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Geopolitical and financial analysis of the rising LNG industry and gas market trends

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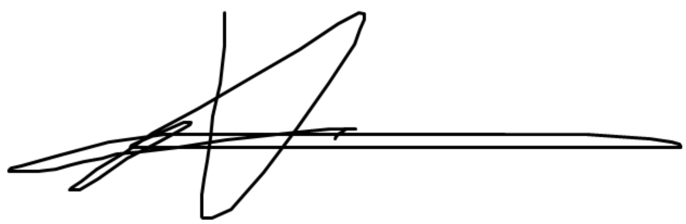

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Abstract

Natural gas is a fossil fuel of great importance that occupies a great share in the global energy mix. It can be utilised in various ways and in many applications. Natural gas can be transported either through a pipeline system or in the form of liquified natural gas (LNG) by ship. The increase of natural gas and especially LNG trading led to the development of regional markets. Initially, each market used similar pricing benchmarks related to crude oil and its products and were affected by the same market fundamentals. Later on, regional markets developed their own pricing formation in the form of gas hubs. Gas hubs play an important role in today's natural gas and LNG trading when they reach full maturity, surpassing other pricing methods globally. Natural gas however, is a politicized commodity especially when traded through pipelines. Supply or even transit countries are able to increase their geopolitical influence by disrupting supply at will when necessary. As energy transition accelerates globally, it is important to look at the future of natural gas and LNG on both the supply and demand side and assess its place in the energy mix of the future.

1. Introduction

Natural gas is nowadays one of most discussed topics not only by energy experts but also simple end users. It has long been branded as the transition fuel to a world with no (or minimum) greenhouse gas emissions. However, the global energy shock caused by the COVID 19 pandemic has accelerated the energy transition process, with several experts even pushing against natural gas and LNG dependence in a premature state. The EU commission is determined to phase out natural gas sooner than the US or Asia, omitting several natural gas projects from the PCI list. However, as the energy demand of the world increases dramatically as well as the energy poverty in developing states, it is unrealistic to expect current renewable energy technologies to cover the missing share. In this context it is crucial to understand the nature of the natural gas and LNG market, its function and its distinctiveness regionally. Natural gas trading is a complex battleground of market dynamics and politics. Major exporters are trying to increase their influence either by supply disruptions or supply exclusiveness, while importers are trying to balance their own financial interests without relying too much on countries with opposing interests and goals. This study offers an insight on the uses of natural gas and LNG and historical information on the creation of global markets. It provides essential knowledge about the microeconomics related to natural gas trading and its different types of price formations, as pricing moves away from oil-indexation to a modern type of hub-based pricing. The most important geopolitical relations regarding natural gas and LNG trading are highlighted, with Europe being a central battleground for a US and Russia influence competition. China is also set to play an important part in global geopolitics as with its new coal-to-gas switching incentive and rapidly rising energy demand. Supply and demand dynamics for future LNG trading are also stressed with the view to assess future geopolitical relations and prices for the commodity.

2. Natural gas and LNG

2.1 Introduction

Natural gas is a conventional source of power with high versatility. It can be used in many types of industries as well as transportation fuel. Natural gas can be processed and liquified for easier storage and transportation. Its liquified form (LNG) can also be used in different sectors and different ways.

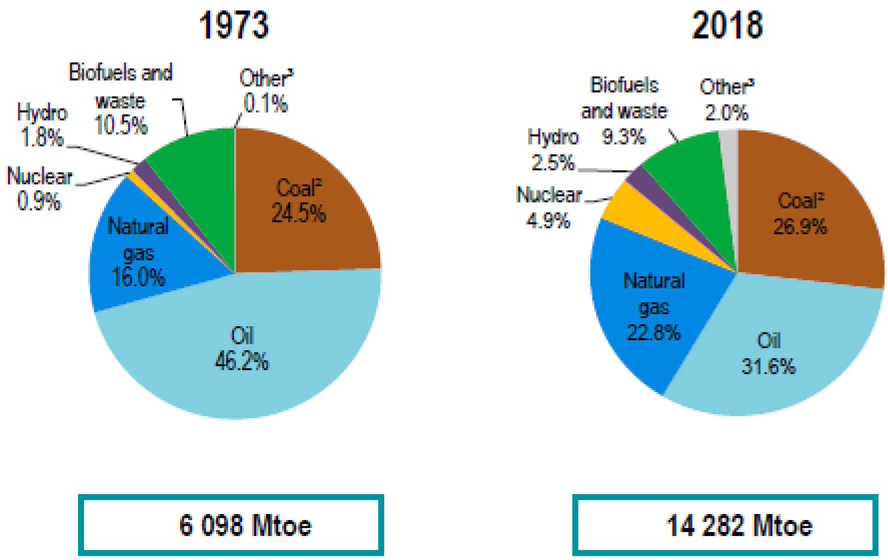
2.2 Natural gas and its uses

Natural gas is a fossil fuel that formed deep under the earth's surface. It consists of several hydrocarbons in different ratios. The largest component and also an indicator of the purity of natural gas is methane (CH_4). (EIA 2020) It is commonly used for heating, cooking, electricity generation and more recently as a fuel for some vehicles. (Riva 2021)

Even though the commercialization of natural gas started back in the late 18th century in Britain, it wasn't until the 20th century and the construction of an effective pipeline system that natural gas started being used extensively from home heating and cooking to manufacturing and processing plants. (APGA 2021)

According to the IEA, the world total energy supply increased from 6.098 Mtoe in 1973 to 14.282 Mtoe in 2018. Natural gas, specifically, increased its share from 16% to 22.8% in the same period. (IEA 2020)

Figure 1:1973 and 2018 source shares of total energy supply



Source: IEA, 2020

The above facts prove the significance of natural gas as an energy source and the growing incentive to use it as an alternative, cleaner source to oil and, especially, coal.

2.3 The rise of LNG and the creation of global markets

The first experiments for the liquefaction of natural gas started back in the 19th century. The U.S were pioneers in the technology, having designed the first operational LNG plant in Virginia in 1912. In 1959, the first LNG cargo sailed from the Louisiana Gulf to the UK. (Adriatic LNG)

Initially, the two LNG markets (Asia-Pacific and Atlantic Basic regions) began in isolation due to distinct differences in project structures, pricing arrangements, terms etc. When Qatar started exporting LNG to both regions, inter-regional trade increased as well as spot market activity. Currently, there are three main global markets; The Asia Pacific Region, the European Region and the Atlantic Basin/North America region. (US Department of Energy 2018)

The Pacific market has always been the largest LNG market. Until recently, Japan has been the largest importer of LNG, only to be surpassed by China in 2021 (Froley 2021). While South Korea and Taiwan are also important importers, India is set to make a difference in the upcoming years.

The European market had, so far, seen less growth as the imported LNG had to compete with an already established pipeline gas market. Russia is the dominant power and major exporter of natural gas with a significant portion of the pipeline natural gas distributed in the European mainland. (US Department of Energy, 2018) However, the European market has emerged as a global gas balancing market, absorbing excess LNG quantities. In 2019, Europe was responsible for over 24% of global LNG imports (Howell et al, 2021)

The North America market had different incentives related to imports and exports throughout the 20th century. The U.S, Mexico and Canada had strong pipeline connections and abundance of supply. Therefore, until the energy crisis in the 1970's, the aforementioned states could cover all of their gas requirements between themselves. In the 1970's, the U.S started temporarily importing LNG from Algeria. However, as the 1980's were a decade of oversupply, the LNG import terminals started shutting down. With the shale gas revolution in the next decades, the U.S became a major net exporter and the terminals previously used for imports became liquefaction and export terminals. (US Department of Energy, 2018)

2.4 Natural gas processing and LNG supply chain

The gas originating from the production field must first be treated prior to liquefaction. Carbon dioxide, water, hydrogen sulphide, helium and nitrogen are removed in different phases before the liquefaction process, as well as hydrocarbons in the mix which are a lot heavier than methane. In order to liquefy natural gas, the feed gas is cooled to approximately -162^{o}C. After the liquefaction, the end product (LNG) takes up about 1/600th of the initial volume of natural gas. In this form, natural gas is much more efficient to be transported. (GIINGL, 2019)

Liquefaction plants are usually a parallel series of processing units called trains. Each of these trains is a standalone processing unit, even though they are built next to each other. The most expensive part of the LNG value chain is liquefaction. Some countries are considering the more and more popular idea of floating liquefaction installations due to environmental concerns and the remote location of some of the resources. The principles of liquefactions are the same with differences observed only in the technological part.

Specialized double-hulled LNG vessels are then utilised for the transportation of the chilled gas. The vessel construction has historically been dominated by Asia as their shipyards possess the most experience. In most cases, these vessels are owned by a shipping company and are chartered to either the seller or the buyer. However, in some integrated projects (like Qatar) the ships are built and owned by the project association. Highly leveraged financing and high capital costs often generate a low rate of return for the investment, but they bring a low risk for the owner of the ship. Planning on the arrival date of the ships as well as preparing the local supplies, infrastructure and trucking are critical for the success of the project.

LNG must then be re-gasified for commercial use. Regasification usually takes place at onshore facilities that include a docking port for the LNG vessel, cryogenic storage to hold the LNG until regasification is completed and a regasification plant. Cryogenic facilities require high expertise, but the regasification stage is less expensive than upstream production and liquefaction. Problems may only arise with local stakeholders, as they need to agree on the long-term with the positioning of the terminals.

After careful planning on the pricing and volumes so that both counterparties are satisfied, the product is then distributed. Both buyers and sellers need to take into account the rapidly changing conditions in the global market in order to maximise their profit (US. Department of Energy, 2018)

2.5 LNG technological developments and innovations

The most important LNG technological innovations that have contributed to its extensive worldwide use while also offering potential growth prospects are (Enerdata 2020):

A) Floating storage and liquefaction facilities (FLNG for floating LNG)

FLNG permits the development of natural gas resources at the sea without the need of offshore liquefaction terminals. The FLNG installation floats above an offshore natural gas production field and allows the production, liquefaction, storage and transfer of natural gas in the form of LNG. The benefit is a lower environmental impact, quicker implementation deadlines, reduced investments, flexibility, mobility and last but not least, political and geopolitical advantages.

B) Floating storage and regasification facilities (FSRU for Floating Storage and Regasification Unit)

FSRU's are floating storage and regasification facilities that operate similarly to onshore facilities. FSRU's offer a solution for the rapid expansion of a project, while onshore facilities are built. They offer similar advantages to FLNG projects.

C) Platform LNG (PLNG)

A novel idea regarding the installation of liquefaction terminals on already existing platforms rather than on ships. This could provide a solution in remote, environmentally sensitive areas.

D) Small Scale LNG (SSLNG)

The scalable and modular design of these projects can overcome the lack of economies at scale; the size of SSLNG facilities can be increased when growth is observed. This presents high investment flexibility, something valued by the operators. SSLNG is generally used for peak load curbing and smoothing short-term fluctuations in the market.

2.6 Transportation use of LNG

LNG can be used directly in transportation in two ways (Enerdata 2020):

a) As a marine fuel

LNG has long been used as a transportation of ships thanks to gas naturally vaporised by the liquid/vapour balance in the tanks. However, only recently LNG carburation has been extended to other types of ships (container ships, bulk carriers, ferries etc), where heavy oil has been used due to its financial advantages historically. This market, about non-existent a few years ago, now has 170 operating ships worldwide. Over 100 ships are on order for delivery until 2025. This rapid increase in demand for LNG as a marine fuel can be explained from the stricter protocols against toxic gas emissions; shipping accounts for about 90% of global sulphur oxides (SO_x) emissions from the transport sector, while is also responsible for high concentrations of local nitrogen oxides (NO_x) and particulate matter emissions around major shipping lanes and port cities. In this context, LNG provides many advantages such as virtually no PM particles, no sulphur and finally, about 85% decreased nitrogen oxide (NO_x) emissions compared to heavy oil.

b) As a road fuel

The use of LNG as a road fuel (mainly trucks and coaches) is rather new but is expected to increase in the next few years along with the expansion of the market. Most truck manufacturers already offer the models in their catalogues. China is leading the way in LNG usage as a road fuel as it is implemented in their energy strategy plan, while USA and Europe follow. Even though LNG trucks are much more expensive to be purchased, they hold a significant advantage in taxation vs typical diesel trucks and they are thought to cover their extra cost in the first two or three years.

2.7 Conclusion

Natural gas is an essential component for the development of many industrial sectors. It can be transported either through pipelines or via ships in the form of liquified natural gas. Technological developments and the creation of global markets have increased the share of natural gas and LNG in the global energy mix.

3. Natural Gas and LNG trading and market analysis

3.1 Introduction

Natural gas and LNG trading and market analysis can be quite complex as it is governed by a lot of factors; from microeconomics to geopolitics. These markets present characteristics depending on their regional conditions and maturity of the market. Consequently, along with the evolution of these regional markets in different pace, different price formations emerged which dominated certain areas of trading. However, these price formations are all affected by the same market fundamentals.

3.2 Economic analysis and trading of natural gas

In order to understand many aspects of the natural gas and LNG markets, essential microeconomic knowledge is needed. Companies and traders use financial instruments to buy or sell quantities, to predict the state of the market and the commodity price or to protect their portfolio against abnormal volatility. Different types of deals, either formal or over-the-counter can be made to accommodate the needs of the players in every case.

3.2.1 Microeconomic analysis and natural gas

Microeconomic analysis for commodity trading applies to natural gas too. In order to understand how the natural gas market functions, some essential notions must be implemented. First of all, the types of contracts involved in commodity trading and, specifically, natural gas trading are:

a) Forward contracts
b) Futures contracts

Forward and future contracts are both agreements to buy or sell an asset at a specific date in the future and at a specific price. These agreements enable buyers to mitigate the risk of a volatile price at the future date of delivery as they lock in at a specific price. Forward contracts are privately negotiated between parties and therefore higher credit risk exists. Due to the high levels of customization of these contracts (any amount can be traded at any time) they are exchanged over-the-counter (OTC) or off-exchange.

On the other hand, futures contracts are traded on exchange. They are also more standardized than forward contracts, there is no counterparty risk (the payment is guaranteed by the exchange clearing house) (CME Group, no date).

Forward contracts are used in order to create forward curves. Forward curves are the graphical presentation between the price of forward contracts and the time to maturity of the contracts. Forward curves are one of the signals that offer a significant amount of information as to the market sentiment and the potential direction of the market (in this case the natural gas markets).

It is important to clarify, however, that forward curves are not price prediction models; they trade daily and all day long in dynamic patterns. A price along the TTF forward curve does not necessarily mean that this will be the price of traded gas when the market gets to that point in time. It is merely the agreed forward price (through a transaction) of natural gas between buyers and sellers in that instant and is subject to change in the next instant of time. Essentially, the forward curve is a model showing how future months are valued, given all the available information at that instant, relative to the nearby or spot contract month. Activity wise, the majority of the activity and therefore liquidity, tends to be in the front point of the curve, with the months in the back mostly following the pattern.

Natural gas participants observe the structure of the forward curve to make decisions. The curve trades in three different structures depending on market conditions. The flat forward curve is the least common configuration (and in the case of natural gas almost non-existent), where prices going forward are basically equal to each other. The two dominant configurations of the forward curve are contango and backwardation.

A contango formation is generally formed when the market is oversupplied and/or demand is low. It occurs when prices are higher in succeeding delivery months than the nearby or spot months. Generally, during periods of contango formation, natural gas storages are filled.

A backwardation formation, on the other hand, proposes that the market is undersupplied or that demand is outstripping supply. During a backwardation period, natural gas storages are emptied in order for supply to meet market demand. (CME Group, 2017)

Even though forward curves are used extensively in the energy industry, understanding the information they provide is not always straightforward for energy professionals. Forward curves are commonly misunderstood to be “a forecast of spot prices”. An interesting phenomenon observed that ultimately undermines that notion is the “parallel shift” in the forward curve, with the entire curve moving up or down depending on the change of a single day spot price. As the natural gas market presents a constant change in spot prices due to seasonality characteristics of the specific market, long-term forward prices change, rather unreasonably, due to expected weather forecasts or physical events in the supply chain. Evidently, these temporary changes in the spot price bear no effect in the long-term for future spot prices and therefore forward curve modifications should be taken lightly. (Perry, 2015)

3.2.2 Gas hub microeconomics

Some important notions for the introduction of natural gas hubs are:

1) Liquidity
2) Volatility and
3) Churn rate.

Trading liquidity is crucial for Europe’s evolution of energy hubs. Higher transaction volumes increase price transparency and decrease transaction costs. The attractiveness and reliability of hubs thus increases, as a means to manage natural gas portfolio hedging and optimisation. The financial crisis of 2008 led to a global gas glut period of oversupply, doubling the liquidity of gas hubs (Timera Energy, 2014).

Volatility is used as a term to describe price fluctuations of a commodity (in this case natural gas). Volatility is measured as the day to day percentage difference in the price of natural gas. As the price of natural gas is related to the interplay of supply and demand, volatility is thus a result of the underlying supply/demand characteristics of the gas market. Consequently, high volatility usually reflects extraordinary supply and/or demand characteristics. Volatility presents a measure to calculate price uncertainty in markets. Entities that trade natural gas might opt not to proceed to investment or risk management activities in times when market volatility is high (EIA 2010).

Churn rate is defined as the ratio of trading volume to physical volume consumed. It is a key metric to assess whether a hub is commercially successful and vibrant. Essentially, churn rate is an indication of how many times a unit of natural gas is traded and re-traded before it is finally consumed. The natural gas industry has established a threshold of 10 as a churn ration in order for a hub to be considered as mature (CME Group, no date).

3.2.3 Risk management of natural gas portfolios (hedging)

Another important tool for industries is hedging. Manufacturing and processing industries, who consume huge volumes of natural gas, volatile gas prices can cause them serious problems. If a company chooses not to manage their exposure, these price fluctuations could result in them exceeding their budget; or worse. Hedging allows market participants to mitigate the impact of volatile and/or rising natural gas prices.

Hedging generally protects the position of a company generally by reducing its exposure to natural gas price fluctuations by shifting the risk to another company with an opposite risk profile, i.e traders or natural gas producers that are willing to accept the risk with potential future profits in mind. Hedging is viable because the price of natural gas in the financial market and the price in the physical market tend to have a strong correlation. While the relationship between these two prices isn't static, the risk of not hedging is significantly higher than the risk of an adverse change in this relationship.

Options, forwards, futures and swaps are some of the financial instruments used for hedging in order to mitigate cost changes (Mercatus Energy, no date).
No matter the type of financial instrument utilised, an extensive analysis must be made by the company including several variants; weather factors, natural gas storages, oil price and macroeconomic announcements. An extensive study on hedging effectiveness incorporating these factors by Song-Zan Chiou-Wei et.al has provided remarkable results. A dynamic hedging strategy utilising multivariate GARCH DCC estimation models without integrating any of the aforementioned market fundamentals has resulted in a 68% of variance reductions for weekly data and 37% of variance reductions of daily data. As more and more of market fundamentals are being integrated in the models, the hedging effectiveness increases. Ultimately, when all variants are included, the hedging effectiveness increases to 89.8% for the weekly data and 77.4% for the daily data. However, it is also argued that even though dynamic hedging is the optimal method for a company instead of using a constant hedging ratio, rebalancing costs could render this option inappropriate for certain portfolios. Another important issue is that companies that opt to hedge need to have reliable information about all the aforementioned factors (weather, storage, oil price, macroeconomics) for a successful model (Zan et al, 2019).

In the case of LNG, hedging tools are either non-existent or do not have sufficient market liquidity compared to crude oil and coal tools which are generally easily accessible. Therefore, it is not possible to perform flexible hedging on LNG operations as of today. Considering that long-term contracts imported to Asian countries and especially Japan are oil-indexed, cross-commodity hedging using crude-oil trading is a viable substitute. However, this does not substantially reduce the basis risk between the price of LNG and the price of oil which are not the same. As new price benchmarks such as Henry Hub, the Title Transfer Facility (TTF) and the Japan Korean Marker (JKM) are used more and more in new contracts, hybrid contracts will present some risk diversification effects. These effects cannot, however, replace actual hedging risk tools. As the LNG market liquidity increases and more reliable LNG price indices are utilised, the possibility of locking in profit margins by hedging procurement contracts linked to these indices with LNG futures and swaps, arises. (KPMG, 2017)

3.2.4 Natural gas trading

Natural gas trading can take place in either:

a) Over-the-counter (OTC) markets
b) On exchange

Over-the-counter trading does not include a centralized trading platform to aggregate bids and offers and allocate trades. Over-the-counter trades are bilateral, non-regulated deals in which buyers and sellers are negotiating directly and in private. They are, usually, not aware of prices or similar transactions from other counterparties in the market. OTC trading includes both standardized and customized products.

Exchange-based trading is based purely on standardized products which are characterized by their time of delivery. The delivery date of said products can extend from days to several years, depending on the liquidity of the relevant market. Typically, the further ahead the date of delivery is, the more liquid the market is thought to be. An important difference of exchange-based trading with over-the-counter trading is that trading on exchange is anonymous and the counterparty risk is managed by the exchange; the exchange obliges the other side of the deal to hold up to their end (IENE, 2014).

The products traded can be classified in various ways. A common way to classify them would be:

1. Short-term products (sport markets)
   From hourly (within day) products to multi-day products.
2. Medium term - prompt and forward markets - “near-curve products”
   From one calendar month to one quarter.
3. Long term - forward markets - “far curve products”
   From half a year (season) products to one calendar year. They could also extend further in the future.

For the LNG markets specifically, an emergence of a growing spot and short-term market can be noticed, which includes spot contracts (for immediate delivery) and contracts of less than four years. Short-term and spot contracts allow uncommitted and divertible LNG to go to the highest value market in response to changing market conditions. Due to the divergence of prices in the markets recently, the short-term LNG market has grown rapidly. From virtually zero spot-trading before 1990, 35% of global LNG volumes were traded on spot basis in 2020. (US Department of Energy, 2018)

3.3 The development of gas hubs and the evolution of pricing formations

The liberalization and deregulation of markets was undertaken with the idea to form competitive conditions that would ultimately lead to a better final product for the end consumer. In this context, gas hubs were formed in North America and Europe which would, with efficient liquidity, create competitive conditions and enable parties to better manage their portfolios. An Asian LNG hub, where at the moment the majority of gas imports take place, still has a long way to go. Pricing formations are a dynamic phenomenon related to many aspects such as domestic politics, global gas hubs and their maturity levels and traditional oil trading.

3.3.1 Natural gas market regulatory framework and Gas target Model

Back in 2011, European market regulators set forward their thinking on key challenges and the best way to deal with them, in order to secure the appropriate regulatory framework needed for the next few years. “Bridge to 2025”, as the European Union Agency for the Cooperation of Energy Regulators (ACER) named their vision, includes a competitive European gas market, consisting of entry-exit zones with liquid virtual trading points (VTP). Infrastructure serves different levels of market integration and is utilised in order to move gas freely to the locations with the highest market value.

Implementing Network Codes is the priority of regulators and other stakeholders in order to make this vision come true. The Network Codes set the objective for non-discriminatory access to gas infrastructure and other cross-border and market integration issues. However, these Network Codes are unlikely to create a “functioning and transparent wholesale market”. For this reason, the Gas Target Model was created, taking into consideration these access issues while establishing a broader analytical context related to the development of a functioning and transparent natural gas wholesale market.

The Gas Target Model allows the implementation and coherent development of the aforementioned Network Codes, as well as provides the pathway for a liquid and dynamic gas market that will benefit all end-consumers with secure gas supplies and competitive prices.

Increasing uncertainty of supply and demand is one of the major reasons for the constant revision of the steps proposed in the Gas Target Model. On the supply side, declining production from the UK and Netherlands, periodic reluctance of Russia to supply quantities due to financial or geopolitical reasons and diversion of LNG cargoes to Asia due to higher prices create tight market conditions pushing up prices. Periodic demand shocks due to extrinsic factors such as the COVID 19 pandemic as well as market related conditions such as coal-generation being more profitable due to coal being displaced from the American energy mix also need monitoring.

European market conditions change rapidly and they need to be monitored. Regulation needs to be flexible and adjustable to these conditions. ACER makes recommendations in order to increase the number of existing gas sources, the security of supply, the appropriate use of storage and LNG, the diversification of upstream supply sources etc. The vision for a liquid spot and forward market is realised and furtherly enhanced with the establishment and increased maturity of the European natural gas hubs (ACER, 2015)

3.3.2 Natural gas pricing and the rise of hubs

Natural gas hubs are trading points and can be either physical, where several pipelines come together or virtual inside a pipeline system. Physical hubs can serve as transaction points for natural gas as well as storage facilities. Virtual hubs are basically trading platforms where a large number of participants can have access. Their main advantage to physical hubs is that all gas that has paid a fee can be traded. In physical hubs, however, only gas physically passing a specific location can be traded.

The establishment of natural gas hubs plays a big role in wholesale trading between natural gas users especially in northwestern Europe. Gas hubs essentially allow gas supply and demand to meet in a marketplace by providing physical and/or financial transaction services through a platform (IENE, 2014).

3.3.3 Gas hub liquidity and the path to maturity

In order for a liberalised wholesale market and a successful trading hub to be created is to ensure that the industrial, residential and commercial sectors are fully liberalised. In this way, suppliers enter into a much needed competition and end-users are encouraged to demand more competitive pricing themselves. The wholesale sector will then, consequently, turn to trading hubs in order to ensure risk management of their portfolios, ultimately leading market suppliers to participate in the trading market through the gas hubs themselves.

Gas contracts used in the trading market tend to be standardised, meaning that terms and conditions are harmonised apart from the price, the delivery period and the quantity. Gas contracts can be traded either bilaterally or on exchanges. Standardisation is essential for a successful hub; It concentrates liquidity, liquidity attracts volumes and volumes attract traders (Heather, 2015).

3.3.4 Gas hub maturity

Liquidity, as mentioned, is essential for a mature, successful gas hub. Adequate liquidity can take however up to 10 or 15 years from the creation of the hub. System operators, suppliers and the governments involved also need to be committed throughout the entire process.

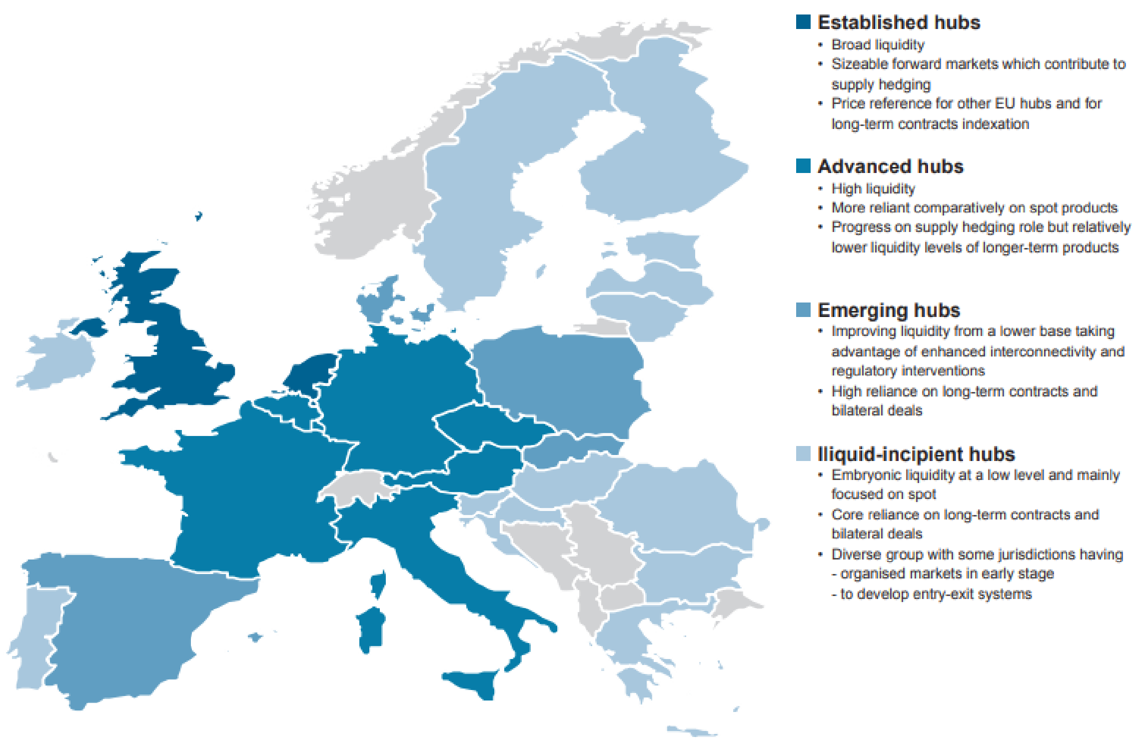
The path to maturity starts with a move to Third Party Access (TPA) to the network infrastructure. Quite often, this requires legislative changes regarding competition, to force incumbents to release gas quantities and capacity to incentivize independent players to enter the market. Bilateral trading, often aided by the first brokers in the market, helps in the creation of trading opportunities between counterparties. Trade reports of these transactions prove to interested parties the beginning of a transparent market. Price discovery entails price disclosure which in turn attracts more parties to the market, usually smaller physical traders at this stage. Some tentative moves by financial players might also be noticed (Heather, 2015).

After the establishment of a natural gas hub, a futures market might be formed. A futures market is essentially a paper market, with no actual expectation that there will be physical delivery of the amount of gas, although any amount can be materialized depending on how the futures market works. The first futures market was introduced by NYMEX in 1990. Henry hub was the underlying physical location for that market. In the NYMEX market, a futures contract will materialize unless the open position is closed before expiration of the contract. Basically, the futures contract represents the linkage between the physical and the financial market. (Fulwood, 2018).

As the market reaches maturity, the forward curve develops for risk management purposes. At the final stage, when there is sufficient liquidity in the hub, traders are able to utilize specific products, such as the Day Ahead (DA) product or the Month Ahead (MA) product, as indices on which to price their physical transactions.

The different levels of hub maturity in the European peninsula are illustrated in figure 2:

Figure 2: Different levels of maturity in European gas hubs



Source: ACER market monitoring, 2017

3.3.5 The possibility of an Asian LNG Hub

Since Asian countries are by definition the largest importers of natural gas, establishing an Asian LNG hub would change the global natural gas pricing system formation mix dramatically. The potential candidates that would develop a gas hub in Asia are China, Japan and Singapore. Considering the most important aspects for the creation of a competitive market, figure 3 illustrates how these 3 countries measure (at present conditions):

Figure 3: Requirements for a competitive market for China, Japan and Singapore

Institutional/Structural Requirement	China	Japan	Singapore
Hands-off government approach	–	–	+/–
Separation of transport and commercial activities	–	+/–	+
Wholesale price deregulation	+/–	+	+
Sufficient network capacity and TPA	–	–	+
Competitive number of market players	+/–	+	–
Involvement of financial institutions	–	+/–	+
Market size	+	+	–

Note: "+" means currently contributing towards a competitive natural gas market, "–" means currently not contributing toward a competitive natural gas market, "+–"means that it is currently unclear

Source: *Fulwood, 2018*

Both China and Japan are large markets. China has diversified their supply from its own production, pipeline imports and LNG imports. Japan is totally reliant on LNG imports in this matter; however, this does not necessarily present an unsurpassable obstacle. Both countries have started deregulation of their markets (Japan is ahead in this aspect) but both have a long way to go in terms of separation of transport and commercial activities and introducing regulated TPA. Political will is essential in these countries to progress the development of an LNG hub.

Singapore on the other hand hosts a liberalized and competitive market. However, it lacks a large number of buyers and sellers; the volumes traded are simply not enough for liquidity to emerge and the hub to be successful (Fulwood, 2018).

As mentioned above, churn rate is highly important to measure the liquidity of a gas hub. Churn rates for Henry Hub and TTF are 53.7 and 16.7 respectively for physical and future trades together. The equivalent churn rate for JKM as of 2020 was calculated at 0.2, rendering the market as highly illiquid (CRA, 2019).

LNG suffers from significant disadvantages regarding multiple trading of the same molecules of gas. The size of LNG cargoes and the uneven schedule of cargo deliveries is an important factor.; pipeline gas deliveries are continuous and “almost” instantaneous. The distances of ports due to the vast size of the Asia Pacific Market result in price uncertainties. Variations in the quality of the LNG cargoes can affect the comparability be reported at different times and locations. Pipelines, also, maintain calorific standards through chromatographers at their entry points, effectively addressing this problem. Last but not least, the pipeline hubs have a geographic location within their system that allows delivery of the gas if parties decide so. It is unclear whether Asia Pacific has such a geographic location where traded LNG there would automatically default to delivery if the parties wished to do so.

In theory, an LNG cargo could be sold and bought, while en route, which would create a churn of two (if this happened once). In order to reach a churn of 16-20, as is the norm in NBP and TTF, this would need to happen as many times and for all the LNG cargoes. This would not be realistic and credible. Concluding, creation of a liquid LNG hub in Asia would face many obstacles, minor or major (Fulwood, 2018).

3.3.6 Natural gas pricing

Natural gas pricing presents different types of formations. The International Gas Union concluded that wholesale gas pricing mechanisms can be categorized as summarized below (IGU, 2020):

Oil Price Escalation (OPE) or otherwise known as Oil-Indexation
The price is usually linked through a base price and an escalation clause to competing fuels, typically crude oil (Brent price), gas oil and/or fuel oil. Less often, coal and electricity prices might be used.

Gas-on-Gas Competition (GOG) or otherwise known as Gas Hub-Pricing
The price, in this case, is determined by the interplay of supply and demand and can be traded over different periods (daily, monthly, quarterly or annually). Trading can take place at physical hubs, like Henry Hub (U.S) or notional hubs, like Title Transfer Facility (TTF) in the Netherlands. Future markets (e.g NYMEX or ICE) are likely to be developed. Gas which is sold long-term is traded through contracts that use monthly gas indices for the final determination of the price, rather than competing fuel indices. Spot LNG cargoes are also usually nowadays priced through Gas Hub indices.

Bilateral Monopoly (BIM)
In this case, the price is determined by a bilateral agreement between a large seller and a larger buyer (often Government or state-owned company level). The price is fixed for a period of time; typically, one year. Either the buyer or the seller are going to be a dominant

force in the market to distinguish this category from GOG, where multiple players are trading bilaterally.

Netback from Final Product (NET)
The price is calculated as a function of the price received by the buyer for the final product they produce. This price formation category is mostly used in cases where gas is used as a feedstock in chemical plants, such as methanol or ammonia.

Regulation: Cost of Service (RCS)
The price is determined formally by a regulatory authority (or even a Ministry) and it is set at a level to cover the "cost of service", including the recovery of investment and/or a reasonable rate of return.

Regulation: Social and Political (RSP)
The price is set, usually by a Ministry and on an irregular basis, on political/social grounds, in response to increasing costs or as a revenue raising test.

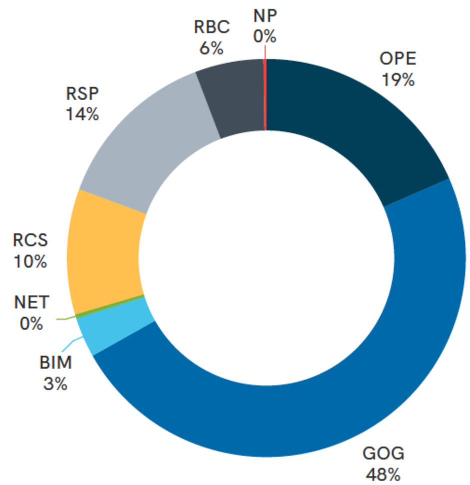
Regulation: Below Cost (RBC)
The price is set, knowingly, below average cost of producing and transporting natural gas, as a way to subsidize the people.

No Price (NP)
The gas is either provided free to the people and industry, usually as a feedstock for chemical and fertilizer plants, refinery processes or enhanced oil recovery. That gas can sometimes be associated with oil or liquids and be treated as a by-product.

Not Known
No data or evidence.

Figure 4 depicts the 2019 data for total consumption and the share of each price formation.

Figure 4: World Price Formation 2019 - Total Consumption



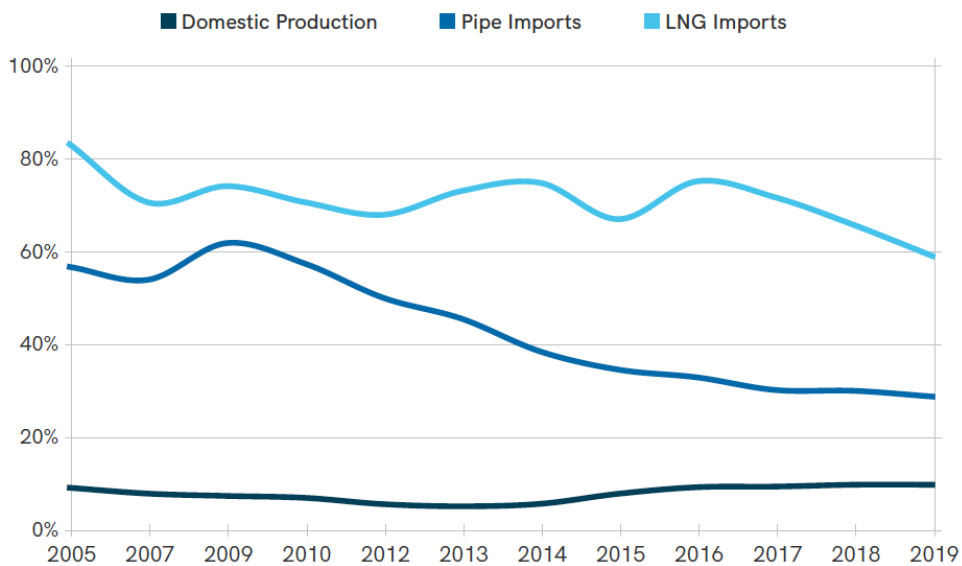
Source: IGU, 2020

However, not all of these categories are used broadly. OPE, GOG, BIM and NET are considered “market” pricing categories and are of higher importance in order to understand global gas pricing in general. RCS, RSP, RBC and NP are a form of “regulated” pricing which is more regional and for different purposes.

As pipeline imports are dominated by GOG and OPE (with a small margin on BIM) and LNG imports include only GOG and OPE pricing, global research focuses on the parameters affecting these two categories. These two competing mechanisms have sparked a large debate among market experts and academia over which one represents gas markets in a more accurate way.

Oil indexation (OPE) is a well-established pricing method that began back in the 1960’s in the Netherlands. However, as oil-indexation pricing is not accurate, due to the fact that crude oil is not the perfect substitute for natural gas, the percentage of oil-indexed quantities consumed and imported through pipeline or as LNG, has dropped in the last few years as illustrated in figure 5.

Figure 5: Changes in Oil-Indexation by consumption category 2005-2019



Source: IGU, 2020

When it comes to LNG, oil-indexation is still more relevant compared to pipeline imports for a number of reasons. LNG has historically relied on long-term, oil indexed contracts in order to secure essential funding for financial intensive projects and supply. For the Asia markets specifically, LNG has traditionally been priced based on the average of a basket of crude oil imports known as the Japanese Customs-cleared Crude (JCC) price. The JCC price presents, typically, a one-month lag from the Brent barrel price. This lag varies depending on the contract terms. The rationale behind the averaging of these Brent prices is to smooth out price spikes that are intrinsic to the oil-market (Till et al, 2020).

The contractual formula used for LNG pricing in Asian countries is presented below:

$$P_{LNG} = a + b*P_{crude} \quad (18)$$

Where:

P_{LNG} is the LNG price in $/MMBtu
P_{crude} is the benchmark crude oil price in $/bbl.
a includes the cost of a premium agreed in the negotiations, a freight rate and a constant term
b is the slope negotiated by the buyer and the seller presented as a percentage

However, oil-indexation has been deemed, as mentioned, problematic in many cases and for various reasons. This view is also backed by recent evidence provided by the drastic impact of the pandemic on energy prices. The effects of the embedded lagged oil price magnify in a volatile environment. The residual of this shock on the energy prices will appear after several months in a market with very different conditions at the time.
The decoupling of oil and gas prices in European markets (in the beginning of the past decade) mostly makes another important topic as to why oil-indexation is becoming less of a trend in European contracts. (Till et al, 2020) A supply surplus and a weakened demand triggered the decoupling in 2009-2010. Oil-linked contracts were highly dominant in 2010 and therefore their influence remained for the next few years. As shown in figure 6, oil indexed and NBP spot prices diverged significantly in the early 2010's, only to diverge in 2014 after oil prices shockingly collapsed. (Fulwood, 2019)

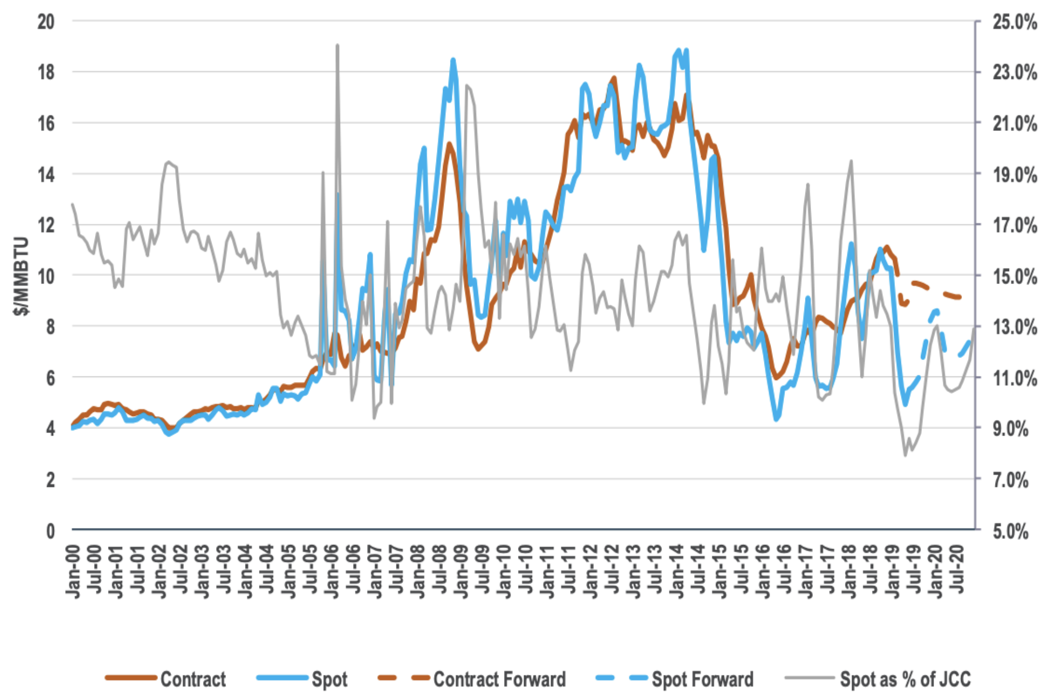
Figure 6: European oil-linked and spot prices.

Source: Fullwood, 2019.

The NBP price presents a higher volatility due to reflecting seasonality demand conditions and periodic disruptions in the supply chain.

Although oil and gas price decoupling plays a role in the European continent for the adoption of gas-hub pricing mechanisms in recent contracts, this is not the case for Asia. As figure 7 shows, there has been no systematic decoupling for oil and gas prices in Japan, a major Asian importer. This is related to the lack of diversification of natural gas supply through pipelines (Japan, Korea and Taiwan markets are solely dependent on LNG) as well as the lack of domestic production.

Figure 7: Japan contract and spot prices



Source: Fullwood, 2019

As there are no liquid hubs or similar market conditions that pushed the European market to the decoupling of oil and gas prices, Asian markets have less incentive to move to gas hub pricing. However, a decoupling can be witnessed in figure 7 in the early 2019 due to a sharp fall in the spot market price. (Fulwood, 2019)

An analysis on the German gas market with a VAR approach back in 2014 by Sebastian Nick and Stefan Thoenes propose that storage, temperature and supply shocks were temporary whereas coil and oil price shocks had a long lasting effect on gas prices (Nick et al, 2014) This is an important observation in order to assess the importance of oil and gas price decoupling.

Even though oil-indexed LNG contracts make less sense with decoupling of oil and gas prices, due to limited alternatives it will remain relevant; just at a lower oil slope. As buyers seek to manage risk on their portfolios, hybrid pricing will become even more relevant. However, recent volatility in LNG spot prices due to a rapid increase in demand in Asia after a prolonged cold snap, has shown that oil-indexed contracts are still not out of the equation. Recent enquiries from buyers for long-term contracts there, have seen oil-indexation as the most secure way to protect their portfolios as there are no uniform global gas prices to hedge against. Industrial experts suggest that long-term term contracts indexed against JKM will need to have a price ceiling in order to be even more competitive (Jaganathan, 2021).

Volatility of hub prices, however, is not the only problem that can appear. As gas shippers used to book their cross-border capacity on a long-term basis, following the rapid decline in demand in 2008, it left them with a substantial spare. These over-bookings were considered sunk costs, leading to low price spreads between the European gas hubs, and a convergence of wholesale prices. Since then, gas shippers have tried to adjust their strategy by relying more and more on short-term cross-border capacity in order to minimize their exposure. This is likely to open the spread between the European gas hubs even further leading, ultimately, to a fragmented northwest European gas market. In this event, midstream companies would benefit as they can recover their costs from cross border capacity bookings, whereas final users would face significant increases in the gas prices paid. This event would challenge the whole idea between a unified European gas market that has been the final goal of the European Gas Target Model (Zimmer et al, 2019).

3.3.7 Natural Gas Market Fundamentals

In order to understand how natural gas/LNG markets function and how prices are formed, a holistic approach is essential. Arguably, the most important parameters affecting natural gas/LNG markets are (EIA, 2020):

- Natural Gas production
- Natural Gas storage levels
- Winter/Summer seasonality
- Economic Growth
- Competition with other fuels
- Geopolitical matters
- Emissions Trading Scheme (currently for Europe)

The interconnection of some of these parameters renders the analysis of the markets often very complicated. It is therefore prudent to first examine each one separately.

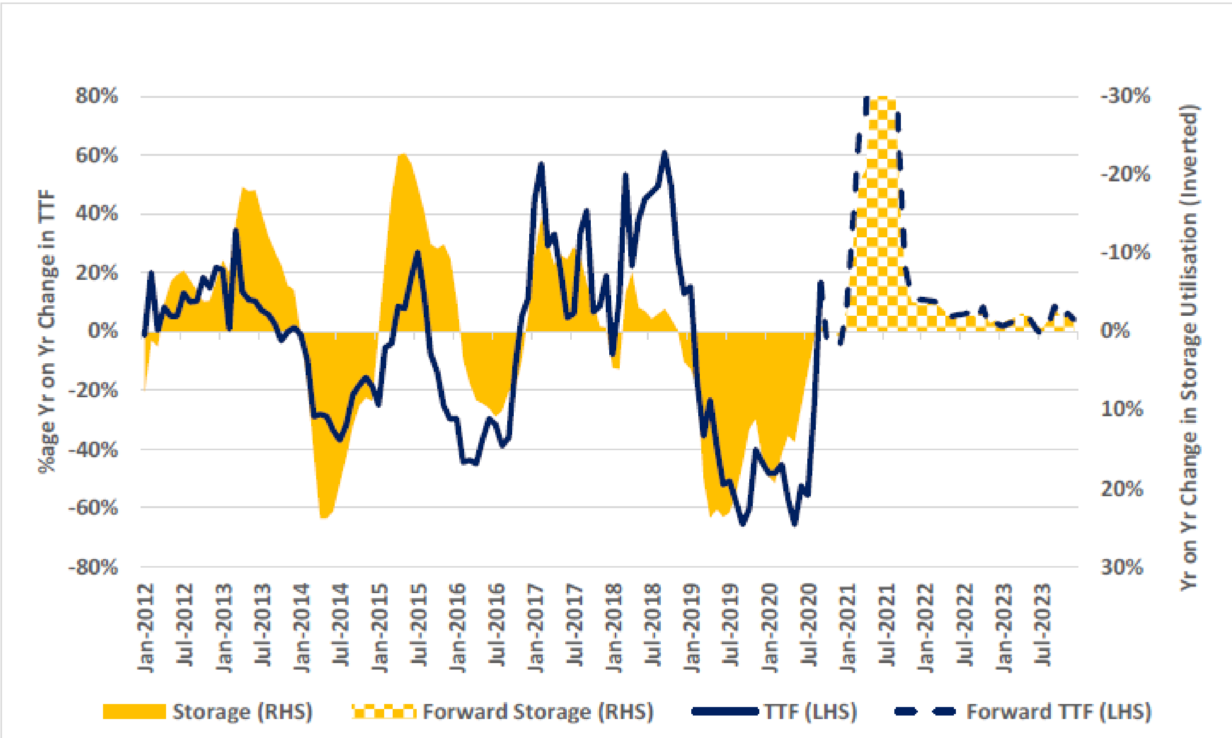
Natural gas supply and demand

As every commodity, natural gas is following the rule of supply and demand. Adequate levels of production are necessary in order to keep the supply up in high demand periods. As countries worldwide move to a post pandemic era, natural gas is establishing itself as the bridging fuel to a net zero carbon emissions scenario in the next decades. Therefore, demand forecasts are constantly revised, as natural gas and LNG are both taking part in new sectors but also replaced by clean, renewable energy in other sectors.

Natural gas storage levels

Natural Gas storage levels is one of the most important parameters affecting natural gas/LNG prices and is directly connected to seasonality. Regarding storage levels, summer is the injection period, as natural gas demand decreases. On the other hand, due to high demand from residential users for heating, winter is the withdrawal period. Natural gas storage facilities offer flexibility to balance supply and demand annually. (CME Group, no date) Historically, a strong correlation between YoY (year-on-year) change in the TTF European gas price and the YoY change in the storage utilisation can be observed. Although, statistically, this correlation does not imply causality, both factors seem to be influenced by the same laws of supply and demand. Figure 8 indicates that, whether one can estimate the outcome for either the storage utilization or the TTF gas price, then they can make a reasonably accurate prediction for the other. (Henderson, 2020)

Figure 8: YoY change in storage utilization and TTF gas price



Source: Henderson, 2021

However, the flexibility to store excessive natural gas and pump it when the market needs it comes with a price. The actual value of gas storage can often be really complicated. The main cost drivers for its value are (Bolyard, 2019):

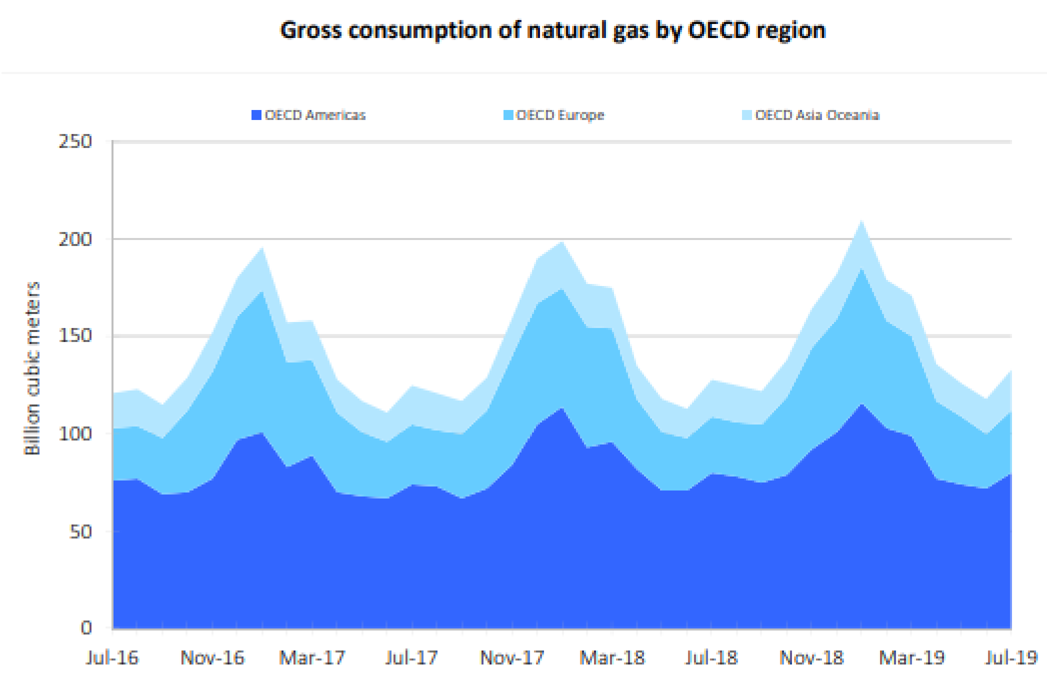
a) The type of storage facility. Salt cavern storage facilities have, for example, higher injection and withdrawal capabilities than deplete well storage facilities. This potential enables users to take advantage of short-term price opportunities while also cutting the fixed cost of owning the storage facility every time the cycle storage is cycled.

b) Market conditions. The market's perception of whether the storage facilities can be filled through the summer and whether there is enough inventory to make it through the winter plays a significant role in storage evaluation.

c) Storage service type (firm vs interruptible). The availability of some storage facilities during peak demand periods (firm) render them more expensive than storage facilities available only in periods of less total demand (interruptible).
d) Market access. The ability to pump stored quantities to a highly volatile and highly priced market during high demand periods maximizes the value of the inventory. The value of storage facilities regarding market access is enhanced by the introduction of new pipeline systems.

Winter/Summer seasonality is a major component defining natural gas prices. Winter season can be called the period roughly between November to March. Summer season, on the other hand, generally ranges from April to October. Natural gas is broadly used for heating during the winter season by residential end-users, the industrial sector and utilities. (CME Group, no date) Figure 9 illustrates the gross consumption of natural gas by OECD region from July 2016 to July 2019. Evidently, peak demand appears right after November each year and before March.

Figure 9: Gross consumption of natural gas by OECD region



Source: IEA, 2019

Economic growth

Economic growth and energy demand are connected. As economies grow, the demand for energy (and therefore natural gas) is increasing. However, as energy efficiency technologies are implemented at an increasing pace, a decoupling of the rates of economic growth and energy demand is witnessed (Sharma, 2019). The bullish trend of carbon markets is not only promoting cleaner energy sources but also higher efficiency methods in fossil fuel utilization. This trend directly affects the decoupling of economic growth and energy demand.

Competition with other fuels

Competition with other fuels can either increase or decrease the demand and therefore price of natural gas. Power plants, steel, iron and paper mills can switch between coal, petroleum and natural gas. The choice of the fuel depends on the relevant price of each specific market. (EIA, 2020)

Geopolitical matters

Geopolitics play a significant role in the energy sector. In order to increase their global or regional influence, the great powers have always tried to control energy trading among other sectors. The complicated relationship between these powers and the global arena is discussed in detail.

The EU Emissions Trading Scheme

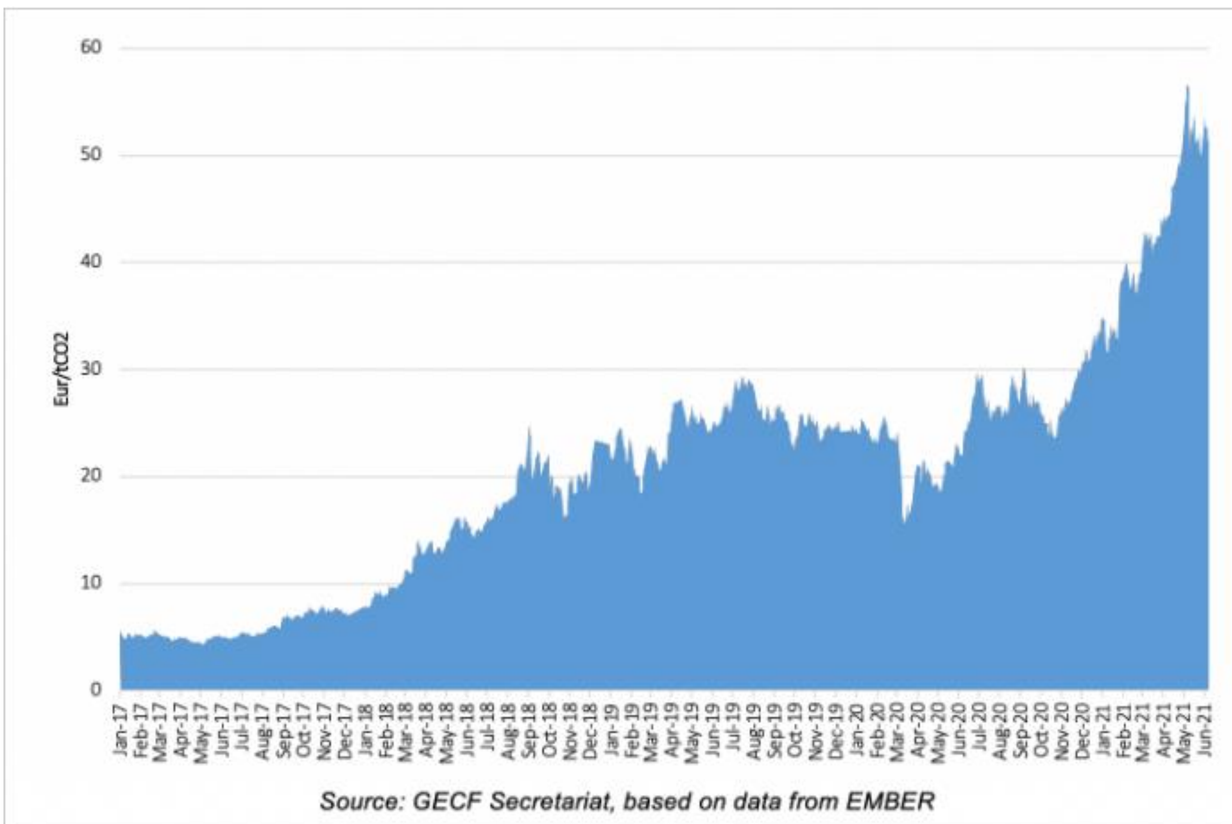
The EU emissions Trading Scheme (EU ETS) is the cornerstone of EU policy to deal with climate change and its most important tool for reducing greenhouse-gas emissions in a cost effective manner. It operates in all EU countries plus Norway, Liechtenstein, Iceland and covers around 40% of Europe's greenhouse gas emissions. The trading system is constantly revised in order to meet new, ambitious goals set by the EU commission, the latest being climate neutrality by 2050, including an intermediate target of an at least 55% reduction in greenhouse gas emissions by 2030. As the EU ETS covers sectors concerning the use of natural gas, such as electricity or heat generation and other energy intensive industries utilising natural gas as feedstock (e.g. aluminium industry), natural gas prices are affected as a consequence (European Commision, 2021)

The EU ETS operates on the principle of a "cap and trade" system. The cap is set as the total amount of greenhouse gas emissions that can be emitted within the system.

Participants need a sufficient amount of allowances to cover their total emissions annually or they are subjected to heavy fines. The rest of the allowances can be traded to other participants.

Carbon prices in the EU have seen a notable increase in the last few years (see figure 10). They averaged 16€/tCO_2 in 2018 and €25/tCO2 in 2019, increasing by 57%. The COVID-19 pandemic caused the carbon allowance prices to drop sharply, due to a massive decrease in electricity demand. A harsh 2020/2021 winter with lower than average temperature (especially in Asia) and a change in climate policies forced carbon prices to record highs in May 2021 (above 50€/tCO_2 on average) soaring above €56/tCO2 on May 14 (Singh, 2021)

Figure 10: Evolution of carbon prices in the EU



Source: Singh, 2021

3.4 Conclusion

Natural gas markets present high complexity in many aspects. The microeconomic profile can be similar to other commodities; however, its approach is completely different. Natural gas hubs are established in the US and Europe, providing market liquidity in their mature form. An Asian gas hub is also an interesting prospect facing, however, various difficulties. The market fundamentals governing its pricing have different values depending on each regional market. Pricing formations are also constantly changing their global share, depending on the evolution of gas hubs in different regions.

4. Geopolitics of natural gas

4.1 Introduction

Geopolitical relations and domestic politics influence natural gas markets massively. International disputes can lead to pipeline disruptions, either from the seller or even from transit states who wish to pursue their own political goals. The emerging LNG markets offer a solution to states who are highly dependent on pipeline imports and wish to diversify their energy imports so that they can increase their energy security.

4.2 Pipeline geopolitics and the LNG solution

Natural gas has been branded as a politicized commodity by several academic studies. Disruption of supply can cripple the economy of a state and have devastating effects on its citizens. In many cases, states integrate energy policy into foreign policy making and institutions in order to prevent these types of problems. The nature of the natural gas market (pipeline system) renders supply much more susceptible to disruption than oil or coal. LNG trading, until recently, offered small flexibility as its infrastructure is much less standardized compared to oil. LNG vessels are also less flexible than the equivalent oil tankers. Natural gas is usually traded through long-term supply contracts, creating long-term linkages and infrastructure between the buyer and the seller. These long-term relationships as well as the form of infrastructure related to the transportation (permanent pipeline systems) enable politics to come into play much easier than they can in the trading of oil.

These long-term gas supply relationships present a variety of degrees of stability. Some relationships between states never experience difficulties and therefore supply disruption from buyers to sellers, while other relationships are much more unstable and prone to supply disruptions.

These long-term agreements between host and transit state governments owe their existence to the nature of the infrastructure; the capital cost needed for both pipeline and LNG storage/ regasification infrastructure is extremely high and in order for the investment to be profitable, several years of production and exportation are needed. States also play a big role as they need to approve installations and routes and, quite often, especially in the case of countries with high criminality, provide security on the facilities. Additionally, the majority of the world's exported gas volumes are controlled by state companies and, therefore, states are actively involved in natural gas trading more than any other commodity.

Political and economic relations between states affect foreign policies related to supply disruptions. Approximately a third of the pipeline infrastructure is between states that share high political and strategic cooperation (UK-Norway and US-Canada, for example). These supply relationships rarely experience foreign policy related supply disruptions (Egypt-Jordan disruptions in 2011). However, even countries of opposing alliances can maintain a healthy supply relationship, such as Russia and Germany. Supply arrangements involving transit states are the ones most prone to disruptions. Transit states have the most incentive and the least risk to cause supply disturbances in order to promote their own economic and political agendas. Generally, natural gas disruption events are rare as continuity benefits both the supplier and the consumer in the long term. However, due to domestic political agendas or personal financial benefit certain actors of the state or a private company involved choose to disturb supply. (Shaffer, 2013)

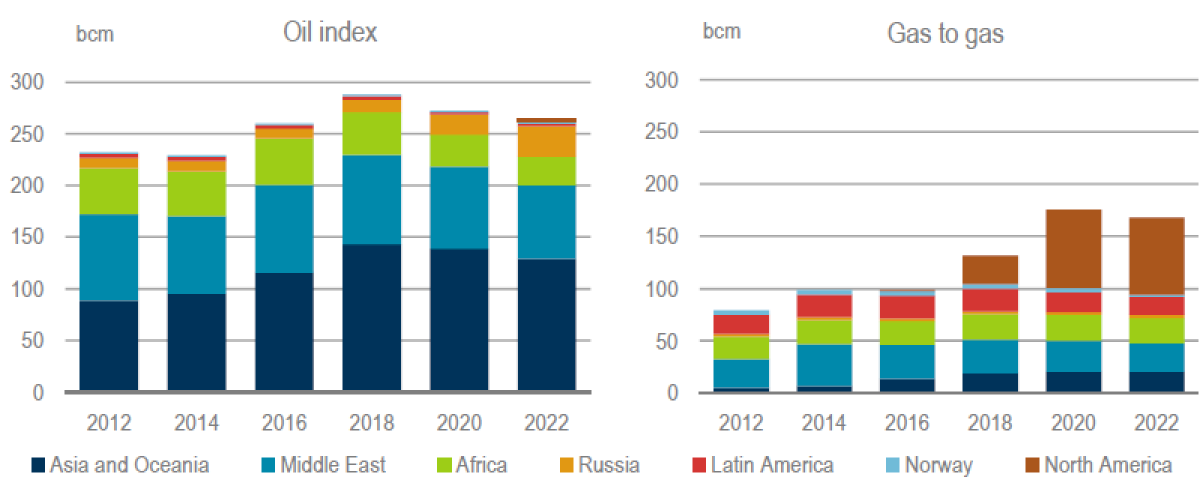
As states globally strive for energy independence, natural gas producers seek to monopolize the market. Europe seeks to reduce its dependence from Russian natural gas which has so far been ineffective. The recent reluctance of Gazprom to book a small transit capacity at both the Yamal pipeline and no extra transit capacity via Ukraine, pushing TTF prices up and causing a havoc in the European gas market is a fine example of how geopolitical motives affect the energy markets and, more specifically, the natural gas market. (Marrow et al, 2021) Russia has been officially accused by EU politicians to deliberately withhold important gas supplies in order to pressure regulatory approval for its new, controversial pipeline project, Nord Stream 2. Russia, on the other hand, responds that their contractual obligations are fulfilled and deny any allegations related to intentional manipulation of natural gas pricing. (Ambrose, 2021) However, with the rapid increase of natural gas traded as LNG, several states globally as well as the whole of the European Union have managed to diversify, up to a certain degree, their natural gas portfolio. As LNG demand is set to increase at a healthy rate in both reference and accelerated (rapid decarbonization) scenarios up until 2050, it is important to look at its effect on certain geopolitical relations. (McKinsey, 2021)

The East Med pipeline is currently one of the most important projects involving several counterparties and interests. The context surrounding the project has massively changed in the last few years in terms of the geopolitics related, the gas market fundamentals, the market and pricing structure and the problems the oil and gas industry and utilities face. The idea behind East Med was mostly the diversification of energy supply for South-East Europe where Russian gas supply is dominant. Both the EU capital and the US were positive of the project in order to weaken Russian influence.
However, for several reasons such as the accelerated energy transition and the persisting national disputes, the project is in high danger of falling apart. First of all, the fields associated with the project seem to have low confirmed quantities and high production costs. As the project is estimated to cost well over 6$ billion and the European natural gas forecast is set to decline in the long run due to decarbonization policies, the viability of the project is questioned. In addition, with the discovery of the giant Zohr field, Egypt became a major energy player in the area, able to export massive LNG quantities. The competition between these two projects would be huge, as the flexibility and competitive prices of the Egyptian LNG would be more attractive than the fixed, European-only East-Med supply. Geopolitical constraints in this matter are equally complicated. Turkey is opposing both exploration activities from Cyprus considering them illegal, as well as export projects such as the East Med. Their goal is to remain the connecting gas corridor between Europe and Asia and East Med would undermine this position. In this context, Ankara signed a maritime border with Libya's government in order to prevent the development of the pipeline. Considering also the fact that Russia entered the East Med saga by acquiring 30% interest in the Shourouk Concession off Egypt's shore, where the Zohr field is located, the geopolitical importance of the project for Europe declines (as Russia can influence the LNG exports targeted to East Med potential consumers and therefore their market share will not be decreased substantially) and its value remains regional due to the proximity of the fields (Fatouh, 2019 and Raimondi, 2020).

4.3 LNG and geopolitics

Security of supply and energy independence is crucial for nations and LNG trading plays an important role in this matter. The US seeks to increase their market share in Europe against Russian gas and therefore their geopolitical influence in the continent. In this context, the “shale revolution” (a combination of hydraulic fracturing and horizontal drilling, enabling the US to ramp up their oil and gas production significantly), has increased the US bargaining power as they can now offer a real competitive alternative to Russian natural gas. With the increase in liquidity and volume on Henry Hub, the US utilize it not only as a domestic pricing benchmark but also as a benchmark for their export sales, often giving them an advantage over more expensive oil-indexed contracts. Figure 11 illustrates the change in pricing formation for export contract volumes from 2012 to 2022.

Figure 11: LNG export contract volumes with oil index and gas to gas, 2012-22



Source: IEA, 2019

The LNG export sales tied to Henry Hub average spot market prices have reduced buyer exposure to price volatility events while they also decouple from geopolitically driven inflation in oil prices (Energy Realpolitik, 2019). The US was the highest exporter in the first quarter of 2021 in Europe with 24% of the overall European LNG imports with Russia being second at 21% (Szymczak, 2021).

Europe is currently the largest natural gas importer ahead of China. However, for various reasons, China is projected to overtake Europe in the next years or decades. Europe seeks to decarbonize its energy mix and therefore there is not going to be an excessive increase in its natural gas demand. On the other hand, China, who is actively trying to

switch from coal to gas and due to its huge size of economy, is expected to increase its gas demand dramatically. China's rise as an important LNG importer is backed by policies to improve air quality in its cities. In this context, the demand for natural gas and LNG for both the industrial and the residential sector will increase significantly (IEA, 2019)
China, who is currently mainly importing natural gas from Kazakhstan, Myanmar and (more recently) Russia, are constructing huge LNG installations in its coast expecting its volumes to be increased significantly in the next few years. The the US are also projected to rapidly increase their natural gas production and more importantly exports, with many FID's in the materialization stage and many regasification plants turned to liquefaction plants to serve this purpose. The US is going to be much more competitive to their export rivals, Australia and Qatar. In this framework, as China is going to diversify its import sources for security of supply purposes, the trade and geopolitical relations between US and China are going to be renegotiated (Hafner, 2020).

The Asian LNG market can also affect the geopolitical relations and imports of Europe as well. Asian LNG markets had drawn spot LNG cargoes away from European LNG terminals in January 2021 by offering high premiums which, in turn, caused a strong spike in TTF and other European hubs. Europe had to double the Algerian pipeline gas imports at the same period, as the oil-indexed gas was far more competitive at that time (Szymczak, 2021). Even though this is not a frequent event (last happened in 2018) it can show how gas dependence can shift geopolitical alliances.

The LNG financial entrance barrier is high and therefore there is high industry concentration. The development and construction of these projects needs at least 4-5 years and the facilities need to be operational at least 20 years in order for them to make the investment worthwhile, a lot of high level of market planning and analysis takes place. In this context, countries that are able to affect both the market and also increase their geopolitical influence through LNG trading are also limited. (Paltsev, 2015)

4.3 Conclusion

Geopolitical relations and political agendas are highly important for natural gas markets globally. Natural gas transported through pipelines presents inelasticity due to the long-term nature of the relevant contracts while it is also prone to disruption either by the supply state or by transit states. On the other hand, LNG trading provides the buyer with higher flexibility in many aspects and security on their energy needs.

5. Natural Gas and LNG trends and projections

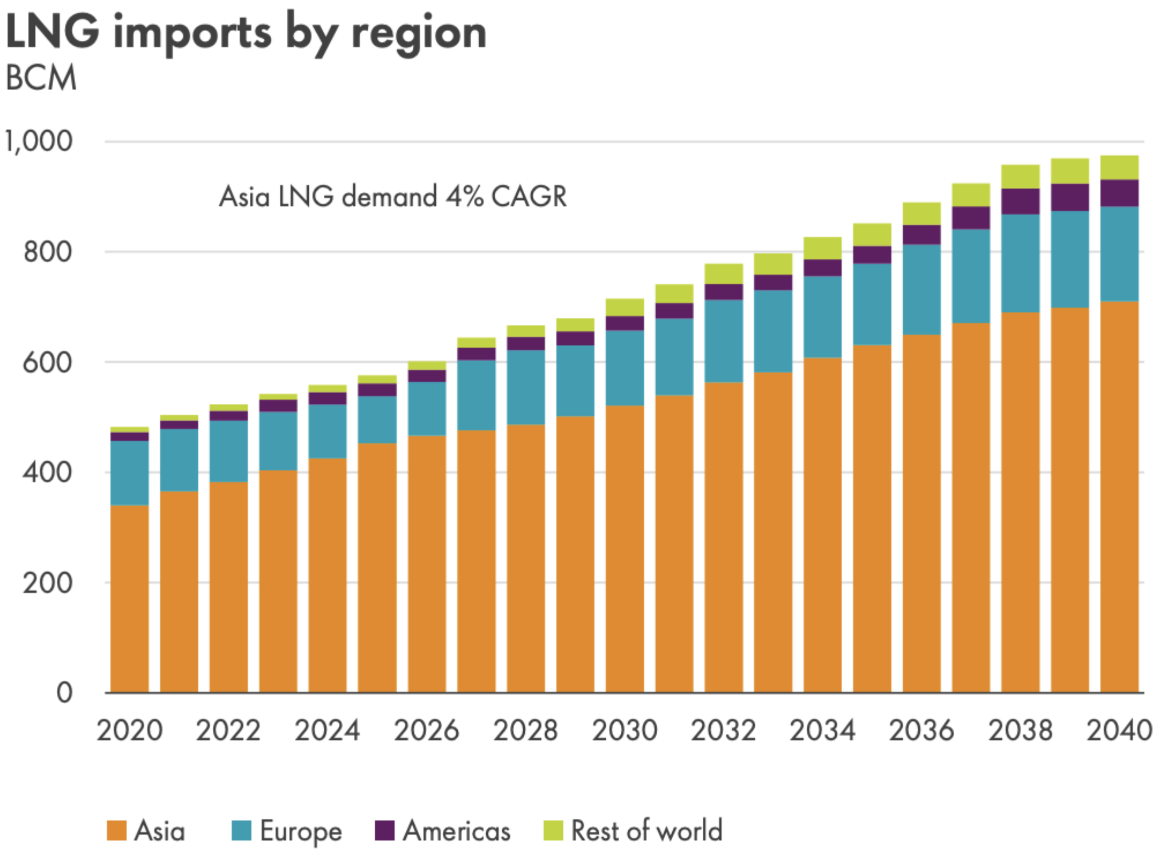
As the energy transition has accelerated and states are looking for alternatives to conventional energy sources, it is important to assess the role of natural gas in this transition. Even though several states such as Japan (Power Technology, 2021) have pledged to reduce natural gas use and increase the share of renewables in their energy mix, there have been a lot of voices calling a unanimous reduction of fossil fuels at an accelerated pace unrealistic. Some experts believe that a rapid phasing out of fossil fuels could destabilize power grids and energy supply. They also insist that the net-zero scenarios proposed should have a more differentiated approach for developed and developing countries.

In the same context, various studies indicate that natural gas, and especially LNG, will remain resilient in the net-zero scenario. In some projections, natural gas is going to outlast the other fossil fuels for another 5 to 10 years, as it is the cleanest of them. More analytically, some reasons contributing to the resilience of natural gas are (McKinsey, 2021):

1) Lower carbon intensity and lower particulate emissions. Both coal and oil generate higher emissions per unit of energy before and during combustion.
2) Low gas prices in some key global markets. Considering normal conditions, the cost of gas in key markets is lower than the other fossil fuels, allowing it to maintain a high percentage of the energy share in the power sector.
3) Rapid increase in the energy demand in Asia. Asia is facing a rapid increase in industrial and power-sector demand. Power-sector increase in demand will require a lot of coal-to-gas switching and therefore will need additional quantities.
4) Substantial share of natural gas demand from high heat intensity applications. Chemicals, along with other industrial sectors, will account for approximately 50% of natural gas demand growth until 2035.

Generally, LNG will remain more resilient than natural gas in total. As it remains the only feasible way to reach energy-starving markets with limited pipeline infrastructure as well as markets in south and south-east Asia where domestic production shows a decline, LNG can be expected to see continued growth until around the mid 2040’s. Figure 12 shows the LNG imports by region until 2040.

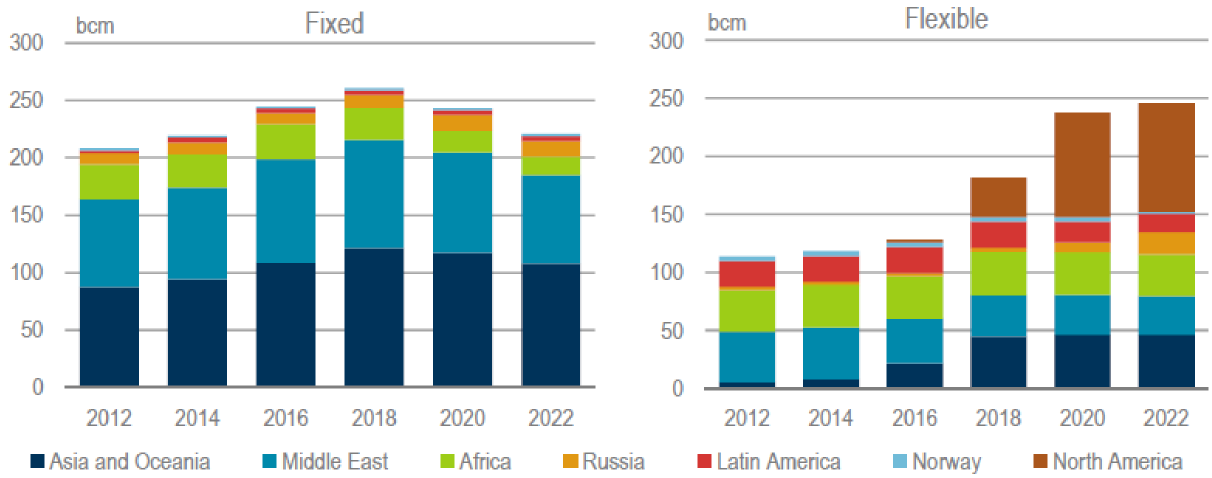
Figure 12: LNG imports by region until 2040



Source: Shell, 2021

On the supply side, LNG market flexibility will increase notably as most US contracts are not restricted to a fixed destination for primary buyers. Flexible volumes delivered have grown but remained rather constant as a share of total volume. However, this is going to change rapidly. Figure 13 depicts the significant increase of flexible volumes vs fixed volumes that were exported and are about to be exported.

Figure 13: LNG export contract volumes, 2012-22



Source: IEA, 2019

Oil price recovery makes Henry Hub-based LNG more attractive as the oil-indexed LNG prices increase. Another advantage is that US developers, such as Cheniere, are rapidly developing modular LNG which allows them to respond to market changes extremely fast. Also, unlike other huge projects elsewhere in the world, there is no upstream component in the US projects, as the natural gas is sourced from the market. Processing and liquefaction are utility-like assets, which offer insufficient returns to the supermajors. Infrastructure investors are, however, interested. Some of these investors have been observed to move down the supply chain to LNG-to-power, LNG shipping and modular LNG distribution.

Russia decided to take more concrete action with respect to LNG. A presidential executive order in 2017 to Gazprom to sell at below-regulated price to LNG export projects, increased the competitiveness of Russian LNG in global markets. Gazprom also demonstrated its will to enter competition with US, Australia and Qatar with the announcement that the schedule for developing the supergiant gas field Bovanenkovskoye will potentially feed LNG projects. (EIA, 2019). Russia plans to utilise the now navigable Northern Sea Route (NSR), proving that year-round trips are possible and taking advantage of the fact that an NSR trip would need half the time for an LNG ship to reach Asia from Yamal fields than it would take from the Suez Canal. This way, along with new pipeline deals signed in 2021 with China, Russia tries to increase their ties to the Asian Market (Szymczak, 2021).
Russia's natural gas strategy, however, is not only commanded by its geopolitical aspirations but also by certain financial aspects. Gazprom has been the market balancer for European supply and demand gas for decades. However, the extreme conditions of

2020, namely a sharp fall in demand due to the pandemic and a windy, warm winter has forced Gazprom to accommodate the supply glut in Europe caused by the rising, cheap LNG imports. These LNG imports were owed to investment decisions taken in the mid 2010's, filling European gas storages to record levels. Gazprom, on their part, refrained themselves from entering a price war and reduced their overall production. Taking into account that due to global changes in the gas market and the emergence of hub-pricing, Gazprom now also needs to take upfront price risk as well. Another important factor that needs to be considered is the irreversible decline at Russia's mega Nadym Pur Taz (NPT) fields utilized by their Central and Southern transportation corridors to Europe. With the development of the new Yamal fields and the supply of the Northern Corridor, overall natural gas transportation from the middle corridor is going to be reduced. Pipelines from the central corridor are also going to be decommissioned in line with the reduction of production from the legacy NPT fields as Gazprom announced. Gazprom's ability to redirect natural gas from the Northern to the Central corridor and Ukraine is absent during the winter (no available booking pipeline capacity) and not viable in the summer due to high transportation costs through this route. Considering the fact that Russia is trying to optimize their transportation costs by developing fields which are closer to the intended market, it is evident that certain decisions (such as reducing natural gas passed through Ukraine) are not only driven by geopolitical motives but also financial ones. In this context, the future flows of Russian natural gas through pipelines are going to be closely related with the production fields used, the distance to the target market and the relevant transportation costs. (Yermakov, 2021)

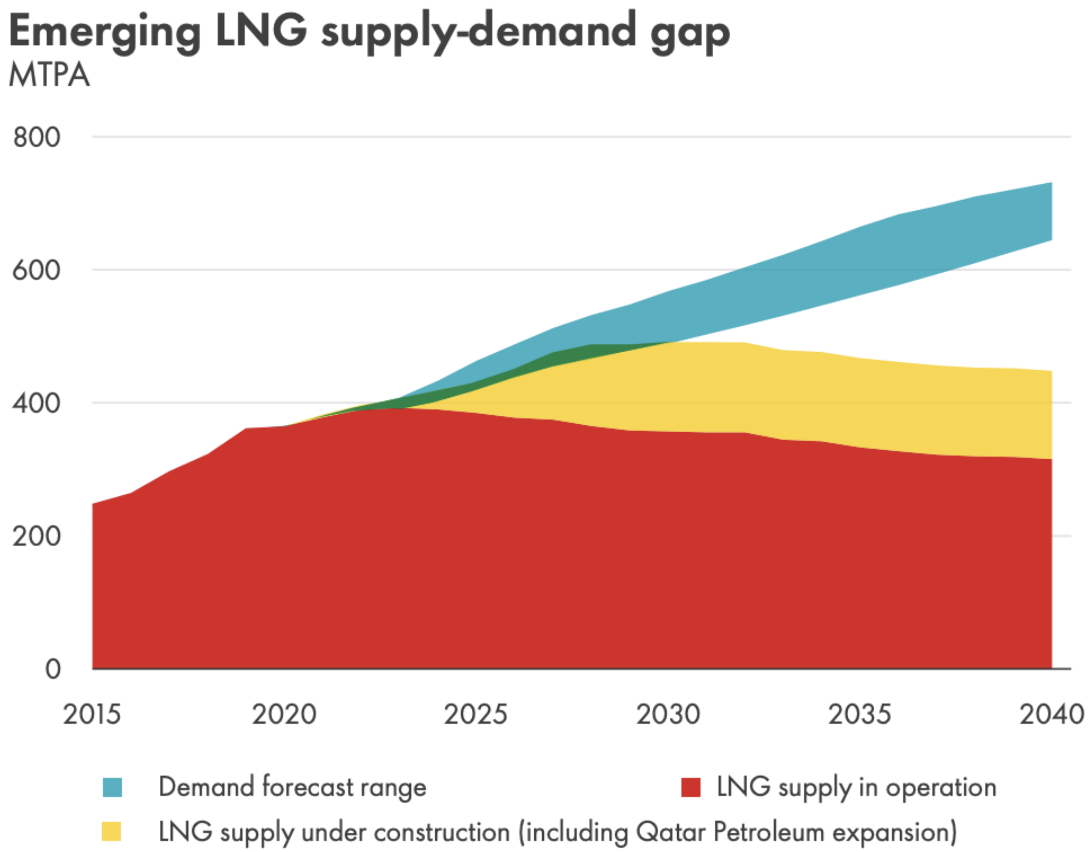
Some analysts believe that there might be a deficit by 2029 due to certain delays in infrastructure. Indefinite suspension in Totals Mozambique ambitious LNG project due to militancy escalation forcing the company to declare a force majeure, as well as a delay of Exxon Mobil to take a final investment in its Rovuma LNG project in the same area, could force buyers to other sources of energy between 2025-2027.
(Evans, 2021)
Qatar has made an ambitious plan with the development of the $30 billion North field expansion project. The original plan is to grow its LNG by 40% to 110 million tons per annum (mtpa) by 2026, reestablishing itself as the undisputed world leading exporter of LNG. Qatar looks to partner with any interested supermajors in order to be able to sell any excess in the quantities produced, while the supermajors are also very interested themselves, even with lower returns, due to a low risk from a resource perspective.
(Bousso, 2021)

Qatar's infrastructure, distribution network (Qatargas signed contracts for as many as 100 new-build, LNG tankers that use LNG as a fuel) and strategic partner alignments (notably Russia) have alarmed high-cost producer competitors, especially those shipping from

Australia and North America, that their projects might face overwhelming pressure in the second half of the decade. (Messler, 2021)

Figure 14 illustrates the supply-demand gap that is forecasted for the next decades.

Figure 14: LNG Supply-Demand Gap until 2040



Source: Shell, 2021

As Asia will remain, mostly due to the rapid increase of China imports, the dominating buyer of global LNG and Europe the balancing market, the interplay between TTF and JKM will underpin pricing formation for the natural gas markets globally. JKM is maturing, already hitting important milestones; the ratio of the spot LNG to derivative market is already 1:1, indicating the same amount of trading in physical markets and as derivatives. This liquidity will act as a circle, resulting in increased derivative volumes and an ultimate use for physical indexation. The novel deals between Tellurian and Vitol and Tellurian and Total in 2018 and 2019 were the first deals signed by a US exporter in an Asian natural gas benchmark, proving JKM's credibility and future establishment. However, NextDecade's 20-year agreement with Royal Dutch Shell, the first long-term contract with US-produced LNG to be indexed to Brent as well as Tokyo Gas's deal with Shell, thought to be the first coal-indexed LNG contract indicate that due to price diversification, further rise and domination of these key hub markers worldwide is going to need adequate time.

Even though new benchmarks will emerge, liquidity is set to concentrate on few key established benchmarks as other trading hubs are going to trade as a basis to these. Liquidity in these markets is going to be sufficient with the increase of freight routes of LNG around the globe. China's flexibility in conventional power generation suggests that the global natural gas price could be set there in the future. Yet, even if this potential market shift materializes, China's push to yuan - denominated benchmarks for oil and other commodities lacks structure that supports a liquid international trading. (Bennet, 2021)

Carbon pricing is also set to play an essential role in natural gas and LNG trading along market dynamics and geopolitics. Top LNG producers, traders and end consumers have pledged to decarbonize the LNG either partially or fully. This would challenge legacy LNG projects that possess limited means to reduce carbon, forcing them to buy expensive carbon offsets, while their new competition invests in carbon reduction technologies and "green" marketing. Emerging markets will possibly consider low carbon LNG expensive, which will probably result in parallel markets, where low efficacy ships with high boil-off rates are destined to meet demand of less sophisticated players. Demand for low-carbon LNG has been mainly expressed by Asian countries, especially Japan and China.
On the supply side of carbon pricing, US exports, even though they have significant advantages in other areas, are at full disadvantage. The lower 48 states have high carbon-intensity gas and high percentages of methane leakage. This presents a real problem right now, demonstrated by the cancelation of Engie, a French utility company, of a US LNG cargo back in late 2020's. US upstream will need years of tighter control and private fund incentive to reduce its emissions to compete with global basins. Meanwhile, the US is trying to offer gas from fields with less emissions; Cheniere has pledged to provide a full greenhouse gas profile for each LNG cargo they produce. (Flowers, 2021)

Technological innovations will also play their part in natural gas and LNG's participation in the energy mix of the future. Singapore LNG aims to build a facility to extract chemicals (ethane, propane, butane) from LNG cargoes and utilize them for other uses (such as petrochemicals). This would allow Singapore to import, not only lean gas, but also "rich" gas (gas with high concentrations of larger hydrocarbons). This will not only increase competitiveness in their chemicals industry, but also increase the energy security and independence of the island. (Jaganathan, 2021)

Carbon capture and storage technologies are also going to be a vital part of the energy transition. Carbon capture and storage (CCS) refers to the trapping of man-made CO_2 emissions in underground storages in order to avoid its release to the atmosphere. The Intergovernmental Panel of Climate Change (IPCC) indicated that most viable 1.5^{o}C pathway scenarios (the incentive to keep global warming at 1.5^{o}C above pre industrial levels) include a substantial amount of CCS. CCS could potentially play an important role in LNG exporters' low-emission development strategies, as they are able to keep monetizing their reserves while also meeting climate goals and remaining competitive in energy intensive industries in all net-zero scenarios. However, as there is no sound business model for private companies that includes CCS, the investment cost cannot be justified, and it is highly likely that state funds are going to be needed. For this reason, burden sharing mechanisms must be implemented that generate revenue for the gas and LNG exporters and also allow for the costs to be shared down the supply chain to the end consumer. (Fattouh, 2021)

6. Conclusion

Natural Gas is a crucial energy source for the energy transition due to its reduced greenhouse gas emissions. In its liquified form, it provides high versatility in its commercial transportation and uses. Natural gas markets evolved a great deal in the last decades, with each regional market governed by specific market dynamics. The underlying derivatives market related to natural gas markets is still under constant development. Apart from the financial aspect affecting the global natural gas and LNG markets, geopolitics play an important role in the development and future of the markets and the energy security and stability of states in general. LNG, specifically, is an essential component in the energy mix of states that crave energy independence and an evolving battleground for the dominance of global powers. The acceleration or delay of infrastructure will play a crucial role in the future of supply and demand dynamics of LNG and therefore geopolitical alliances and energy security.

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