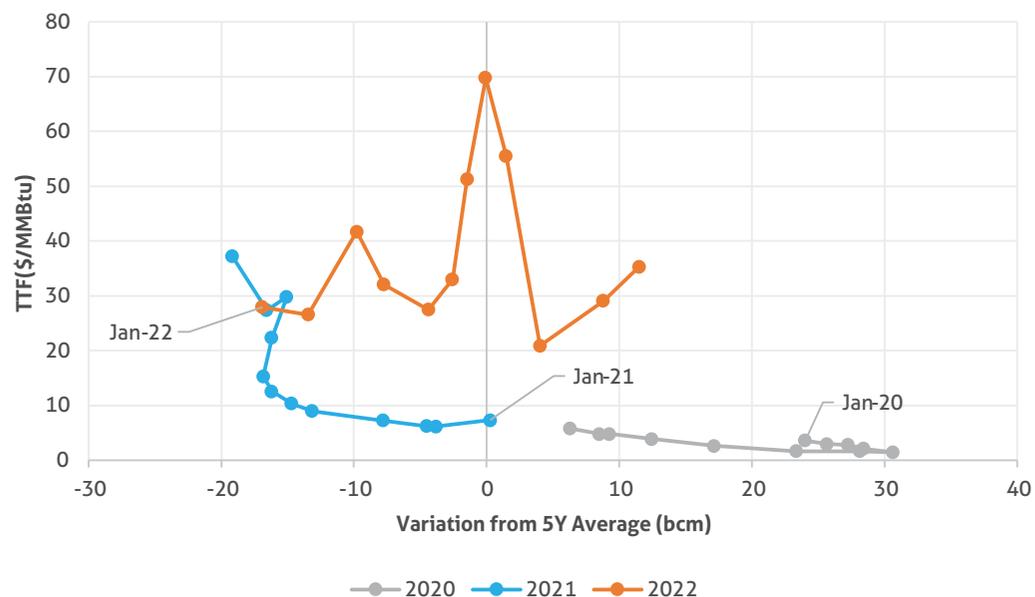
Source: GECF Secretariat based on data from the European Commission and Cedigaz

Incidentally, commencing in 2023, Member States will be allowed to meet their 90% target through the storage of LNG, or other alternative fuels.

5.1.1.2 The Impact of Gas Prices on the Filling of UGS Sites in the EU

The correlation between the TTF price against the level of gas in underground storage in the EU is shown in Figure 141. The movement of the storage level may provide insight into the impact of gas prices on the incentive to fill underground gas storage sites. This is because the commercial arrangements of storage site operators are based on purchasing cheap gas during the summer for storage, then reselling to the grid at higher prices during the winter. There have been marked differences in the approach towards gas injections in each of the previous three years, characterised by the various drivers, which were predominant in each period.

Figure 141: Correlation between TTF and filling of UGS sites in the EU



Source: GECF Secretariat based on data from AGSI+ and Refinitiv Eikon

In the year 2020, the Covid-19 pandemic brought about a substantial reduction in gas demand, which in turn depressed gas prices to record lows, particularly during the second and third quarters. Accordingly, the monthly variation of storage level against the five-year average remained positive throughout the year, even entering the winter season.

Next, in 2021, as many economies emerged from the effect of the first wave, gas demand picked up during this post-pandemic recovery. Gas prices exhibited notable escalation, and the TTF price increased to \$20/MMBtu during the summer. Storage operators on the continent were naturally disinclined towards the filling of gas storage during this period. As a result, the delta below the five-year average widened during the year, reaching 16.6 bcm at the start of winter.

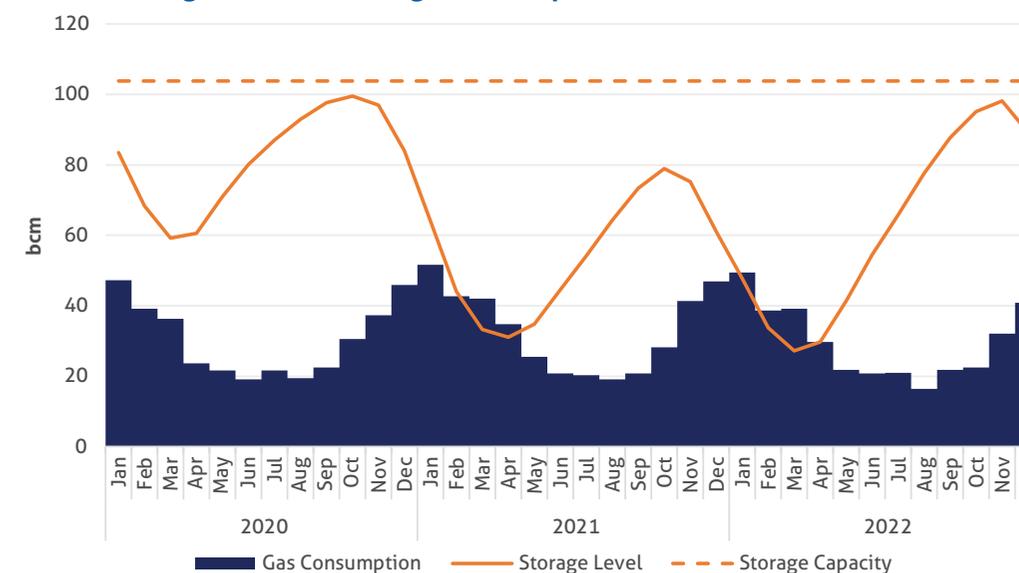
This meant that the region entered 2022 in a challenging position with regard to the level of gas held in underground storage. As previously mentioned, this pushed the European Commission into mandating EU countries to fill their gas storage sites, despite the soaring prices during the year. Unlike in previous years, when these record TTF prices would have discouraged storage operators from purchasing gas, the filling regulations in place, along with the concerns of reduced gas supply, prompted continuous and consistent increases in storage levels throughout 2022. This is evident from the sustained narrowing of the variation in the monthly storage level from that of the five-year average, closing completely by September. At this point, the initial target of 80% of capacity was achieved, and consequently the TTF prices plummeted. Operators took this opportunity to capitalise and continue gas injections towards maximum capacity in many EU countries, prior to the winter of 2022/23.

5.1.1.3 Underground Gas Storage Balance in the EU

Gas storage is a key element in balancing the supply and demand of a region. In the EU, this factor is even more critical in meeting its gas demand, since the continent is almost entirely reliant upon gas imports, via both pipeline and LNG, to compensate for the relatively low levels of indigenous production.

Typically, gas consumption and storage levels follow seasonal patterns. In the summer, when gas demand is lower, storage sites are filled until the shoulder month of October. This trend is reversed during the winter period from November to March when the additional heating requirement causes gas consumption to increase by a factor of approximately two (Figure 142).

Figure 142: Trend in gas consumption and UGS level in the EU

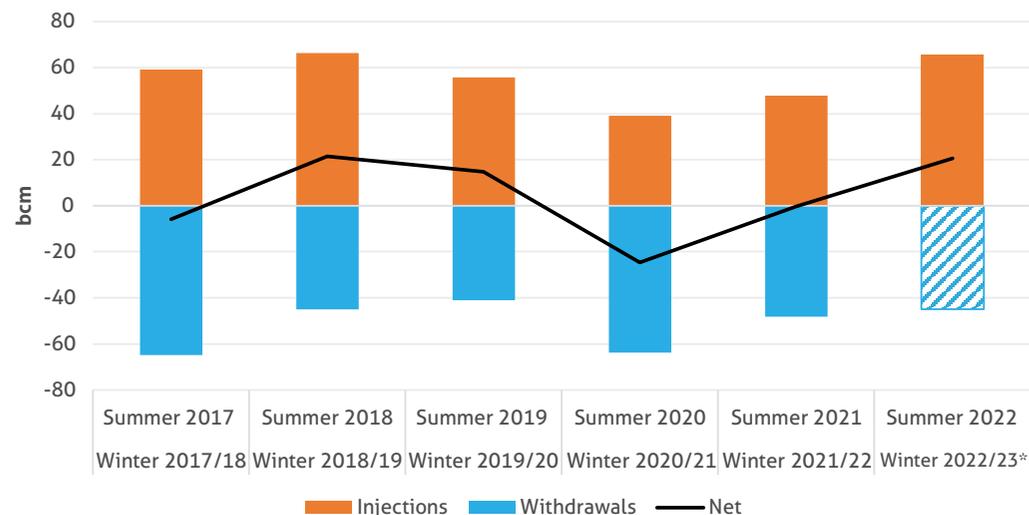


Source: GECF Secretariat based on data from McKinsey and AGSI+

Assuming the volume of gas, which may be consumed over the winter of 2022/23, to be approximately the average of the previous three seasons, the elevated storage level may be expected to satisfy nine weeks of demand in the region. Importantly, this estimation is caveated by the location of storage sites across the region, as well as the level of pipeline interconnectivity between individual countries. Further factors, which may influence this estimation, include the recommendation by the European Commission to reduce gas consumption by 15% over the winter period, as well as the current dynamics of gas supply, specifically lowered pipeline gas availability, and the ramping up of LNG imports.

Figure 143 shows the volume of gas withdrawn in each winter since 2017/18, along with the volume of gas stored during the preceding summer, and the net difference between both of these quantities. During the injection period from April to October 2022, 65 bcm of gas was put into storage, which was an increase of 37% over the same period in the previous year. Conversely, during the 2021/22 winter period, 48 bcm of gas was withdrawn from underground storage, which was 24% less than over the period from November 2020 to March 2021.

Figure 143: Trend in net UGS withdrawals in the EU



Source: GECF Secretariat based on data from AGSI+

The high level of gas in storage in November 2022 practically ensures that the region will end the winter in a net positive position, barring a sizeable gas withdrawal due to an unusually cold winter, as was the case in 2017/18 and 2020/21.

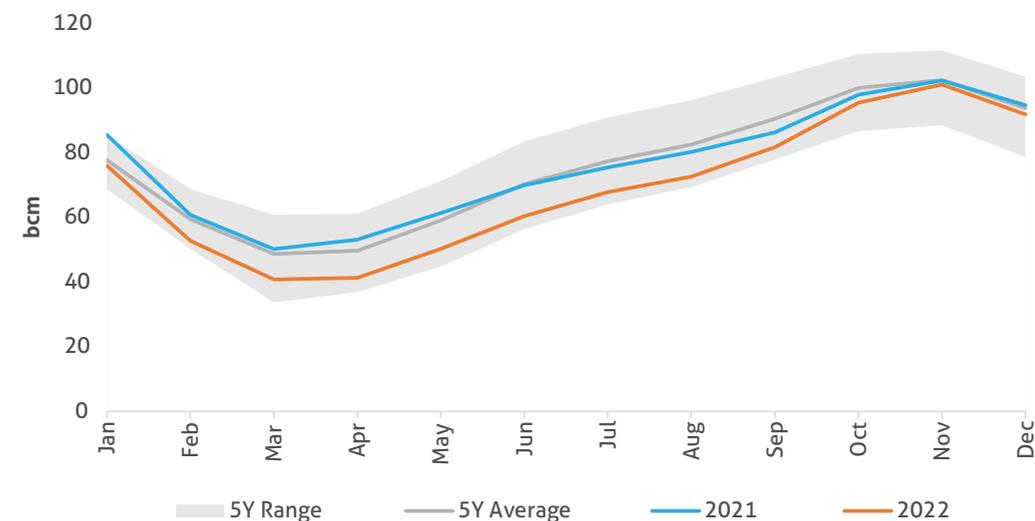
5.1.2 North America

5.1.2.1 Underground Gas Storage in the US

Increased LNG imports by Europe in 2022 had a direct impact on the availability of gas for storage in the US. In this regard, the amount of gas in underground storage throughout 2022 was lower than the level of 2021, and even that of the five-year average (Figure 144).

In 2021, gas stocks stood at 97.8 bcm by October, but this was followed by a large winter withdrawal. The average level of gas in storage in January 2022 was therefore just 1.6 bcm below the five-year average. The gas demand continued over the remainder of that 2021/22 winter period, and the delta below the five-year average storage level widened to 7.9 bcm by March.

Figure 144: UGS in the US

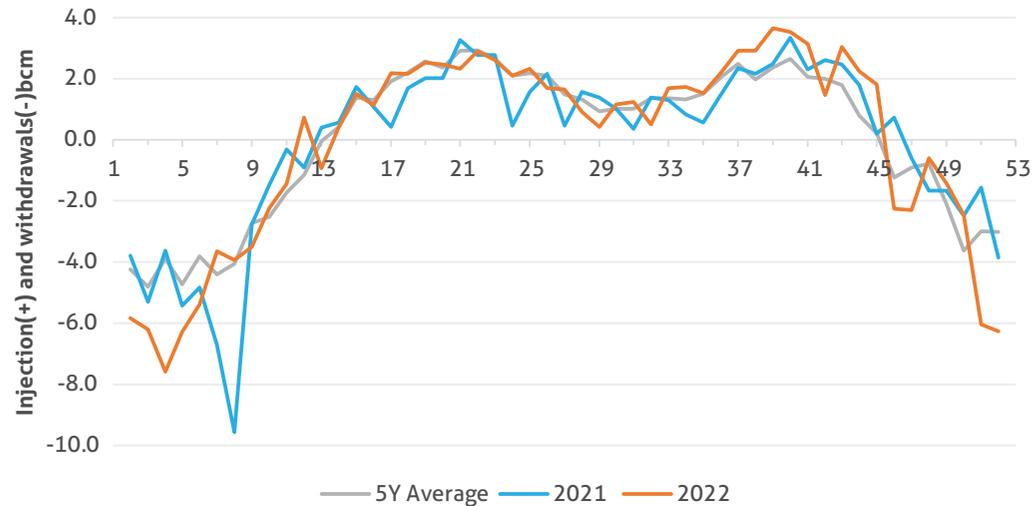


Source: GECF Secretariat based on data from US EIA

From that point, and throughout the summer, the US began prioritising gas exports via LNG, over injections into their domestic storage sites. This was reflected in the widening of the delta below the five-year average storage level, reaching a deficit of 10 bcm by August.

The trend was reversed during the subsequent three months, with elevated quantities of gas injections bringing the storage level to 101 bcm by November. From August to October, the rate of gas storage in the US was 2.3 bcm/week, compared with 1.6 bcm/week in the earlier part of the net injection season (Figure 145).

Figure 145: Weekly rate of UGS level changes in the US



Source: GECF Secretariat based on data from US EIA

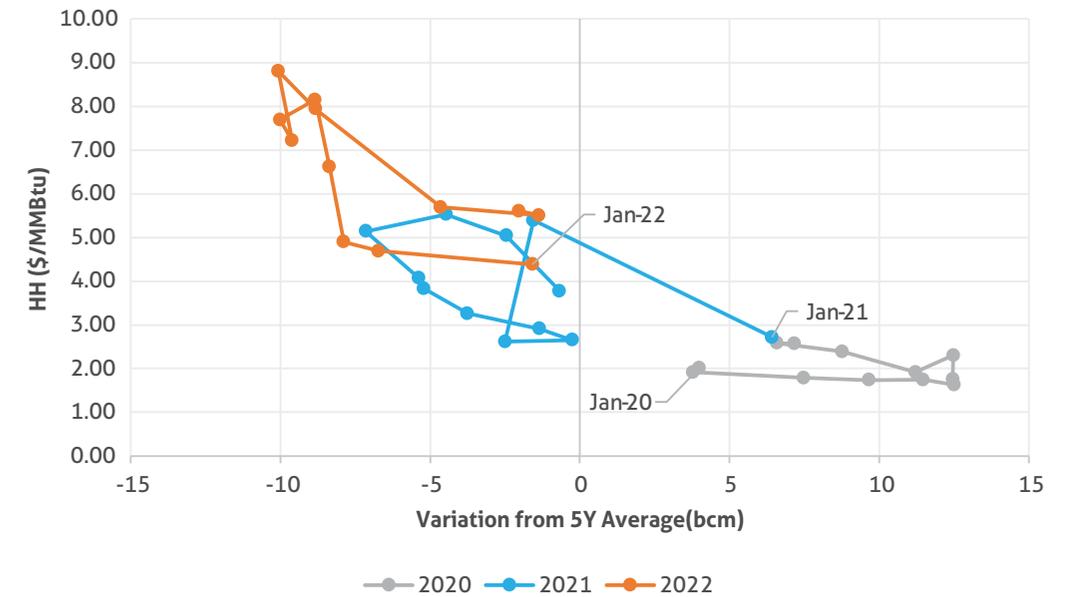
5.1.2.2 The Impact of Gas Prices on the Filling of UGS Sites in the US

Figure 146 shows the correlation between the Henry Hub (HH) price against the level of gas in underground storage in the US over the past three years.

While there was a distinct grouping of the data points for each of the three years, the overall tactic towards gas injections was observed to be consistent, and in line with the conventional approach. Generally, storage operators purchase gas for storage at lower prices during the summer, to then resell when prices rise in the subsequent winter period. Consequently, when summer prices are elevated, this incentive is reduced, and the effect of this is reflected in a widening of the variation from the five-year average.

This is clearly observed in 2021, and even more particularly in 2022, when prices tracked from \$5/MMBtu to \$9/MMBtu during the net injection season, bringing the storage level to 10 bcm short of the five-year average in September. At this time, storage levels in Europe were well ahead of their mandated targets, which softened demand and caused prices to plummet. This encouraged operators to have a late-season rally in gas injections ahead of the 2022/23 winter months.

Figure 146: Correlation between HH and filling of UGS Sites in the US

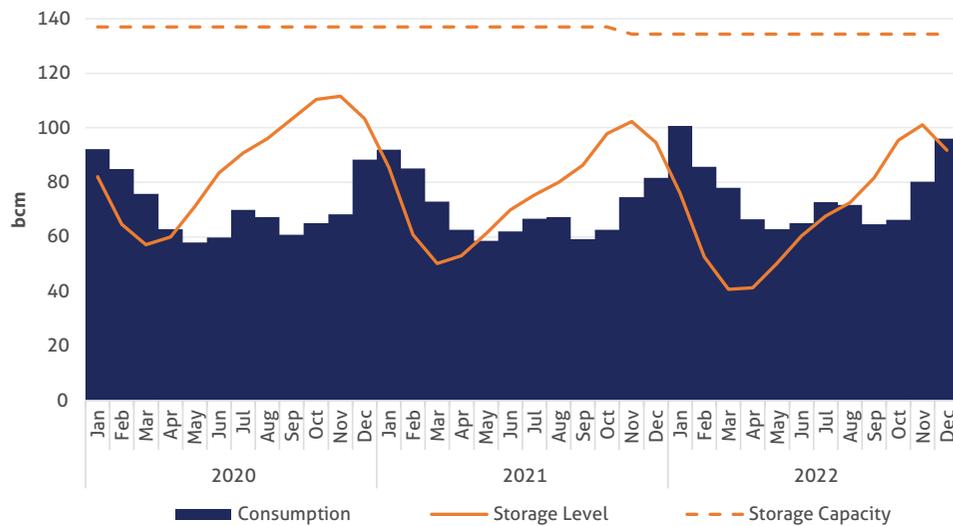


Source: GECF Secretariat based on data from US EIA and Refinitiv Eikon

5.1.2.3 Underground Gas Storage Balance in the US

In the US, while gas storage is a key element in the supply/demand balance, the high level of production, both domestically as well as pipeline import from Canada, allows the country some more flexibility with respect to gas injections. Another notable difference from the European region is that consumption levels are generally higher in the US during the summer. This is a result of electricity demand for cooling, and consequentially during this period, gas demand is only about 25% lower on average than in the winter months (Figure 147).

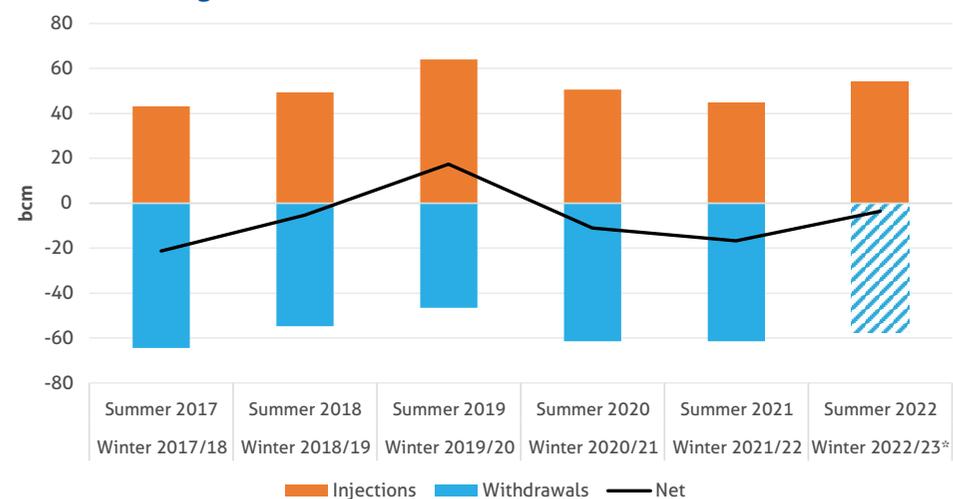
Figure 147: Trend of consumption and UGS Level in the US



Source: GECF Secretariat based on data from US EIA and AGSI+

Figure 148 shows the balance for underground gas storage in the US over the past five seasons: the volume of gas injected during the filling season of a particular year, the amount withdrawn from storage over the following winter, and the net difference between these quantities. In the net injection period from April to October 2022, 54 bcm of gas was put into storage in the US, which was an increase of 21% over the amount stored in the previous year. In the previous five years, a larger quantity was stored only in 2019. On the other hand, during the winter of 2021/22, 61 bcm of gas was withdrawn, which was the same as the previous winter.

Figure 148: Trend in net UGS withdrawals in the US



Source: GECF Secretariat based on data from US EIA

Therefore, similar to Europe, the high level of gas in storage in the US is potentially encouraging for the country to finish the upcoming winter period close to equal to last year's level. Furthermore, considering the average gas consumption over the past three winters as a representation, this gas storage level by November 2022 may be estimated to satisfy around 4.5 weeks of gas demand in the US. This approximation considers the country as a whole, and may vary with the actual distribution of underground storage sites.

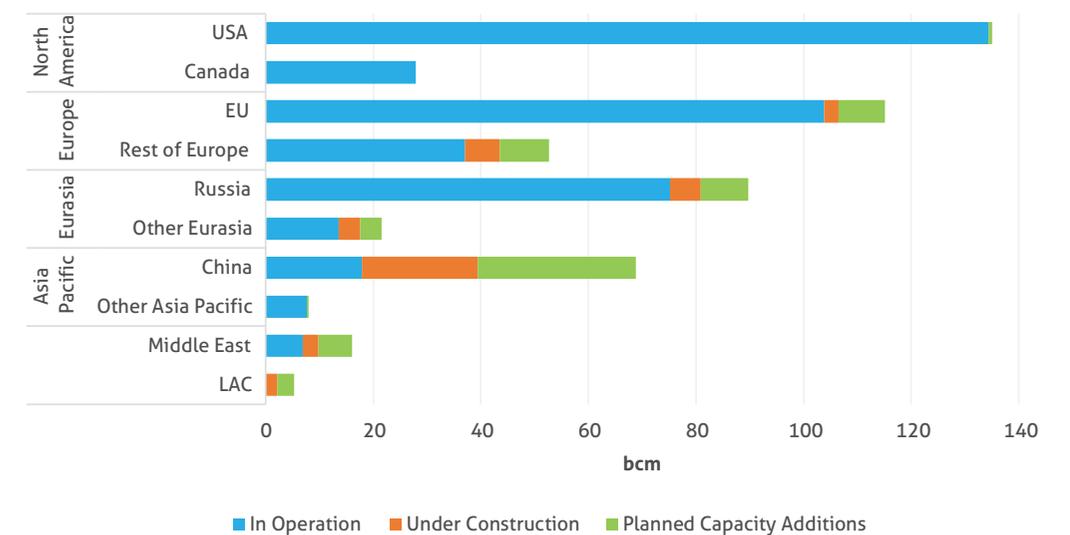
5.1.3 Asia Pacific

China currently has the largest working gas capacity for underground gas storage within the Asia Pacific region. By the end of 2022, China had commissioned around 5 bcm of new storage sites around the country, particularly along the route of the Power of Siberia pipeline, which brings gas supply from Russia. These capacity additions have increased its total to 18 bcm, representing 70% of the capacity within the region, but still only 4% on the global level.

This relatively low level of underground gas storage capacity has in recent times been viewed as a security of supply issue for China. To rectify this, the country has been determinedly embarking on capacity additions, emphasised as a priority under the National Energy Administration's Implementation Plan for National Gas Storage Capacity Construction. The total working gas capacity is targeted at 70 bcm by 2030 and 80 bcm by 2035 to meet around 13% of the nation's gas consumption needs.

This would move China up the global rankings to the country with the third largest gas reserve capacity, considering that in that timeframe, no other region is adding new storage sites at the same rate (Figure 149).

Figure 149: Global UGS status: current and future capacity



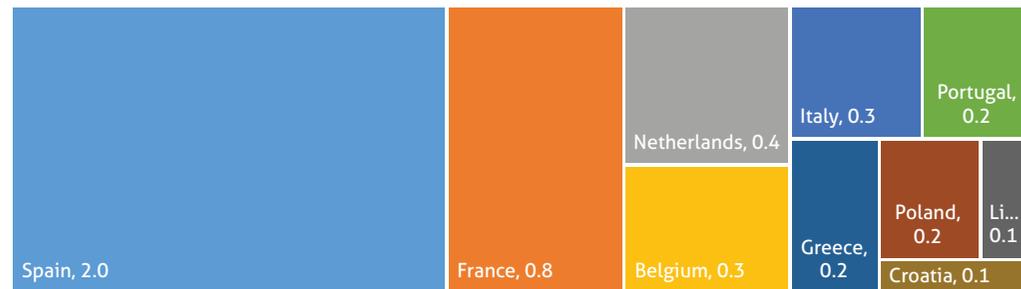
Source: GECF Secretariat based on data from Cedigaz

5.2 LNG Storage

5.2.1 Europe

To complement the underground gas storage capability, the EU also has gas storage capacity in the form of LNG. These reserves amount to around 4.7 bcm equivalent of LNG and are distributed as per the location of receiving terminals on the continent. As such, half of the LNG storage is found in the Iberian Peninsula, with Spain leading the capacity at 43% (Figure 150).

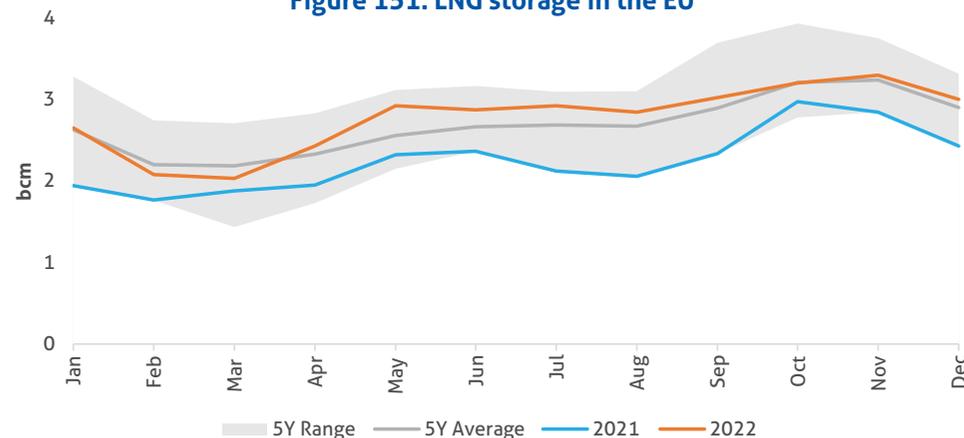
Figure 150: Distribution of LNG storage capacity in the EU (bcm)



Source: GECF Secretariat based on data from ALSI

Unlike underground gas storage, which follows a seasonal pattern, LNG storage levels in the EU vary depending on the frequency of cargo imports and the time required to distribute the regasified LNG into the grid. In 2022, the monthly level of LNG in storage was noted to be consistently higher than in 2021 (Figure 151). This was a result of the European countries ramping up cargo imports in the face of reduced pipeline supply. It can be observed by the marked increase from March 2022, moving above the five-year average and remaining at elevated levels for the remainder of the year.

Figure 151: LNG storage in the EU



Source: GECF Secretariat based on data from ALSI

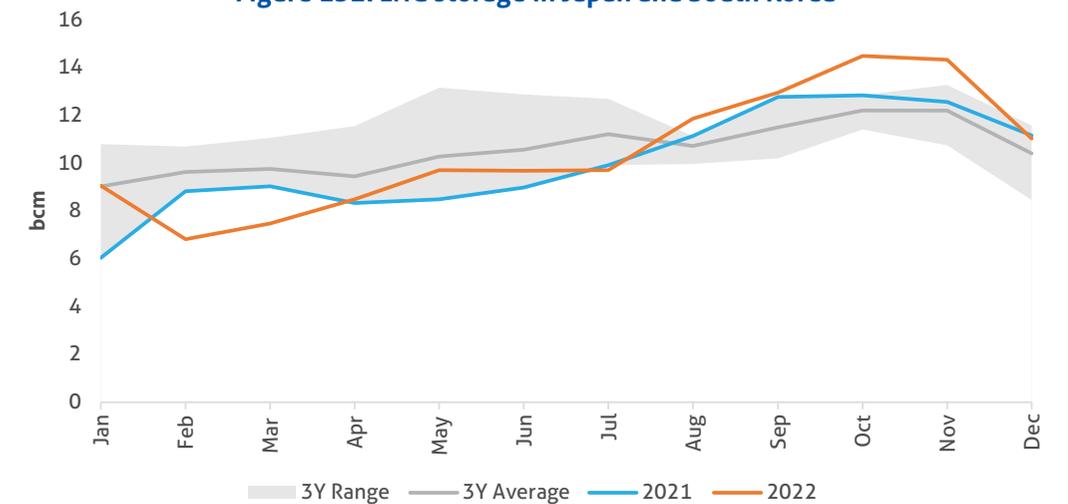
At the highest point, LNG in storage reached 3.3 bcm in November, approaching the winter season. By then, Spain, France, the Netherlands and Portugal were all filled beyond 70% capacity.

5.2.2 Asia Pacific

Japan and South Korea are two of the top LNG importing countries in the Asia Pacific region, as well as on the global level. At present, Japan and South Korea account for around 9.8 bcm and 6.8 bcm of LNG storage capacity, respectively. Since they possess little or no capacity for storing gas in underground sites, LNG storage is even more critical, and there is a slight but discernible trend linked to seasonal demand (Figure 152).

During the first half of 2022, the level of LNG in storage was muted compared with the three-year average. This was likely a result of reduced LNG imports due to extremely high prices in the European market creating strong demand for cargoes in that region. The second half of the year demonstrated the opposite trend, as demand for cargoes in the Asia Pacific increased on the approach to winter season. At the same time, European demand softened as underground gas reserves reached capacity, allowing for a redirection of LNG cargoes from Europe to Asia Pacific.

Figure 152: LNG storage in Japan and South Korea



Source: GECF Secretariat based on data from Refinitiv

Overall, the average monthly storage level in 2022 was around 10.5 bcm, compared with 10.0 bcm in 2021 and 10.6 bcm for the three-year average. Despite the reduced appetite in 2022 due to the pandemic, China is expected to be amongst the world's top LNG importers in the medium term. In this regard, the country is also rapidly investing in LNG storage capacity. During the course of 2022, the largest LNG importer in China

was involved in the construction of a project with an estimated capacity of 2.5 bcm. The site will have six tanks of capacity 270,000 cubic metres each, which would be the largest in the world. Each tank would have the ability to store an entire cargo from a Q-Max class LNG carrier. The same tank farm will also have four tanks of capacity of 220,000 cubic metres each. When fully commissioned, the storage facility is envisioned to process around 8.5 bcm of LNG each year.

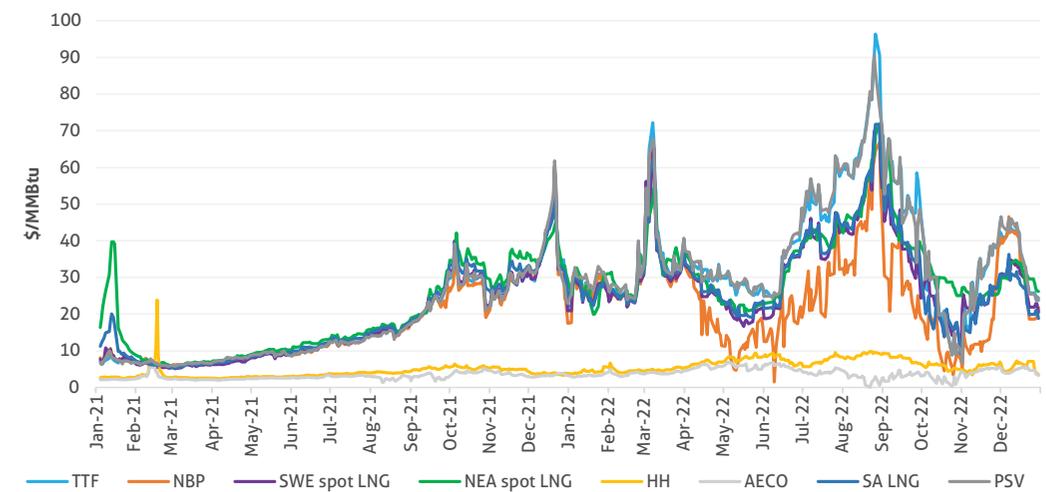
Energy Prices

6.1 Gas Prices

6.1.1 Gas & LNG Spot Prices

Gas and LNG spot prices in 2022 surpassed historical highs and recorded extreme volatility, as depicted in Figure 153. Already elevated spot prices at the end of 2021 were fuelled by escalating geopolitical tensions in Eastern Europe, growing concerns for the security of gas supply, particularly in Europe and the tightening of the global LNG market. Europe became the premier LNG market for suppliers as TTF spot prices maintained a high premium over Asian LNG spot prices. Meanwhile, Asian LNG spot prices closely tracked movements in TTF spot prices throughout the year. High spot price levels in Europe together with several EU regulations to tackle the energy crisis, served to attract sufficient LNG volumes to replace reduced pipeline gas imports and fill underground storage levels.

Figure 153: Daily gas & LNG spot prices



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon
 Note: SA LNG price is an average of the LNG delivered prices for Argentina, Brazil and Chile based on Argus assessment.

In January and February 2022, gas and LNG spot prices in Europe and Asia had some downward movement due to lower gas demand driven by relatively mild temperatures and strong wind generation in Europe. However, in March 2022, spot prices soared following escalating geopolitical tensions in Europe, and TTF spot prices hit their first peak of the year. Several LNG plant outages from both planned and unplanned maintenance, also contributed to the further tightening of the global LNG market.

During the shoulder months, European spot prices eased due to reduced gas demand in the residential sector, initial signs of demand destruction in the industrial sector, and strong LNG imports to the region. Meanwhile, in Asia, extensive COVID-related lockdowns in China and fuel switching reduced LNG demand in the region. However, in June 2022, European spot prices experienced some bullish movement driven by several factors, including a reduction in pipeline gas flows through Nord Stream I, a heat wave in Europe and announcements of the further delay in the restart of the Freeport LNG facility.

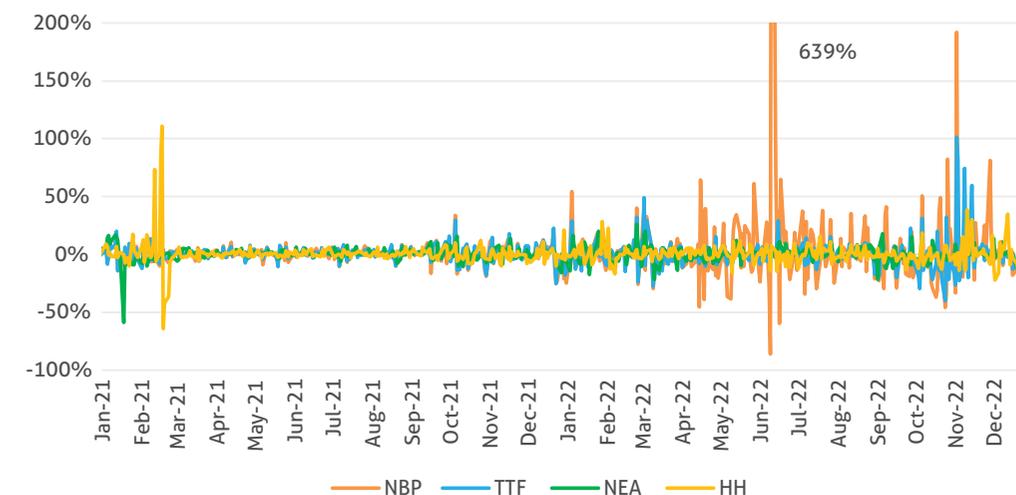
In July 2022, European hub prices continued to soar as heightened geopolitical tensions aggravated concerns about gas supply shortages. Subsequently, already tight market fundamentals in Europe, driven by strong gas demand for cooling, maintenance in Norway, intermittent nuclear output, low hydro levels, and reduced pipeline gas imports, were exacerbated by Gazprom's announcement of a three-day shutdown of Nord Stream I for unplanned maintenance. A combination of these factors culminated in the daily TTF spot price spiking to an all-time high above \$96/MMBtu and the NEA LNG spot price soaring above \$72/MMBtu in August 2022. Following this, spot prices in Europe fell sharply in September 2022, driven by high EU storage levels, which has surpassed its targeted 80%, and more so, by the intervention of EU energy ministers to implement emergency measures to tackle the energy crisis.

European spot prices continued to decline in October 2022, dipping below 2021 levels and trading at a discount to Asian LNG spot prices for the first time since November 2021. This was driven by unusually mild weather, robust LNG imports, record storage injections and a decline in industrial activity. However, there was a strong rebound in European spot prices in November and December 2022 as a result of colder temperatures, unplanned outages at some Norwegian gas fields and lower wind generation. Asian LNG prices followed a similar trend and in mid-December 2022, gained a slight premium over European spot gas prices.

Spot price volatility was even more rampant in 2022 compared to the previous year as illustrated in Figure 154 below. More so, European hub prices experienced much higher volatility compared to Asian LNG spot prices. NBP spot prices exhibited the largest volatility with daily swings ranging from -86% to 639%. Meanwhile, NEA LNG spot price swings ranged from -59% to 26%.

The cumulative annual price variability provides a good indication of price volatility and refers to the cumulative absolute daily price variations over the year. In 2022, the cumulative annual price variability (on a \$/MMBtu basis) of TTF and NBP spot prices were 701 and 864, respectively, significantly higher compared to 229 and 243 in 2021. Meanwhile, in Asia, the annual variability of the NEA LNG spot price was 389, compared to 205 in 2021. While gas supply and demand dynamics still govern the general spot price movement, prices have increasingly become more influenced by news, policy announcements and political negotiations, leading to higher price volatility.

Figure 154: Daily variation of spot prices



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

6.1.1.1 European Spot Gas and LNG Prices

The TTF spot gas price averaged \$37.57/MMBtu in 2022, which was 136% higher than the average of \$15.91/MMBtu in 2021. The NBP spot gas price averaged \$25.47/MMBtu, which was 62% higher than the average of \$15.72/MMBtu in 2021 (Figure 155). Other European price benchmarks followed a similar trend, with the PSV spot gas price averaging \$38.01/MMBtu in 2022, 136% higher y-o-y. European spot LNG prices were also significantly higher compared to the previous year, although maintaining a discount to the hub prices, with the NWE and SWE LNG prices averaging \$31.70 and \$31.14/MMBtu in 2022, respectively.

Figure 155: Monthly European spot gas prices

Source: GECF Secretariat based on data from Refinitiv Eikon

In January 2022, weak market fundamentals in Europe driven by mild temperatures, strong wind output and robust LNG imports resulted in softer spot prices. However, European hub prices grew sharply following escalating geopolitical tensions and heightened concerns about Russian gas supply to Europe at the end of February 2022. Daily TTF spot prices peaked above \$72/MMBtu in March 2022 and remained elevated for the following months. This was driven by a reduction in pipeline gas flows through Nord Stream I to 60% capacity on June 14, 2022, followed by a further reduction to 40% capacity on June 16, 2022, heat waves in Europe and announcement of a further delay in the restart of Freeport LNG facility.

On the other hand, the daily NBP spot price slumped below \$6/MMBtu in May 2022, as the UK gas market became heavily oversupplied. Furthermore, an unexpected outage due to a filter blockage at the IUK interconnector from the UK to Belgium in June 2022, resulted in the daily NBP spot price plunging below \$2/MMBtu in June 2022, further widening the disparity between TTF and NBP spot prices.

In July and August 2022, European hub prices continued to soar due to growing concerns about supply shortages. Heat waves in Europe reduced hydropower, and resulted in low water levels in the Rhine, which caused coal and oil supply disruptions to Germany and boosted gas demand for power generation. In addition, the announcement by Gazprom of a maintenance shutdown on Nord Stream I from August 31 – September 2, 2022, coupled with maintenance activities on the Norwegian Continental Shelf (NCS) and lower wind output, sent daily TTF spot prices soaring to an all-time high above \$96/MMBtu on August 26, 2022.

Following this, prices eased in September and October 2022 due to continued strong LNG imports, high EU storage levels, high wind output, mild temperatures and a slowdown in industrial activity. EU storage levels had reached around 95% capacity at the end of October 2022.

European hub prices rebounded in November 2022 primarily driven by colder temperatures, which increased demand for heating. In addition, unplanned outages at some Norwegian gas fields and lower wind generation supported prices in the region. Another announced delay in the restart of the Freeport LNG facility may have also contributed to the bullish movement in prices. At the end of December 2022, warmer-than-usual temperatures, high storage levels, robust LNG sendout and higher wind and nuclear generation also weighed on prices.

Furthermore, in December 2022, two additional regulations were promulgated, which may have also added some bearish sentiment to European spot prices:

- Council Regulation (EU) 2022/2576 of December 19, 2022 - Enhancing solidarity through better coordination of gas purchases, reliable price benchmarks and exchanges of gas across borders.
- Council Regulation (EU) 2022/2578 of December 22, 2022 - Establishing a market correction mechanism to protect EU citizens and the economy against excessively high prices. ICE warned that it could be forced to relocate trading of TTF futures to London in case of implementation of the price cap mechanism.

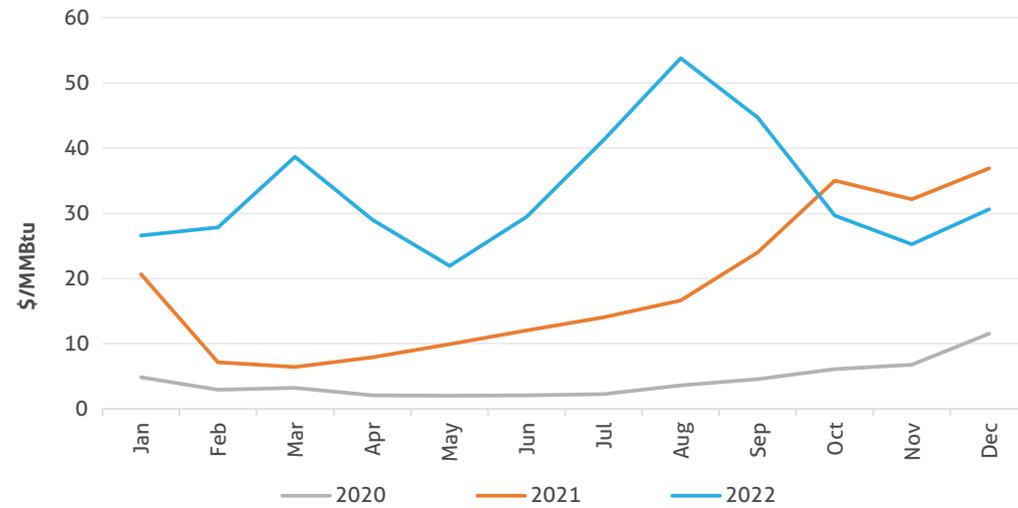
6.1.1.2 Asia Pacific Spot LNG Prices

The average Northeast Asia (NEA) spot LNG price increased by 79% y-o-y to an average of \$33.24/MMBtu in 2022 (Figure 156). Meanwhile, in 2021, the NEA spot LNG price averaged \$18.60/MMBtu.

In 2022, NEA LNG spot prices closely tracked European hub prices, but trailed at a discount. Overall weak market fundamentals, including sufficient supply, healthy LNG inventory levels and muted buying interest in the region, limited further price gains. In addition, lower gas demand due to mild winter and summer temperatures, as well as China's zero-COVID policy added some downward pressure on spot LNG prices.

High LNG spot prices also caused some utilities in Japan and South Korea to switch to coal, reducing gas demand. Meanwhile, an unplanned disruption at Shell's Prelude LNG facility in Australia in June 2022 and the delayed restart of the Freeport LNG facility may have contributed to some bullish movement in prices.

Figure 156: Monthly Northeast Asian spot LNG prices

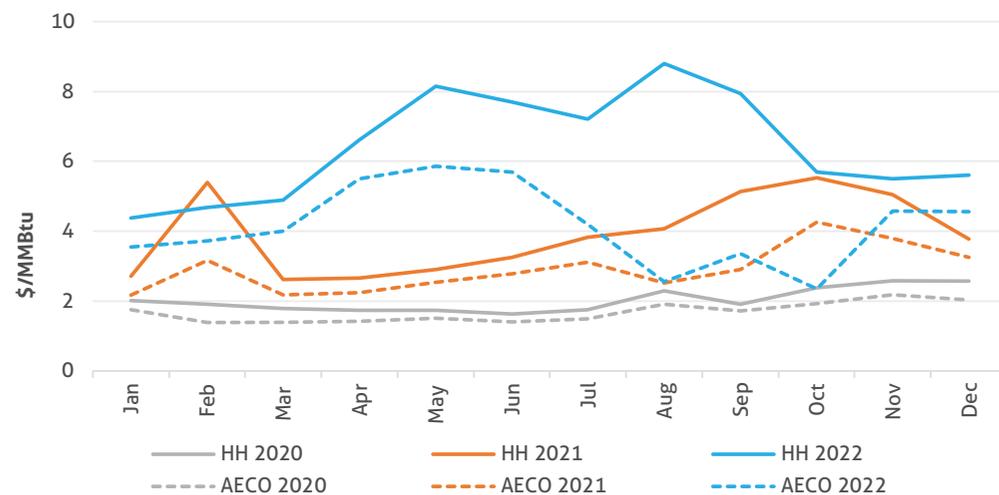


Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

6.1.1.3 North American Spot Gas Prices

The Henry Hub (HH) spot gas price averaged \$6.43/MMBtu in 2022, which was 64% higher than the average of \$3.91/MMBtu in 2021 (Figure 157). This was its highest annual average since 2008. Meanwhile, in Canada, the average Alberta Energy Company (AECO) spot gas price was \$4.16/MMBtu, 43% higher than the average of \$2.91/MMBtu in 2021.

Figure 157: Monthly North American gas spot prices



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

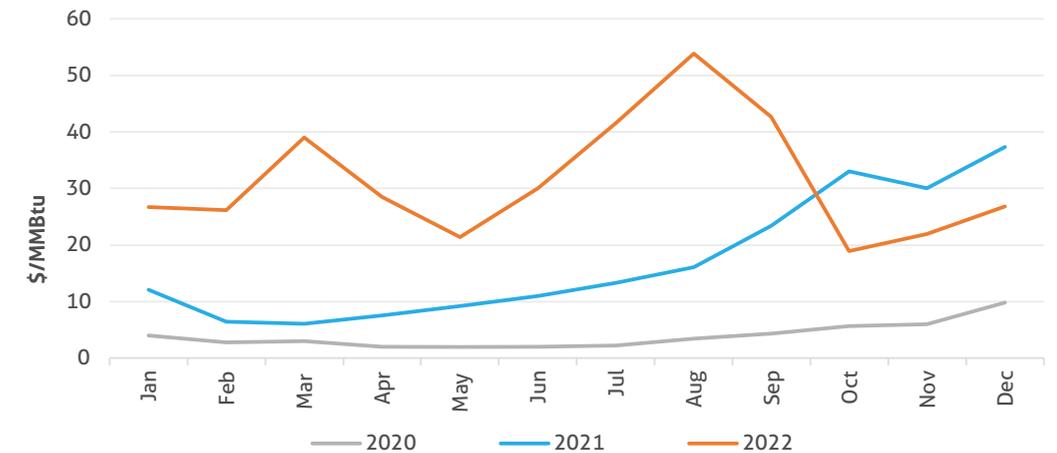
The bullish trend in HH spot gas prices was due to growing tightness in the US gas market. The increase in US gas production was insufficient to meet the rising gas demand for both domestic consumption and LNG exports. There was a significant ramp-up in US LNG exports to Europe to compensate for lower pipeline gas imports from Russia. In the domestic market, higher gas demand for power generation, lower shale gas production in some fields and lower storage injections also supported prices. The US underground gas storage level in 2022 was well below its five-year historical average.

In the second half of August 2022, daily HH spot prices traded above \$9/MMBtu. However, at the end of 2022, HH spot prices plunged to around \$3.5/MMBtu, its lowest level since December 2021.

6.1.1.4 South American Spot LNG Prices

The South America (SA) LNG price averaged \$31.46/MMBtu in 2022, 84% higher than the average of \$17.11/MMBtu in 2021 (Figure 158). The LNG spot prices in South America continued to closely track European and Asian spot LNG prices. LNG delivered prices for Argentina, Brazil and Chile averaged \$31.32/MMBtu, \$31.12/MMBtu and \$31.94/MMBtu respectively in 2022.

Figure 158: Monthly South American LNG spot prices



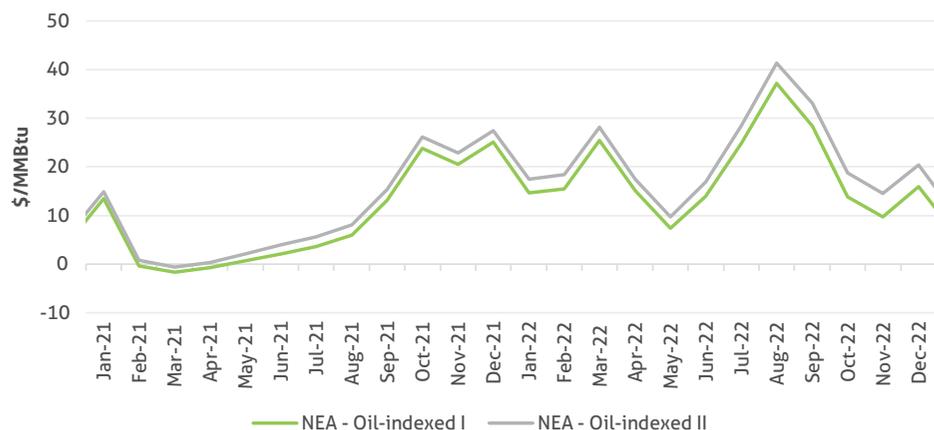
Source: GECF Secretariat based on data from Argus

Note: SA LNG price is an average of the LNG delivered prices for Argentina, Brazil and Chile based on Argus assessment.

6.1.2 Spot and Oil-indexed Long-Term LNG Price Spreads

In 2022, the Oil-indexed I LNG price averaged \$14.76/MMBtu, increasing by 51% y-o-y. Similarly, the Oil-indexed II LNG price averaged \$11.20/MMBtu, increasing by 40% y-o-y (Figure 159). The average discount of Oil-indexed I and Oil-indexed II prices to the NEA spot LNG price widened in comparison to the previous year to around \$18/MMBtu and \$22/MMBtu, respectively.

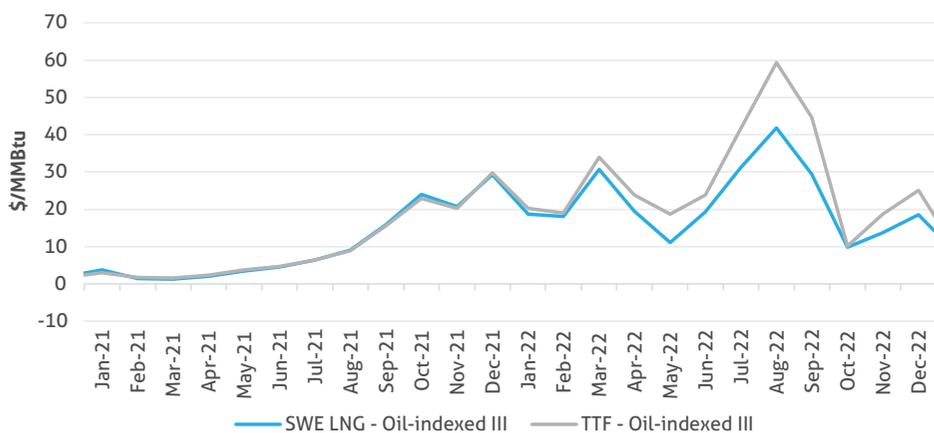
Figure 159: Asia Pacific’s spot and oil-indexed price spread



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon
 Note: Oil-indexed I (using traditional LTC slope): $14.9\% \times \text{Brent} (601) + 0.5$
 Oil-indexed II (using 5-year historical average LTC): $(2021 - 11.2\%; 2022 - 10.9\%) \times \text{Brent} (301) + 0.5$

In Europe, the Oil-indexed III price averaged \$9.33/MMBtu in 2022, increasing by 59% y-o-y (Figure 160). The average SWE LNG spot price held a premium of around \$22/MMBtu over the Oil-indexed III price, which was higher than the \$10/MMBtu premium in 2021.

Figure 160: Europe’s spot and oil-indexed price spread

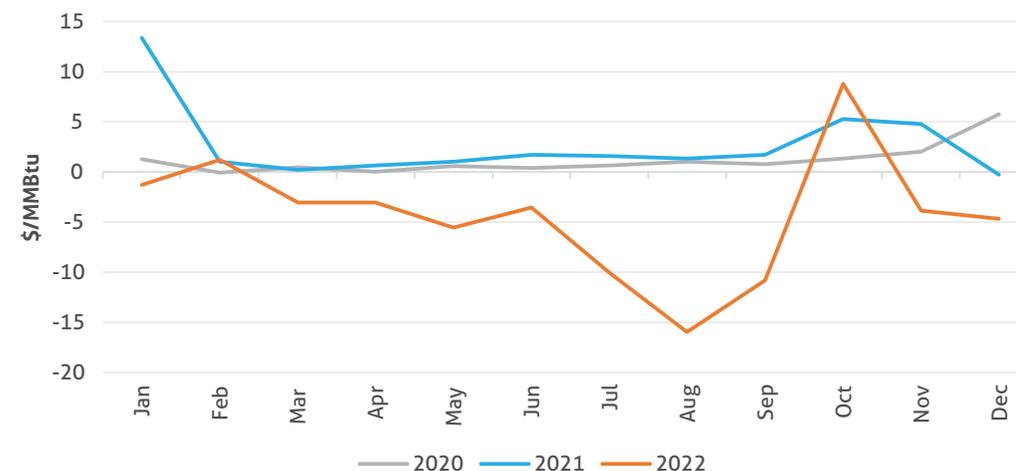


Source: GECF Secretariat based on data from Argus and Refinitiv Eikon
 Note: Oil-indexed III: Argus assessment for European LTC.

6.1.3 Regional Spot Gas & LNG Price Spreads

The NEA-TTF inter-basin price spread was negative and averaged -\$4.33/MMBtu in 2022. TTF spot prices held a premium over NEA LNG for all months except February and October 2022. Furthermore, in August 2022, TTF held its highest premium over NEA LNG spot prices, with a monthly average of \$16/MMBtu (Figure 161). This dynamic supported brisk LNG deliveries into Europe to compensate for supply shortages and to meet ambitious underground storage level targets.

Figure 161: NEA-TTF price spread

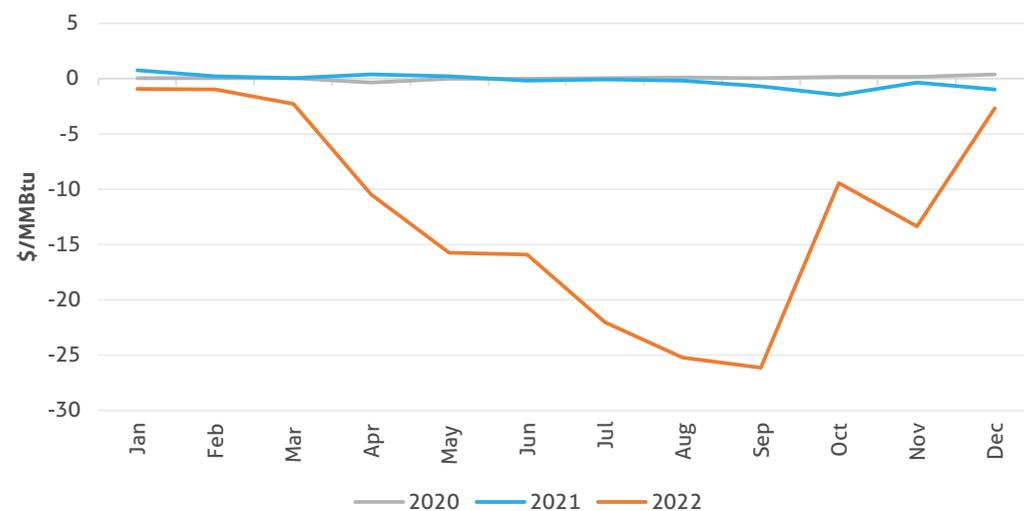


Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

In Europe, NBP traded at a significant discount to TTF of around \$12.10/MMBtu in 2022, compared to an average of \$0.19/MMBtu during the previous year (Figure 162). TTF spot prices increased significantly, more than doubling its annual average in the previous year, resulting in a wider disparity between both European gas hubs.

Since Q4 2021, gas markets in the UK and NW Europe started to become disconnected, with a widening differential between the TTF and NBP spot prices. Almost 45% of NW Europe’s LNG import capacity is located in the UK; however, there is limited capacity to re-export the gas to continental Europe via two interconnector pipelines to Belgium and Netherlands. In April 2022, the differential between TTF and NBP was amplified as NBP spot prices slumped due to a heavily oversupplied UK market, as well as weaker gas demand. At the same time, technical constraints on the IUK interconnector to Belgium reduced pipeline gas flows from the UK to NW Europe. As a consequence, NBP traded at a significant discount to TTF, reaching its largest spread in September 2022 of around \$26/MMBtu.

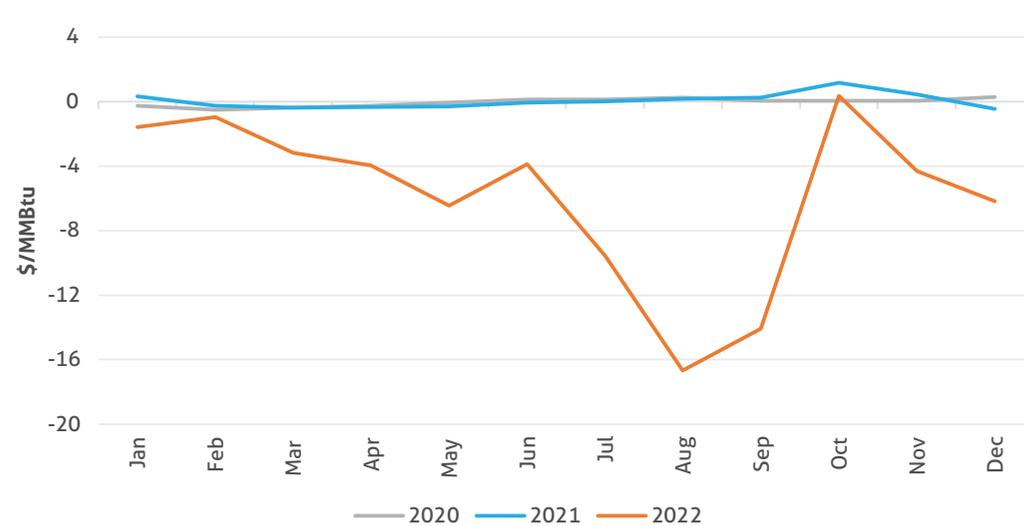
Figure 162: NBP-TTF price spread



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

The NWE LNG price also traded at a discount of \$5.87/MMBtu to TTF, reflecting the tightness of the regasification capacity in northwest Europe and the continued influx of LNG cargoes into the region. In August 2022, the NWE LNG-TTF price spread reached its highest negative value of -\$16.67/MMBtu due to the spike in TTF spot prices during the month (Figure 163).

Figure 163: NWE LNG-TTF price spread



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

The NWE LNG-SA LNG price spread averaged \$0.2/MMBtu in 2022, indicating a strong correlation between both prices (Figure 164). In addition, NEA-HH and TTF-HH spreads widened significantly in 2022 to \$26.81/MMBtu and \$31.14/MMBtu, respectively, due to the uptick in Asian and European spot prices (Figure 165 and Figure 166).

Figure 164: NWE LNG-SA LNG price spread

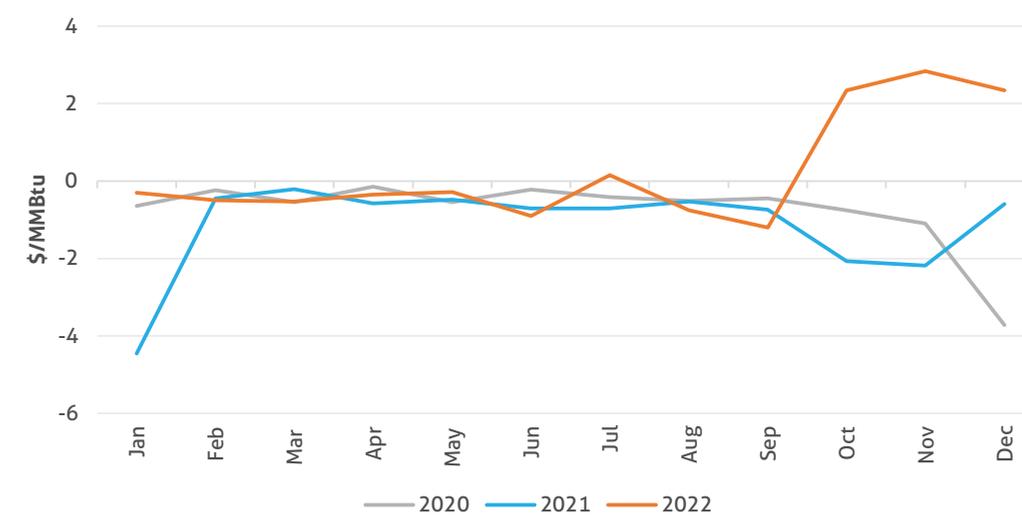


Figure 165: NEA-HH price spread

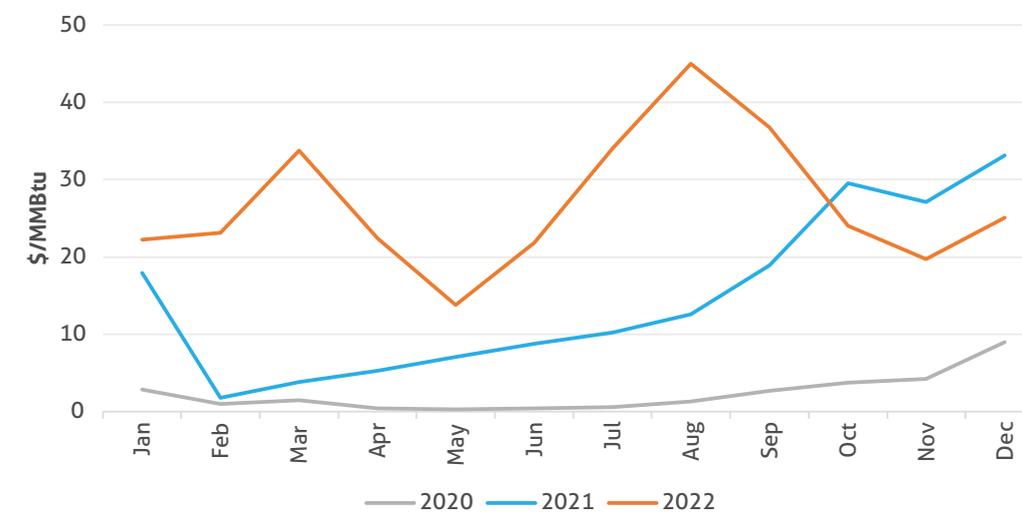
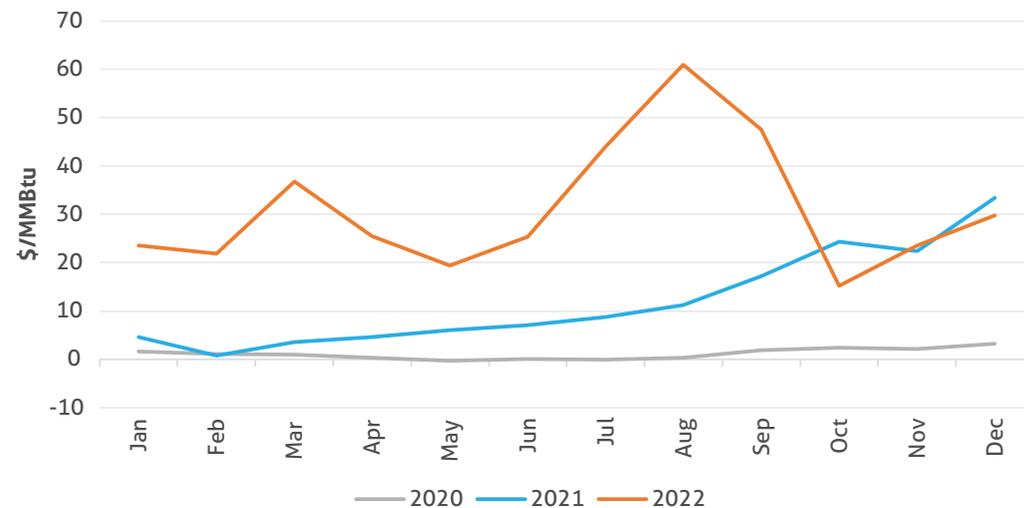


Figure 166: TTF-HH price spread



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon

6.1.4 Short-term Perspectives

Global gas and LNG spot prices in 2023 are expected to remain volatile and may face headwinds from several factors including a relatively mild winter, high underground gas storage levels in Europe, high LNG inventories in Asia and weakened gas demand growth in the midst of a slowdown in global economic growth. However, there may be some upward pressure on spot prices this year due to the anticipated recovery in China's gas demand, higher import demand in price-sensitive countries in Asia and a rebound in gas demand in the industrial sector. Any further supply disruptions or extreme weather conditions during the year may also boost prices.

Gas and LNG spot prices in 2023 may also be influenced by market interventions, which may attempt to correct any supply/demand imbalances. One such government intervention was the Council Regulation (EU) 2022/2578, which established a market correction mechanism (MCM) for TTF derivatives. This regulation became effective on February 15, 2023 and will apply for one year.

In addition to this mechanism, the EU Agency for the Cooperation of Energy Regulators (ACER) is expected to publish a daily LNG price benchmark by March 31, 2023 (as per Regulation (EU) 2022/2576). ACER published its first LNG price assessments for northwest Europe and south Europe on January 19, 2023.

The MCM will be triggered if the following two conditions are met: the front-month TTF settlement price exceeds €180/MWh for three days and is €35/MWh higher than the reference price during the same period. In this regard, if both conditions are met,

ACER will publish a 'market correction notice' on its website whereby activating the MCM. Subsequently, on the following day, transactions with prices of €35 above the reference price published by ACER on the previous day will not be allowed for TTF front-month to front-year derivatives. It should be noted that this mechanism will not apply to TTF day-ahead or over-the-counter (OTC) transactions.

Several trading firms and financial institutions have expressed their concerns over the potential impact of this regulation on the functioning of Europe's gas market. The operators of the Intercontinental Exchange (ICE) in which TTF derivatives are traded, conducted an assessment of the potential implications of this regulation on trading and financial stability and decided to launch a parallel TTF market to allow its clients to adequately manage their risk exposure if the MCM prevents such functioning. Accordingly, the ICE launched its parallel TTF market at its London-based ICE Futures Europe Exchange on February 20, 2023.

The European Central Bank (ECB) has conveyed similar concerns regarding the potential negative impact on financial stability in the euro area. The ECB has warned that the regulation can result in higher volatility and margin calls, as well as incentivize migration from trading venues in the EU. In addition, the European Federation of Energy Traders (EFET) has also expressed concerns that the price cap can lead to increased demand, reduced supply and reopening of LNG contracts.

In addition to its direct impact on the inherent functioning of the European gas market, the MCM can impact the global gas market. If triggered, the mechanism may affect Asian LNG prices, which have closely tracked European hub prices over the past two years. However, if Asian LNG demand rises, there will be increased competition for cargoes, and any TTF price limit may incentivize sellers to divert cargoes away from the EU. This can result in a deficit of gas in the EU and ultimately, regional gas demand destruction. Consequently, these regulations may have spillover effects on the global gas market, leading to market distortions and lower investment in the industry which may only serve to further tighten the gas market.

However, based on current gas market conditions and the relatively high TTF price level that will cause the MCM to be triggered, there is a low probability that the MCM would be activated in the short term, unless there are further severe supply disruptions to the EU.

6.2 Cross Commodity Prices

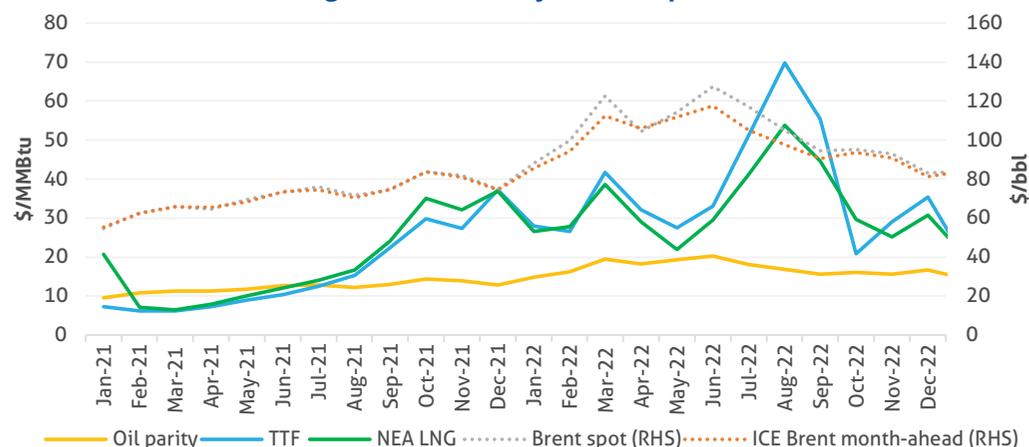
6.2.1 Oil Prices

Brent spot price averaged \$103.68/bbl, increasing by 46% compared to the previous year. Meanwhile, the Brent month-ahead price averaged \$98.89/bbl and was 40% higher y-o-y (Figure 167). Daily Brent oil prices remained above \$80/bbl throughout the year, except in December 2022, when it fell below that level for a few days. Brent spot prices recorded a daily high of \$135.35/bbl in 2022, while Brent month-ahead prices recorded a high of \$127.98/bbl.

In the first quarter of 2022, the bullish movement in oil prices was driven by easing of COVID-19 restrictions globally and lessening concerns about the spread of new variants. More so, rising concerns about potential supply chain disruptions and oil supply shortages amidst geopolitical tensions in eastern Europe supported prices. Monthly oil prices peaked in March 2022, with Brent spot and month-ahead prices reaching \$122.67/bbl and \$112.46/bbl respectively. Subsequently, prices dipped slightly in April 2022 due to softer market fundamentals, with reinstated lockdown measures in China weighing heavily on demand. In June 2022, oil prices rebounded sharply with monthly Brent spot and month-ahead prices soaring to highs of \$127.41/bbl and \$117.50/bbl respectively. This was a result of robust oil demand and several supply disruptions. However, mounting concerns about a slowdown in global economic growth and the potential spill-over effects on global oil demand resulted in a gradual decline in prices in the second half of 2022. The introduction of a price cap of \$60/bbl on Russian oil by G7 and EU countries on December 5, 2022 may have also weighed on oil prices.

With regard to the differential between oil parity and spot prices, oil prices have maintained a discount to spot prices in Europe and Asia Pacific. In 2022, the premium of TTF and NEA spot prices over the oil parity price increased to \$20/bbl and \$16/bbl respectively.

Figure 167: Monthly crude oil prices



Source: GECF Secretariat based on data from Refinitiv Eikon
 Note: A conversion factor of 5.8 was used to calculate the oil parity price in \$/MMBtu based on the ICE Brent month-ahead price.

6.2.2 Coal Prices

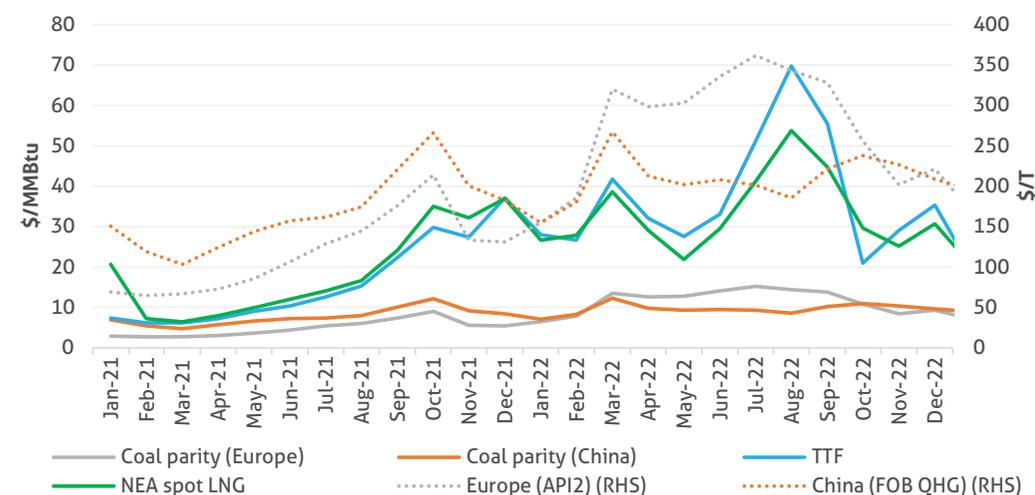
In 2022, the European API2 coal price averaged \$276.01/T, increasing by 138% compared to the previous year. Meanwhile, the China Qinhuangdao (QHG) coal price averaged \$208.93/T, and was 25% higher y-o-y (Figure 168).

High coal prices were fundamentally due to increased gas-to-coal switching in both regions which increased the demand for coal. In Europe, high gas spot prices, together with lower wind and nuclear output, drove the switch to coal in the power sector. Many EU countries, including Germany, which had started aggressive coal phase-out programs in line with their energy transition policies, announced plans to restart idle coal-fired power capacity. Meanwhile, in China, lower hydropower was largely responsible for higher coal-fired generation however, COVID-19 lockdown measures may have capped further increases in coal demand.

European coal prices were significantly higher than Chinese coal prices in 2022, with European coal prices holding a premium of more than \$100/T during the period May – September 2022. Furthermore, European coal prices reached a high of \$361.90/T in July 2022, which may have been due to the anticipation of the EU ban on Russian coal imports which took effect from August 2022. The EU ban also coincided with a partial Indonesian ban on its coal exports.

The energy crunch and high spot gas and LNG prices have put upward pressure on coal prices, with significant gas-to-coal switching taking place particularly in Europe. Furthermore, in 2022, the premium of the TTF spot price over the API2 parity price increased to \$26/MMBtu, increasing by 135% y-o-y. In addition, the premium of the NEA LNG spot price over the QHG parity price widened to \$24/MMBtu, increasing by 116% y-o-y.

Figure 168: Monthly coal parity prices



Source: GECF Secretariat based on data from Argus and Refinitiv Eikon
 Note: Conversion factors of 23.79 and 21.81 were used to calculate the coal prices in \$/MMBtu for Europe (API2) and China (QHG) respectively.

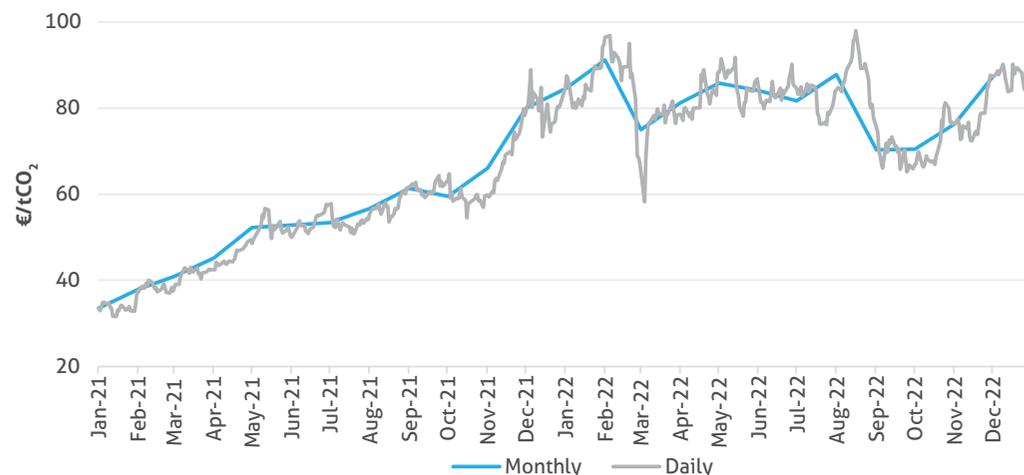
6.2.3 Carbon Prices

EU carbon prices reached new highs in 2022, with an annual average of €81.31/ tCO₂, an increase of 53% compared to 2021 (Figure 169). This bullish movement of EU carbon prices was mainly driven by higher demand for European Union Allowances (EUAs) due to increased coal-fired generation, as high TTF spot prices incentivized the switch to coal. In addition, lower nuclear and renewables output also increased hydrocarbon demand in Europe’s power sector.

EU carbon prices also experienced high volatility during the year, reaching above €96/ tCO₂ in early February 2022, and then falling sharply to a low of €58/ tCO₂ in March 2022. Then, in August 2022, EU carbon prices again spiked to €98/ tCO₂ as a result of strong demand and a reduction in EUA auction supply. Reduced nuclear power generation, as well as low hydropower due to extreme drought conditions in Europe, also increased the demand for EUAs. Subsequently, on September 27, 2022, the European Parliament announced a deal that will ‘frontload’ CO₂ emission allowances and thus, increase liquidity in the market. In this regard, it aims to lower carbon prices and ease pressure on electricity prices. The allowances would be auctioned from May 2023 until the end of 2025, and once €20 billion is raised from the auction, the mechanism would stop.

This frontloading of EUAs, together with a gloomy economic outlook for Europe, is expected to weigh on EU carbon prices in 2023. However, EU carbon prices are still expected to remain relatively high, with an annual average of around €70/tCO₂ based on estimates from Refinitiv Eikon (as of October 13, 2022).

Figure 169: EU carbon prices



Source: GECF Secretariat based on data from Refinitiv Eikon

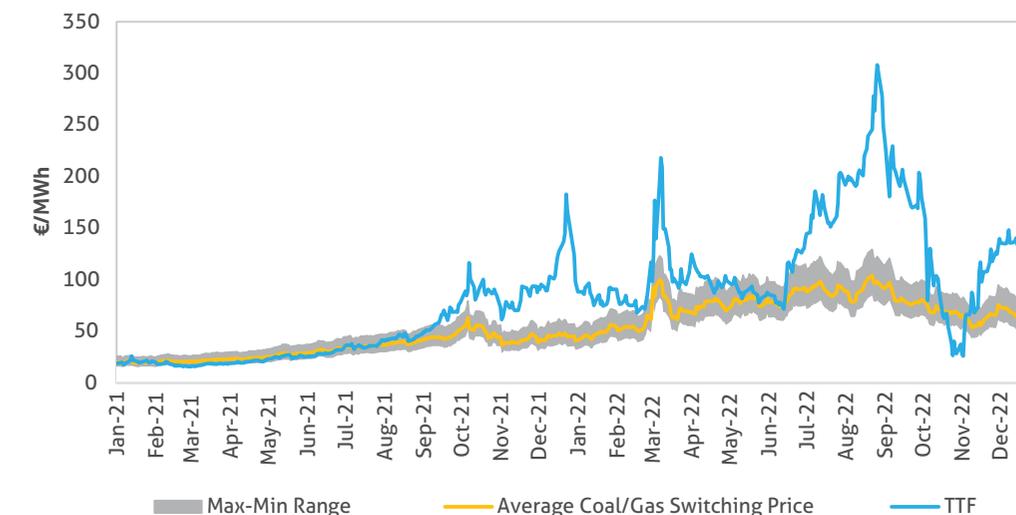
6.2.4 Fuel switching

TTF spot prices held a premium over the average coal-to-gas switching price of €79/ MWh in 2022, which was 276% higher y-o-y, due to tight market conditions. This increased gas-to-coal switching in Europe during the year. Nevertheless, there were significant fluctuations during the year with TTF spot prices falling within the switching range, and even below it.

From January - April 2022, TTF spot prices remained above the coal-to-gas switching range. However, weaker market fundamentals in May 2022, caused TTF spot prices to fall within the coal-to-gas switching range. In mid-June 2022, TTF spot prices rebounded widening the spread between the TTF spot price and the average coal-to-gas switching price, which reached its highest in August 2022 at €136/MWh. Subsequently, TTF spot prices tumbled in October 2022 and fell below the switching range however, there was a quick rebound in November and December 2022 (Figure 170).

Furthermore, in 2023, the premium of TTF spot prices over the average coal-to-gas switching price is expected to be lower than in 2022. Thus, this may incentivise some coal-to-gas switching to meet any increased demand in the power sector.

Figure 170: TTF vs coal-to-gas switching price



Source: GECF Secretariat based on data from Refinitiv Eikon
 Note: Coal-to-gas switching price is the price of gas at which the cost of generating electricity with coal or gas is equal. The estimate takes into consideration coal prices, CO₂ emissions prices, operation costs and power plant efficiencies. The efficiencies considered for gas plants are max: 56%, min: 46%, avg: 49.13%. The efficiencies considered for coal plants are max: 40%, min: 34%, avg: 36%.

CHAPTER
07

Regional Grouping

Term	Meaning
Advanced Economies (AEs)	Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Macau (China), Malta, Netherlands, New Zealand, Norway, Portugal, Puerto Rico, San Marino, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan (Province of China), United Kingdom, United States
Africa	Algeria, Angola, Benin, Central African Rep., Congo, Democratic Republic of the Congo, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Ghana, Gabon, Ivory Coast, Kenya, Libya, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, South Sudan, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe
Asia Pacific	Afghanistan, Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Cook Islands, Democratic People’s Republic of Korea, Fiji, French Polynesia, Hong Kong, India, Indonesia, Japan, Kiribati, Korea, Lao People’s Democratic Republic, Macau (China), Malaysia, Maldives, Mongolia, Myanmar, Nepal, New Caledonia, New Zealand, Pakistan, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan (Province of China), Thailand, Timor-Leste, Tonga, Vanuatu and Vietnam
Emerging Markets and Developing Economies (EMDEs)	All other countries not included in “Advanced Economies”
Eurasia	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine and Uzbekistan
Europe	European Union and Albania, Bosnia and Herzegovina, Gibraltar, Iceland, Montenegro, Norway, Serbia, Switzerland, Macedonia, Moldova, Türkiye and the United Kingdom
European Union	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden
Euro area	Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain



G7	Canada, France, Germany, Italy, Japan, the United Kingdom and the United States
G20	Argentina, Australia, Brazil, Canada, China, EU, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Türkiye, the United Kingdom and the United States
GECF Members	Algeria, Bolivia, Egypt, Equatorial Guinea, Libya, Iran, Nigeria, Qatar, Russia, Trinidad and Tobago, United Arab Emirates and Venezuela
GECF Observers	Angola, Azerbaijan, Iraq, Malaysia, Mozambique, Norway and Peru
Latin America and the Caribbean (LAC)	Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Malvinas), French Guyana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Pierre et Miquelon, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay and Venezuela
Middle East	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen
Middle East and North Africa (MENA)	Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates and Yemen
North America	Canada, Mexico and United States
OECD Countries	Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, the Slovak Republic, Slovenia, Switzerland, Türkiye, the United Kingdom and the United States
OECD Americas	Canada, Chile, Mexico and the United States
OECD Asia Oceania	Australia, Japan, Korea and New Zealand
OECD Europe	Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, the Slovak Republic, Slovenia, Switzerland, Türkiye and the United Kingdom
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guyana, Guyana, Paraguay, Peru, Suriname, Uruguay and Venezuela

CHAPTER 08

Abbreviations

Abbreviation	Explanation
ACQ	Annual contracted quantity
AE	Advanced economies
AECO	Alberta Energy Company
bcm	Billion cubic metres
bcma	Billion cubic metres per annum
CBAM	Carbon border adjustment mechanism
CBM	Coal bed methane
CCGT	Combined cycle gas turbine
CCS	Carbon, capture and storage
CCUS	Carbon capture, utilization and storage
CNG	Compressed natural gas
CO ₂	Carbon dioxide
CPI	Consumer price index
EC	European Commission
ECB	European Central Bank
EEI	Energy efficiency existing ship index
EMDE	Emerging markets and developing economies
EU	European Union
EU ETS	European Union emissions trading scheme
EUA	European Union allowance
Fed	Federal Reserve
FEED	Front end engineering design
FID	Final investment decision
G7	Group of Seven

GDP	Gross domestic product
GECF	Gas Exporting Countries Forum
GHG	Greenhouse gas
HDD	Heating degree days
HH	Henry Hub
IEA	International Energy Agency
IMF	International Monetary Fund
IMO	International Maritime Organization
JKM	Japan Korea Marker
LNG	Liquefied natural gas
LAC	Latin America and the Caribbean
LT	Long-term
MENA	Middle East and North Africa
METI	Ministry of Trade and Industry in Japan
Mt	Million tonnes
MMBtu	Million British Thermal Units
Mtpa	Million tonnes per annum
MWh	Megawatt hour
NEA	North East Asia
NBP	National balancing Point
NDC	Nationally determined contribution
NGV	Natural gas vehicle
NZBA	Net-Zero Banking Alliance
OECD	Organization for Economic Co-operation and Development
PNG	Pipeline natural gas
PPAC	Petroleum Planning & Analysis Cell
QHG	Qinhuangdao
R-LNG	Regasified LNG
SA	South America
SPA	Sales and purchase agreement
SWE	South West Europe
T&T	Trinidad and Tobago

TANAP	Trans-Anatolian Gas Pipeline
tcm	Trillion cubic metres
tCO₂	Ton of carbon dioxide
TTF	Title Transfer Facility
TWh	Terawatt hour
UGS	Underground gas storage
UAE	United Arab Emirates
UK	United Kingdom
US	United States
y-o-y	year-on-year

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Gas Exporting Countries Forum , GECF

GECF Headquarters

P.O.Box 23753, Tornado Tower

47th & 48th Floors, West Bay, Doha

www.gecf.org



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