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Natural gas pipeline politics in and around the European Union

Modelling – based assessment of Russian and European strategies

Doctoral School of International Relations and Political Science
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Doctoral dissertation

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Abbreviations

ACER	Agency for the Cooperation of Energy Regulators
BCM	Billion cubic meter
BEMIP	Baltic Energy Market Interconnection Plan
BRUA	Interconnector between Bulgaria, Romania, Hungary
CBA	Cost-benefit analysis
CEE	Central Eastern Europe
CEF	Connecting Europe Facility
EGMM	European Gas Market Model
ENTSOG	European Network of Transmission System Operators for Gas
IGB	Interconnector Greece Bulgaria
IEA	International Energy Agency
INEA	Innovation and Networks Executive Agency
REKK	Regional Centre for Energy Policy Research
LNG	Liquified Natural Gas
NS2	Nord Stream 2
NRA	National Regulatory Authority
PCI	Project of Common Interest
PINT	Put in one at a time
SCP	Southern Caucasus Pipeline
SGC	Southern Gas Corridor
SSO	Storage system operator
TAP	Trans Adriatic Pipeline
TANAP	Trans Anatolian Pipeline
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan

Country codes

AL	Albania
AT	Austria
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
DZ	Algeria
EE	Estonia
ES	Spain
FI	Finland
FR	France
GE	Georgia
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Latvia
LU	Luxemburg
LV	Lithuania
ME	Montenegro
MD	Moldova
MK	North Macedonia
MT	Malta
NL	Netherland
PL	Poland
PT	Portugal
RO	Romania
RU	Russia
RS	Serbia
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UA	Ukraine
UK	United Kingdom

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1 Introduction

Pipeline politics is deeply rooted in energy economics, political economy, and geopolitics and is discussed in international and energy law, therefore this topic has to be discussed interdisciplinary. Natural gas pipeline investment decisions in and around the EU between 2000-2020 have been shaped by the drastically changing regulatory environment within the EU, unforeseen changes in the global gas market due to technological developments in shale gas developments, and growing geopolitical tensions closely related to large transmission pipelines.

Energy politics in the European Union has three main pillars: competitiveness, security of supply, and sustainability. Building a common European energy market was the goal of the first pillar and therefore the unbundling and liberalization of the sector were dominating the natural gas market-related agenda and legislation set between 1990-2009. In January 2009 the transit shipments of natural gas via Ukraine were stopped for about two weeks creating supply shortages in certain Central European[1] countries, impacting even household consumers for several days in Bulgaria and Serbia. The reason for the supply disruption was political: a transit dispute between Ukraine and Russia. Although European gas natural companies and politics reacted immediately and in two weeks' time redirection of volumes from West to East solved the problems in the short term, the vulnerability of the EU energy system and the network's resilience to outside suppliers was demonstrated (Kaderják & Tóth , 2011; Yafimava, 2011, pp. 183-204). In the next decade (2009-2019), the security of natural gas supply was put high on the agenda. The EU developed a toolbox to address the challenge of this vulnerability by applying already existing market and competition rules against Russian state-owned natural gas giant Gazprom, and by adopting a set of new legislation to strengthen cooperation between EU member states and their respective actors. This toolbox entails building a more robust natural gas

[1] In this thesis I often use the term Central European. I refer under this term to EU member states that form a continuous block from Germany and Austria via Czechia, Slovakia and Poland, Hungary to Romania. When I use the term Central Eastern Europe, than I refer to a wider block, consisting of Central Europe plus Ukraine, Moldova, Belarus, Georgia.

network infrastructure (hardware) and a cooperation mechanism to prepare for the security of supply events (software). Parallel to these developments the Russian energy strategy in 2009 made its main priority to diversify its supply routes to Europe with the final aim to bypass Ukraine and thereby eliminate the transit risk. The third pillar, sustainability gained new momentum in 2019 with the Green Deal (2019) and the ambitious decarbonization agenda of the von Leyden Commission. In the 2000's gas was regarded as a necessary and useful fuel supporting the energy transition. With the emergence of the green agenda the debate on the role of natural gas turned into calling for "greening of gas". The sustainability goals have a crucial impact on the future of natural gas, but this will be only considered in this thesis as a constraint on the market size.

This dissertation aims to assess the success and the limits of the EU infrastructure development toolbox against power politics in the upstream and the conflicts with the Russian pipeline strategy. The analytical framework considers the changing global market circumstances between 2009-2020 in the field of natural gas, most prominently the increased supply of liquified natural gas (LNG) from the USA as a new entrant to the market and the growing (geo)political tensions with Russia, the largest pipeline supplier of the EU. The decarbonization agenda of the EU, which since the mid-2010's has shifted the emphasis of policy setting on the sustainability pillar has been considered in this dissertation only in terms of its impact on future gas demand.

This dissertation focuses on the power politics surrounding the natural gas pipeline projects planned and implemented between 2009-2020, which is the era when the security of supply-related legislation forming was dominating the EU legislative agenda in the natural gas sector. The geographical coverage of the analysis is the territory of the European Union plus the Energy Community Contracting Parties[2], Russia, and Turkey.

[2] The Energy Community is an international organization between the EU and neighbouring countries that aim to implement the energy acquis as listed in the Treaty establishing the Energy Community. The Energy Community has nine Contracting Parties - Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, Georgia, Moldova, Montenegro, Serbia and Ukraine.

Traditional pipeline economics offers a robust and well-developed analytical toolset financial cost-benefit analysis on how pipeline investments shall be decided on, but pure economical considerations cannot explain investment into excess capacities of infrastructure that is a common tool to reduce reliance on a single supplier, or on a buyer or on a transit country. International law and studies on governance failures offer a good understanding of power relations and failures or success conditions of cooperation and coalition building. A purely legal analysis would fail to capture the network structure effects of natural gas transportation and interdependencies of the projects. Geopolitics on natural gas also has a broad literature discussing military and power politics and explains the broad economic, political, and power relationship of main state actors which cannot be neglected when discussing European pipeline developments. However, in this specific case, the decision-making actors on individual projects are private or state-owned companies. To analyse the interplay of the economic, governance, and geopolitical factors related to infrastructure investments, the dissertation uses market modelling as a preliminary analytical method, where the network infrastructure and the supply sources are sufficiently represented in detail, while the geopolitical factors and political considerations are reflected in the analysed scenarios. The quantitative results of the modelling can substantially contribute to the evaluation of the political choices designed by the scenarios.

Market modelling was applied in the last two decades to study the impacts of large pipelines on the European gas market – most prominently of Nord Stream 2[3] indicated by a sharply growing number of studies. The number of models and their geographical representation is also growing as the necessary input datasets are becoming publicly available. Most of the models applied to impact analysis of new sources via pipeline or LNG are partial equilibrium models and used to describe the market forces within the gas market. One of the early models is the EGMM that has been used in this dissertation (Kiss, et al., 2016). In the modelling-based chapters of this thesis that rely on

[3] Nord Stream 2 is a 55 bcm/yr capacity transmission project directly connecting Russia and Germany under the Baltic Sea. The project was proposed in 2014 to double the capacity of the already existing Nord Stream 1 (that already had 55 bcm/yr capacity).

EGMM my contribution was to conceptualize the geopolitical changes in the gas market, to verify the baselines and to formulate the main assumptions used for the model calibration to reflect the market position of key players. I had a leading role in designing the scenarios along the research questions and in the selection of the key output variables. Finally, my task was to analyse and interpret the modelling results. I drafted the first text for the academic articles and worked as a corresponding author for two out of the three publications that form the basis of the dissertation: Takácsné Tóth, et al., (2020) and Kotek, et al., (2016). Actual model runs and visualization of the results were mainly done by Péter Kotek and Adrienn Selei.

The modelling literature on natural gas pipelines focuses mainly on the security of supply risks and welfare change, that Russian pipelines might cause in different European countries, and on the flows. Most of them conclude that abandoning the Ukrainian route via Nord Stream 2 does not pose security of supply threat to Europe. Depending on the demand assumptions and pipeline setups they use, most of them claim that Nord Stream 2 would benefit Germany and Western Europe but would result in a price increase in Central Eastern Europe (Mitrova, et al., 2016). There is a consensus in these studies that economics alone does not explain the investment of Gazprom into the large pipelines, rather political considerations mainly related to transit risks are the main drivers (Paltsev, 2014). The dissertation will contribute to this modelling literature with the assessment of three distinct modelling case studies connected by the narrative that Russian and European Union pipeline strategies do conflict. *The first one*, which has been published in Energy Policy in 2020, puts the Russian marketing strategy in the focus with a novel approach to the pricing of short-term Russian sales in a profit-maximizing manner. With this addition, the Russian marketing strategies on different pipeline setups can be tested (Takácsné Tóth, et al., 2020). *The second case* shifts the focus from the Russian pipeline investments to the European Union's Projects of Common Interest (PCIs) using socio-economic cost-benefit analysis to quantify the combined impact of the existing and planned PCIs on the European welfare, quantifying market integration, security of supply, and sustainability benefits (Selei & Takácsné Tóth, 2022). The modelling of PCIs is complemented by the analysis of the geographical distribution of the Connecting Europe Facility (CEF) for gas projects between 20142020. The *third case study*, which was first published in Hungarian (Kotek, et al., 2016) and later in English in Competition and Regulation (Kotek, et al., 2020), describes the change in modelled socio-economic results of selected PCI projects driven by the Russian pipeline strategy. The narrative supported by these modelling case studies helps explain the divisive nature of Russian pipelines, most prominently Nord Stream 2 within Europe; contributing to understanding the importance of certain PCI projects despite their low utilization.

Taking the timeframe of 2009-2019 the dissertation aims to answer the following questions:

1. How would Russian Gazprom use the Ukrainian infrastructure under different combinations of availability of the new routes, if it were a profit maximizing actor?
2. How successful was the EU's pipeline strategy in infrastructure planning, in selecting and implementing the right projects of common interests between 2013-2020 to improve the resilience of the EU gas markets to supply shocks and growing market power of upstream supplies?
3. How did the European and the Russian pipeline strategies influence each other under a worsening geopolitical EU-Russia relationship between 2009-2020?

The structure of the dissertation is the following. This introduction is followed by Chapter 2: an overview of global and European natural gas markets to set the scene and provide a wider picture. The analytical framework in Chapter 3 explains how the dissertation fits ino the interdisciplinary framework of pipeline politics. Chapter 4 summarizes the methodology, the most important lines of research in the field and highlights the novelty of the approach of applying market modelling to explain the motivations and choices of different state, institutional, and company actors.

The analytical part (Chapters 5-7) is based on three modelling exercises. Chapter 5 discusses the Russian pipeline strategy, by applying gas market modelling to test different pipeline route scenarios combined with gas marketing options.

Chapter 6 first gives an overview of the geographical distribution of EU projects of common interest (PCIs) in natural gas, and then modelling is applied to test the welfare impacts of the EU-supported natural gas PCIs implemented between 2013 and 2020.

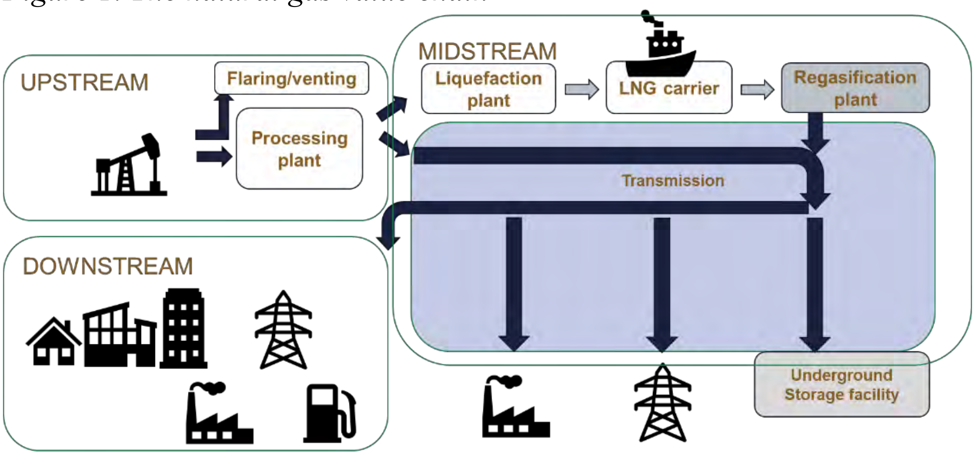
In Chapter 7, the Russian and the EU pipeline strategies are modelled simultaneously. The benefit per cost ratio of various key PCI projects is calculated in a with and in a without Nord Stream 2 scenario. The difference shows the impacts of the Russian Strategy on new EU investments: it is estimated that about 1 billion € additional investment is needed from the EU side to compensate the negative impacts of the Russian pipeline strategy.

Finally, Chapter 8 discusses the main findings of the modelling chapters concerning infrastructure investments in the natural gas sector and the policy implications. Given that the years since the closing of the draft manuscript (in February 2021) the geopolitical realities in relation to the natural gas market of Europe have substantially changed, a subchapter of the conclusions is dedicated to these changes and their impact on the modelling results and the policy implications derived from them.

2 Background

The supply chain of the natural gas sector consists of three main parts: upstream, midstream and downstream, as depicted in Figure 1. The production site of natural gas depends on the geological availability of the resource. Technically production can be offshore (on sea) or onshore (on land). The cleaned product is a gaseous material, that consists mainly of methane (CH_4), which is transported via pipeline from the production site to the consumers. To adjust the supply to the seasonally changing demand, gas can be stored in different storage facilities, usually underground or in a liquified form in tanks. In case the transport of gas is overseas, an alternative to pipeline transport is the LNG technology: to liquefy the natural gas in terminals, and subsequently transport it via LNG carriers (ships) to the LNG receiving terminal where LNG is regasified and injected into the local pipeline system.

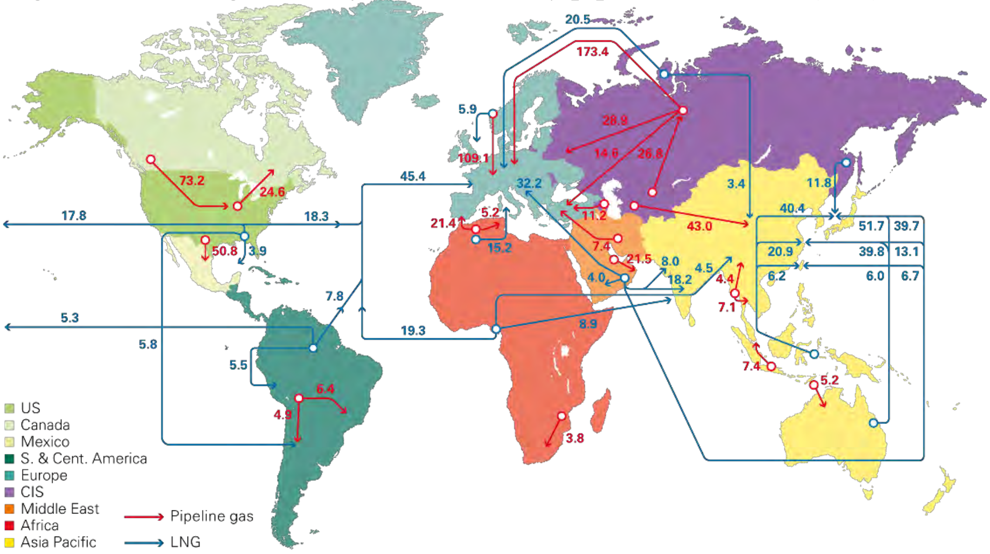
Figure 1. The natural gas value chain



Source: own drawing

Globally the proved natural gas reserves were 198.8 trillion cubic meters in 2019 according to BP (2019). With the current production rate natural gas would be enough for 50 years, hence resources are not scarce, but the investment into upstream production – and the available supply – depends on the demand and price of the commodity. The large production and consumption centres do not necessarily coincide, although the large producers, like Russia and the USA, also developed their domestic gas markets. The balance of national supply and demand allows for export from the resource-rich countries to other countries that need import of the commodity. Connecting producers to consumers require a substantial amount of investment therefore costs and risks of the infrastructure investment are shared by the buyers and sellers. The transmission pipeline part of the supply chain is the focus of the dissertation.

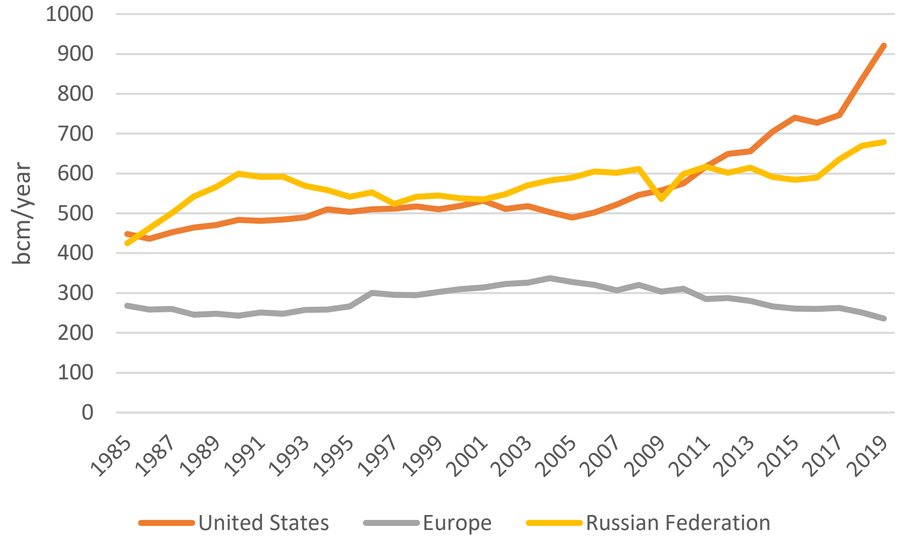
Figure 2. Global gas trade flows in 2019 by pipeline and LNG (bcm)



Source: BP Statistical Review of World Energy, 2019

Figure 2 depicts the international trade movements of gas globally. LNG gained growing importance in the global gas trade. LNG accounts for approximately 10% of the global gas consumption in 2021. As of April 2022 there were 19 exporting and 40 LNG importing countries in the world, Australia being the largest supplier followed by the US who overtook Qatar, that used to be the largest LNG supplier until 2020. (IGU, 2022) With the shale gas revolution at the beginning of the 2000s, US production started to increase and surpassed Russian production in 2011 (Figure 3). The USA became a net exporter in 2016 and challenged the status quo despite the volumes exported being small in the first years.

Figure 3. Natural gas production in the USA, Russia and Europe 1985-2019 (bcm/yr)

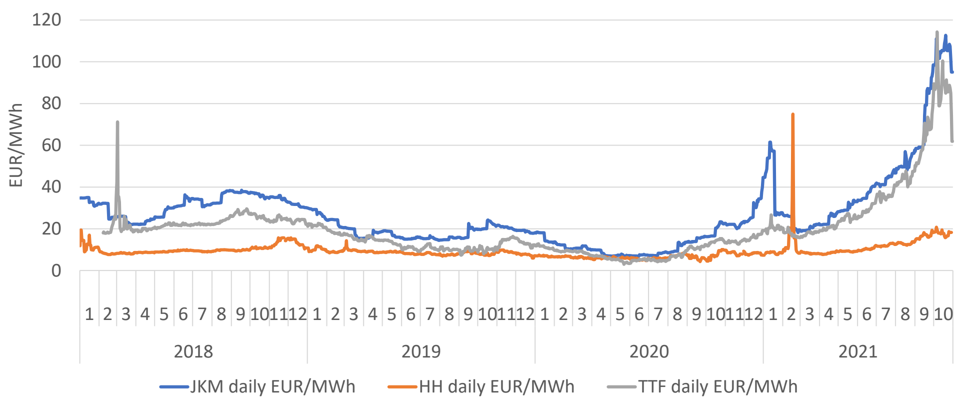


Note: Europe covers European members of the OECD plus Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Gibraltar, Latvia, Lithuania, Malta, Montenegro, North Macedonia, Romania, Serbia, and Ukraine.
Source: BP Statistical review

There are two main characteristics of US LNG sales, both rooted in the competitive nature of the US market and the presence of private companies: (1) there was a new pricing formula for LNG introduced, which was based on the 115% of the US Henry hub price + liquefaction costs instead of the oil-based formula applied in other regions, (2) there was no restriction on the destination of the LNG cargoes. The increased availability of spot cargoes (ships available on short notice and without destination restrictions) and the notion that long-term alternative sources are available had an impact on other suppliers' pricing as well. The US LNG argument became a tool for European buyers to obtain better prices from Russian export monopolist Gazprom (Mitrova & Boersma, 2018).

Figure 4 shows that the highest-priced region is East Asia (illustrated with the Japanese spot gas price), and the lowest price is always the Henry hub. The European gas price indices are the German border price (indicating the Russian long-term contract price in Germany) and the TTF (a Dutch trading hub). The European gas prices are up until 2020 always in-between the US and the Asian prices. It is the strategic interest of the EU to increase the competition on the upstream level to close the gap between the prices offered by Russia (German border price) and the hypothetical price cap calculated based on the US LNG price + cost of transportation to Europe. This dissertation aims to contribute to the understanding of the effectiveness and the limits of the natural gas infrastructure strategy (software and hardware alike) of the EU to reach this goal.

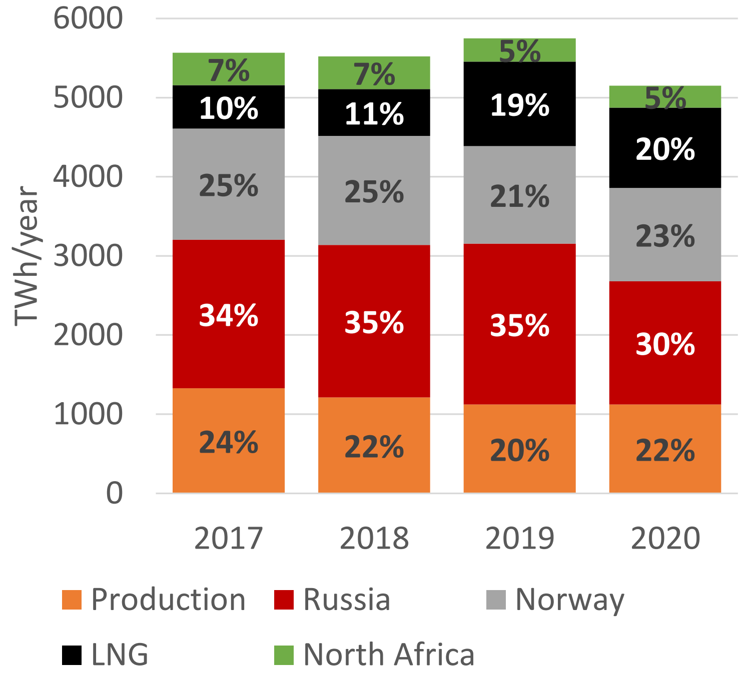
Figure 4. Major global price indicators of natural gas, 2018-2021 (€/MWh)



Source: Takácsné Tóth, Kotek, & Selei (2021)

The EU is the second largest natural gas importing region of the world after the Asia Pacific. As Figure 2 indicates, the main supplier to Europe is Russia via several different pipeline routes, but LNG is also part of the supply mix. Domestic gas production is sharply declining, import dependence grew form 48% in 2000 to 78% in 2018 (Figure 5) In 2020 only about 22% of the consumption was covered by domestic sources, and about the same volume arrived from Norway (a partner in the European Economic Area). As Figure 5 shows, the LNG and the Russian import volumes show the largest flexibility in the supply mix. On the LNG side the USA (with the growing number of private actors operating LNG terminals) is only one of the many suppliers and not even the largest supplier to Europe. For the Russian import, there is one state-owned export monopolist of pipeline gas, Gazprom accounting for a growing share of European imports.[4] There is a growing Russian LNG export as well, with new Russian players, like Novatek, partly targeting Europe.

Figure 5. Natural gas demand and supply mix in the EU28, 2017-2020 (TWh/year and %)

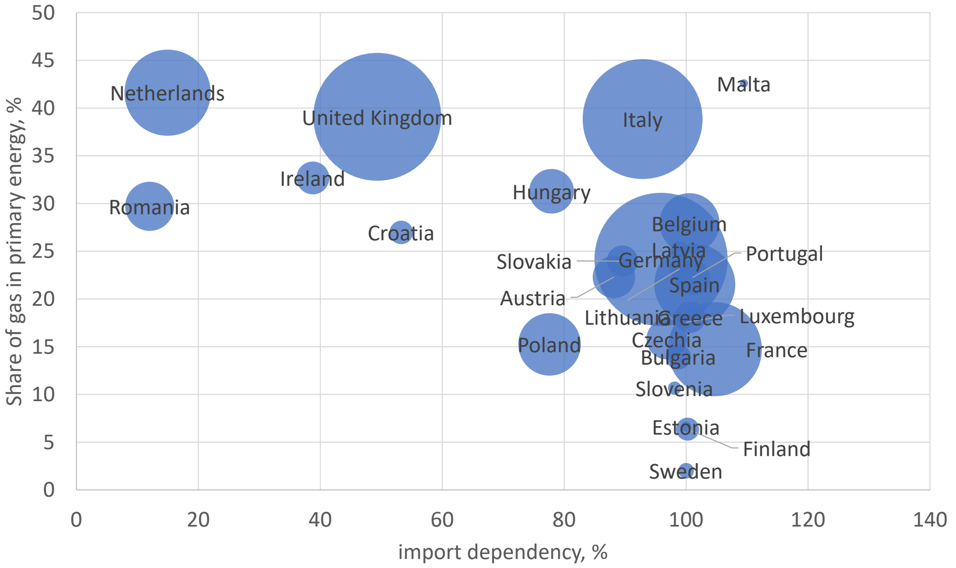


Source: Kotek (2021)

The annual gas consumption of EU28 in 2019 was around 425 bcm. Natural gas accounts on average for 24% of the primary energy mix of the EU, with different importance in the different member states (Figure 6), which does impact their views on the importance of natural gas pipeline politics. Countries in the upper right part of the chart are more exposed to a potential price effect of upstream market power. Market size and gas dependency of the European countries can be found in Annex Table 20-

[4] Figures for 2020 show a decline of Russian exports to Europe, that was partly due to the fact that in 2019 Gazprom shipped additional volumes and stored that in European storages to prepare for a potential disruption on the Ukrainian route. The other reason was the Covid-19 pandemic's impact on EU demand.

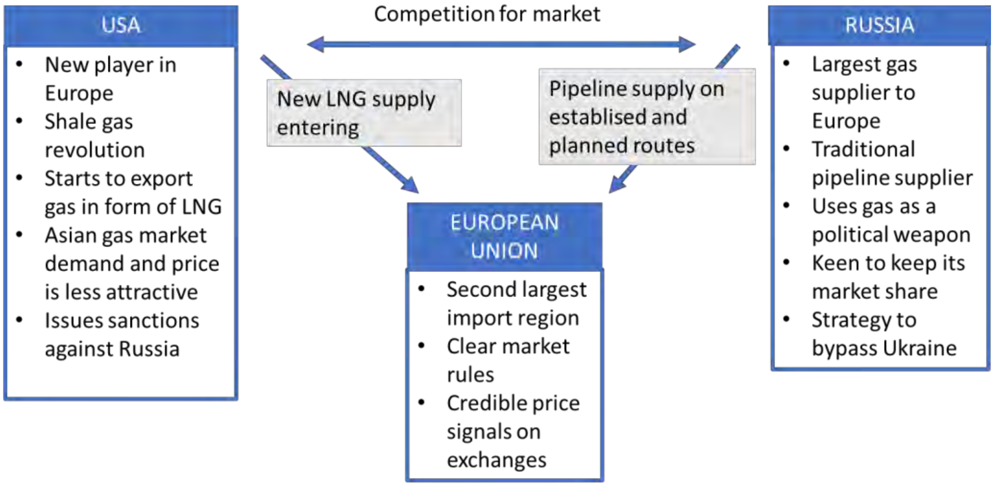
Figure 6. Role of gas, import dependency and market size in the EU, 2018 (%)



Source: Own, based on Eurostat

Import dependence and share of gas in the energy mix are rough indicators and can only partly explain the vulnerability of the countries and the interconnected EU gas markets to supply shocks. In a global setting, geopolitical interests and considerations of the other actors also play a major role. A simplified chart in Figure 7 summarizes the main driving factors of the global players. The US as a new entrant to the global gas market aims to sell its LNG (via private companies) to the highest-priced market – which is not necessarily the EU. The US as a global actor is interested to reduce the revenues of Russia on natural gas. Russia wants to keep the market share and the revenues in its core EU market, but at the same time as a political goal decides to bypass Ukraine. the historical transit route.

Figure 7. Relationship between main actors and key factors driving their interests



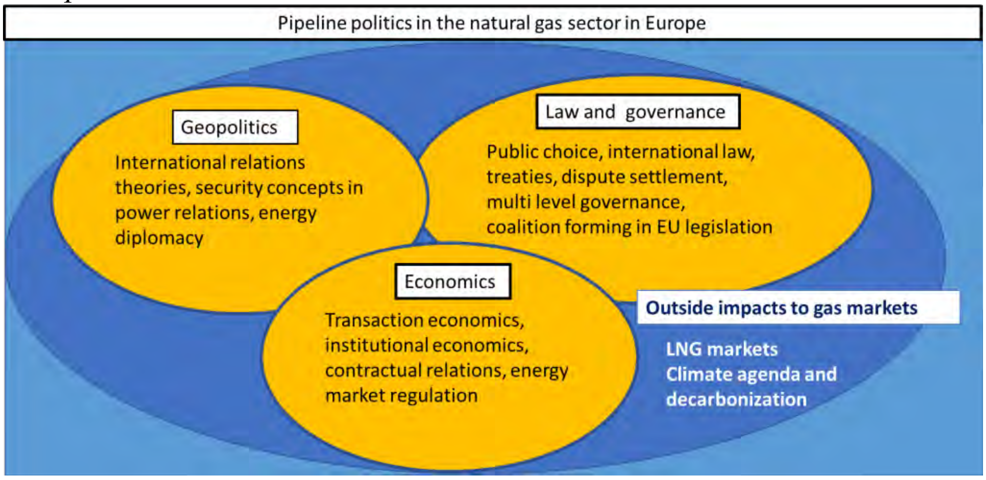
Source: Own compilation

Access to consumers in the countries of the EU depends to a large extent on the infrastructure in place and on how it is used. Therefore, the existing and planned network structure is of key importance in the resilience of this network to supply shocks. The impact of the network on prices must be studied as well.

3 Analytical framework

The analytical framework used in this dissertation is interdisciplinary. It is possible and necessary to discuss the natural gas pipeline network development from different perspectives: economic, regulatory, strategical, international relations, power politics, and institutional angles (Figure 8).

Figure 8. An analytical framework to assess natural pipeline politics in Europe



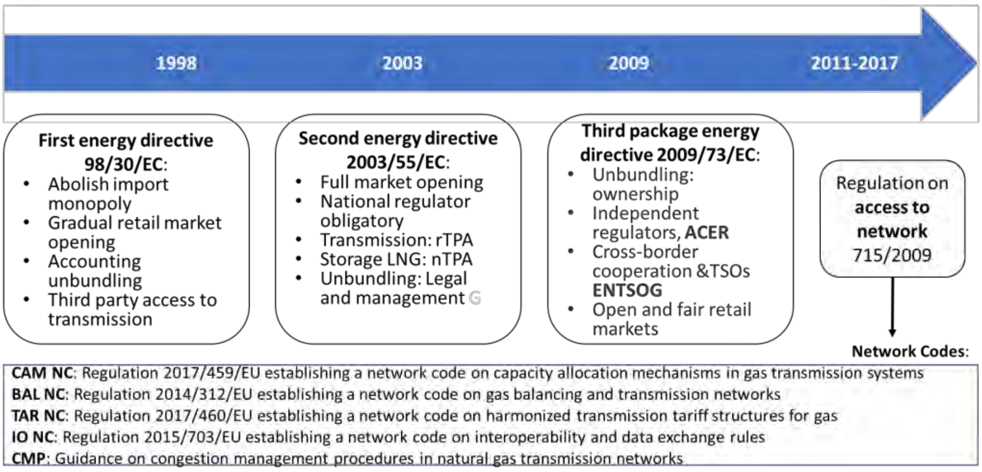
Source: Own compilation

The economics of gas markets provides the basis of the analysis as the understanding of investment decisions of (private and publicly owned) companies into the pipeline networks is the core question of the dissertation. As the pipeline investments analysed do have an international character and connect physically different legal and regulatory jurisdictions, the policy forming, agenda, and legislative framework setting on the European level must be considered that ultimately takes the perspective of national interest representation at the higher international (EU) level in the focus of the analysis. As the natural gas market has developed into a global market in the last thirty years, geopolitical considerations cannot be neglected when discussing European-Russian pipeline relationships.

3.1 Economics

Pipeline infrastructure has been discussed in classical and neoclassical energy economics as energy – and among them, natural gas – markets are highly concentrated. Transportation is a capital-intensive and natural monopolistic activity therefore the discussion on how regulation should balance between interests of companies (pipeline owners) and consumers is one of the pillars that our approach must consider. The development of the regulatory model applied in the EU on natural gas markets is based on the theory of natural monopoly regulation. The European regulatory model introduced legal unbundling of competitive and regulated segments of the value chain; third-party access rules to the pipeline (rTPA) with an entry-exit tariff regime and the liberalization of the markets via introducing a retail choice of the consumer. Throughout the twenty years between the First Gas Directive (in 1998) and 2018, when the Third Gas directive and accompanying Network Codes were already in place (Figure 9), the EU gas markets have changed dramatically and developed into a well-functioning internal market. (ACER, 2018)

Figure 9. Timeline for the legislation on the internal EU gas market



Source: Own compilation

Institutional economics and industrial economics often select the natural gas industry to test theories of industry structures, as the sector requires large upstream investments and commitments of buyers as the infrastructure cannot be repurposed or moved to a different place. With uncertainty and economic opportunism on either end of the pipeline, the risk of stranded assets is high. Long-term contracts are one of the multiple forms of vertical coordination, in between the one extreme of full vertical integration of the entire value chain into one firm and the other being the short-term trading on anonymous spot markets (i.e. no cooperation) (Makholm, 2012). The historical long-term gas supply contracts were designed to mitigate the risks of buyers and sellers alike. They ensured that the large investments into upstream and transportation assets will recover, by lifting the volume risks from the seller via the take or pay obligations, meaning that the buyer has to pay for the agreed yearly quantity even if it has not been used, and the price risk from the buyer by agreeing to a price formula that indexed the starting price usually to oil prices with a 6-9 month lagging (Neumann, et al., 2015). This structure has been accompanied by long-term shipping contracts with ship-or-pay clauses that reserved the pipelines for the sole use of the long-term contract holder, under the condition that there will be a constant cash flow to the pipeline operator. In a ground-breaking book edited by Jonathan Stern on Gas Pricing of Internationally Traded Gas (2012), the historical development of gas pricing in the main gas-consuming regions of the world is discussed with theoretical scrutiny on the underlying market structure and political and geological circumstances. The analysis concludes that at the beginning of the 2000s the regional markets slowly moved towards globalization both physically and in pricing terms due to growing LNG supply. Restructuring of the natural gas markets and liberalization (starting in the USA first then in the UK in the 1980s and with the first Gas Directive in the European Union in 1998) has challenged the long-term contracts resulting in shorter, more flexible, and smaller annual contracted volumes and a shift from oil-pricing to gas-on-gas pricing to better serve the changing needs of the buyers. Zajdler (2012) explains with infrastructural constraints (lack of interconnectivity of the pipeline networks and no access to LNG sources) and liquidity problems (no developed hubs in the region) the slower shift to gas-on-gas pricing and more flexibility in the gas long-term contracts in Central Eastern Europe than it has happened in Western Europe.

Investment decisions and financing of gas infrastructure have been at the heart of regulatory economics. There are regional differences in the investment models applied for new infrastructure. In the USA the typical model was historically to develop private pipelines with (regulated) point-to-point tariffs, and investment decisions therefore, are strictly market driven. Point-to-point tariffs are to be paid for shipping the gas on a given route to the destination point. On contrary, in Europe, the typical model was that state-owned utilities financed the infrastructure development and socialized the costs via tariffs. On the cross-border infrastructure, the mandatory tariff structure applied in all EU member states is the entry-exit system since 2014, which does indeed encourage wholesale trade within and between the market zones, however, does not provide clear signals to investors about where the investment would be needed. In an entry-exit system tariffs are to be paid for using the entry and the exit points and the route and distance of the shipment are left for the TSOs. In such a system it is considered, that internal bottlenecks are non-existent. Therefore, instead of market-based project development (like in the US), the long-term system planning approach became the EU norm, with strong administrative and coordination efforts between the national and European-level planning (Makholm, 2015).

3.2 Law and governance

Energy has always been at the heart of European integration. The European Union is rooted in the Euratom and the Coal and Steel Treaty, and in the idea that transparency and interdependency in energy issues can lead to more peace. Still beside the overarching political goal of peace in Europe the economics of the energy markets were the focus. No doubt that out of the three pillars of energy policy in the EU (competitiveness, security of supply, and sustainability) the first was the guiding principle during the liberalization process (1990-2009). Security of supply was the main focus from 2009-2019. Since the Paris Agreement (2015) the sustainability focus is gaining momentum and is dominating the agenda setting of the von Leyen Commission (since 2019).
The following chapters summarize the energy policy-related legislation of these three eras with a special emphasis on pipeline investment and touch upon the energy governance issues that formed the implementation of the pipeline policy of the EU.

3.2.1 European Commission as a watchdog on fair competition

In the 1990-2009 period there was no special focus on Russian investments or pipeline investments, Russian market dominance, especially in the new member states, was however noted. The regulation of the gas markets and especially the antitrust measures applied against energy utilities in Europe, and later also against Gazprom (as a dominant player in the upstream markets) have seriously constrained the level playing field of the company. Important building blocks of the long-term contracts were challenged directly by the EU competition law, e.g., applying destination clauses that prohibited the further sale of the purchased gas that was typical of Russian and Algerian gas supply contracts. The European Commission investigated these territorial sales restrictions in gas supply contracts between Gazprom and ENI, the Italian incumbent gas company (2003), and also Gazprom and OMV, the Austrian incumbent gas company (2004). and Gazprom and E.ON Ruhrgas, a German gas company (2005). These investigations resulted in settlements under which companies committed to release their consumers of the destination clause and to exclude such clauses in future contracts. With that simple move, a very important tool for market segmentation was abolished (Zajdler, 2012, p. 51). The Commission opened proceedings against Gazprom in 2012 and investigated the Russian gas marketing strategy in Central Eastern Europe (CEE) for 6 years and found that Gazprom was abusing its dominant / monopoly position and prices applied in certain CEE countries were monopolistic, contracts comprised clauses that were opposing free trade (European Commission, 2012). In May 2018 the Commission imposed binding obligations on Gazprom to enable the free flow of gas at competitive prices in CEE gas markets. The case resulted after several years of delay in a compromise solution when Gazprom promised to keep certain market rules, that in the meantime the market has already enforced to accept. It is repeated in the obligation that Gazprom cannot restrict the resale of gas cross-border, but it goes further by placing a positive obligation on Gazprom. The company has to enable gas flows to and from countries where physical interconnections are not in place yet (Bulgaria and the Baltics) and to provide competitive gas prices compared to those prices at Western European liquid hubs. (European Commission, 2018)

Still, the Commission and other EU institutions did not interfere in the bilateral energy relations of countries but rather concentrated efforts on enforcing competition in the gas market. The Commission has two main tools at hand: issuing antitrust cases on the utility company level or starting infringement procedures against member states for not imposing the EU legislation. The European Commission's limited power was restricted to acting as an impartial watchdog of fair competition and ensuring a level playing field. The empowerment of consumers showed remarkable success in shaping the Russian marketing strategy towards Europe within the existing framework of long-term contracts.

When oil-indexed prices (of the Russian contracts) were from 2006-2013 constantly above hub prices, the European partners of the Russian contracts were in trouble as they were losing market and were making losses. Gazprom, on the other hand, was reluctant to change the long-term contract conditions, neither the formula (from oil indexation to hub pricing) nor the take-or-pay obligation[5]. Developments in the EU gas market proved that gas-on-gas pricing prevails, and oil indexation is phasing out in contracts, despite the strong opposition of Gazprom and its reluctance to change. The change in contract pricing of the Russian contracts was to a large extent enforced by arbitration court decisions (Mitrova, et al., 2015; Neumann, et al., 2015; von Hirschhausen, et al., 2020; Wachsmuth, et al., 2017).

Instead of dedicated actions against one supplier (Gazprom) or a project (Nord Stream 2) the market approach has been implemented consistently and successfully. The internal gas market and the competition with other suppliers on the common EU gas market (including LNG from the US) that has put a strong pressure on Gazprom to adjust its pricing strategy, marketing and supply services (EY & REKK, 2018).

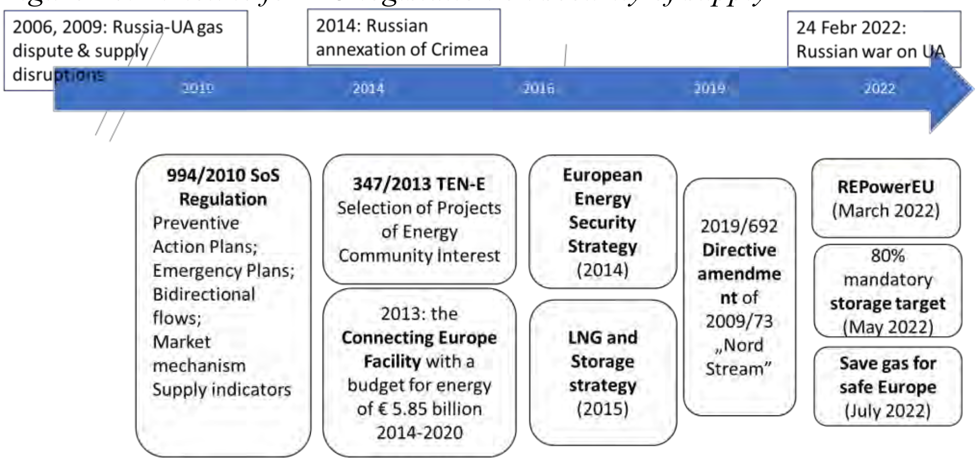
3.2.2 Security of supply-driven legislation and new energy governance

According to Heffron and Talus (2016), the security of supply-related legislation forming is the third stage of energy law development and is followed by law on energy infrastructure as the fourth development stage. In their view, these stages follow the economics and regulation-driven energy

[5] Take-or pay (TOP) obligation means that buyers have to pay for the annually contracted gas quantity, even if they do not take it.

legislation to provide adequate answers to the failure of these first two stages, that is the lack of private investment in the energy sector. Indeed, the three EU energy legislative packages on the rules of electricity and gas markets did not focus on the security of supply aspects of the gas and electricity networks. The vulnerability of Central Eastern European countries and their risk perception considering their reliance on Russian gas grew unacceptable strong after 2009 and has materialized in strong lobbying for more EU-level coordination, financial support for infrastructure building, and more solidarity from the Western European countries in the efforts to solve the security of supply challenge. The development of the legislation in this field is summarized in Figure 10.

Figure 10. Timeline for EU legislation on security of supply



Source: Own compilation

Neofunctionalist theory on spillover was tested on the observed developments in the field of energy by Stüwe (2017). He claims that the European Commission has gained a coordinating and moderating role with a strong mandate. The Commission intervened in certain external policy issues mostly as a reaction to "external shocks". Institutional spillover and functional spillover could be observed as well. The missing legislative background (no foreign policy mandate in energy matters) and the reactions to certain actions by some member states do however undermine the EU supremacy, and some spillback can also be observed. For example, Hungary abstained from voting in the Council for the SOS Directive because it did not agree with the clause to share the long-term contract agreements details with the Commission[6]. Important developments were the newly established cooperation mechanisms of member states in crisis, and solidarity mechanisms to supply vulnerable consumers. Financial tools were put in place to support new infrastructure to end the energy isolation of countries, and to allow reverse flow on existing pipelines and better interconnectivity within the EU (Regulation 2010/994). The obligation to establish physical reverse flow on existing EU-EU borders was the first attempt at direct intervention – based on the security of supply grounds – into the member states' realm to decide on their gas infrastructure investment. Member states did not agree to a full obligation in the text of the Regulation, therefore an exemption from reverse flow obligation could be granted by the national regulators based on their assessment. In the case of cross-border reverse flow projects, the exemption of one country could prevent the project to happen, even if the other country would have requested the project. An example of that is the Hungarian-Austrian reverse flow project that was exempted by the Austrian regulatory authority despite the Hungarian side requesting the investment. (E-Control, 2013) The Commission was granted no power to enforce any investment into the infrastructure not even on security of supply grounds.

The rules formulated on the single market (Gas directives) are depoliticized and they rely as a basic principle on an unbiased universal rule of law, where political considerations cannot play a role. The European regulatory framework however failed to secure an adequate level of investment into the network. To address this problem the 347/2013 Regulation on infrastructure (Figure 10) sets up the institutional framework to select infrastructure projects, that are projects of common interest. In the gas field, these are typically cross-border pipelines between EU member states, LNG regasification terminals, and storages if they have a cross-border impact. As the name suggests, the European interest to build these projects can be market integration, security of supply-driven, or sustainability based. This is not a market-based approach, but more a planning-based system. It is ultimately the Commission to decide which projects to select, however, the national

[6] Information provided by Mónika Zsigri, policy officer of DG ENER on 3 December 2020

interest and lobbying power of Member states often jeopardize the consistency of the selection process.

The European Energy Security Strategy (2014) was openly addressing the problem of Russian gas dependency also listing potential measures to reduce the dependency, and followed by a stress test modelling Russian supply cut scenarios. The Energy Union package and strategic documents based on that, like the LNG and Storage Strategy (2016) explicitly address the threat of Russian supply disruption, the need to speak with one voice in EU energy matters and refer to the political aspects of the worsening Russian-EU relationship.

A financial tool was put in place by the EU to support investments into infrastructure to address the vulnerability. Between 2014-2019 5 billion € has been dedicated to supporting energy investments in the field of electricity gas and oil infrastructure to support better interconnectivity of the EU infrastructure. (European Commission, 2020) Details on that and how the funds have been used on gas projects will be discussed in Chapter 6.1.1

3.2.3 Governance in new infrastructure development in the EU

Building new pipelines in the EU has been considered an economic activity, where the transmission system operators (TSOs) react to market needs, signalled by congestion on existing pipelines, and build incremental capacity from the congestion rents. Alternatively, it is also possible to test the market need via open season procedures[7] and in case sufficient demand for the new pipelines is present, the pipeline is built and the return on investment is secured by long-term bookings and paid through the transmission tariffs. In any case, the infrastructure development plans of TSOs are approved by independent national regulators just as the applied tariffs on the transmission system.

[7] An open season procedure is a transparent call of infrastructure operators for users to submit their demand requests for additional infrastructure capacity at certain points of the system. The call can be non-binding in the early phase of a project or binding in the later phase to secure the necessary financing.

Due to the nature of complex decision-making in the EU, the very sophisticated rulebook on how to use existing capacities was published first in 2017, but up until today the EU has been unable to develop a well-functioning framework on how to incentivise and regulate new pipeline investments. (Yafimava, 2018) As described above, the TEN-E Regulation 347/2013 set up the framework for the PCI selection, which mainly focused on smaller interconnectors between member states. The lack of clear and well-defined rules has left large pipeline investments from outside the EU in uncertainty and a patchwork of different frameworks was applied by different entities from open season to intergovernmental agreements and exemption regimes. The problems were exacerbated with the Nord Stream 2 pipeline, which has been widely debated as the project turned out to be not only political but geopolitical as well, contrary to what has been claimed by the proponents of the project (Wood & Henke, 2021).

Under certain conditions,[8] an exemption can be granted by the national regulator from the regulated tariffs and the third-party access rules. These exemptions must be approved by the European Commission in a decision. According to van Nuffel et al. (2020), the exemption request later has become rather a rule than an exception for new investments in the field of LNG terminal buildings in Western Europe. An exemption was granted also for some storage sites and the Trans Adriatic Pipeline project (European Commission, 2013), a flagship European project on the so-called Southern Gas Corridor[9]. The Commission approved the national decisions usually by setting certain conditions to ensure that the market is not unduly distorted by these exemptions.

[8] Defined by Art 36 (1) of the Gas Directive 73/2009

[9] The Southern Corridor consists of three projects, connecting the giant Shah Deniz field in Azerbaijani sector of the Caspian Sea to Italy. SCP (Southern Caucasus Pipeline) connects Azerbaijan via Georgia to Turkey. TANAP (Trans Anatolian Pipeline) runs through Turkey to the Greek border. TAP enters the EU in Greece and runs via Albania to Italy under the Mediterranean Sea. The entire corridor is about 3500 km long, and to build it was worth of an investment of approximately USD 40 bn, out of which is EUR 4.5 bn is the investment into the TAP pipeline. (tap-ag.com)

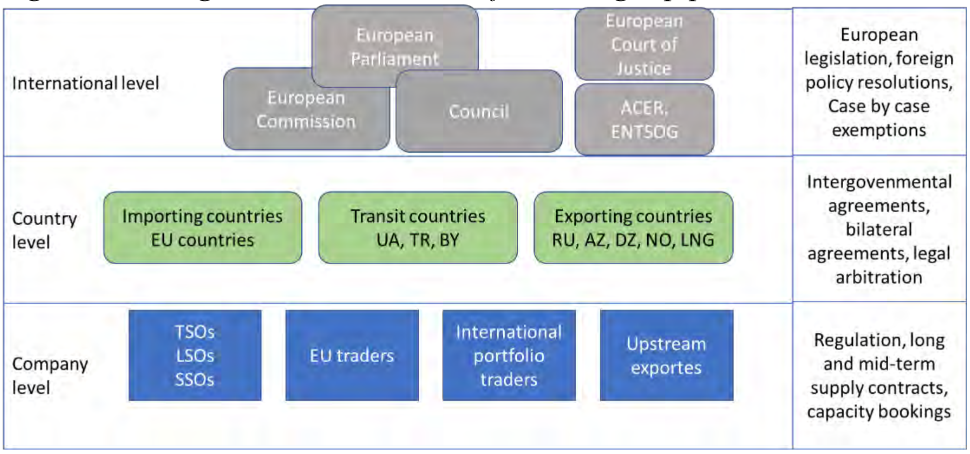
Exemption decisions related to Russian pipelines have a long history. The South Stream pipeline[10] failed and was withdrawn by Russia in December 2014 partly due to the strong opposition of the European Commission towards the bilateral intergovernmental framework between Russia and the countries on the route that aimed to circumvent the EU rules on exemption request related to unbundling and third-party access (Farchy & Oliver, 2014). The withdrawal was announced by President Putin, which again shows how much Russian politics on „the highest level" is involved in the pipeline projects of Gazprom (Richard, 2015a). The fact that both the Bulgarian and the Hungarian governments stepped back from their agreement with Russia shows that there was a certain unity in Europe on this matter then (Stern, et al., 2015).

The clash of views of different EU institutions concerning exemptions on Russian pipelines and the change in perceptions over time on the same project is well illustrated by the OPAL decisions. This project is the onshore continuation of the Nord Stream in Germany and further to Czechia. Without this pipeline, the Nord Stream capacities would lead nowhere. The German authorities exempted the OPAL from third-party access rules, but this decision was not fully approved by the Commission. The Commission restricted the capacity use for Gazprom up to 50% of OPAL capacity. Later the Commission changed its view and allowed the full use of the capacities, which immediately led to a reduction of transit on the Russian Belorussian Polish Yamal route. Poland therefore successfully turned to the Court, which annulled the Commission's decision to annul the restrictions on OPAL capacity use on the grounds of "lack of solidarity" within the EU. (General Court of Justice, 2019) Schmidt-Felzmann (2020) points out the example of Nord Stream 2 the multiple authority conflicts at different sites and levels.

[10] The South Stream pipeline was initiated by Gazprom and Italian ENI in 2007. The project was considered as a competitive to the Nabucco pipeline that the European Commission initiated to diversify supply of the EU. (Nabucco pipeline failed and was withdrawn in 2013.) The route of South Stream was modified several times as the negotiations with individual countries along the planned route developed. The first section was planned as an offshore pipeline across the Black Sea to Bulgaria than leading up to Austria with a branch to Italy. The project was cancelled in 2014 and later renamed to TurkStream. Turk Stream 1 was built with a landfall point in Turkey. TurkStream 2 started to supply gas to Bulgaria 1 January 2020. The last section was built in 2019-2020, it is called Balkan Stream and leads via Bulgaria and Serbia to Hungary. It started to supply Hungary with gas from 1 October 2021.

She claims that formal adjudication has been a primary tool for the EU and several of its member states to assert their authority at the local, national, and EU level rather than political strategies. She also points to the opportunity of external actors (here Russia via Nord Stream 2) to contest EU authority in the realm of pipeline construction across hierarchical levels and national boundaries. She points to the opposing interests and actions taken at different levels in the OPAL case where local and federal governments supported the external challenger (Russia and Gazprom) in opposition to the EU (and the USA).

Figure 11. The governance structure of natural gas pipelines in the EU



Source: Own compilation

Figure 11 illustrates the complexity of the pipeline governance structure in the EU when it comes to pipelines crossing several jurisdictions. Building a new pipeline is complicated, but to stop one from being built outside of the national jurisdiction is as difficult, if not impossible. The negative view of Central Eastern European and Baltic States on Nord Stream 2 was clearly articulated repeatedly at the time of the announcement of the Nord Stream 2 project plan in 2014. In a letter signed in November 2015 by Czechia, Estonia, Greece, Hungary, Latvia, Lithuania, Poland, Slovakia, and Romania jointly state that the project should come under the closest regulatory scrutiny and call for "an inclusive debate" at the *EU summit* (Gotev, 2015).

Resolutions in the *European Parliament* on the state of EU – Russia relations (European Parliament, 2015) and later the Navalny poisoning (European Parliament, 2020) but also in the *European Council* repeatedly acknowledged the geopolitical challenge of the Russian pipeline politics.

CEE countries and especially Poland have called on the *Commission* to address the Russian diversification strategy and to find ways to prevent the Nord Stream 2 pipeline to happen as the pipeline is against EU interest and undermines what has been achieved by the market integration and by the Security of Supply regulation and its implementation. Slovakia and the Baltic states lined up to signalling their concerns about the project most loudly and consistently. An unexpected alliance outside of CEE came when Danish concerns were put into real action. Denmark put a law in place that allowed the prohibition of a project due to security of supply concerns, which is unique in Europe. Still, the law was not revoked as alternative pipeline routes could have bypassed Danish territorial waters anyway. Licencing of the project caused serious delays to the project and won precious time for Ukraine in the trilateral (Brzozowski, 2019).

Wood and Henke (2021) in their case study on Denmark's decision-making on Nord Stream 2 claim that the Nord Stream 2 project and its permit granting illustrate how in the energy policy domain illiberal regimes attempt to exploit the liberal democratic legal system through nominally commercial entities. In their view, the permit was granted despite the increasing foreign policy, security, and environmental concerns for the project and the raising of local public perceptions, because Denmark is a rule-of-law state.

Despite attempts of its neighbour countries on the Baltic Sea shore to stop the project Germany has proclaimed its sovereign decision-making power on the Nord Stream 2 project. Attempts of business and political proponents to keep the project out of political space – as happened with Nord Stream 1 before – failed. With growing awareness of the public and the shift in perception towards Russia in foreign policy fields (starting with the Annexation of Crimea in 2014 and the poisoning of Navalny in 2020) Germany might even make use of the – long opposed, and in 2019 accepted – amendment of the Gas directive.

European institutions were supposed to be watchdogs of market functioning and not to play geopolitical cards. Any attempt to use existing EU legislation against a specific project has been heavily criticised by academic scholars, but also by certain member states. (Goldthau & Sitter, 2014; Goldthau, 2016) Finally, the Commission proposed in 2017 an Amendment to the Gas directive that was clearly targeting to set rules on pipelines from third countries with the aim to enforce legal unbundling and third-party access rules. Interview with a legal expert with a good overview on the Commission's efforts to meet the request of CEE countries suggested that there was a scrutiny by the Commission legal services that doubted the necessity of any amendment of the Directive. Opposition on lower levels, via a coalition formed by Germany successfully secured the blocking minority so the proposal did not make it to the Council meeting, until a sudden breakthrough by the Romanian presidency in February 2019. The agreement behind the deal was that France provided support for Germany against American pressure on sanctions and in exchange for that the approval from German side of the proposed directive amendment was requested. (Simon, 2019) The coincidence with the German – US clash on sanctions underpins this reasoning (Lohmann & Westphal, 2019). According to participants of the meetings and high-level ministry officials Germany has approached several smaller states to keep up the blocking minority – among them Hungary as well – but this was considered non-negotiable on the highest political level. The amendment was approved in the Agriculture and Fisheries Council 15/04/2019 without votes against with the abstention of Bulgaria (Directive (EU) 2019/692, 2019).

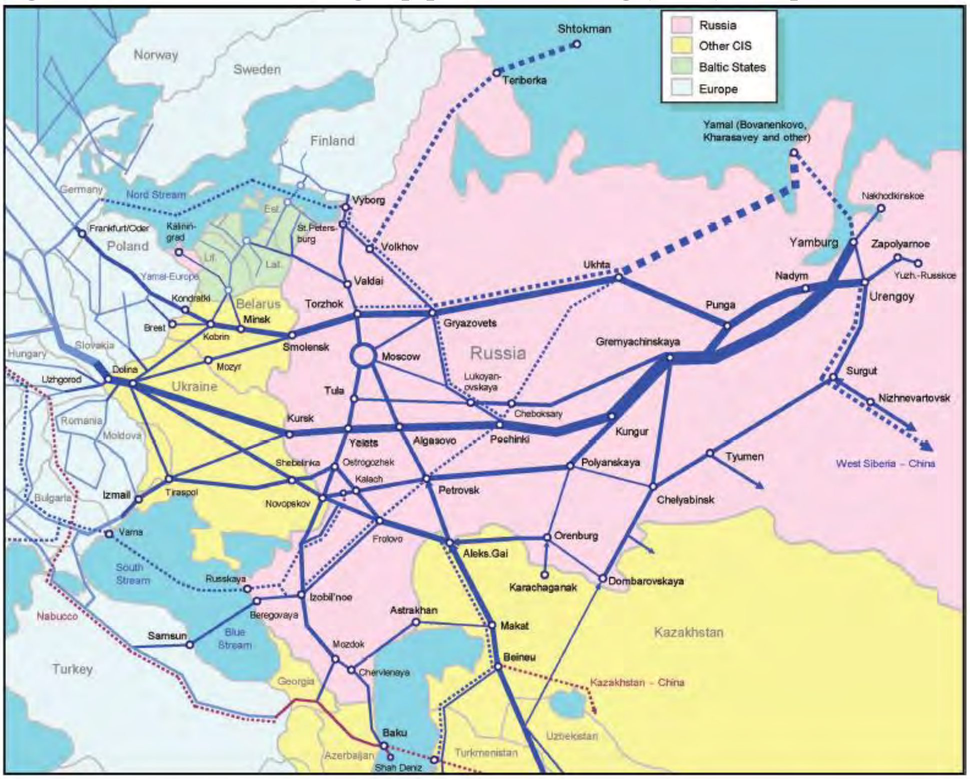
Yafimava (2019) argues that the ruling causes regulatory uncertainty as the German regulator has to decide on the unbundling requirement for the operation of Nord Stream 2 that most probably will lead to some delays in the operation and probably to a 20% cap on the capacities of the pipeline which Gazprom will not be able to use – similar to what has been applied on OPAL in a famous Court Decision (General Court of Justice, 2019) a few month earlier.

Rules adopted are strongly opposed by Gazprom, and a Case has been opened to annul the decision, and it is now in appeal (Case C-348/20 P, 2020). The Amendment was a European-level legal attempt to stop the project on legal grounds, declaring that offshore projects also need to compile with EU rules on unbundling and third-party access, which is certainly a problem for a Gazprom-owned pipeline. Germany had to consider the Nord Stream 2 consortiums' application for derogation from EU rules in a very heated domestic and international political environment and finally rejected the exemption request (Westphal, et al., 2020). While German authorities administratively dealt with licencing issues in 2021, the Russian political pressure to speed up the process and start full operation of Nord Stream 2 strengthened and was communicated by President Putin in numerous television interviews. He was urging the green light for the project to allow for additional supplies to Europe that could stop – in his reasoning – the energy crisis. This leads us to geopolitical considerations.

3.3 Geopolitics

Geopolitics is focusing on the power balance between states in a broader term, not only related to energy politics. It is though undeniable that the natural gas-related power games in Eurasia after the Cold war were all strongly connected to energy: in the Caspian Sea region, in the Caucasus, in Eastern Europe, and finally in the Ukrainian-Russian conflicts. The largest shift in international power balance has been without a doubt the falling apart of the Soviet Union in 1990, which also meant the end of the bipolar world order. The consequences of the natural gas exports have been tremendous as many of the oil and natural gas reserves, and large parts of the transport system have become part of new states as depicted on Figure 12 (Yafimava, 2011, pp. 30-31; Ericson, 2012) . This has been an economic loss for Russia, but also a source of security and military challenge as the Russian influence on these states has weakened. The Caspian region has become a sort of battlefield for the influence of large powers – Russia, Iran, and the USA –, with other close neighbours like Turkey having increasing ambitions in transiting the natural gas resources of the region, and other import-oriented economies like the EU, Japan, and China being interested to get access to the reserves. (Zhiznin, 2007)

Figure 12. Russian natural gas pipelines, existing (2011) and planned



Source: Ericson (2012)

The pipeline infrastructure inherited from Soviet times determined the dependencies of the newly emerged states, many of them relied on Russian pipelines to be able to reach the export markets (e.g., Turkmen gas was sold via Russia and Ukraine to Central Europe). Therefore, the development of oil and gas reserves on the Caspian Sea and the diversification of export routes have been common goals for the new sovereign states bordering the Caspian Sea: Turkmenistan, Azerbaijan, and Kazakhstan. The eastern link was built after lengthy negotiations and at a huge cost from Turkmenistan via Uzbekistan and Kazakhstan to China about 1800 km long in three parallel lines.

On the western route, the plan was to build a so-called Southern Corridor to supply gas to Southern and Central Eastern Europe. On this goal Turkey (as a future transit state) and the EU as a large importing block could easily agree. This idea was strongly backed by the USA, as the US foreign policy assumed that the freedom of the new Central Asian States can only be secured if their dependence on Russia decreases via diversification[11]. The Southern Pipeline route from Azerbaijan to Europe was based on the Shah Deniz fields developed by British Petroleum (a multinational company of European origin) and SOCAR. The Southern Corridor consists of three projects and is connecting the giant Shah Deniz field in the Azerbaijani sector of the Caspian Sea to Italy: Southern Caucasus Pipeline (SCP) connects Azerbaijan via Georgia to Turkey. Trans Anatolian Pipeline (TANAP) runs through Turkey to the Greek border (Figure 13). Trans Adriatic Pipeline (TAP) enters the EU in Greece and runs via Albania to Italy under the Mediterranean Sea. The entire corridor is about 3500 km long, and the building is worth an investment of approximately USD 40 bn, out of which EUR 4.5 bn is the investment into the TAP pipeline[12]. This project has been put into operation stepwise, and the final part – which delivers a new source of gas to the EU – started commercial operations in January 2021.

Figure 13. The Southern Corridor

Source: www.tap-ag.com

Despite the obvious economic interest of all countries around the Caspian Sea to develop the rich oil and gas resources and related undersea pipeline(s), a multilateral framework agreement on how these resources should be divided was completely lacking. Finally, the twenty years long negotiations resulted in a Convention on the legal status of the Caspian Sea, which was a treaty signed by all countries bordering the Caspian Sea: Russia, Kazakhstan,

[11] This statement was done and articulated in a panel discussion available online from the Atlantic Council 16 February 2021: Energy diplomacy and Transatlantic cooperation in action: Opening the Southern Gas Corridor https://www.atlanticcouncil.org/event/energy-diplomacy-and-transatlantic-cooperation-in-action-opening-the-southern-gas-corridor/

[12] www.tap-ag.com

Azerbaijan, Iran, and Turkmenistan on 12 August 2018. The Convention solved the issue of the legal status of the sea and the corresponding mining rights (Kadir, 2019). This agreement might pave the way for further developments and cooperation of natural gas production and transport in the region, e.g., to manage to ship Turkmen gas via the SCP-TANAP-TAP corridor.

Moving from Central Asia to the Caucasus region the geopolitical tensions around natural gas resources resulted in military conflicts as well. Previous to the 2008 Russia – Georgia war, on the 22 of January 2006 the natural gas transit pipeline in Mozdok (at that time the only pipeline supplying gas to Georgia) exploded, just one hour after the high voltage power transmission line Kavkasioni was attacked. The Georgian side blamed the Russian "terrorist" attack for the "accident", which resulted in the complete halt of Russian import of natural gas to Georgia for about a month. Georgian lesson learned was that the "technical" risk of supply disruption outweighs political risks. (Gochitashvili & Javakhishvili, 2012) Therefore, the supply of natural gas to Georgia was completely diverted to Azerbaijan from 2008, when Abkhazia was occupied by Russia. The transit of Russian gas to Armenia kept on flowing. The 2020 war between Azerbaijan and Armenia on Nagorno-Karabakh could have easily escalated to a larger conflict as so many regional interests were present, and the fight endangered the Trans-Anatolian Pipeline route as well, which only passes 60 km away from Nagorno-Karabakh. (Cohen & Arlin, 2020) With the peace treaty supported by Russia as well, it seems now that a long-lasting regional conflict has come to an end.

The longest-lasting and closest conflict to the EU has been the repeated Russian – Ukrainian gas crisis in 2006 and 2009 with worsening geopolitical relationship not only between the two parties but between the EU and Russia, and the USA and Russia, which reached their hights when in 2014 Russia annexed Crimea, and with the still ongoing military actions in Donbas.

Geopolitics around European pipeline investments has been shaped by very different narratives of the Russian –Ukrainian transit dispute by the respective parties consistently blaming each other for the transit disruptions. Vatansever & Korányi (2013) warn that blaming only one side is a serious simplification. No doubt however that the good image of Gazprom as a reliable gas supplier has been seriously eroded in Europe after the 2009 crisis (see more on that in Chapter 5.1). The use of gas as a political weapon against transiting countries and those importing countries that are (close to 100%) dependent on Russian gas has a wide literature. (Kandiyoti, 2015) Eastern European countries with a very high dependence on Russian gas supplies have felt their vulnerability to supply disruptions and the lack of leverage in price negotiations with Russia. The supply security aspects widely discussed in the literature point out that besides the continuous and uninterrupted physical supply, the affordability of prices is also a factor that has to be taken into account. Kaderják (2014) shows by the example of Hungary how infrastructure investment coupled with the introduction of market and competition could increase leverage against the dominant (Russian) supplier.

The Ukrainian transit route dispute and the geopolitics surrounding the Russian perception of Ukraine moving too close to the EU and NATO have been the main cause for the continuous involvement of the USA on this matter. The strong bipartisan support of the USA towards Ukraine has been uninterrupted independently of the person of the president. The USA has been very active on the Nord Stream 2 issues opposing the pipeline on very similar grounds as it happened under the Cold War when the first pipelines between the Soviet Union and Germany were built: claiming that more connection to Russia makes Europe vulnerable and reliant on Russian supplies. (Blinken, 1987) The 2014 annexation of Crimea has further strengthened the arguments about the strong connection between natural gas pipelines and war. Danish opposition has been strongly connected to a strong USA call on the NATO and EU allies to prevent the Nord Stream 2 project to happen. The USA narrative was the most straightforward to articulate the harm the EU – especially Germany – was causing to Ukraine in financial and military terms by assisting the Russian diversification strategy. (EURACTIV with Reuters, 2015)

Besides increased political pressure on European allies, most prominently Germany, the US has utilized the sanctions regime against pipeline laying companies that help the Russian upstream production come online. The mechanism was put in please already in the summer of 2017 (Kaderják, et al., 2018), however, the US retrained from sharpening this weapon, as the EU allies signalled that they do not consider such a move a friendly move – which can cause economic harm to European companies as well. The main goal of Ukraine and the US was to stop the pipeline, but as it became evident that it cannot be stopped, the strategy was changed to delaying the commissioning of the pipeline beyond December 2019, when the Russian – Ukrainian transit contract was about to expire. Such a result could not have been achieved without the US sanctions put in place at the end of December 2019, which led to stopping ship-laying vessels from implementing the projects[13]. The largest armed conflict that developed after the time horizon of the analysis of the thesis, the war of Ukraine and Russia is discussed in chapter 8.6.

[13] Panel discussion: Is Nord Stream 2 an EU and German project? Dissonant voices in Europe February 26, 2021 8:30 AM, https://www.atlanticcouncil.org/event/is-nord-stream-2-an-eu-and-german-project/

4 Methodology

The main analytical tool of this dissertation to assess the impact of gas infrastructure building on prices, competition, and security of supply in Europe is *gas market modelling*. Economic modelling is a suitable toolbox to help the understanding of market developments. In a complex and interconnected network, mathematical modelling is used to quantify the impact of regulatory or infrastructure changes on the market and different stakeholders. To arrive at reliable and trustworthy conclusions a deep understanding of the industry, the regulation in the modelled region and the technological and market developments is inevitable. This knowledge helps to calibrate the model to reflect the observed characteristics of the market. Even the best mathematically sound models might deliver useless results when not the right questions are asked, or assumptions are tested that are wrong or are rooted in the misunderstanding of the regulatory frameworks governing the industry. Therefore, modelling must follow some basic best practices that are worth following to avoid fundamental mistakes.

The European Gas Market Model, EGMM[14] was used in this dissertation. This model was developed in the Regional Centre for Energy Policy Research at the initiative and under the methodological guidance of the director of REKK at that time, Péter Kaderják. The model was developed by a group of researchers among them the author of this thesis. András Kiss formulated the mathematical part of the original model (called the Danube Region Gas Market Model) in 2012 based on the concept of a similar European Electricity Market Model (EEMM), that he developed earlier. László Paizs programmed the input data preparation tool and created the project evaluation cost-benefit calculation module back in 2013. Pálma Szolnoki, Péter Kotek, Adrienn Selei, and the author of this thesis formed the team who designed the original concept of the model, filled up with data and tested the runs. Later the team extended the model's geographical coverage from the original 12 countries to 35 countries and fine-tuned the input dataset. The LNG module has been

[14] The detailed description of the model is available in Kiss, Selei and Takácsné Tóth (2016) and the detailed formulas are provided in the Annex 1. to this dissertation

developed by Péter Kotek. As described earlier, the author has been adding to the REKK teamwork mainly by conceptualizing the geopolitical changes in the gas market and the shifts in the market positions of key players, changes in the European regulation and thereby formed the model calibration updates to reflect the changing market realities in the simplified perfect competition setup of the model. The other important task of the author for the modelling chapters of this thesis was to formulate the scenarios and analyse and interpret the modelling results. Actual model runs were mainly done by Péter Kotek and Adrienn Selei.

The next chapter provides a short overview of gas market model types, what they are used for, and their basic characteristics, that helps to better position the EGMM in the modelling world. The most important building blocks of EGMM are shortly introduced but the modelling indices and formulas are kept for the annex. The modelling approach used for infrastructure assessment is described next, followed by the scenario development and the limitations of modelling.

4.1 Gas market modelling

Energy sector modelling has a wide range of literature and there are many different models used for different purposes. The energy system models like the TIMES model or the PRIMES model are typically used to capture the interrelations of the entire energy system of a country (or the EU) related to assumptions on GDP, demographical developments, and macro policies. These sort of models helps long-term planning of the energy strategy by simulating the energy consumption and the energy supply system. As an output, they define among others the fuel mix and investment need into different technologies for example to achieve different emission goals.

Sectoral models of the electricity or gas sector focus more on the functioning of a narrower sector but with more accuracy as it has a more detailed representation of the network, supply, and demand. These models are often used to define the infrastructure need, the supply structure, flows on the infrastructure, and prices on the markets. In the natural gas sector, two distinct model families are used. One group is called the “North American” model when perfect competition is assumed explicitly. The other group uses game theoretical equilibriums, these are called “European” models. The names refer to the competitive nature of the US markets and to the more concentrated and oligopolistic European ones. Still, these names are outdated and misleading, as today the European regulatory framework has implemented unbundling and third-party access to the network, hence for the wholesale segment we can argue that it is de facto competitive. For the model groups there is a clear trade-off: while “European” game theoretical models have more sophisticated mathematical solutions, they sacrifice the detailed representation of supply and demand due to necessary simplifications on the input part; the “North American” perfect competition models, on the other hand, offer more realistic empiricism and sacrifice the theoretical sophistication.

When models are compared, the typical classifications use the following key characteristics: the purpose of the model; behavioural assumptions used; simulation or optimization; expectations of the players, dynamic or static; sectoral aggregation; geographical coverage; pricing principles of the infrastructure and the granularity. (Table 1) Some models that are used to assess the European gas markets are “North American” type, among these EGMM as well. The purpose of EGMM is to describe prices and quantities in the European gas markets. Models however still differ in their geographical coverage, some cover North America or the Americas, some Western Europe, others the EU, and there are even a few global models. Models also differ in the granularity they apply: some have only one period, some operate with two seasons, and the EGMM has 12 consecutive months.

Table 1. The typology of gas market models

Model property	GTM (America)	GRI (America)	AGAS (America)	EGM (Europe)	DYNOPOLY (Europe)	Coopers & Lybrand (Europe)
Purpose of model	Describe prices and quantities in the North American gas market	Describe prices and quantities in the North American gas market	Describe prices and quantities in the North American gas market	Investigate the nature of the market equilibrium in the west European gas market	Strategic investment game between Norway, Russia and Algeria	Forecast gas demand and price equilibrium in individual countries
Behavioural assumptions	Perfect competition	Perfect competition	Perfect competition	Nash-Cournot players, perfect competition, collusion	Nash-Cournot where players maximise discounted future profits under perfect foresight	Simulates equilibrium between supply and demand
Simulation or optimisation	Optimisation	Optimisation	Optimisation	Optimisation	Optimisation	Simulation
Expectations	Myopic	Perfect foresight	Perfect foresight	Myopic	Perfect foresight	Myopic
Dynamic relationships and properties	Static cost and demand functions market model	Cost curves containing shadow price of reserves, static demand functions	Static supply and demand	Static equations	Static demand functions, investments determine capacities in subsequent periods	Lagged values in demand equations
Sectoral aggregation	Residential, manufacturing, electricity generation	Residential, manufacturing, electricity generation; Core and non-core markets	One aggregate function in each region	Household, industry, electricity generation	Economy-wide demand function	Residential, industry, electricity generation
Geographical coverage	USA, Canada, Mexico	USA, Canada, Mexico	USA, Canada, Mexico	Demand: NL, FR, BE, NL, IT, UK Supply: RU, NO, DZ, LY	Strategic players: RU, NO, DZ Demand: European Community	All West and Central European countries using gas
Pricing principles in transmission and distribution	Cost-plus	Cost-plus	Cost-plus	Cost-plus	Cost-plus	Cost-plus

Source: ECON Report Nr 89/97

4.2 The European Gas Market Model

Table 2 shows the European Gas Market Model's main features along with the specifications used in the ECON Report (1997).

Table 2. Specification of EGMM

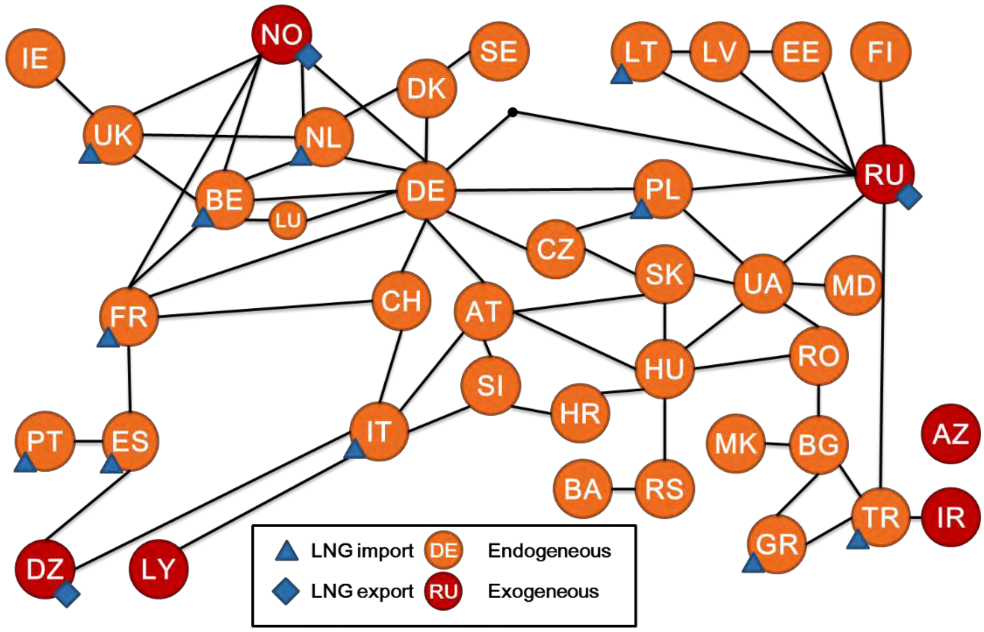
Model property	Europe
Purpose of model	Investigating the natural gas market in the EU and its neighborhood
Behavioural assumptions	perfect competition
Simulation or optimisation	optimization
Expectations	perfect foresight
Dynamic relationships and properties	dynamic partial equilibrium, optimization
Sectoral aggregation	optional: total demand or three sectors (household and services, electricity generation, industry
Geographical coverage	European Union 28 + Switzerland + Turkey + Energy Community Contracting Parties
Pricing principles in transmission and distribution	cost-plus

Source: own assessment based on ECON classification

EGMM is a competitive, dynamic, multi-market partial equilibrium model that simulates the operation of the wholesale natural gas market across the whole of Europe. It includes a supply-demand representation of EU28 countries, Switzerland, and the Contracting Parties[15] of the Energy Community, and Turkey, including gas storage and transportation linkages. Large external markets Russia, Norway, Libya, Algeria, Azerbaijan, Iran and LNG exporters are represented exogenously with market prices, long-term supply contracts, and physical connections to Europe. (Figure 14)

[15] Contracting Parties of the Energy Community Treaty are the European Union and Albania, Bosnia and Herzegovina, Georgia, Kosovo, Montenegro, North Macedonia, Moldova, Serbia and Ukraine.

Figure 14. Geographical representation of the EGMM model



Source: REKK

The timeframe of the model covers 12 consecutive months and market participants have perfect information over this period. Dynamic connections between months are introduced by the operation of gas storages and take-or-pay constraints (minimum and maximum deliveries are calculated over the entire 12-month period, enabling contractual flexibility).

The European Gas Market Model consists of the following building blocks: (1) local demand; (2) local supply; (3) gas storages; (4) external markets and supply sources; (5) cross-border pipeline connections; (6) LNG infrastructure (7) long-term take-or-pay contracts; and (8) spot trading. (For more information on the building blocks and the mathematical description of EGMM please turn to the Annexes)

To reflect the very important features of the European natural gas market – as described in the introduction chapter – the EGMM input dataset has been developed throughout the years in various research projects and with the active participation and often project management of the author of this dissertation.

1. The *cost of transportation is reflected* by entry and exit tariffs on the interconnection points of the system (trade), the production entry

points, the storage entry and exit points, and the domestic exit points (consumers). The tariffs applied are based on yearly data collection from the regulatory authorities' websites. The use of tariffs enables running modelling scenarios that can test the regulatory barriers related to tariff pancaking (when transiting countries set the tariffs above the actual cost of transportation to collect part of the producer's rents). It is also possible to test the competitiveness of certain routes, like the traditional Ukrainian route with the new Nord Stream 2 route. This tariff option has been used in the modelling chapters of this dissertation. It must be noted that the modelling of the European Network of Transmission System Operators (ENTSO-G) does not have this feature and is not taking into account the cost of transportation when modelling the gas markets.

2. The *detailed representation of long-term contacts* in the EGMM modelling supports the calibration of the perfect competition model to reflect the limitations of this basic assumption when being applied to the European gas markets. The long-term contracts in the modelling are defining the volumes and costs of supply between buyers and sellers and the inflexibilities of the deliveries applying to take or pay provisions. The delivery routes of these long-term contracts are also pre-defined in the EGMM based on data collection from CEDIGAZ, IEA, and different articles of the Oxford Institute of Energy Strategies, the European Commission's Quarterly gas reports, or academic publications. In the different modelling chapters of this dissertation, the calibration of the long-term contracts is different, as it has been based on the latest available information at the time when the modelling was performed. The scenarios in the modelling utilize this modelling feature by making use of the possibility to set up scenarios when the long-term contracts between Russia and its buyers are delivered on different routes or by using different pricing strategies. Contract prices can be given exogenously, indexed to internal market prices, or set to a combination of the two options. The delivery routes must be specified as input data for each contract. It is possible to divide the delivered quantities among several parallel routes in pre-

determined proportions, and routes can also be changed from one month to the next.

3. The *development of future infrastructure* in the EGMM reflects the European way of infrastructure investment: the pipeline investment is not an endogenous decision in the model but is rather based on the long-term network plans of the European TSOs. The scenarios of the modelling chapters therefore can build upon the assessment of different envisaged pipeline scenarios comparing their (exogenous) costs and (modelled) benefits.

4.3 Literature of pipeline infrastructure modelling in Europe

There is extensive literature on the numerical modelling of natural gas markets. Prominent modelling tools and applications focus on the European consumer market. The models and publications using them are listed in Table 3.

Table 3. European gas models and related publications

Model	Publication
GASTALE	Boots et al. (2004), Egging & Gabriel (2006)
NATGAS	Zwart (2009)
TIGER	Lochner & Bothe (2007), Lochner (2011), Dieckhöner et al. (2013)
GASMOD	Holz et al. (2008)
RAMONA	Fodstad et al. (2016)
World Gas Model	Egging et al. (2010)
Global Gas Model	Holz et al. (2013), Richter & Holz (2015)
GaMMES	Abada et al. (2013)
EPRG-Gas Market Model	Chyong & Hobbs (2014)

Source: own compilation

These models assessed the security of supply resilience of the network (2006-2015) then the impact of increased LNG inflow (2010-) and finally also the impact of Russian pipeline policy (2012-) on the European gas network, on the security of supply and prices. The security of supply of the gas markets and how certain gas disruption scenarios would impact the security of supply in Europe and which countries would be impacted most have been tested mainly after the 2009 crisis and reached their peak in 2014-15 when the annexation of Crimea and the de facto war between Ukraine and Russia posed an unusual threat to EU gas supplies. Lochner (2011) modelled with the TIGER model the Ukrainian crisis and found that storage stock and reverse flow on existing pipelines are needed to prevent supply cuts to consumers in Bulgaria, Serbia, and Romania. Richter and Holz (2015) modelled Russian disruption scenarios and arrived at the same conclusion, that due to infrastructure bottlenecks some Eastern European countries cannot be supplied in a crisis, while in general Western Europe is not severely affected. The impact of new gas infrastructures on different outcomes was extensively analysed using market modelling tools in the literature. Many papers assessed the impact of the Russian pipeline strategy: Mitrova, Boersma, & Galkina (2016), Paltsev (2014) and Vatansever (2017) examined several gas import and infrastructure scenarios: disruption of Ukrainian transit, the commissioning of Nord Stream 2, South Stream, and TurkStream 2. They concluded that the European gas mix is fairly robust and will maintain a significant share of natural gas from Russia in all scenarios even if the Ukrainian system is not used. They also found that Europe will suffer a significant price spike if Russian deliveries circumnavigate Ukraine. On the other hand, Henderson and Sharples (2018) argue that Europe's growing need for gas imports due to decreasing inland production cannot be satisfied without the Ukrainian system even if Nord Stream 2 and TurkStream are built.

The social welfare effect of the new gas infrastructure was also extensively analysed. Hecking and Weiser (2017) examined the capacity extension effect of the Nord Stream pipeline and found a significant (between 13 and 35 billion€/year in the 2025 scenario) increase in aggregate EU28 consumer welfare. Abrell, Chavaz, and Weigt (2016) conclude that Nord Stream 2 would lower European gas prices by around 6%, yielding around 1% growth in social welfare, assuming that the Ukrainian system is not used for gas transit. Our previous study analysed the effect of the Russian export strategies and new transit infrastructure on European social welfare and wholesale gas prices (Takácsné, et al., 2020).

Some models even go beyond the static approach and allow for infrastructure changes within the time frame of the simulations. Lise&Hobbs (2008) extend the GASTALE model to automatically include new pipelines and storage units whenever the forecasted congestion rents exceed a specified threshold value. In the Global Gas Model, transmission and storage system operators decide about new investments based on a private cost-benefit analysis. The RAMONA model also represents a strategic long-term perspective on infrastructure decisions (Fodstad, et al., 2016).

More recently combined electricity and gas modelling was applied by Deane, Ciaráin, and Gallachóir (2017). They find that interruption of Russian gas supply to the EU could lead to a rise in average gas prices of 28% and additionally 12% in electricity prices.

Moreover, Eser, Chokani, and Abhari (2019) connect two existing models, a market and a network model and run them combined: the market model sets the broader pricing conditions while the network model in the follow-up run optimizes the flows in a very detailed network setting. Their results show that Europe would have to pay a very high price to substitute Russian gas with LNG and additional investments into reverse flow capacities on existing pipelines would be needed.

Reflecting on the changing European policy setting the impact of decarbonization and the declining demand has been assessed. Analysis by Holz&Kemfert (2020) suggests that if there is a decreasing gas need due to the decarbonization agenda there is no need for more gas pipelines nor LNG terminals in Europe. Similar results are reached by von Hirschhausen, Kemfert, & Praeger (2020) who point out the huge risk of gas infrastructure becoming stranded assets as they estimate an accelerated phase-out of natural gas by 2040. These two studies, related to the German Institute for Economic Research (DIW) are also reflecting the Nord Stream 2 (or as they call it Baltic

Sea Pipeline) arguing that German politics should not prioritize the project but should rather stop it.

The welfare effect of PCI projects was also analysed previously in the literature. Kiss, Selei & Tóth (2016) analysed the welfare effect of a set of shortlisted gas PCIs from the second PCI list in Central Eastern Europe and South East Europe and identified those combinations of projects that result in the highest net benefit.

Kotek, Crespo, Egging, & Takácsné (2019) evaluated the social economic value of the PCI projects from the third list using three models with different spatial-temporal resolutions and information structures. Their results show that the decarbonization goals do not need much investment in gas infrastructure, as the gas demand projections are decreasing, and this lower demand can be served by the current infrastructure, and only a limited number of PCIs are needed.

The dissertation contributes to previous academic research done in the field of regulation of natural monopolies especially in the field of energy networks by assessing with market modelling tools the use of different pipeline routes and marketing strategies of Russia. (Chapter 5)

Modelling applied in the dissertation contributes to the understanding of how changing parameters of the long-term contracts (annual contract quantity, flexibility, and especially change in delivery point and capacity bookings along the route) impact wholesale gas prices of the European countries and the welfare of the citizens. The dissertation adds to the modelling literature the Russian perspective, by applying profit maximization to the Russian sales strategy when selling spot volumes to the European market complementary to long-term contract deliveries. (Chapter 5)

The dissertation also contributes to the development of a methodological sound modelling-based cost-benefit analysis of infrastructure investment applied to the European gas PCI projects. (Chapters 6 and 7)

Thereby the competitive nature of the European and the Russian pipeline strategy is captured which is new in the literature.

4.4 Scenario-based modelling of infrastructure investments

The scenarios developed here are not for forecasting the future but to enable the comparison of possible infrastructure setups or marketing strategies. To set up the basis for comparison, the so called the reference scenario, a deep understanding of the market functioning is required. How precise the modelling can reflect the reality, depends by large on the availability and reliability of the underlying datasets. In this regard we saw a tremendous development throughout the years between 2010 and 2020. The third energy package in 2009 set up the ENTSOG and as a main task ENTSOG must provide transparency to the market. Basic data on infrastructure capacity, regulatory frameworks, bookings and daily market flows are now publicly available. Part of this data is used as input, but other parts for verification. Verification means checking the outputs, how precise the modelling can reproduce the flows and prices that are actually observed on the pipelines (see more on that in chapter 4.5). The selection of scenarios is reflecting the alternative options being considered at a given point of time by the decision makers or analyst.

4.4.1 Incremental approach

A comparative static framework is used for the evaluation of pipeline investments, contrasting equilibrium outcomes with and without the investments, that is called incremental approach. In chapter 5 the different Russian pipeline investments are compared to the reference (calibrated to market reality as of 2019). In chapter 6 different sets of the EU PCI projects are added to the 2020 and 2030 reference scenarios. Finally in chapter 7 the impact of Nord Stream 2 is measured using a reference with and one reference without the project. The same PCI project will be assessed one by one to these two references to test their usefulness for the EU. Based on the selected outputs of the modelling the scenarios are compared to each other or to a common reference baseline. In this dissertation the main indices used to measure the changes caused by the modelled infrastructure or scenario are the benefit per cost ratio (B/C), the net present value (NPV) or the change in wholesale gas prices of countries and welfare of different stakeholders. The next chapter explains how a modelling-based cost-benefit analysis (CBA) method was applied in chapter 6.3 and chapter 7.3.3.

4.4.2 Socio-economic cost-benefit analysis

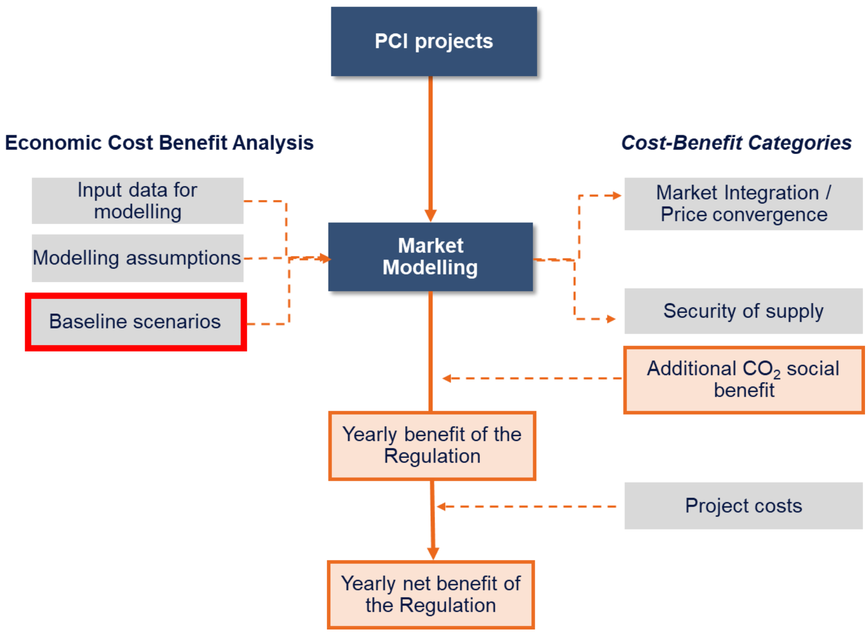
As defined by the European Commission in its “Guide to Cost-Benefit Analysis of investment projects” (European Commission, 2014), CBA is an analytical tool to be used to appraise an investment decision to assess the welfare change attributable to it. The CBA methodology used during the PCI selection process has been developed by the ENTSO-G as required in Article 11 of the TEN-E Regulation 347/2013. This CBA methodology is used to assess the system's needs to elaborate the Ten-Year Network Development Plans, and then to assess the projects through an incremental approach for the PCI selection process. As part of the CBA analysis, network and market modelling are necessary for system and project assessment. This method is based on a multi-criteria analysis (MCA), combining a monetised CBA with non-monetised elements. These indicators are then used by the Regional Groups in the evaluation of the candidate projects for the PCI list before submitting the proposal for the draft PCI list.

Although this methodology is subject to continuous fine-tuning based on the opinion of the European Commission and other stakeholders, there are still shortcomings to be solved. The Florence School of Regulation (2020) for example, points at the lack of full monetisation of the CBA indicators as a pitfall of the CBA methodologies, which makes the assessment process less transparent and objective. Another important drawback of this methodology is that it evaluates projects one by one, and hence does not consider the competitiveness or complementarity among projects. A recent study by Trinomics and Artelys (2020) points out that the oversimplistic sustainability indicators used by ENTSO-G are capacity based and not flow based, therefore the calculated CO_2 emission savings are independent of the potential use of the project and cannot capture the effects caused in third countries. De Nooit (2011) argues that while the MCA leaves it to the decision-maker in dialog/debate with society to make the trade-off, CBA tries to infer the weights by establishing how citizens make these trade-offs by expressing all effects in monetary terms. Based on a critical assessment of the socio-economic cost-benefit analysis of three electricity transmission lines, he claims that CBA is likely to get closer to answering the question of what happens to welfare than MCA. We share the concerns of Nooit and will restrict our analysis to a CBA without any application of an MCA, and as van Nuffel (2020) suggests we calculate CO_2 emission impacts flow-based.

The CBA applied in this dissertation is a simplified version of the methodology that has been developed in studies of the Energy Community Secretariat on project evaluations between 2013-2019 (REKK & DNV GL, 2020). It does not include the qualitative multi-criteria assessment.

A methodologically sound socio-economic cost-benefit analysis requires that market integration, security of supply, and sustainability impact of the infrastructure are monetized. The conceptual framework on how these categories are estimated by modelling is depicted in Figure 15.

Figure 15. Conceptual framework of gas market modelling



Source: own depiction (REKK & DNV GL, 2020)

During the modelling, we follow the total welfare approach. Welfare is quantified for all stakeholder groups including consumers, producers, traders, and infrastructure operators. We also use an incremental approach, total welfare change is measured by modelling with and without the PCIs. Changes in all welfare components due to price and flow changes in the TEN-E scenarios (when PCIs are included) compared to the Baselines capture the market integration benefits and partly the competition-related benefits.

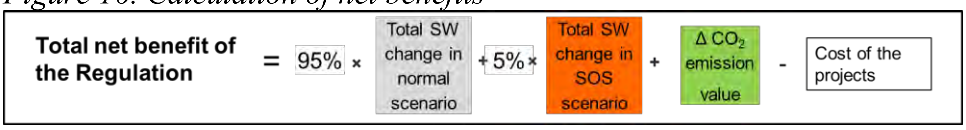
The security of supply benefits are measured by the change in welfare in the case of a modelled gas supply disruption. This disturbance is assessed as a 100% reduction of the riskiest delivery route of Russian long-term contracts in January for one month (on the Ukrainian route in 2020 and on the Turkish route in 2030). The difference in welfare between supply shock scenarios with and without the projects represents the security of supply benefit of the evaluated PCIs.

To calculate the aggregate change in socio-economic welfare for a given year due to the evaluated PCIs, we calculate the weighted sum of project-related welfare changes under normal and SOS conditions. Weights are the assumed probabilities for normal and SOS scenarios to occur: 95% normal, 5% supply disruption – assuming a 1 in 20 probability of disruption.

Sustainability benefits are estimated by the reduction in greenhouse gas emissions. For gas infrastructure projects, this is estimated by multiplying the corresponding change in the countries' CO_2 emissions with an exogenous carbon value. The modelled change in gas demand alters the average primary energy mix without crowding out renewables.

As a next step, these overall yearly benefits are compared to the yearly investment cost of the evaluated projects: net benefit and a benefit per cost ratio are calculated. Investment costs are annualized assuming a 25-year assessment period and a 4% social discount rate. (Figure 16)

Figure 16. Calculation of net benefits



Note: SW = social welfare
Source: own compilation

4.5 Data sources

Data for the modelling scenarios were derived from publicly available sources: infrastructure capacity data on transmission, LNG, and storage from Gas Infrastructure Europe, demand and production data from Eurostat, and future forecasts from Primes or IEA. For publicly not available data on long-term contract prices the foreign trade statistics formed the basis of estimates (Table 4).

Table 4. Summary of modelling input parameters and data sources

Category	Data Unit	Source
Consumption	Annual Quantity (TWh/year) Monthly distribution (% of annual quantity)	PRIMES or Eurostat, supplemented by Energy Community or Eurostat data if applicable
Production	Minimum and maximum production (GWh/day)	PRIMES or Eurostat, supplemented by Energy Community or Eurostat data if applicable
Pipeline infrastructures	Daily maximum flow (GWh/day)	GIE, ENTSO-G, Energy Community data
Storage infrastructures	Injection (GWh/day), withdrawal (GWh/day), working gas capacity (TWh)	GSE
LNG infrastructures	Regasification capacity (GWh/day)	GLE, GIIGNL
LTC contracts	Yearly minimum maximum quantity, Seasonal minimum, and maximum quantity	Gazprom, National Regulators Annual reports, Eurostat, Platts, Cedigaz
Storage, LNG regasification, and transmission tariffs	€/MWh	TSO, SSO, and LSO webpages

5 Russian natural gas pipeline strategy

This chapter provides a modelling-based analysis to examine the economic rationale behind Russian export strategies to Europe under different transit route combinations [16], Ultimately it is for the seller to determine its optimal marketing strategy and transport route, and once alternative routes bypassing its transit are in place, Ukraine cannot force Gazprom to use its network. While examining the benefits and costs of certain marketing strategies for Russia, special attention is given to the role and exposure of the so-called Visegrad 4 (V4) countries[17] in the larger geopolitical game. With a common history of high Russian gas dependence, the V4 welfare position will change with the rerouting of the traditional gas supply in anticipation of reduced transit through Ukraine.

5.1 Transit risk and diversification

Russia was the main supplier of gas to Europe by the end of the Cold War and was the monopoly supplier in the Eastern part, the Baltics, and the Balkans. Relations with Germany have been based on mutually beneficial interdependence, meaning that Germany has been the largest European buyer of Gazprom, and Gazprom has been the largest import source for Germany. Russian supplies were part of a good mix together with their domestic production, Dutch and Norwegian supplies. Therefore, a stable supply to Germany was key for Russia and Gazprom as well (Högselius, 2021).
Against this background, the collapse of the Soviet Union (1990) and the accession of Central Eastern European countries to the EU (2004, 2007, 2013) challenged Russia's geographical sphere of influence (Deák, 2019). Russia was relying on fossil fuel revenues, which provided 30-50% of the federal budget revenues depending on changes in gas prices. (Sabitova &

[16] Publication supporting this chapter: Tóth, B. T., Kotek, P., & Selei, A. (2020). Rerouting Europe's gas transit landscape-Effects of Russian natural gas infrastructure strategy on the V4. *Energy Policy*, *146*, 111748 Parts of the text of this publication have been taken over without modification in this chapter.
[17] Czechia, Hungary, Poland and Slovakia

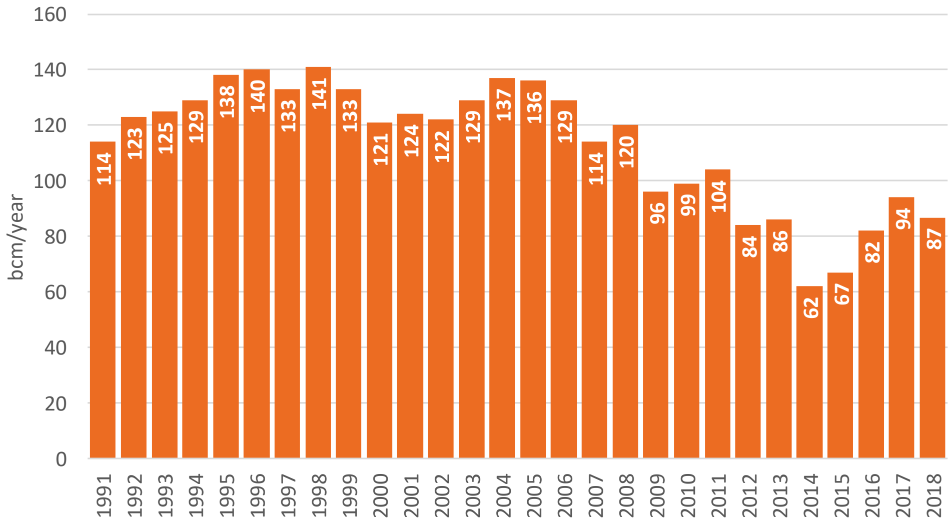
Shavaleyeva, 2015) Russia suddenly had to face transit risks as the Soviet Union fall apart, losing the ability to fully control the natural gas value chain (Yafimava, 2011).

Russian strategy was to secure the assets and was keen to get hold (secure ownership) on the gas transit infrastructure. This has been strongly refused by the transit states as they considered that holding the key infrastructure in national ownership provides them leverage against Russia in their gas price and transit fee negotiations. Their vulnerability towards the Russian gas supplies was inevitable, with all security consequences from supply disruptions to unilateral price increases. The transit framework of the 1990s, which relied partly on gas for the transit service and special prices for the countries of the former Soviet Union, could not resist the changing market and political circumstances. A smooth development to a mutually acceptable price and service structure could not be reached, and trust between the parties, which is inevitable for cooperation vanished. As Katja Yafimava puts it: „The January 2009 Russia-Ukraine gas crisis was the result of a spectacular failure of all bilateral and multilateral frameworks underpinning Russia-western CIS gas transit relationships, when both of the contractual and the legal/regulatory spaces broke down, leading to the breakdown of the space of flows" (Yafimava, 2011, p. 333).

Security concepts build on Buzan's Regional Security Complex Theory (Buzan 1991) but the analysis of Katja Yafimava on the Russian transit (2011) also points to the interdependencies of the exporting and importing countries, highlighting that the security perspective of the producing countries leads to similar strategies as of the consumers. Diversification of supply routes is key to them as well: to reduce transit risks and diversification of buyers and to reduce exposure of the state budget revenues on gas sales to a dominant buyer market.

Therefore, the Russian energy strategy, adopted in 2010, formulated the need to reduce transit risk, to bypass Ukraine as a transit country on the way to the main buyers in Europe. The move was strategically logical, although a rather costly solution. The energy strategy of 2010 calculated a total investment need of 277-289 billion USD on 2007 prices into the gas pipeline transportation system between 2019-2030 (MERF, 2010, p. 147). The highest priority was given to Nord Stream, followed by South Stream. The idea of the diversification of buyers - namely to connect China and Korea - has been given a lower priority. Keeping the stable supplies of volumes on the European market was the main goal. Rebuilding a new multilateral framework "*Elaboration of initiative proposals for updating the existing and formulating new international legal documents in the energy sector, including the development of internationally-recognized rules of transit and establishment of the mechanism for transit risks insurance*" (MERF, 2010, p. 165) was among the strategic actions listed. In the following energy strategy (MERF, 2019) the same strategy was further deepened with a growing emphasis on diversification towards Eastern Asia, but the main line did not change. In the 1990s the Ukrainian system carried 140 bcm of gas which by 2018 is down to about 87 bcm after recovering from the historical low of 58 bcm in 2014 (Figure 17).

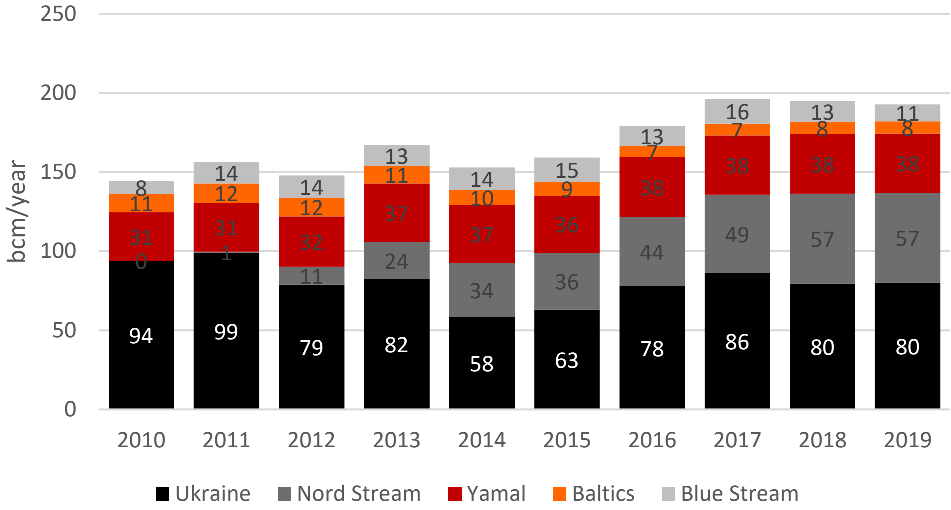
Figure 17. Transit volumes in Ukraine 1990-2018, bcm/yr



Source: Based on data from Ukrtransgaz and Naftogaz (Takácsné Tóth, et al., 2019, p. 212)

Figure 18 illustrates growing Russian sales amidst a successful diversification strategy. Russian natural gas imports (about 150-200 billion cubic meters per year) constitute 35% of the EU28 plus Turkey's gas consumption, showing a substantial increase from 2015 to 2018.

Figure 18. Russian deliveries on main gas transport routes into the EU and Turkey 2010 –2019, bcm/yr



Note: Gas measured at standard cubic
Source: Based on the IEA database on European gas flows. meters (Takácsné Tóth, et al., 2019, p. 212)

The Baltic countries are supplied by Russia directly and via Belarus, the Polish market is reached through Belarus via the Yamal pipeline and also via Ukraine. Germany is directly connected via the Nord Stream 1 offshore pipeline under the Baltic Sea. Turkey was first directly connected with Russia via Blue Stream under the Black Sea. Turk Stream 1 became operational from 2020, reducing the Ukrainian transit through the Balkans by 15 bcm/year. (Figure 19)

Since 2013, Ukrainian transit represents less than 50% of Russia's total natural gas export to Europe and Turkey. The decline continued from 1 January 2020 with TurkStream 1 (15.75 bcm/year capacity) starting to deliver gas from Russia directly to Turkey and rerouting all Turkish, Bulgarian, Greek, and North Macedonian contracts to the Southern route. The rerouting of further contracts from the Ukrainian route is set to continue with Gazprom planning to double the capacity of Nord Stream. Though the main priority was the northern route for Russia, due to unexpectedly high opposition of some key players (like the European Commission and the US governments) and minor actors (Polish and Danish authorities), the TurkStream 2 was put earlier in operation (from 1. January 2020 additional 55 bcm/year) together with the connecting infrastructure through Bulgaria, Serbia and Hungary called the Balkan Stream (15.75 bcm/year down to 6 bcm/yr at the RS-HU border by 1. October 2021).

Figure 19. Map illustrating the Russian pipeline strategy to bypass Ukraine

Note: The map serves illustration purposes. Blue lines depict the main routes via Ukraine, entering the EU in Poland, Slovakia, Hungary, and Romania. The red lines indicate the pipelines built after 1990 with Nord Stream and TurkStream being the two large trunk pipelines providing the backbone of the diversification strategy.
Source: own depiction using ENTSOG's pipeline map as a basis

The transit contract concluded following the 2009 gas disruption crisis between Russia and Ukraine has not proven to be a stable framework for business relations over the next ten years. Disagreements were leading to the largest claims on record for a transit agreement before the Stockholm Court of Arbitration lasting four years. Gazprom won USD 2 billion in the first arbitration ruling on Russian gas supplies to Ukraine in December 2017 over gas that was delivered but not paid for by account of price disagreement. In February 2018, the next case ruled that Gazprom should pay Naftogaz USD

4.56 billion in damages for not transmitting the agreed amount of natural gas to Europe under the 2009 transit deal. This means that Naftogaz is owed a net USD 2.56 billion by Gazprom, a celebrated victory for Naftogaz, but heavily debated by Gazprom (Eyl-Mazzega, 2018; Pirani, 2018a).
In the days following the ruling the agreed renewal of direct deliveries of gas from Russia to Ukraine that was supposed to start on 1 March 2018 was cancelled which, together with cold weather, high demand, and an unexpected fall out of part of Norwegian supply, led to the largest ever price spike at that time (and up until 2020) on European spot markets. Still, the European gas network and the internal market have proved to be resilient, and consumers could be supplied without major interruptions (Kotek, et al., 2018).
We found that previous modelling literature (see the chapter on methodology for gas market modelling) has covered different infrastructure scenarios extensively while largely neglecting the impact of possible Russian gas marketing strategies: how Russia might use the available infrastructure capacities for long-term or flexible spot deliveries and how the Russian gas can be priced to maximize the Russian profits. It follows that our modelling exercise aims to contribute to the discourse by incorporating the effects of Russian sales and marketing strategies with the different infrastructure scenarios. The outputs follow a similar structure to these other authors – Russian profits from European gas sales and the welfare change across European markets are examined.

5.2 Scenarios and main assumptions

Using market modelling as a primary analytical tool we examined the effect of the possible Russian sales strategies under the assumption of new transit pipelines and ensuing changes to delivery routes. The welfare effect in the V4 and EU28 along with profit change for Gazprom was quantified in the different scenarios. The analysis was carried out using the European Gas Market Model (EGMM), as described in chapter 4. The scenario assessment was executed for the year 2025 when key pieces of infrastructure (Nord Stream 2 and TurkStream 1-2) were assumed to be in place. Furthermore, by

2025 domestic production in Europe was assumed to fall dramatically setting a new normal for import demand. All scenarios used the PRIMES reference scenario demand and production data.[18] The infrastructure assumptions included existing interconnectors, storages, and LNG terminals plus those projects that have already reached FID by 2019.[19] The base case defined nine scenarios in two dimensions.

The first dimension is the future of Russian gas international pipelines:[20]

- TurkStream 1 materializes (TS1).
- TurkStream 1 and Nord Stream 2 materialize (TS1_NS2).
- TurkStream 1-2 and Nord Stream 2 materialize (TS1_TS2_NS2).

The second dimension is the gas sales strategy of Russia through Ukraine:

- No transit through Ukraine. The Russian long-term contracts currently delivered through Ukraine are rerouted (detailed below) (0).
- Only long-term contracts are delivered through Ukraine (LTC).
- Gazprom continues to use the Ukrainian system not only for delivering long-term contracted gas but also for short-term (spot) trading. In these scenarios Russian spot gas is sold to German and Austrian markets, however, Gazprom does not sell gas directly to Ukraine (LTC+spot).

Combining the two dimensions results in nine scenarios numbered accordingly in Table 5.

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[18] PRIMES reference case is not a forecast rather a prolongation of 2016 energy market trends to the 2050 time horizon. The scenario assumes that 2020 climate goals are met, and climate policies enacted until December 2014 are in place. On the simulated time horizon natural gas keeps its place in the primary energy mix, and the European gas consumption does not change compared to the 2015 level. The reference scenario is considered a conservative approach.

[19] IT-CH, BG-RS (IBS), CH-FR, CH-DE, TR-GR (TAP), GR-IT (TAP), GE-TR (TANAP), GR-BG (IGB), SI-HR, HR-SI, IT-AT, AT-DE, DE-AT, GR-AL (TAP), RO-HU (BRUA), FI-EE (Balticconnector), PL-LT (GIPL), LT-PL (GIPL), EE-LT2, LT-EE2, DK-SE2, AZ-GE, PL-SK, SK-PL, RO-BG, BG-GR, TR-BG, RO-MD, RS-HU (Southern Corridor) LNG terminal expansions in Poland, Greece and Spain.

Table 5. Modelled scenarios of the Russian natural gas pipeline strategy

	TS1	TS1 and NS2	TS1, TS2 and NS2
No transit (0)	(1) TS1_0	(4) TS1_NS2_0	(7) TS1_TS2_NS2_0
Only long-term contracted gas (LTC)	(2) TS1_LTC	(5) TS1_NS2_LTC	(8) TS1_TS2_NS2_LTC
LTC + spot (spot)	(3) TS1_LTC+spot	(6) TS1_NS2_LTC+spot	(9) TS1_TS2_NS2_LTC+spot

Source: REKK EGMM modelling

Beyond the abovementioned infrastructure assumptions and sales strategies, the scenarios differ according to the routes and delivery points of long-term contacts and the price of spot gas sold by Russia. The routes of long-term contracts are determined as follows (for more details see the Annex 2):

- Scenarios in which Russia delivers long-term contracts through Ukraine, and long-term contracted gas to Hungary,[21] Serbia, Bosnia, Croatia, Romania, Moldova, Bulgaria, Greece, and Macedonia are transited through Ukraine independently from the possible alternatives.
- In scenarios in which transit through Ukraine is avoided, all the above contacts are rerouted to alternative delivery points.
    - If only TurkStream 1 is commissioned, all the above contracts are rerouted to this Southern route from Turkey, meaning only 36% of the contract volume can be delivered due to capacity constraints (Scenario 1).
    - If Nord Stream 2 is also commissioned some contracts are rerouted here: Hungary, Serbia, Bosnia, and Croatia get the Russian gas via Nord Stream 2. The remaining contracts arrive through Turkey. This comes close to meeting the entire contracted volume (Scenario 4).
    - If TurkStream 2 is also commissioned, Hungarian, Serbian, Bosnian, and Croatian contracts are assumed to be delivered

[21] 40% of the Hungarian contract is delivered to Hungary through Austria, which is unchanged in all scenarios. Assumptions detailed in main text concern the remaining 60%.

here, keeping Nord Stream 2 capacities open for additional spot deliveries. Some contracted quantities cannot be delivered (Scenario 7).

- To be freed from infrastructure constraints, an additional Scenario (7a) assumes all pieces of cross-border infrastructure are built to allow contracted quantities to be delivered through Turkey[22] (we refer to this additional infrastructure as Balkan Stream in this article).

In those scenarios, where Russia sells spot gas through Ukraine in addition to LTCs, it does so in a fashion that maximizes Gazprom's profit. The prices of long-term contracts are identical in all analysed scenarios and the spot gas can reach German and Austrian markets by three routes: (i) via Nord Stream 2, (ii) via Yamal pipeline through Belarus and Poland, and (iii) via Brotherhood pipeline through Ukraine, Slovakia, and Czechia. In the model, spot prices are exogenous and determined at the Russian border, allowing actual prices to differ from market to market according to the cost of transportation.

5.3 Modelling results

5.3.1 The effects of different marketing strategies

In this subsection, the effects of the different Russian marketing strategies (detailed above) are examined. Scenario 3 (TS1_LTC+spot) was chosen as a reference point, whereby Russia uses the Ukrainian system for delivering both long-term contracts and spot sales, which is reflective of the market and the infrastructure situation from January 2020.

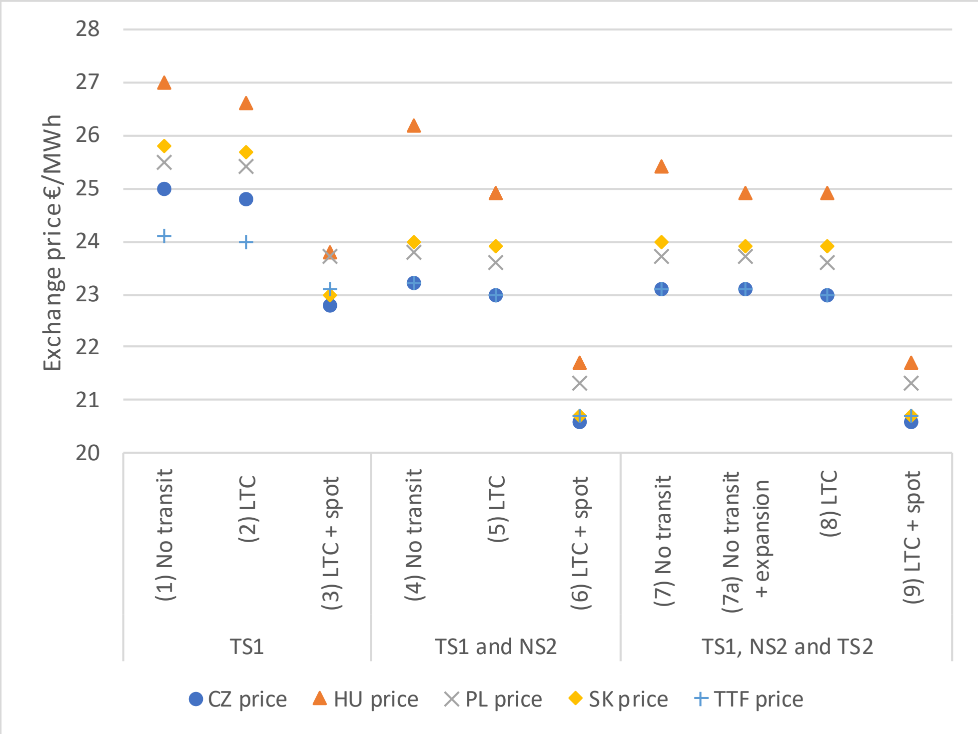
Social welfare is measured for Hungary, Czechia, Slovakia and Poland, the EU28, Ukraine, and Russia.[23] First, changes in wholesale gas prices for the

[22] Missing infrastructure on the Bulgaria-Romania-Hungary and on the Bulgaria-Serbia-Hungary routes

[23] Social welfare contains the following elements: consumer surplus, producer surplus, operational profit for infrastructure operators (TSO, LNG terminal and storage operator), congestion rent for TSOs and infrastructure operators, and profit of traders.

V4 and TTF are illustrated in Figure 20. TTF stands for the German and Western European wholesale gas prices.

Figure 20. Price effects of the modelled scenarios, €/MWh

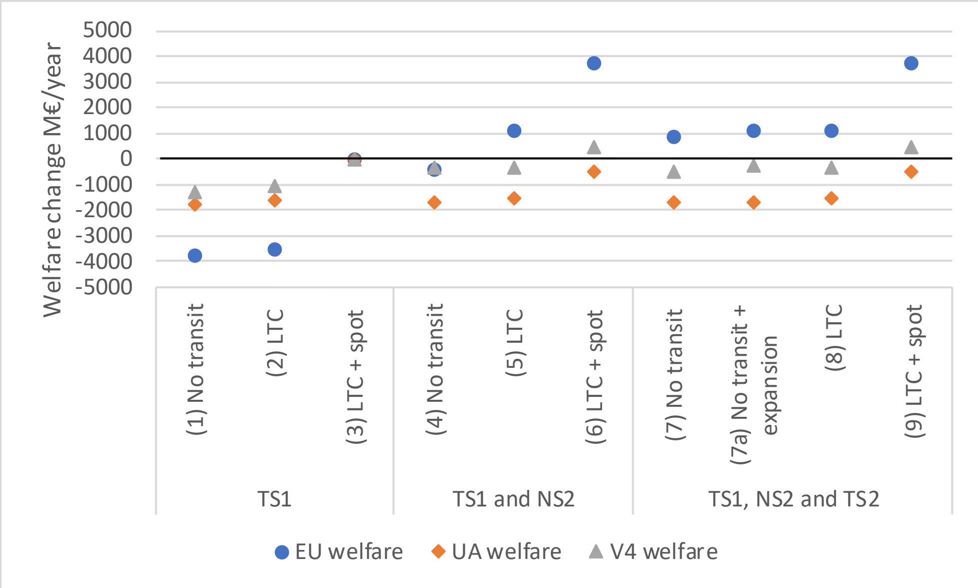


Source: REKK EGMM modelling

The highest prices in the selected CEE countries occur when Russia does not deliver gas through Ukraine under all infrastructure conditions (Scenarios 1, 4 and 7). Compared to these scenarios, prices are slightly lower when only LTCs (~10 bcm transit) are delivered through Ukraine (in Scenarios 2, 5, and 8). When Russia delivers LTC and spot volumes through Ukraine, significant price reductions can be observed (around 2 €/MWh in V4 on average) (Scenarios 3, 6 and 9). Generally, more infrastructure results in lower prices. Shifting to the social welfare outcomes shown in Figure 21, the worst-case outcome for all parties occurs when Gazprom does not deliver gas through Ukraine – in all infrastructure scenarios. The highest social welfare for the V4, EU28, and Ukraine occurs when Russia sells spot volumes alongside LTCs through Ukraine. It is not only a more favourable strategy for gas-purchasing parties but – as it will be shown later – also more profitable for

Russia. This holds even if all the planned infrastructure is commissioned (Scenario 9).

Figure 21. Welfare results of modelled scenarios, m€/year



Source: REKK EGMM modelling

Figure 21 also shows that the same sales strategy with Nord Stream 2 increases social welfare both in the V4 and EU28, 491m€ (comparing Scenarios 6 and 3) for the former, which is around 2.5% of the total V4 welfare. TurkStream 2 only leads to a significant welfare effect if Russia ceases Ukrainian transit.

In line with our expectations, Ukraine can realize the highest social welfare in Scenario 3, when Russia sells both long-term contracted and spot gas through Ukraine, and neither Nord Stream 2 nor TurkStream 2 is built. The launch of Nord Stream 2 significantly reduces spot sales of Russian gas via Ukraine (by 281 TWh/year) and associated transit revenue for the Ukrainian TSO. However, the new infrastructure increases the welfare of Ukrainian consumers since the surplus of gas sources in the region results in lower prices (Table 6).

Table 6. Welfare change of the without Ukraine transit scenarios compared to Sc3 (m€)

	TS1	TS1 and NS2	TS1+2 NS2 + Balkan Stream

m€/year	(1) No transit	(4) No transit	(7a) No transit
EU welfare	-3747	-339	1170
UA welfare	-1718	-1662	-1671
V4 welfare	-1253	-315	-250
DE welfare	-344	-493	212

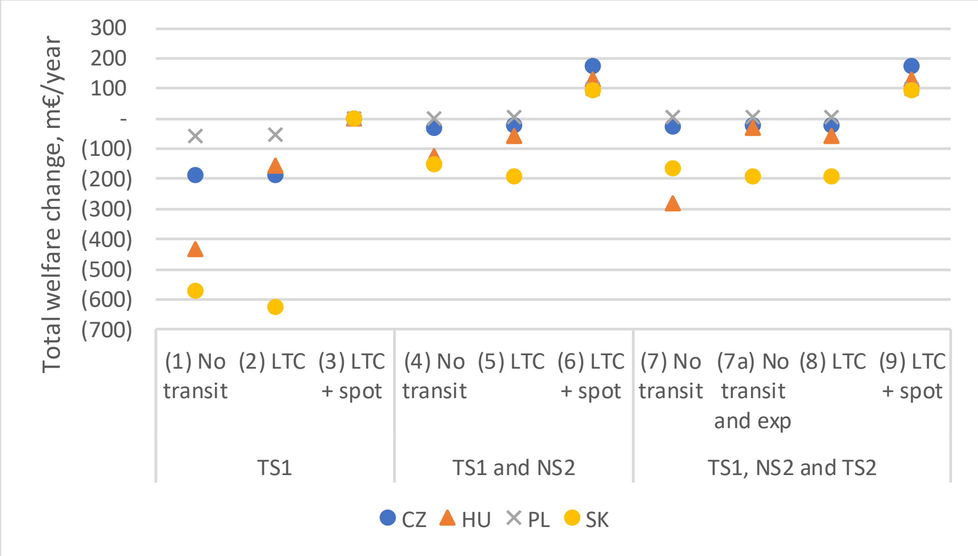
Source: EGMM result

Considering the no transit scenarios (1, 4, and 7a), the total social welfare of EU28 increases with TurkStream 2 if Nord Stream 2 is built since some LTCs are rerouted to the southern route freeing capacity on Nord Stream 2 to sell additional spot gas to Western European customers at favourable prices. For Germany, as the main beneficiary of the rerouting of Russian transit from Ukraine, the no-transit scenario is beneficial only if all Russian pipelines are built including the ones in the South. If Balkan Stream is assumed to be built (Scenario 7a), V4 total welfare is still significantly lower (by 250 m€) than the welfare accrued in Scenario 3 when no additional infrastructure is added and Russia sells LTC and spot gas through Ukraine (see Figure 21). It should be noted that welfare change calculations did implicitly consider the investment cost of new infrastructure through the applied tariffs on interconnection points.

5.3.2 The position change of CEE countries in the uncertain future

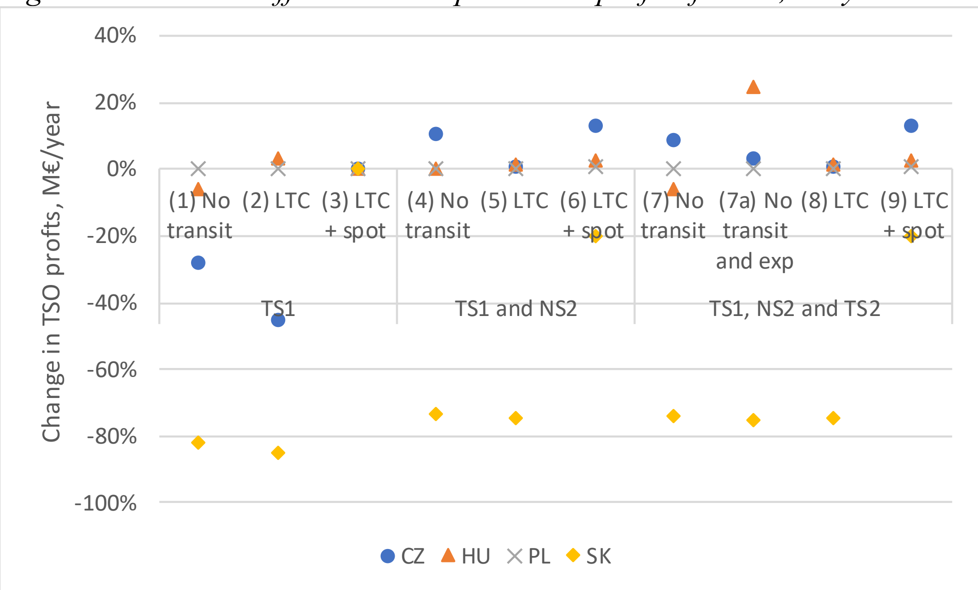
This subsection lays out the results for the selected CEE countries. From Figure 22 it is evident that total Polish welfare is not impacted by any scenario, meaning that the Polish position on pipeline policies is rather (geo)political. Czechia is similarly immune to any potential changes in gas flows and pipeline politics. Hungary and Slovakia are the most affected. Hungarian price (reflected in consumer welfare) is the most sensitive to Russian manoeuvres while in Slovakia the large swings in total welfare are mostly explained by the loss of transit revenues (Figure 22). The only CEE TSO profiting from additional infrastructure is in the Czechia, and the German TSOs benefit as well in all scenarios (Figure 23).

Figure 22. Scenario effects on the total welfare in V4 countries, m€/yr



Source: REKK EGMM modelling

Figure 23. Scenario effects on the operational profit of TSOs, m€/yr



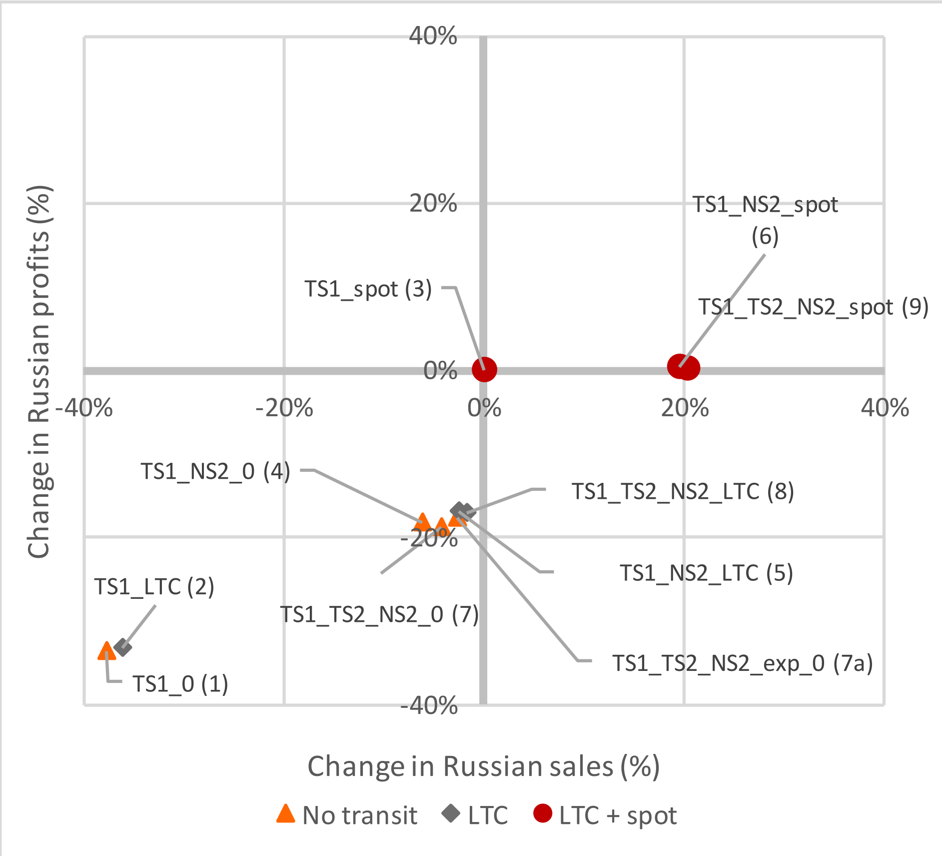
Source: REKK EGMM modelling

5.3.3 Position of Russia in the different scenarios

Russian profit in this chapter is defined as Gazprom's profit on piped gas sales to the EU, quantified as the difference between the revenues from long-term contracted and spot gas sales on the different European markets and variable costs of Gazprom.[24]

Under the assumption that Gazprom seeks to maximize profit and market share, any threat to cut Ukrainian transit is not credible without Nord Stream 2. Drawing from Figure 24 in all infrastructure scenarios, LTC transit through Ukraine marginally increases Russian profit by 1-3% compared to zero transit because it frees capacities on the Nord Stream route to sell additional spot volumes. However, this profit is still significantly lower than what Gazprom could achieve by selling LTC and spot gas through Ukraine. Russia realizes the lowest profit levels in the no-transit scenarios.

Figure 24. Change in Russian sales and Russian profits compared to Sc3, %



Source: REKK EGMM modelling

[24] The cost of gas exploitation and transportation is taken into consideration, with new infrastructure investment costs accounted for in the capacity and volume fees applied on the entry and exit points.

Figure 24 also illustrates that Russia can only marginally increase its profit with the additional infrastructure, even if significantly higher volumes are sold, mostly because larger volumes can be sold only at lower prices. Additionally, the cost of building an alternative international pipeline system (through the tariffs) is borne by Russia.

Furthermore, Russian profit would be significantly lower in the no-transit scenarios with both TurkStream and Balkan Stream (Scenario 7a) than under the current sales strategy using Ukraine for both long-term contracted and spot gas with the existing infrastructure (Scenario 3). In this sense, it is not in the economic interest of Russia or the profit maximization strategy of Gazprom to stop Ukrainian transit. However, if Russia follows its geopolitical interest and insists on avoiding Ukraine, it would result in at least a 15% profit loss. Among the no-transit scenarios, the highest profit can be reached in Scenario 7a; hence we expect Gazprom to actively take part in open-season auctions across the region. This is further supported by modelling results that show: in case TurkStream 1 and Nord Stream 2 are in place, TurkStream 2 is rational for Russia only if the requisite capacities comprising the Balkan Stream are guaranteed to be built (Scenario 7a).

If Russia could not have arranged transit with Ukraine for 2020, Gazprom would have lost 9,208 m€ in profit assuming the current infrastructure (difference between Scenario 3 and Scenario 1). Additionally, Russia also loses significant profit (yearly 4,844 m€) compared to the current situation if all the additional infrastructure (including Balkan Stream) is completed to bypass Ukraine (Scenario 7a compared to Scenario 3).

Table 7. Modelled Russian profit change (bn €), exported quantity (TWh/yr), and market share (%)

	TS1			TS1 and NS2			TS1, TS2, and NS2			
	(1) No transit	**(2) LTC**	**(3) LTC + spot**	**(4) No transit**	**(5) LTC**	**(6) LTC + spot**	**(7) No transit**	**(7a) No transit + Balkan Stream**	**(8) LTC**	**(9) LTC + spot**
Change of Russian profit, billion €/year[25]	-9.21	-9.08	0	-4.96	-4.62	0.12	-5.12	-4.84	-4.66	0.07
Russian gas sales in EU28, TWh/year	1175	1213	2020	1891	1964	2459	1925	1965	1964	2459
Market share of Russia in EU 28 consumption, %	24	24	40	38	39	49	38	39	39	49

Source: REKK EGMM modelling

The last 2 rows in Table 7 illustrate that if Nord Stream 2 is commissioned, Ukrainian transit is unnecessary for maintaining Russia's current share of EU28 imports (~40%). And even though TurkStream 2 could further increase its market share, Gazprom's profits do not increase despite the higher quantity sold.

Across all of the different sales strategies, it can be said that the use of Ukraine's transit system is profitable for Russia. If Gazprom uses Ukrainian transit for spot sales it can increase sales by nearly 30% and profit by 25%,

[25]Modelled Russian revenue from gas sales into Europe is m€26,000-m€42,000 with profit m€18,000-m€27 000 in the different scenarios. For comparison, according to its annual report revenues of Gazprom from European gas sales was around m€27,800-28,800 in 2016-2017. Our modelled prices for 2025 are significantly higher than those of 2016-2017, leading to the higher revenues calculated for 2025.

even with Northern and Southern alternative routes in place compared to the no transit scenarios with the same infrastructure assumptions.

5.4 Discussion of the modelling results

The results leave no doubt that without Nord Stream 2 the threat of ceasing Ukrainian transit is not credible and, following the conclusions of Paltsev (2014), using the Ukrainian system for gas transit to Europe and not investing in alternative routes is the highest profit option for Russia. However, since the main goal of Russia's strategy is route diversification and bypassing the Ukrainian gas system, the no transit option must be analysed as well.

Similar to the results of Mitrova, Boersma, and Galkina (2016) we found that if every proposed alternative Russian pipeline (Nord Stream 2 and TurkStream 2) is constructed, Ukrainian transit is not necessary to maintain Russia's share of 2019 (close to 40%) of European gas consumption. Still, avoiding Ukrainian transit is a loss-making choice for Gazprom, costing it €5 billion/year profit and a 50% market share.

The modelling results support our previous works (Kotek, et al., 2016; Takácsné Tóth, et al., 2017) and others (Mitrova, et al., 2016; Vatansever, 2017) that cessation of Ukrainian transit would result in tighter supply and increased wholesale gas prices in Central and Eastern Europe. This could be compensated partly but not entirely if all infrastructure elements of the alternative Russian pipeline projects are completed. For Slovakia, Hungary, and to a lesser extent Czechia, the loss of Ukrainian transit cannot be compensated in welfare terms even if all additional Russian projects (Nord Stream 2 and TurkStream 2 plus Balkan Stream) are financed by Gazprom through capacity bookings. These findings are supported by recent developments when for the first time the Russian diversification strategy will materialize in project development in a V4 country. After lengthy negotiations on a high political level on the renewal of the Hungarian long-term gas supply contract with Russia, a package deal was accomplished: in June 2020 the framework of the supply contract has been agreed upon under the condition, that Hungary's energy regulator approved the investment for the project connecting the country to Turkish Stream pipeline through Serbia in the countries Ten Year Network Development Plan. Accordingly, FGSZ, the Hungarian transmission system operator will start operations of the new route on 1 October 2021. The first 6 bcm per year capacity was approved unconditionally (being part of the regulatory asset base), while a further 2.5 bcm per year capacity is conditional on the outcome of the Open Season procedure. (Hungarian Energy and Public Utility Regulatory Authority, 2020)

Slovakia's welfare losses are mostly attributable to TSO revenues from lower transit flows, which explains why the discourse analysis of Osička et al. (2018) found that between relevant V4 stakeholders (Ministry of Foreign Affairs, Ministry of Economic Affairs, regulators and TSOs) the issue of future of gas transit is mentioned most in Slovakia and dominates the agenda. Our modelling findings are also in line with the same discourse analysis results related to Hungary: in Hungary "future transit flows" are mentioned together with "missing infrastructure" and "harmonization". The notion of future transit flows is even less of a priority in Czechia and in Poland, further supported by the modelling results: the Czech TSO revenues are not impacted by any infrastructure or sales strategy change.

The divisive nature of the Nord Stream 2 project in the European Union is captured well by the results: additional infrastructure will always increase EU28 welfare but the distributional effects favour Western Europe.

Table 8 is summarizing the modelling results by assigning symbols to the relative position change (in terms of total welfare) of the different countries (regions) analysed compared to Scenario 3. Scenario 3 is the reference scenario, reflecting the infrastructure reality and the Russian sales strategy based on the new transit contract at the beginning of 2020.

Table 8. Summary results of change in the position of key stakeholders

	TS1			TS1+NS2			TS1, TS2 and NS2			
	(1) No transit	(2) LTC	(3) LTC + spot	(4) No transit	(5) LTC	(6) LTC + spot	(7) No transit	(7a) No transit + Balkan Stream	(8) LTC	(9) LTC + spot
EU28	− −	− −	ref	−	+	++	+	+	+	++
DE	− −	− −	ref	−	+	++	+	+	+	++
RU	− −	− −	ref	− −	− −	+	− −	− −	− −	0
UA	− −	− −	ref	− −	− −	−	− −	− −	− −	−
V4	− −	− −	ref	−	−	+	−	−	−	+
CZ	− −	− −	ref	−	0	++	0	0	0	++
HU	− −	−	ref	−	−	+	− −	−	−	+
PL	− −	− −	ref	0	0	++	0	0	0	++
SK	− −	− −	ref	−	−	+	−	−	−	+

++: large relative welfare gains; + slightly positive welfare gain; 0 no considerable change; − slightly negative welfare change, − − large welfare loss;
Note: results of the table are based on total welfare change but for Russia results are categorized based on the profit change
Source: own compilation

The modelling results show unequivocally the socio-economic rationale for the EU28, and V4 countries, in particular, to maintain Ukrainian transit in the future. Since Nord Stream 1 started operation, the European Commission and several member states have consistently opposed any large Russian route diversification projects precisely to defend the viability of Ukrainian transit. However, the EU remains polarized between those that gain from Russian diversification projects and those that do not.

The V4 strategy to oppose and delay the Russian pipeline projects was intended to support the Ukrainian position in the transit dispute negotiations with Russia. V4 countries were united in that support, independent of how deeply they were individually impacted. We found substantial variation among V4 countries as to the impact of a complete or nearly complete cessation of Ukrainian gas transit. Polish welfare would not be impacted at all and Czechia is mostly immune to the change in gas flows. Hungary and Slovakia are much more affected by these decisions –Hungary through the gas prices and Slovakia by the loss of transit revenues. Modelling results show that natural gas wholesale prices in the EU and in all V4 countries always increase when Russia does not deliver gas through Ukraine, independent of new infrastructure. The price would increase an average of €2/MWh in V4 countries if the Ukrainian route is not used by Russia, while the Western European price (TTF) would be largely unaffected.

Our modelling scenario suggests that the economic rationale for Gazprom and Russia strongly supports an agreement on transit via Ukraine even if the additional infrastructure is completed, and even after the current 2020-2024 agreement will expire. This economic interest is also supported by historical facts, with transit through Ukraine growing in recent years. This is because despite all of the political rhetoric the economic rationale for Gazprom to use the flexibility provided only through the Ukrainian route to serve growing European gas demand.

Furthermore, gas delivery has been uninterrupted even during the annexation of Crimea and the ensuing frosty relationship between the EU and Russia. This allows for some optimism that the situation can be remedied after 2020 as well, though rebuilding trust is not envisaged to be easily achieved (Mitrova, et al., 2019; Pirani, 2019).

As the Romanian offshore gas as an alternative source to Central Eastern Europe will not reach FID in the short to mid-term, Hungary will advocate for the completion of the Balkan Stream, especially if investment costs are partly borne by Russia /Gazprom via long-term capacity bookings (Scenario 7a in Table 8). This unfortunate outcome would leave Ukraine further isolated and long-term capacity bookings on the southern route would present the very real prospect of losing its transit in the mid to long term. This scenario would lead to the underutilization of other pipelines in CEE that would become stranded assets embedded into the tariffs paid by consumers.

The decrease in Ukraine's gas transit will probably accelerate the development of its gas production and invest more in energy efficiency. In the long run, gas will probably lose relevance in Ukraine's domestic politics. Russian energy strategies put the diversification of transit routes into focus since 2010. This has partly been implemented not only towards the European market but also towards Asia with the Power of Siberia pipeline launched in December 2019 delivering 38 bcm/ year gas to China. We agree with Kutcherov et al (2020) that the Russian energy strategy needs a revision as prospects of the European market are mixed for Russia. As the competition of LNG and other suppliers keeps prices down, and the green goals of the new Commission will accelerate the transition from gas to clean technologies and reduce the demand, in the long run, increased gas sales and growing market share in Europe can only be reached at low prices and would not increase Russian profit substantially. It must also be noted that in an oversupplied global gas market redirecting gas to Asia will not increase the bargaining power of Russia/Gazprom towards European buyers. In a scarce global LNG market situation is however much different, Russian power over European gas price setting can increase.

Overlapping interests between parties could provide a baseline for rebuilding trust and finding a way to ensure the utilization of the Ukrainian pipeline system in a transparent and cost-efficient manner under the European regulatory framework. In our estimate, the Ukrainian system could still be economically rational for the delivery of about two third of the current yearly transit to Europe, even with or without Nord Stream 2, TurkStream 2, and Balkan Stream.

6 EU infrastructure policy[26]

The key objective of Regulation (EU) No 347/2013 on guidelines for trans-European energy infrastructure is the development and interoperability of trans-European energy networks to be connected by the timely implementation of PCIs. The PCIs should allow for the better integration of renewable energy sources, improved security of supply, and more competition leading to lower prices.

In 2013, when the TEN-E Regulation came into force, natural gas security of supply concerns over repeated supply disruptions from Russia, the most severe in January 2009, was setting the agenda. The fragmented structure of the gas network left certain member states isolated from the interconnected EU transmission system, such as between the Baltics and Finland in the so-called BEMIP. The limited interconnectivity between member states also created large wholesale price differentials, with CEE member states typically depending on a single source paying more.

Before the TEN-E Regulation, network investments were predominantly related to new import pipelines from non-EU member states (Russia, Libya, Norway, and Algeria) and LNG terminals, mostly exempted from third-party access rules. New interconnectors between member states were rare, but typically also exempted (e.g., OPAL). Therefore, the need for interconnections contributing to market integration was crucial.

To implement the TEN-E Regulation, a methodology and selection process were developed, whereby every two years a so-called list of PCIs was established and published as an Annex to the regulation. Different roles were assigned to different institutions in the process: ENTSOG assisted the Regional Groups (consisting of representatives of member state's ministries and energy regulators) with data gathering and developing and applying a

[26] Borbála Takácsné Tóth (2020): Coalitions of V4 countries in gas security of supply IDN Conference Book p 486-506.
Adrienn Selei and Borbála Takácsné Tóth (2022): A modelling-based assessment of EU supported natural gas projects of common interest Energy Policy, Volume 166, 2022, 113045
Parts of the text of these publications have been taken over without modification in this chapter.

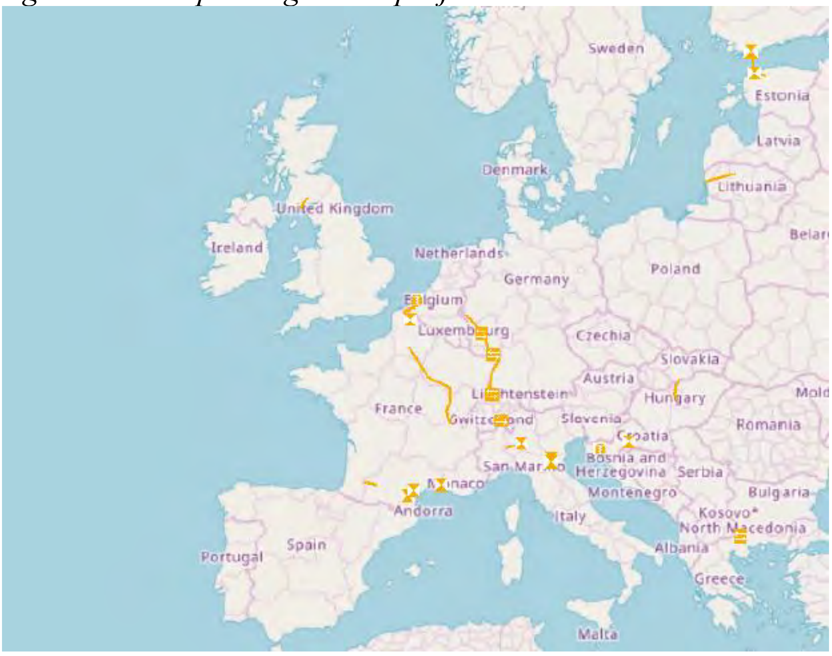
methodology to assess the proposed PCI projects. Regional Groups proposed the list of PCIs that was finally approved by the European Commission. The ACER monitors the implementation of PCIs and provides opinions on the selection methodology of ENTSOG. Furthermore, the Innovation and Networks Executive Agency (INEA) is responsible to oversee the CEF funds allocated to PCIs. Table 9 summarizes the four PCI lists by infrastructure category. The number and the share of gas projects on the PCI lists decline over time mainly because projects were withdrawn or clustered together to reduce the number of projects on the list. Slow progress and delays are common for electricity and gas PCI projects, for electricity transmission lines are mostly due to permitting issues while for gas projects it is related to project financing (ACER, 2021). It is a fact that out of the 32 gas projects included in the 4th PCI list, 17 survive from the first list, most of which remain under non-FID status despite the regulatory push and EU financial support. According to the INEA's PCI Interactive map in Figure 25, 12 gas PCI projects have been commissioned by 2020 out of which 9 are included in this analysis.

Table 9. PCI lists by infrastructure category, 2020

	Date of adoption	Total nr of PCIs	**Electricity PCIs**	**Gas PCIs**	**Oil PCIs**	**CO2 PCIs**	**Smart grid PCIs**
1st PCI list	October 2013	248	131	109	6	0	2
2nd PCI list	November 2015	195	108	77	7	0	3
3rd PCI list	November 2017	173	102	53	6	4	4
4th PCI list	October 2019	149	100	32	6	5	6

Source: Akkermans et al., (2020) p. 58

Figure 25. Completed gas PCI projects



Source: PCI Interactive map, 07.07.2021

ACER reports that about 8 billion € or 30% of the total estimated investment costs (26.6 billion €) for gas projects has materialized by January 2021 (ACER, 2021 p.24).

Most of the newly built gas interconnectors from 2010 were PCIs supported by CEF or by other EU grants. Based on the CEF decisions between 2014-2020, 1.4 billion € in work grants were awarded to 16 projects, mainly between 2014-2018, the majority of which have not been commissioned yet. One can speculate as to how many of these projects would have been built or revised without the PCI status and the CEF support effectively intervening in the market, but the question that must be asked with the support of EU taxpayer money is whether these investments were worth it from a socio-economic point of view.

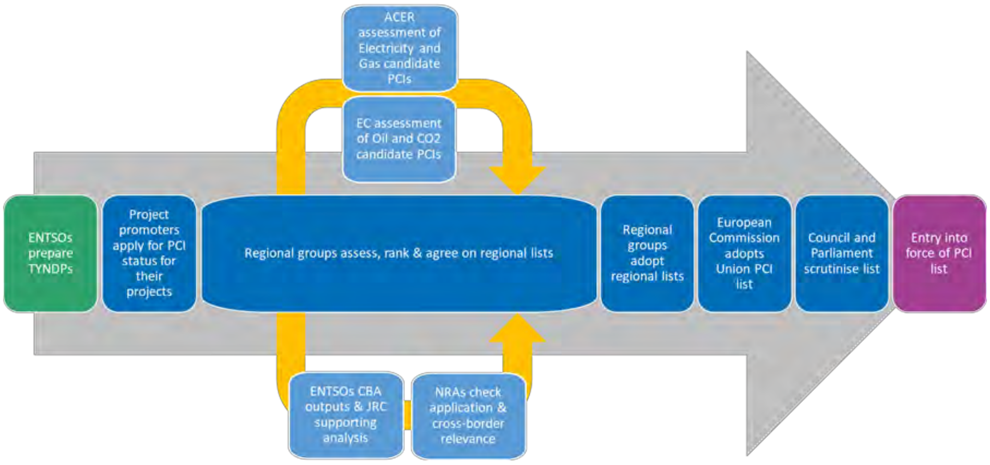
The ACER reports (ACER, 2021) leave some uncertainty over PCI costs and even more over the credibility of the planned commission date of projects. However, the biggest missing piece from ACER's perspective is reliable data on the benefits of the individual and combined PCIs. The following modelling analysis aims to fill this gap and provides a modelling-based quantification of the socio-economic benefits attributable to the selected and supported PCIs.

6.1 Selecting projects and geographical distribution of gas PCIs

The European Union pipeline strategy in natural gas relies on coordinated planning of the natural gas transmission, storage, and LNG infrastructure. Coordination of the national development plans on the EU level is done in a two-year planning cycle by ENTSOG. The Ten-Year Network Development Plan provides information on the investments planned by the member states. Methodology for cost benefit assessment of the submitted projects was developed by ENTSOG and approved by the European Commission 18 February 2019 (ENTSOG, 2018) It must be noted here that non-EU promoters' projects are not covered by this document. This means that e.g., Russian projects, like Nord Stream 2 were not part of the TYNDP, despite the project has been under construction. The onshore continuation of the project, EUGAL (besides OPAL) was a TYNDP project, as the promoter was a German TSO.

The same applies to the Southern Route of the Russian strategy: Turkish entry to Bulgaria and Balkan Stream was not part of the TYNDP for long, although their impact on the regional gas flows was politically already widely discussed. Selection of the EU priority projects (PCIs) that was based on the TYNDP modelling could not reflect the challenge of the Russian strategy, as it has simply neglected the Russian project developments. Despite this fundamental error the PCI candidates went through a complex evaluation process, as depicted in Figure 26 and described in detail in our study evaluating the Regulation (EU) No 347/2013 on guidelines for trans-European energy infrastructure (Akkermans, et al., 2020).

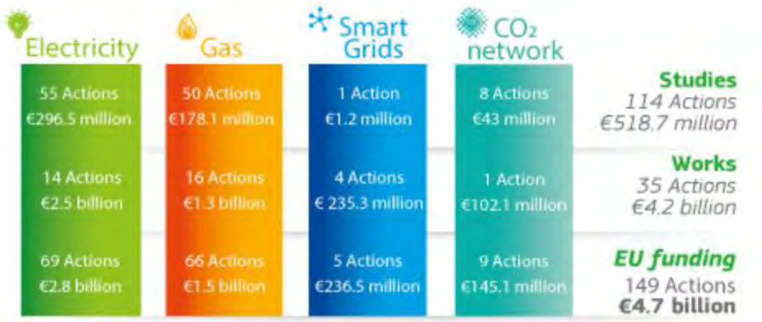
Figure 26. PCI selection process scheme



Source:Akkermans et. al (2020) p.54.

When PCI projects are selected, they become eligible for EU funding from the Connecting Europe Facility. CEF was established to provide funding for European interest projects in the field of digitalization, transport, and energy, to create the backbone infrastructure in Europe in these fields. It is the Innovation and Networks Executive Agency (INEA) that is managing the CEF funds (about 28 billion € since 2014). The budget for energy projects was predefined for the 2014 – 2020 cycle. It was ~5 billion €. The distribution of the funds is the following: INEA launched one or two open calls for energy projects each year with a framework budget that was to be distributed. Gas, electricity, smart grid, and CO_2 storage PCI projects could apply under the same call. INEA was performing the first administrative check of the applications and was organizing an independent expert review of each application. The applications were evaluated along a set of criteria that does not assess the merit of the project itself, as it was taken for granted that each PCI has already demonstrated its European value added during the PCI selection process. The applications were to demonstrate that the action they request money for was the logical next step of the implementation process and that the budget they asked for was reasonable. The experts could reject a proposal only if the proposal was poorly written. The decision on how much money and to which project would go was done by the Commission where again member states were consulted. All in all, the distribution of CEF funds was rather political than technical despite the in-build guarantees of independent expert reviews. With the allocation of CEF funds, the Commission could to a certain extent express its preferences for some projects but obviously, it was also possible to use CEF funds to compensate certain member states for their cooperation on issues that are not necessarily in line with their core national interest. According to INEA, 4.7 billion € were spent on energy projects between 2014-2020 (DG ENER, 2020). Out of this budget, 1.5 billion € were spent on gas projects, the majority on building gas infrastructure projects (Figure 27).

Figure 27. CEF financial assistance per sector (2014-2020)



Source: Impact assessment of the TEN-E regulation (2020) p. 130.

To check the geographical distribution and timeline of CEF funds that were allocated to gas projects, data had to be collected from the primary documents. CEF decisions are published after each call in a form of a Commission decision[27]. The documents reveal the project identification number, the name of the action, the applicant, and the maximum CEF fund awarded. It is not possible to follow the development of the project more in debt, but individual project sheets of the PCIs can be collected via the PCI interactive map[28] one by one. These project sheets include how much of the cost of the project has been funded by CEF. Based on the bottom-up dataset of the CEF decisions and the interactive PCI map the aggregated figure

[27] There have been the following Decisions published that form the basis of the data used: CEF Decision 2014, 2015_1; 2015_2;2016_1; 2016_2; 2017; 2017_Synergy; 2018_2; 2018_2; 2019;2020
[28] PCI Transparency Platform: https://ec.europa.eu/energy/infrastructure/transparency_platform/map-viewer/main.html

published by INEA can be well reconstructed and a more detailed analysis of the CEF funding performed. There is no data published on projects that did not receive funding. In the following two sections, we summarize the findings of the database and use the Interactive PCI map to visualize the geographical distribution of the projects. For the regional analysis the regional groups are defined by the 347/2013 TEN-E Regulation Annex 1, see Table 10.

Table 10. Gas regional groups in the EU

Region	Countries included
NSI West Gas	Belgium, Denmark, France, Germany, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, and Spain
NSI East Gas	Austria, Bulgaria, Croatia, Cyprus, Czechia, Germany, Greece, Hungary, Italy, Poland, Romania, Slovakia, and Slovenia
SGC	Austria, Bulgaria, Croatia, Czechia, Cyprus, France, Germany, Hungary, Greece, Italy, Poland, Romania, Slovakia, and Slovenia
BEMIP Gas	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden

Note: NSI West Gas = North-South gas interconnections in Western Europe NSI East Gas= North-South gas interconnections in Central Eastern and South Eastern Europe, SGC = Southern Gas Corridor, BEMIP= Baltic Energy Market Interconnection Plan

Source: 347/2013 Regulation Annex 1

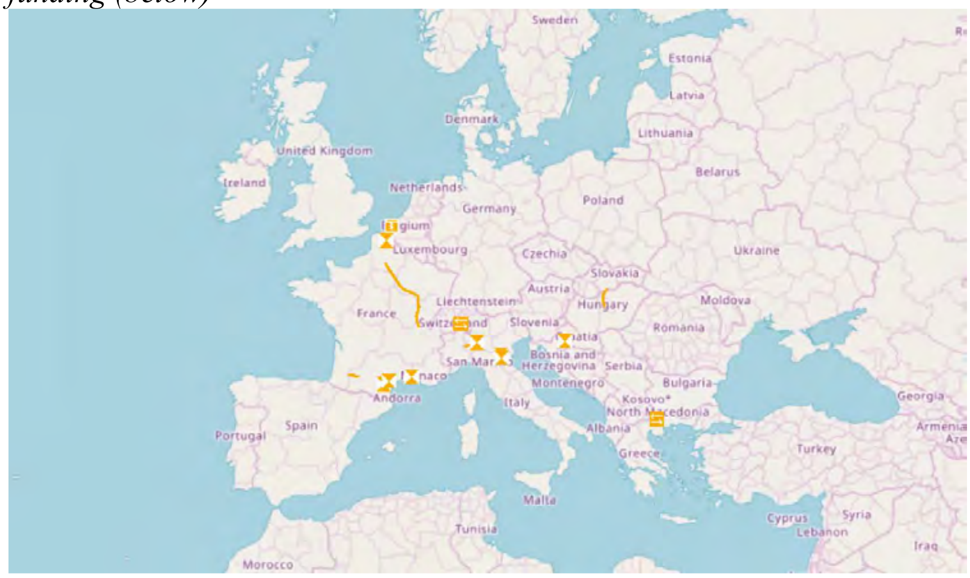
Some member states are included in several regional groups, e.g., Poland is part of three gas groups. The allocation of funds to individual member states is also possible with the help of this bottom-up compiled database. The maps in Figure 28 illustrate the geographical distribution of the gas PCI projects that were implemented between 2014-2020. In North-West Europe mainly compressor station reinforcement and reverse flow projects were implemented, and the majority of them happened without any financial support from the EU. The French new transmission line building project aimed to connect the northern and southern parts of the network leading to the emergence of a single French price zone, but as it has no impact on the cross-border capacities, it was not modelled. The only project of CEE without CEF funding is the Hungarian-Slovakian, but that has received work funds (30 m€, 17% of CAPEX), from the European Energy Programme for

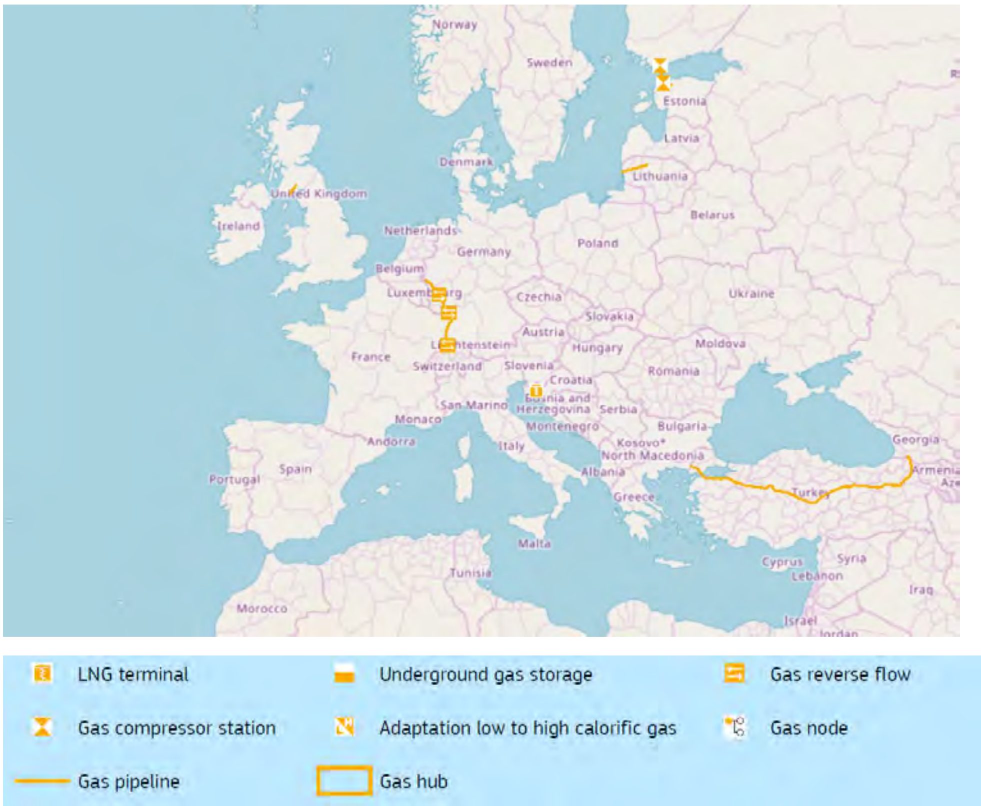
Recovery, which was a predecessor of the CEF funds, therefore should rather belong to the map on top Figure 28 (Beöthy, et al., 2016).

On the map below in Figure 28 we see the Southern Gas Corridor as the largest PCI, stretching from Azerbaijan via Georgia to Turkey. This project has been on all four PCI lists, but its implementation goes well beyond the EU infrastructure regulatory framework. The project has been strongly supported on the highest EU political level, but it has been implemented under an intergovernmental agreement framework, exempted from the EU third-party access rules and regulated tariffs. CEF financing (a few m€ out of the 40 billion € budget) has been rather just a positive political signal than an effective enabler of the project.

Among the completed PCIs we find two very important projects that could not have been built without strong EU financial, political and regulatory support. The first one is the Balticconnector that is connecting Finland to the Baltics and has been the backbone project of the first gas regional market coupling started in January 2020. The other emblematic security of supply-driven diversification project is the Krk LNG terminal in Croatia, which was almost 50% financed by CEF and came online in 2021. PCI projects have a usually difficult political background, fragile economics, and geopolitical hurdles; therefore their implementation takes often a decade.

Figure 28. Completed gas projects without CEF funding (on top) with CEF funding (below)



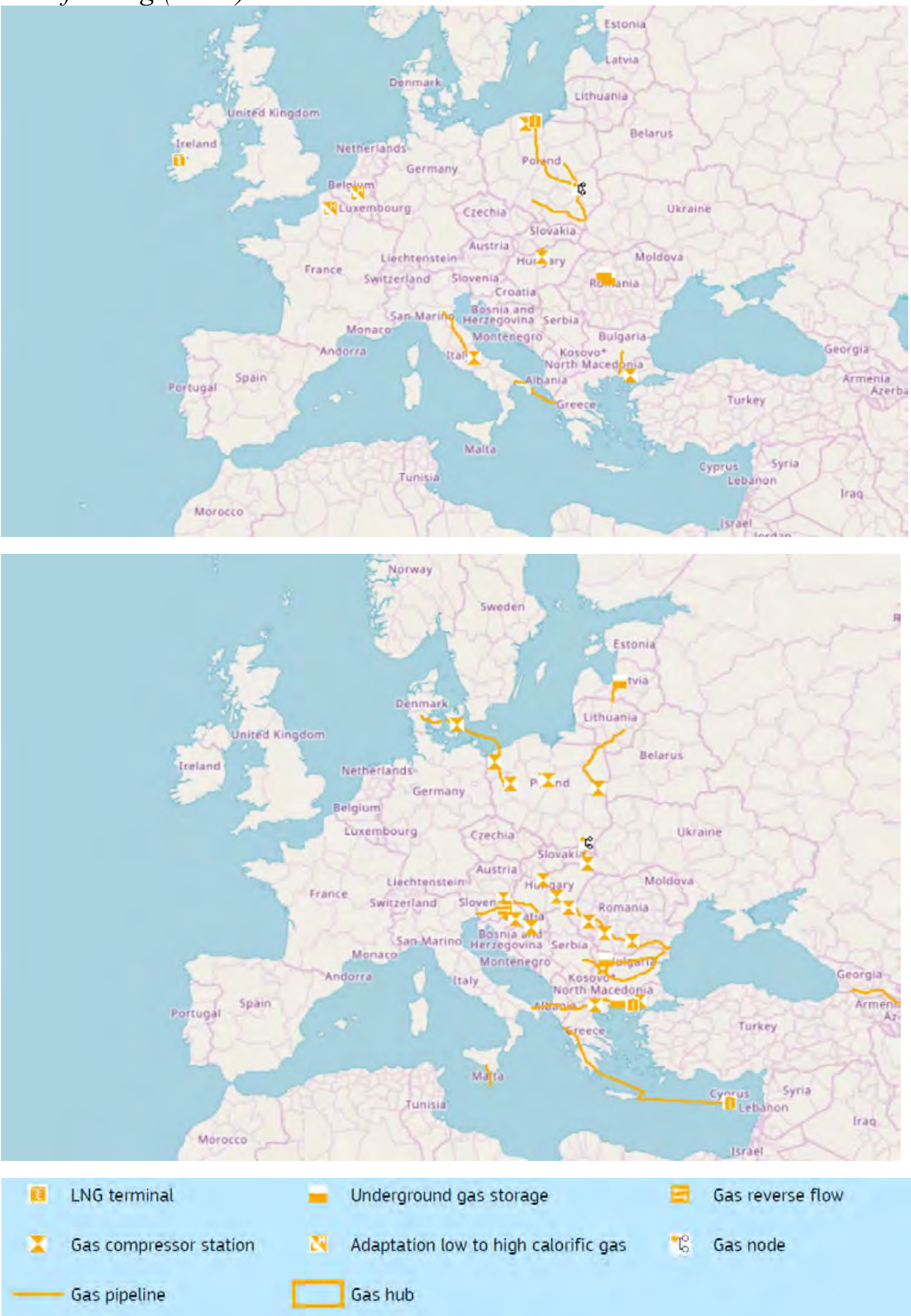


Source: © Eurogeographics for the administrative boundaries; © PLATTS for the underlying energy network. Cartography: European Commission, DG Energy 2021 (author download)

Figure 29 presents the maps of the PCI projects of the 4th list, which was adopted on October 31, 2019 (European Commission, 2019). As we will see, there are quite some projects "in the pipe" meaning that they are for a long time having a PCI status and could apply for CEF funds (which is a follow-up step to the achievement of the PCI status). On the top of Figure 29 there are the projects that have not received CEF financing, below that the ones that already did. It is remarkable, that most of the projects have already received some sort of CEF funding for works meaning that the projects are not commercially viable, they serve security of supply purposes. The CEF-funded projects are concentrated in the Central Eastern part of the EU, the Baltics, and Southeast Europe. This is no surprise as the CEF funding is targeted to those regions where the security of gas supply was supposed to be balanced by new infrastructure investment. Many of those projects with the highest funding have not been realized easily, most of them are actually in a 2-3 year delay from their original plans' despite the huge funds and strong political EU support. (e.g., the Lithuania-Poland interconnector, the BRUA pipeline connecting Bulgaria, Romania, and Hungary[29]. There are different reasons given for the delays, but most prominently it is the national interest of one of the hosting countries that are behind the regulatory or legal barriers witnessed. When two countries with a price difference are connected, one of them will most probably see the prices increasing, while the other will experience the opposite. The willingness of the country with a potential price increase will be much less to implement the project. In the case of the projects that would connect Romania to the neighbours, the effective commission of the projects was not happening for years, as Romania did not want to have its production sold outside the country. The national regulators and ministries responsible for licensing and authorization of the project were assisting with these delays (e.g., in the case of the Interconnector Romania-Bulgaria, Romania-Moldova, and Romania-Hungary). It could also happen, that the incumbent company has a strong lobby power or is not being properly unbundled has a direct influence on the TSO and can block investments that would weaken its market position. This happened to most of the Bulgarian projects, where many of those long-frozen projects are located: e.g., the interconnector Romania-Bulgaria (PCI); Interconnector Greece-Bulgaria (PCI and exempted from TPA); and Interconnector Serbia-Bulgaria (PCI) and the rehabilitation of the Bulgarian gas ring (PCI).

[29] The BRUA pipeline was originally planned to connect Bulgaria, Romania, Hungary and Austria with the aim to provide third party access and route for all potential sources from the south, including the Bulgarian and Romanian new offshore fields. Disputes about the Romanian legal framework governing gas extraction and exports did not support the business case of the project. Regulatory authorities also could not agree on the tariff regime and open season bookings, and the pipeline was shortened and reduced to connect Romania to Hungary. The first phase (with a 1.75 bcm/yr capacity towards HU and 3.7 bcm/yr to BG) was put in operation in 2020. Extension is planned for 2022 =additional 4.4 bcm/yr to HU) depending on the regulatory and market circumstances.

Figure 29. Ongoing natural gas projects without CEF funding (up) and with CEF funding (down)



Source: © Eurogeographics for the administrative boundaries; © PLATTS for the underlying energy network. Cartography: European Commission, DG Energy 2021 (author download)

Bulgaria, although identified as the most vulnerable country to cuts of Russian deliveries via Ukraine and the only EU member states where household consumers could not have been supplied in 2009 did not commission any new infrastructure until 2019 except for a tiny link to

Romania that had capacity problems during wintertime. Gazprom was the first to be able to finalize a project in Bulgaria, the TurkStream. The new Turkish route can flow gas from Turkey to Bulgaria, which has been the other way around up until 2019. Since then, things speeded up: the Balkanstream is in motion and the section in Bulgaria and Serbia was laid and commissioned in January 2021, the last section to Hungary in October 2021.

6.1.1 Financial support of PCIs out of CEF funds

The Connecting Europe Facility has provided EU grants for the priority infrastructure project to accelerate their implementation both via studies and for grants for works, in total the amount of 4.7 billion € between 2014-2020 according to our database (Table 11).[30]

Table 11. Allocation of CEF energy funds by project category 2014 2020, (bn€ and %)

Infrastructure category	Total CEF awarded (billion€)	Percentage of total (%)
Electricity	2.96	60
Gas	1.60	32
Energy storage	0.02	0
Smart grid	0.24	5
CO2	0.15	3
Total	4.96	100

Source: CEF decisions, PCI interactive map

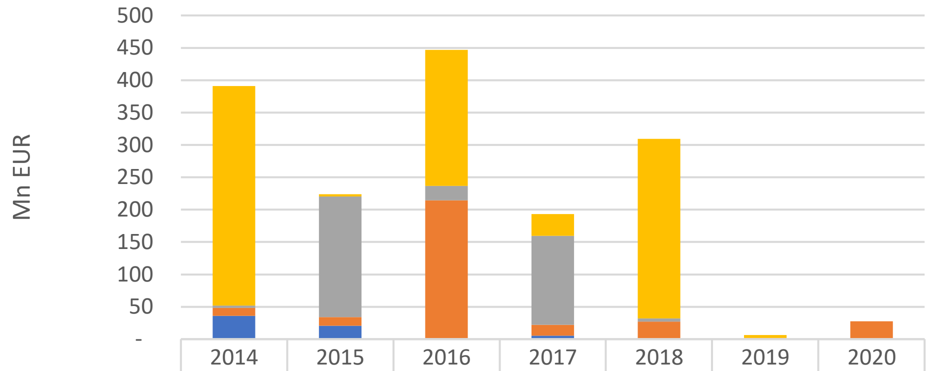
15% of CEF funding was spent on studies, and 85% on work. Table 11 shows that majority of the works funds was allocated to electricity projects (60%), a smaller share to gas (32%), and minor funds were provided for CO_2 (3%), smart grid (5%) and energy storage projects (below 1%).

The difference in the timing to support gas and electricity projects is visible in Figure 30 and Figure 31. A large volume of funds was allocated to gas projects between 2014-2018 (Figure 30), while electricity project support was

[30] The slight difference in the INEA summary could not be traced back. The difference is most probably because not all projects could spend the maximum amount of the allocated budget.

negligible at the beginning of the period and was concentrated between 2016-2020 (Figure 31)

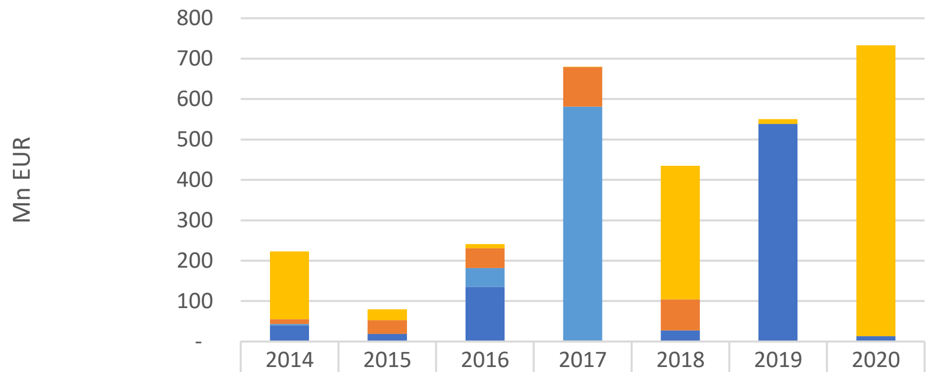
Figure 30. CEF funds allocated to gas infrastructure projects 2014 – 2020, (m€)



	2014	2015	2016	2017	2018	2019	2020
BEMIP Gas	339	4	210	33	277	5	-
SGC	4	186	22	138	5	-	-
NSI East Gas	12	14	213	17	27	2	28
NSI West Gas	36	20	2	5	-	-	-

Source: Author based on CEF decisions

Figure 31. CEF funds allocated to electricity infrastructure projects 2014 – 2020, (m€)

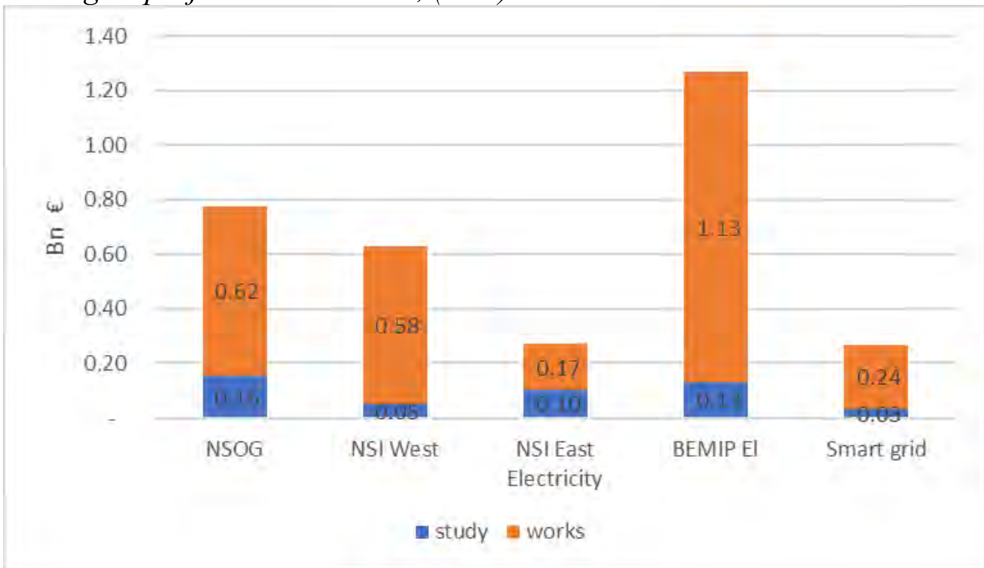


	2014	2015	2016	2017	2018	2019	2020
BEMIP EL	168	27	10	0	331	12	720
NSI East Electricity	12	34	50	98	77	-	-
NSI West Electricity	3	1	47	578	-	-	-
NSOG	40	19	135	3	27	538	14

Source: Author based on CEF decisions

Looking at the regional distribution of funds, the electricity funds are directed to about the same extent to Western Europe (to the offshore grids and NSI West) and to the Baltic Interconnection Plan (BEMIP el) (Figure 32), while the gas support is sent to the East, to BEMIP being the largest beneficiary region (Figure 33).

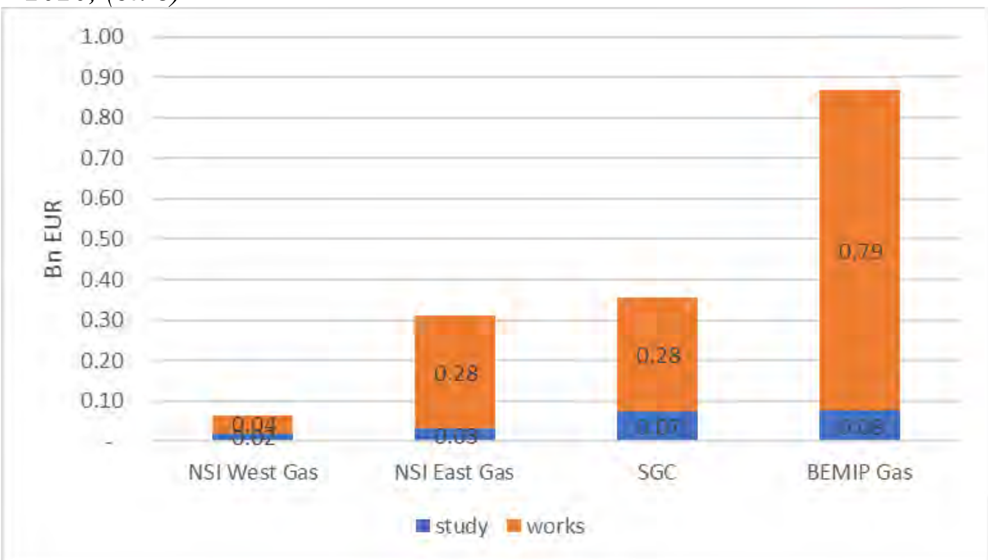
Figure 32. Regional distribution of CEF funds allocated to electricity and smart grid projects 2014 – 2020, (bn €)



Source: Author based on CEF decisions

The following chart shows the regional distribution of the gas funds, showing that only 4% of the gas funds were allocated to the NSI West region, which is Western Europe (Figure 33).

Figure 33. Regional distribution of CEF funds allocated to gas projects 2014 – 2020, (bn €)



Source: Author based on CEF decisions

Shifting the focus from the regional definition used in the TEN-E regulation to the individual country level, results show that out of the 1.6 billion € that was awarded in form of CEF support to gas projects, 618 m€ was spent on projects located in Poland.[31] The other large beneficiary is Hungary, although not directly supported through the Hungarian TSO. In the Krk LNG terminal, a large part of the capacities is long-term booked by Hungarian traders. This project was declared a Hungarian strategic priority. The other source diversification option of Hungary, the connection to the Romanian offshore gas deposits also received substantial CEF support. (For details see Table 12) Altogether 1.3 billion € was spent on gas infrastructure projects between 2014-2020, on projects which had a total CAPEX of 3.137 billion €. The EU financed 45% of the investment in these gas projects. By March 2021 only 35% of the funds were spent on projects that are already commissioned and are in operation. This means that the remaining 65% of the funds are allocated to projects that might with a high chance end up being a stranded assets at the time when they come online[32]. The project that is most promising of the projects "in the pipe" is the Denmark-Poland interconnection, which is aiming to bring a new source of gas to Poland (from the Baltic Sea) to substitute Russian supplies in Poland. The project is very much political, the main driver behind it is the Polish desire to be independent of Russian supplies. Cost considerations are less decisive. On the Polish strategy see more in Weiner (2018).

[31]These are the interconnector between Poland and Lithuania (GIPL), the interconnector between Poland and Slovakia, and the Denmark-Poland Interconnector Actually there has been CEF awarded also to the Interconnector Czechia Poland, but it has been withdrawn as the project did not proceed.

[32] The GIPL project has been delayed since 2016, and has mostly lost its original purpose which was to end the isolation of the Baltics (492 m€CEF, 60% of the CAPEX).The Romanian part of the BRUA was meant to connect the new Romanian offshore gas production to Central Easter Europe. At the time of the analysis (2020) there is little chance that the upstream project will reach FID (448 m€ CEF, 40% of the CAPEX). The Poland-Slovakia Interconnector connects two countries with decreasing transit flows due to the rerouting of Russian gas (269 m€ CEF, 40% of the CAPEX).

Table 12. Natural gas projects that received CEF funding for construction works, 2014-2020, (% and m€)

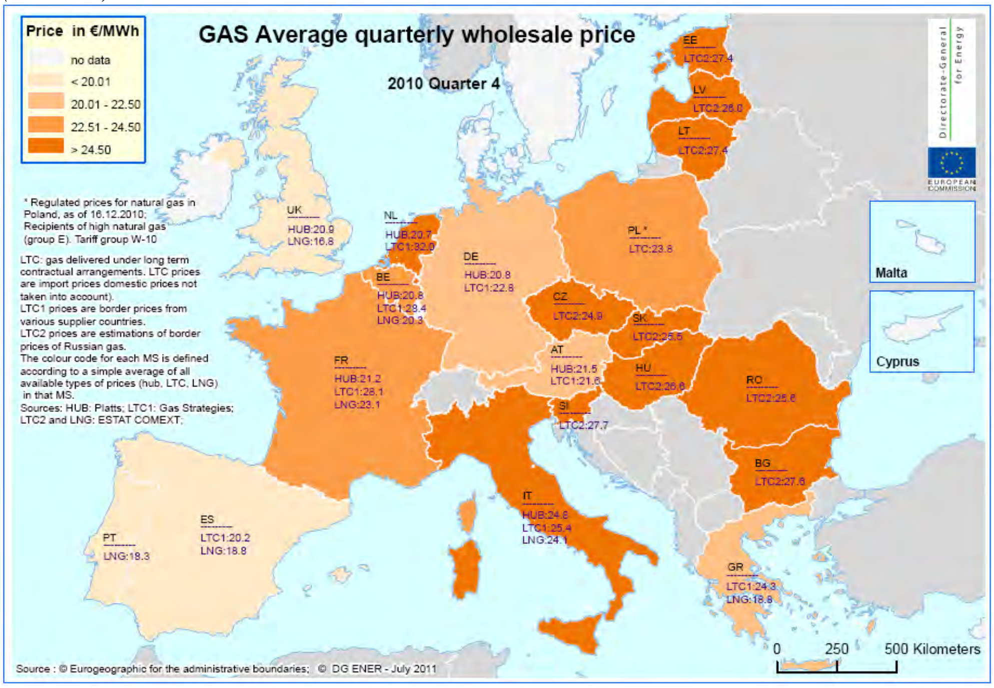
PCI name	Corridor GAS	Country	Applicant	CEF m€	Year	Support share, %	CAPEX, m€
5.2. PCI Twinning of Southwest Scotland onshore system between Cluden and Brighouse Bay.	NSI West	UK	Gaslink Independent System Operator Limited	34	2014	33%	102
8.2.3. Capacity enhancement of Klaipeda-Kiemenai pipeline in Lithuania	BEMIP	LT	AB Amber Grid	28	2014	50%	55
8.5. PCI Poland-Lithuania interconnection ["GIPL"]	BEMIP	LT, PL	GAZ-SYSTEM S.A. / AB Amber Grid	295	2014	60%	492
5.10. PCI Reverse flow interconnection on TENP pipeline in Germany	NSI West	DE	Fluxys TENP GmbH	9	2015	50%	17
7.1.5. Gas pipeline from Bulgaria to Austria via Romania and Hungary	SGC	RO	TRANSGAZ S.A.	179	2015	40%	448
8.1.1. Interconnector between Estonia and Finland "Balticconnector"	BEMIP	FI, EE	Elering AS / Baltic Connector Oy	188	2016	75%	250
8.2.2. Enhancement of Estonia-Latvia interconnection	BEMIP	EE	Elering AS	19	2016	50%	37
6.2.1. Poland – Slovakia interconnection	NSI East	SK, PL	eustream, a.s. / GAZ-SYSTEM S.A.	108	2016	40%	269
6.5.1. LNG Regasification vessel in Krk	NSI East	HR	LNG Hrvatska d.o.o.	101	2016	46%	220
6.5.1. LNG Regasification vessel in Krk	NSI East	HR	Plinacro Ltd	16	2017	50%	33
7.3.2. LNG storage located in Cyprus ["Mediterranean Gas Storage"]	SGC	CY	Ministry of Energy, Commerce, Industry and Tourism	101	2017	40%	253
6.8.2 Rehabilitation, modernization and expansion of the Bulgarian transmission system Phase 2	NSI East	BG	Bulgartransgaz EAD	27	2018	40%	68
8.2.4 Enhancement of Inčukalns Underground Gas Storage (LV)	BEMIP	LV	Joint Stock Company "Conexus Baltic Grid"	44	2018	50%	88
8.3.1 Reinforcement of Nybro-Poland/Denmark Interconnection	BEMIP	PL,DK	GAZ-SYSTEM S.A.	215	2018	30%	716
8.2.1 Enhancement of Latvia-Lithuania interconnection	BEMIP	LT,LV	AS Conexus Baltic Grid | AB Amber Grid	5	2019	50%	10
6.8.3 Gas interconnection Bulgaria-Serbia ["IBS"] (6.10 on the 3rd PCI list)	NSI East	BG	BG	28	2020	36%	77

Source: author based on CEF decisions

6.1.2 The market environment change between 2010 2020

The fragmented structure of the network left certain member states isolated from the interconnected EU transmission system. Isolation of gas markets was the most pressing need identified for the Baltics and Finland (BEMIP). The limited interconnectivity between member states allowed for large differences in wholesale gas prices resulting in a high margin in the new member states that were typically sourcing their gas from a single source (Figure 34).

Figure 34. Average quarterly wholesale gas prices in Europe, 2010Q4 (€/MWh)



Source: Quarterly Report on the European Gas markets

Investments in 2010-11 into the network were predominantly related to new import pipelines (from Russia, Libya, Norway, and Algeria) and LNG terminals, to a large extent exempted from third-party access rules. New interconnectors between member states were rare, and typically also exempted from unbundling and third-party access rules, e.g., OPAL, BBL (European Commission, 2011) . There was a need for interconnections that are not exempted, that can host spot flows and thereby can contribute to market integration. Most of the newly built interconnectors since 2010 in the gas system were PCIs and supported by CEF (or by other EU grants). Without this support, most of them (or maybe any of them) would not have been built. Besides TEN-E other EU legislation and actions were also targeted to support the resilience of the system. The security of supply Regulation (EU) 2017/1938 includes a provision on the need to introduce reverse flow on the EU-EU borders. The reverse flow projects implemented on existing pipelines did not only contribute to the security of supply goals but also contributed to market integration and price convergence, allowing gas to flow from the cheaper to the higher-priced markets.

The network codes and the competition cases investigated by the EU contributed to what was achieved by 2020. ACER in its yearly market monitoring report proudly stated, that we see today that a resilient gas network was developed, where gas prices are correlated and infrastructure capacities are auctioned and used to provide the necessary flexibility to the market (ACER, 2020). There is a consensus among the key stakeholders, that the gas market today is much more resilient to supply shocks than it was in 2009 (Akkermans, et al., 2020).

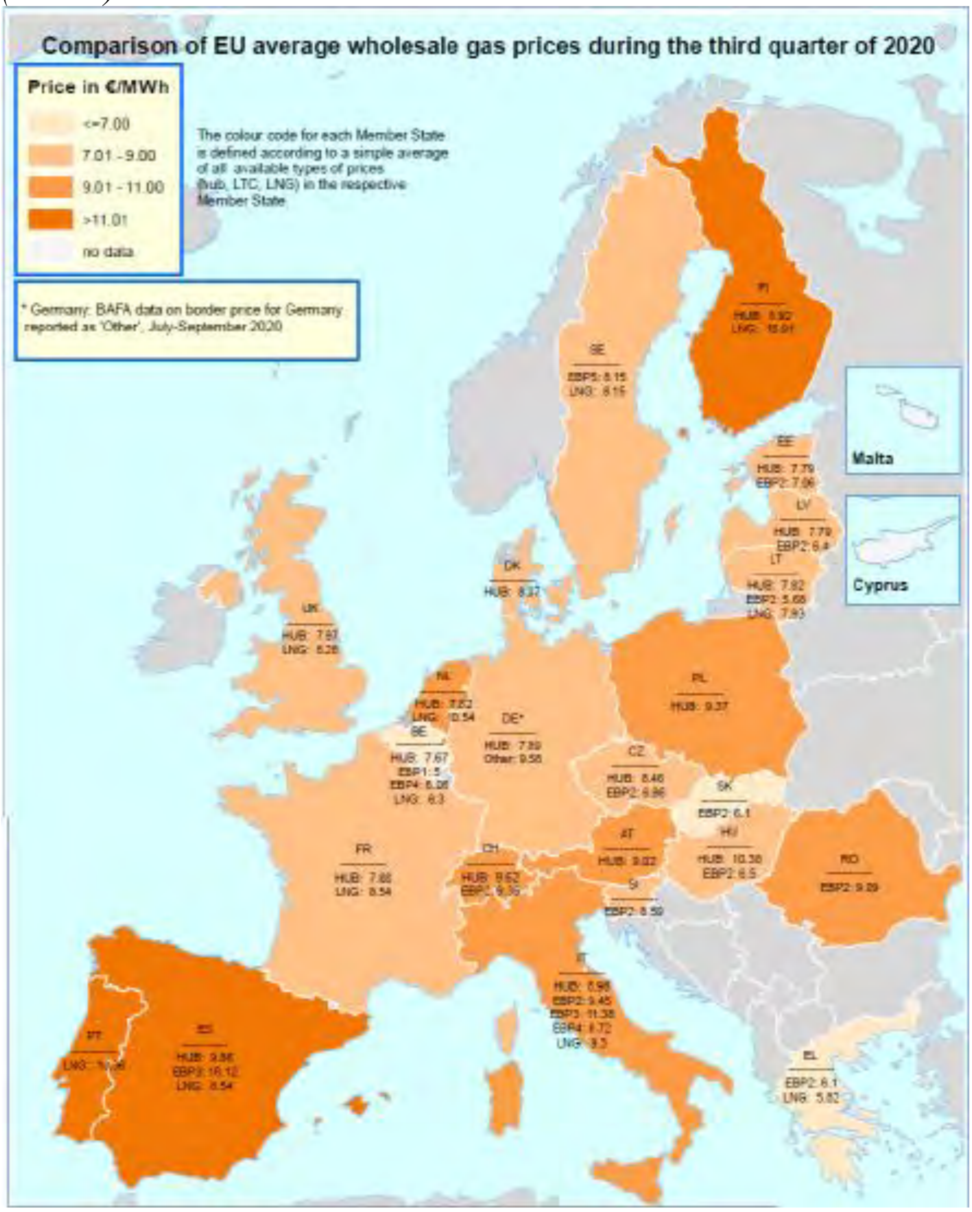
Global market developments also contributed to the favourable changes in the EU gas market between 2016-2020. The oversupply in the European and global gas market has coincided with a substantial gas demand drop in the EU due to the financial crisis but also due to energy efficiency and renewable energy policies.

Due to partly the regulatory scrutiny of the third package but mainly to the competition of the few suppliers to the EU (pipeline and LNG) the contractual conditions in the EU changed dramatically: shorter contracts on smaller volumes are priced on (now liquid) hubs rather than on oil, with delivery points on a hub and not on borders. As a consequence, more short-term trade and better utilization of the existing infrastructure happen.

The very favourable EU gas market conditions (including prices that converged) are no doubt a combined impact of TEN-E, the SOS Regulation, the Network Codes, energy efficiency investments, demand drop due to the crisis, and favourable global market conditions. The European Commission reports unprecedentedly low wholesale gas prices (Figure 35) that are about

50% lower than those reported in 2010 (Market Observatory for Energy, 2020).

Figure 35. Average quarterly wholesale gas prices in Europe, 2020Q3, (€/MWh)



Source: Quarterly Report on the European Gas markets Q3 2020

We see no isolated market in the EU and the market players can make good use of the substantial LNG terminal and storage capacities when market circumstances are favourable, as in 20192020. As the policy of the EU shifts from security of supply to more sustainability and decarbonization, the future outlook of the gas markets has also changed dramatically. At the time when the TEN-E regulation was drafted in the early 2010s the market forecasts were predicting gas demand increase in the EU. This has changed first to forecasts referring to high unpredictability of gas demand (mid 2010s), but as the green agenda started to question the sustainability of fossil gas in the EU energy mix, market consent was reached on predicting a decreasing or at the most stagnating gas demand in the EU by 2030.

The remaining and already well-identified infrastructure needs are primarily in the Eastern Baltic Sea region, the Central and South-Eastern part of Europe, see Artelys (2020) and Kotek et al, (2019).

6.2 Scenarios and main assumptions

The modelling for this case study was carried out in summer 2020. The European Union energy policy shifted the focus from the security of supply objective to the sustainability pillar and was about to change the TEN-E infrastructure regulation with the aim to align it with the decarbonization agenda. The political discussion about the role of gas questioned the rationale to invest into gas infrastructure given the full decarbonization goal was agreed between member states. Gas infrastructure projects usually have a 20 – 30 year payback time, which leaves little to no ground for new investments if natural gas is to be phased out by 2050. Wholesale gas prices in the EU were on historical low levels, the willingness to invest was already very low. During the Covid pandemic the stagnating European gas demand decreased further. Most of the gas PCI projects were seriously delayed compared to their original schedule, those that were built seemed to be underutilized. Therefore, the question could be asked: was the infrastructure strategy of the EU worth the investment? Are the PCIs rightly selected? Does the EU need them for market integration or security of supply reasons? The analysis has been done separately for those projects that were already implemented, for those that were in the making (projects with a final investment decision), and those that were in planning phase.

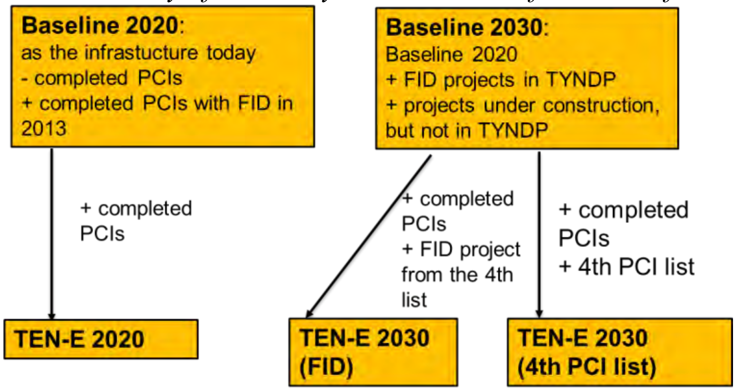
As we are to evaluate the effect of the regulation, projects will not be evaluated one-by-one, but as a whole group. Modelling was conducted for the years 2020 and 2030, 2020 representing a current gas infrastructure situation, while 2030 tries to capture the best estimate for the future market situation.

The scenarios estimate the monetized benefit of the TEN-E regulation in terms of socioeconomic welfare change (Figure 36):

- *A Baseline (without Regulation) scenario* infrastructure setup is as follows.
  - For 2020 as the infrastructure today: l
  - Latest (2019) capacity map of ENTSOs + FID projects of TYNDP 2018 that were planned to be commissioned by 2020 + those that were commissioned in 2019-2020 but are not part of the TYNDP (e.g., Turkish Stream 1), excluding all PCI projects that were commissioned until 1 January 2020 except for those that already had an FID in 2013 (TAP-TANAP-SCPX are included into the Baseline).
  - For 2030: as the infrastructure for 2020 + FID projects of the TYNPD 2018 (expected to be commissioned between 2020 and 2030) + the projects under construction that are not part of the TYNDP (e.g., Nord Stream 2, Turkish Stream 2).
- A *'TEN-E scenario'* would be compared to this baseline scenario: a market situation assuming the infrastructure of the baseline scenario with additions.
  - For 2020 the already commissioned PCI projects up to now (*TEN-E 2020).*
  - For 2030 the 2020 setup + The PCI projects with an FID. (*TEN-E 2030 FID*).
- As a more forward-looking approach, we also analysed the overall effect of the PCI projects already implemented and all the projects on the 4th PCI list (*TEN-E 2030 4th PCI*).

The list and the detailed data of the analysed projects can be found in the Annex (Table 21 and Table 22 and Table 23).

Figure 36. Summary of the analysed scenarios of the EU infrastructure policy



Source: own compilation

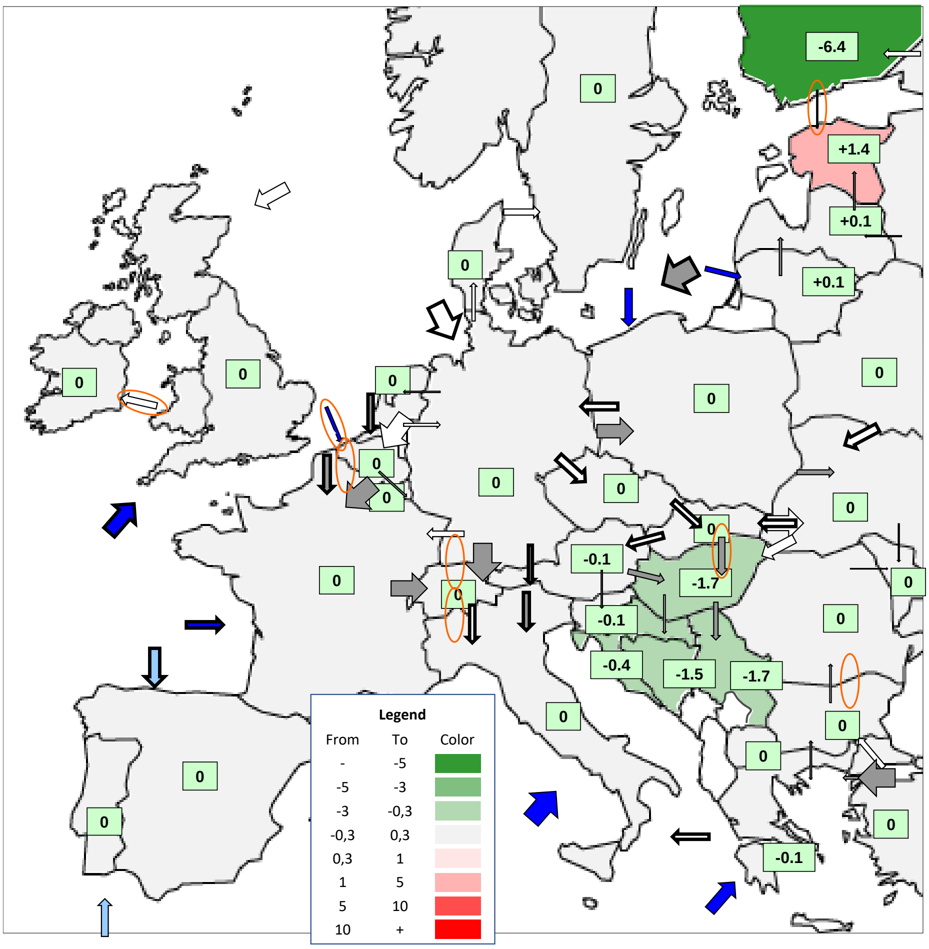
The difference in total social welfare between the TEN-E and Baseline scenarios gives the yearly benefit of the Regulation (brought by the commissioning of PCIs) assuming a 2020 and 2030 state of the word. To monetize the sustainability effects, a price for CO_2 emissions was set to 19.7 €/t in 2020 and 27 €/t in 2030.

6.3 Modelling results

6.3.1 Evaluation of commissioned PCIs in 2020

Figure 37: Price effect of commissioned PCIs in normal scenario 2020 (€/MWhFigure 37 shows the yearly average price effect of commissioned PCIs. There is a significant price decline in the Central-Southern-Eastern Europe due to the SK-HU interconnector and price convergence in the Baltic Region due to Balticconnector.

Figure 37: Price effect of commissioned PCIs in normal scenario 2020 (€/MWh)



The green boxes represent the €/MWh price change attributable to PCIs, the blue arrows show LNG flows, the white arrows modelled gas flows on pipelines. Size of the arrows indicate the volume of gas delivered. Dark grey and dark blue arrows indicate that there is congestion on the pipeline interconnections or at respective LNG regasification terminals at least in one month. New projects are circled. Empty circles indicate new project without utilization.

Source: REKK modelling

Table 13 shows that the market integration benefits in the normal scenario are the highest, security of supply benefit is also significant, and CO_2 emission reduction benefits are marginal. As CO_2 benefits are calculated assuming that the additional gas consumed in the EU crowds out other fossil fuels, the results show, that there is limited room for enabling (by these projects) a coal to gas switching.

Table 13. Welfare effect of commissioned PCIs compared to the 2020 baseline

I.	Weighted average price change (€/MWh)	-0.03
II.	Normal Welfare (m€/year)	127.6
III.	SOS Welfare (m€/year)	117.6
IV.	Total Welfare (m€/year) (0.95*II.+0,05*III.)	127.1
V.	CO2 benefit (m€/year)	5.4
VI.	Total yearly benefit (m€/year) (IV.+V.)	132.5
VII.	Annualized investment cost (m€)	109
VIII.	Yearly net benefit (m€/year) (VI.-VII.)	23.5
IX.	Benefit/Cost ratio (VI./VII.)	1.2

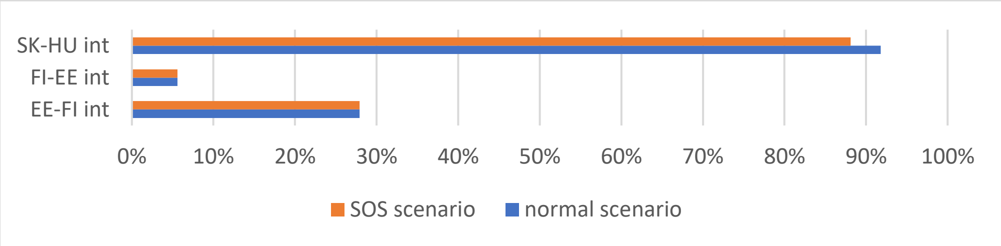
Source: REKK modelling

The overall social welfare benefit of the commissioned PCIs in 2020 is EUR 132.5 million per year, mainly due to the significant price decline in CSEE and the price convergence in the Baltic Region. The highest welfare gains are realized by the Finnish and Hungarian consumers, while the Lithuanian LNG operator and Latvian and German TSOs also gain significantly.

The net benefit (modelled yearly benefits decreased by annualized investment costs) of these projects calculated for 2020 is positive (EUR 23.5 million per year) with a B/C ratio above 1 (1.2), even in the low-price environment. Hence, it can be concluded that the overall benefits of the commissioned PCIs outweigh the cost in the long-term, meeting the TEN-E Regulation requirements (Article 4 1(b) paragraph).

The majority of socio-economic benefits are attributable to market integration. Security of supply benefits of the PCIs are low in 2020 as the disruption scenario assumed the one-month supply cut on the largest Russian supply route (Ukraine). This risk has been addressed by some PCIs (e.g. the Southern Corridor provides new source to Italy form Azerbaijan, Hungary-Slovakia interconnector allows for more inflow to Hungary from the West) but also by Russia, that implemented consequently a route diversification strategy by investing into Turk Stream and Nord Stream as well. [33] The SOS modelling – not deferring much from a normal scenario confirms that the resilience of the natural gas network has improved substantially.

Figure 38: Utilization of commissioned projects in 2020, (%)



Source: REKK modelling

**only projects with utilization rates above zero*

The utilization of the infrastructure (Figure 38) follows the price changes shown above. The SK-HU interconnector and the Balticconnector are used both in the normal and the SOS scenarios when other PCIs are not. Reverse flow projects and certain internal pipelines are not used by the model, partly because non-PCI projects have been implemented parallel and they became obsolete. This is the case for the BG-RO pipeline, where the Turk Stream and Balkan Stream pipeline changed the market and the commercial flows substantially.

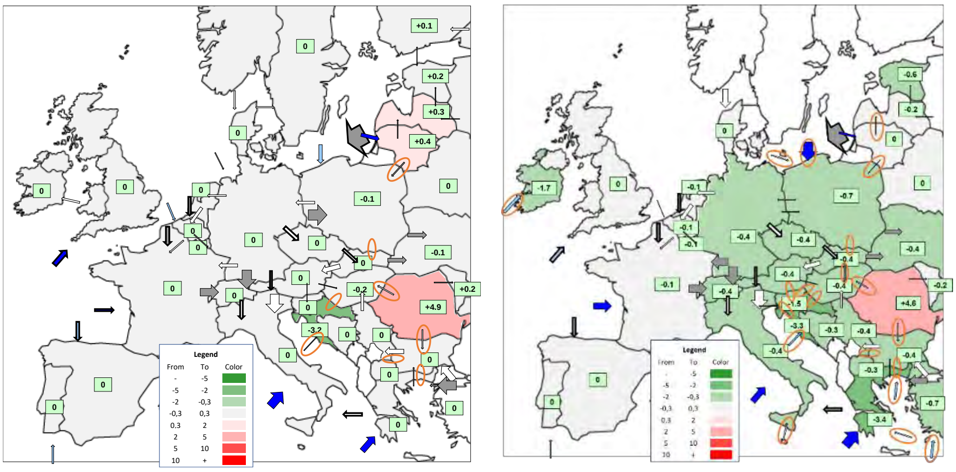
6.3.2 Modelling results for 2030 - forward looking analysis

Even if the positive impact of the commissioned PCIs is significant, there are remaining infrastructure needs identified by the Regional Groups and some remaining bottlenecks that still need to be addressed. [34]
In order to quantify additional benefits from the 4th PCI list, they are included in the 2030 Baseline scenario. Beyond calculating the overall welfare effect

[33] In the light of the 2022 Russian Ukrainian war considering a full Russian supply cut could have been tested as well. An excuse to not doing so is that none of the methodologies considered war scenarios in 2020. It is for another article to assess war and sanction readiness of the European gas system.
[34] Methodology for assessing the gas candidate PCI projects PCI 2018-2019 exercise 17 June 2019 Draft for Regional Groups comments

of all projects from the 4th PCI list, first only those with an FID were included. As a first step, Figure 39 illustrates the price effect of the modelled projects.

Figure 39: Price effect of PCIs with FID (left) and all projects from the 4th PCI list (right) in normal scenario (€/MWh)

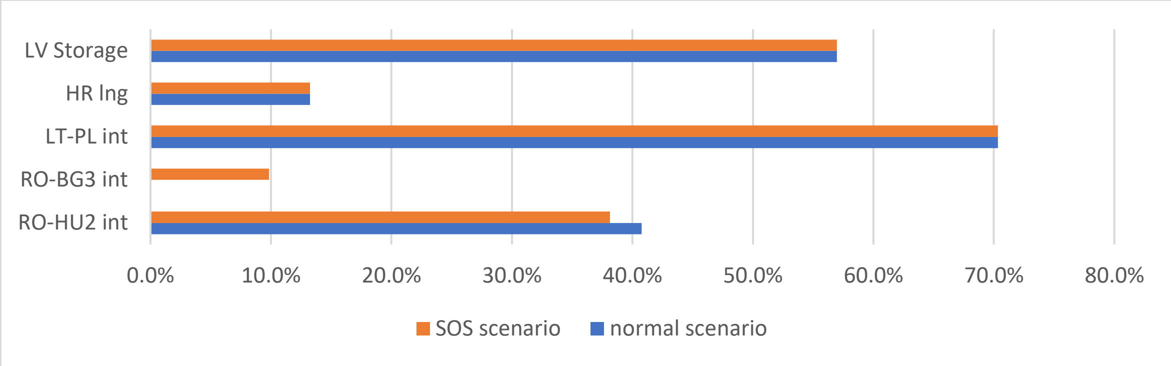


The green boxes represent the €/MWh price change attributable to PCIs, the blue arrows show LNG flows, the white arrows modelled gas flows on pipelines. Size of the arrows indicate the volume of gas delivered. Dark grey and dark blue arrows indicate that there is congestion on the pipeline interconnections or at respective LNG regasification terminals at least in one month. New projects are circled. Empty circles indicate new project without utilization.

Source: REKK modelling

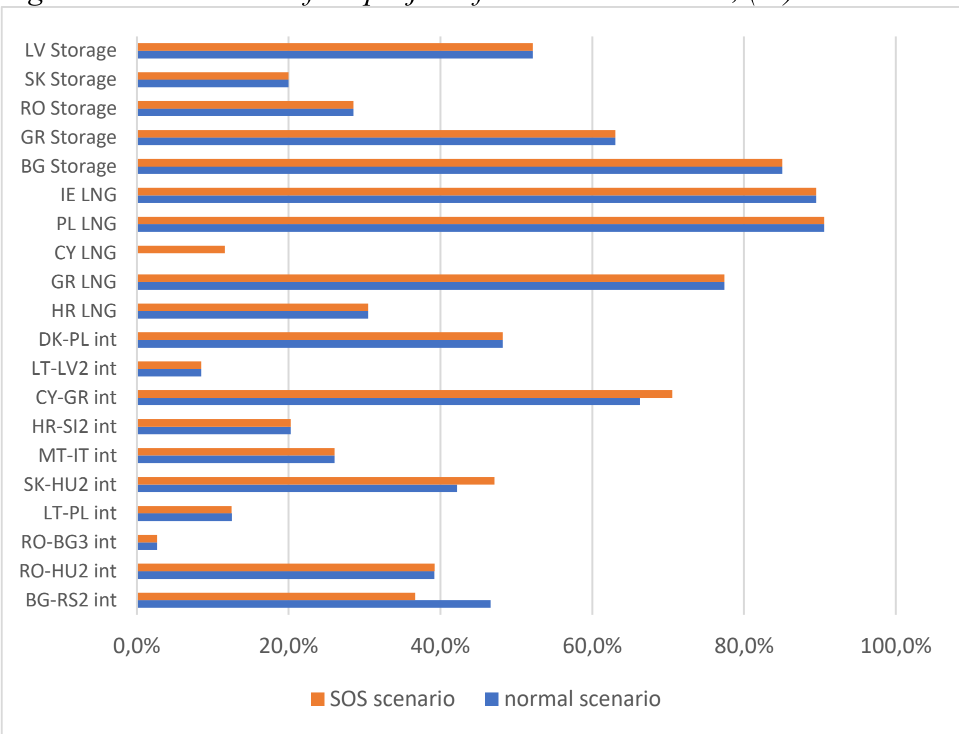
With FID projects from the 4th PCI list, the situation in the CSEE region changes compared to 2020, as there is lower flow on the Slovakian-Hungarian interconnector and the Romanian-Hungarian interconnector is used instead (Figure 40). Increased Romanian production also leads to higher flows on the Romanian-Bulgarian interconnector in the security of supply scenario. Croatian LNG has significant impact in Croatia but it does not affect other markets. GIPL is also highly used to deliver gas from Lithuania to Poland raising prices in Poland and lowering them in Baltic countries. Beyond the effect of FID projects, prices fall in some additional countries mainly due to the high utilization of new LNG capacities in Greece, Poland and Ireland (Figure 41).

Figure 40: Utilization of FID PCI projects, (%)



** only projects with utilization rates above zero*
Source: REKK modelling

Figure 41: Utilization of all projects from the 4th PCI list, (%)



Source: REKK modelling
** only projects with utilization rates above zero*

The welfare outcomes show that although the additional benefits of the FID PCI projects are significant (EUR 74.3 million per year in 2030), they do not outweigh the costs, yielding negative net benefit (EUR -44.7 million per year) compared to the 2030 Baseline scenario. The overall Benefit/Cost Ratio of these projects is 0.62 with most FID PCI benefits realized by Romanian producers (Table 14).

Gas imports in 2030 are about the same as for 2020 based on stagnant projected EU gas demand and only a small decline in EU production (based on EUCO 3232.5 scenario). Furthermore, there is a convergence of gas markets and high competition among external suppliers (pipeline and LNG) leading to a drop in overall gas prices. These effects together reduce the need for new EU gas infrastructure. Consequently, although FID PCIs would bring significant additional benefits, they are considerably lower in 2030 than it was expected when they were decided to be implemented because:

- Forecasts for future gas demand have been substantially lowered in the last decade by all institutions.
- Due to the construction of competing (partly non-PCI) projects some PCI projects may remain unused.

The clear message is that any delay in implementation of FID PCIs diminishes benefits and increases the risk of building stranded assets.

Table 14. Welfare effect of FID PCIs and PCIs of 4th list compared to the 2030 baseline

		Only FID projects	All projects from the 4th PCI list
I.	Weighted average price change (€/MWh)	-0.01	-0.19
II.	Normal Welfare (m€/year)	83.2	428.4
III.	SOS Welfare (m€/year)	68.5	432.4
IV.	Total Welfare (m€/year) (0.95*II.+0,05*III.)	82.5	428.6
V.	CO2 benefit (m€/year)	-8.2	13.4
VI.	Total yearly benefit (m€/year) (IV.+V.)	74.3	442
VII.	Annualized investment cost (m€)	119	670
VIII.	Yearly net benefit (m€/year) (VI.-VII.)	-44.7	-228
IX.	Benefit/Cost ratio (VI./VII.)	0.62	0.66

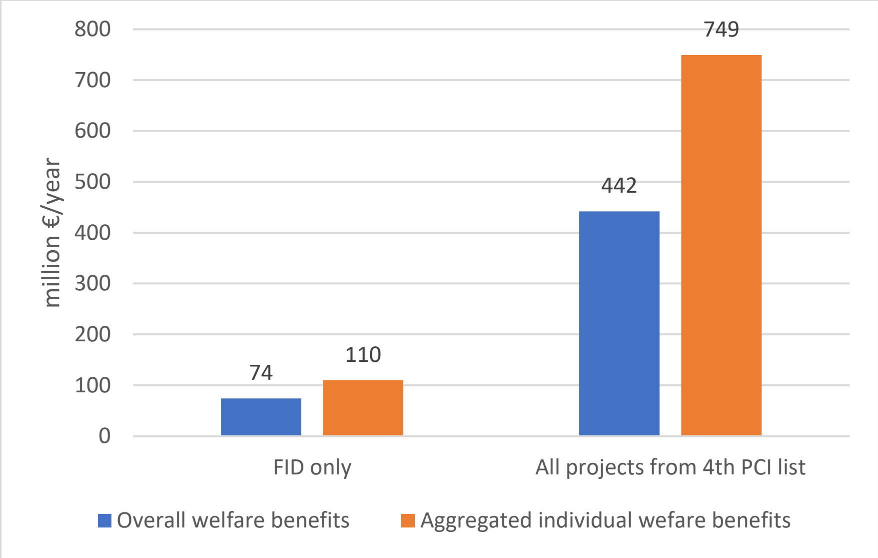
Source: REKK modelling

Comparing the overall welfare effect of all projects from the 4th PCI list to the Baseline 2030, it can be observed that despite significant benefits from the 4th PCI list, the net benefit is still negative (EUR -228 million per year) due to some enormous project costs, and the Benefit/Cost Ratio is 0.66. The most significant welfare gains here go to new LNG terminals (Table 14).

Similar to the 2020 results the sustainability benefit of the 4th PCI projects is limited, and in case of the FID projects the positive CO_2 benefits are offset by the Romanian result, where due to price increase the consumption of gas is decreasing. Due to the simplicity of our methodology for sustainability this results in estimating an increased CO2 emission. The comparison of modelled benefits with the total investment cost can be misleading, not only because the benefits may be underestimated but mostly because there are several competing projects on the list with the same goals and it is unlikely that all of them will be realized. ENTSOG's corridor approach used in a project-based evaluation can leave projects on the list that are about to solve the same regional need. In previous lists, about 40% of the proposed PCIs have been withdrawn or not resubmitted. The PCI selection process evaluates each project on an equal basis and does not select from two that might be competing. Rather, the goal is only to select the project that contributes most to the listed needs. Therefore, although remaining bottlenecks still need to be addressed, not all listed projects are necessary, otherwise some of them may result in financing stranded assets.

In order to better illustrate the competitive impact between projects and corridors in the PCI list, a PINT (put one in at a time) analysis is used to quantify the benefit of the individual projects. Figure 42 shows the sum of individual benefits of the projects using the PINT methodology compared to the clustered benefits (when we include them into the model together) which are significantly higher (by 50% in case of FID projects and 70% in case of the whole PCI list) than in the clustered welfare effect. These results support our previous statement that the PCI list include several projects aiming the same goals.

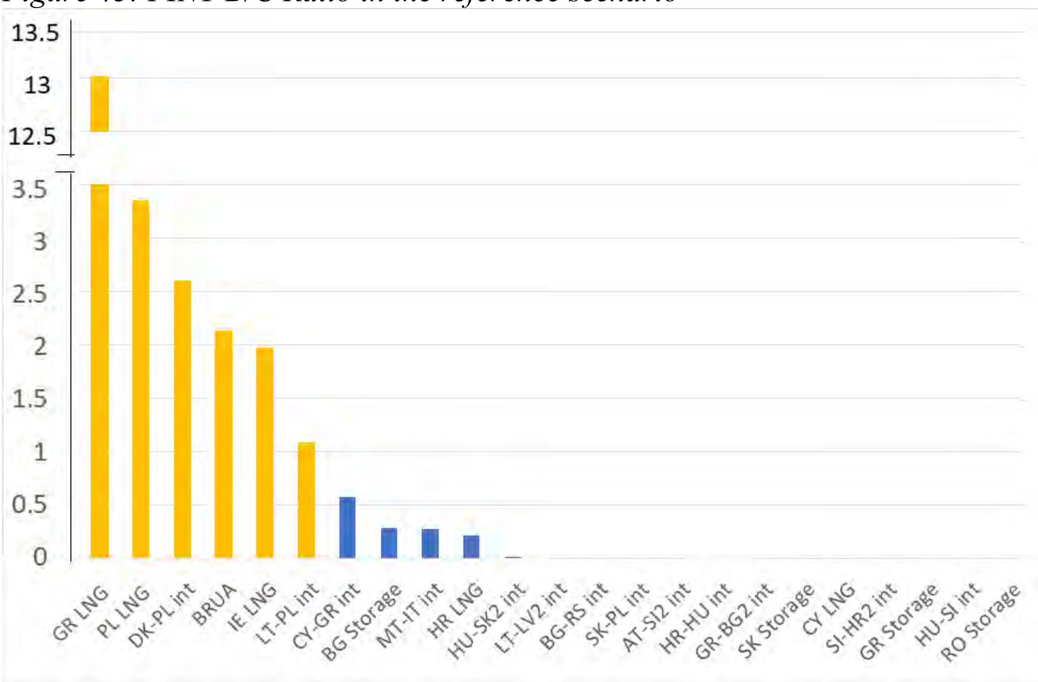
Figure 42: Clustered vs. aggregated individual PINT benefits, (m€/yr)



Source: EGMM modelling

Figure 43 illustrates that using the PINT B/C ratio less than half of the projects have quantifiable benefits and only six projects have benefit/cost ratio larger than one: three LNG terminals, the BRUA corridor, the Poland-Lithuania interconnector and the Baltic Pipe (DK-PL).

Figure 43: PINT B/C Ratio in the reference scenario



Source: EGMM modelling

6.3.3 Sensitivity results

Since modelled benefits for 2030 are highly dependent on the assumptions applied in the EUCO3232.5 scenario, additional sensitivity scenarios are executed. The first sensitivity scenario uses a lower level of Romanian production35. A crucial assumption is high Romanian production, which significantly affects benefits associated with CSEE gas infrastructure projects, and in reality is uncertain in 2020 market conditions. British Petroleum estimates a 10.6 reserves per production ratio for the Romanian gas in 2019, meaning, that the resources are very limited (BP, 2020). The second sensitivity assumes less LNG arrives to Europe (50% of current 2020 LNG import, around 600 TWh) The volume of LNG inflows to Europe can change along Asian appetite for gas but also along geopolitics as discussed also Egging-Bratseth, Holz & Czempinski (2021). The low LNG scenario estimates the benefits of the PCIs in a less oversupplied market with higher prices.

Table 15: Modelling results in the sensitivity scenarios, EU27

2030		Total yearly benefit m€	Annualized investment cost, m€	Net benefit m€	B/C
Baseline	FID only	74	119	-45	0.6
	4th PCI list	442	670	-228	0.7
Low RO production	FID only	17	119	-102	0.1
	4th PCI list	355	670	-315	0.5
High price environment	FID only	171	119	52	1.4
	4th PCI list	664	670	-6	1.0

Source: REKK modelling

[35] We used the assumption of 52.3 TWh/yr (in line with the ENTSOG TYNDP), as opposed to the 123 TWh/year in the Baseline scenarios.

Table 15 shows that the modelled benefits vary significantly across the sensitivity scenarios. For one, lower Romanian production yields significantly lower benefits for the assessed projects, especially those that were planned to transmit partly this new Romanian source. For two, lower LNG imports yield much higher benefits for the assessed projects which perform better when gas prices are higher (both market integration and SOS). In this sensitivity scenario the B/C ratio for FID PCIs is 1.4 and for the 4th list is 1. Alternatively proposed LNG terminals produce more benefits when European LNG imports are higher.

Even though FID PCIs and the 4th list did not perform well in the Baseline Scenario, the social net benefits of these projects were positive or at least close to zero in the low LNG sensitivity scenario. It is evident that the B/C Ratio of future PCI projects highly depends on market expectations.

6.4 Discussion of the modelling results

This chapter evaluated the success of the EU's selection and support for natural gas interconnection, LNG and storage projects that foster market integration, contribute to security of supply and help the EU reaching its sustainability goals.

There are numerous factors that make it difficult for EU decision makers to reach this goal. First, the aim is not to select projects that are economical but those that are not financially feasible or do not result in direct benefits for host member states but for wider European welfare, especially consumers. Therefore, it is suggested that the CBA is applied to candidate PCIs focusing on exclusion of unrealistic project proposals and flagging competing alternatives. Second, the EU cannot force promoters to proceed with their projects. The long delays in project implementation due to lack of commitment, conflicting interests of promoters or political gamesmanship behind the scenes resulted sometimes allowing competing alternative projects to overtake PCIs. Following ACER recommendations, projects with overoptimistic commissioning dates, repeated delays, rescheduling or without serious progress should be put under increased scrutiny. Third, large Russian infrastructure projects (Nord Stream 1, Turk Stream 1 and 2) have a huge impact on EU flows redirected away from Ukraine to Central and Eastern Europe. Thus, the scenario design should take into account the strategic behaviour of key suppliers to the EU and more geopolitically framed sensitivity scenarios needs to be designed to estimate the effect of the PCI projects. Fourth, there is a certain time requirement for large investment projects to materialize. Market circumstances have changed dramatically in only a few years' time, markedly impacting the benefits from these projects. ACER reports confirm that delays to gas PCI implementation are due to uncertainty over future supply and demand.

Despite all these factors, it can be firmly concluded that even with substantial modelling simplifications and a conservative approach underestimating benefits, the natural gas PCI projects implemented up to now were beneficial from a European perspective, contributing to the internal gas market and resulting in a robust and resilient gas network that ensures security of supply. The commissioned PCIs have lowered prices considerably in more isolated member states. The underutilization of certain projects is a result of changing market circumstances and the redirection of Russian flows. The combined effect of these lead to a reduction of SOS benefits. The FID PCIs are mostly supported by CEF funds awarded between 2014-2016 but according to the modelled outcomes the net benefits of these investments are less than the costs in the Baseline scenario. The results, however, depend on market circumstances. The low-price environment characterizing 2020 does not support the projects, but any scarcity in LNG supply that would increase the European prices (as experienced in 2021) would reverse this. The non-FID projects do not perform well as a package under any conditions because of competing projects that will not happen together.

Furthermore, in a decarbonized future the need for gas will be limited and any further investments should be made future proof allowing for alternative use, especially hydrogen transport. Any delay in implementation reduces the effective years of the projects when they can generate income and increases the risk of stranded assets. Though according to the new TEN-E proposal the EU will not financially support natural gas projects going forward, those funds already allocated to FID projects that will materialize in coming years will contribute to keeping EU natural gas prices competitive.

7 The interplay of the Russian and the European pipeline strategies

7.1 Lack of a coordination and cooperation on infrastructure development

This chapter aims to show by modelling tools that the pipeline strategies of Russia and the EU result in unnecessary investments and excess capacities that are underutilized.[36] Several reasons contributed to the uncoordinated infrastructure development. The mutual suspicion on both sides and the politically increasingly tense relationship between Russia and the EU did not allow for substituting the hardware (pipes) with software (a legal regulatory framework). During the worsening relationship, dialogue between the highest and even expert level ceased between Russia and the EU. Russia has never consulted any institution of the EU about an EU opinion on the Nord Stream pipeline, they considered that the pipeline is a German-Russian project. This is partly due to the lack of communication between the parties. Lack of communication in the planning phase led to uninformed guesses taken by both parties regarding whether the others' announced infrastructure priorities are "a serious threat" or something to be ignored. The timing was crucial: the projects that can come first will benefit from the change in market situation most. A competing alternative infrastructure can ruin the business case for the planned pipeline. Finally, the path dependency related to the large investment decisions typical for pipelines does not allow for easy corrections. FIDs result

[36] Publication supporting this chapter: *Péter Kotek– Adrienn Selei– Borbála Takácsné Tóth-* The Impact of The Construction of the Nord Stream 2 Gas Pipeline on Gas Prices and Competition, Competition and Regulation, Pál Valentiny, Zombor Berezvai, István Csongor Nagy (ed) (2020) The Institute of Economics at the Hungarian Academy of Sciences, 248-264, ISSN 1789-9702

in a high probability of the commissioning of the project. Similar overinvestment occurred in the gas-fired power plant fleet in early 2000.

Infrastructure decisions are based on the best available information and most trusted future assumptions available at a certain time. The demand projections of the EU were overambitious up until 2015, projecting growing demand in key scenarios. This implied wishful thinking and a systematic bias, that more projects seemed to be necessary to fulfil the expectedly growing import need. The outcome of the diversification strategies applied by each party seems in the framework of the decarbonization agenda an even more unnecessary investment (Holz & Kemfert, 2020) In our modelling this aspect will not be considered, we will show without the decarbonization aspect of how the two infrastructure strategies contradict to each other and hence result in a suboptimal outcome.

7.2 Analyzed scenarios and assumptions

The modelling for this chapter was carried out in 2015. The data and assumptions were based on latest available TYNDPs at that time. The reference scenario was calibrated in 2015 on the 2020 future, hence demand projections were optimistic and projected growth This explains the slightly increasing demand assumption for the EU[37]. The modelling wanted to test how the Nord Stream 2 project will change gas prices in the region, and to what extent the Nord Stream 2 will influence the need for additional European infrastructure investments.

As a first step, we analysed the deviations from a baseline reference scenario caused by the NS2 project and the simultaneous change of the transmission path used by the Russian long-term contracts. We assumed that the transmission routes change as follows: except for the gas transmitted to Bulgaria, Greece, Macedonia, Moldova, and Romania, all the gas that had

[37] In later years, the more moderate estimates of the IEA and of the European Commission were used also by ENTSOG: A stagnating even slightly decreasing gas demand was assumed for 2030 and sharper decline thereafter. This change in the main assumptions (on European gas demand) explains that the results presented in this chapter differ from the results of chapter 5.3.

previously been covered by Russian long-term contracts and transported through Ukraine will arrive in Europe through the Nord Stream2. (See Annex 3 Table 24 for the detailed description of changes of the transmission paths of long term contracts.) We assume that the pricing of the contracts is neutral from the perspective of the buyers, in other words, Russian gas will arrive in a given country at the same price as before.

The input data needed for modelling originates from publicly accessible sources: the natural gas transmission, storage, and regasification infrastructure were assembled based on the capacity map of the ENTSOG, demand was determined based on the data published by the Eurostat and other national statistical offices, prices were derived from publicly available exchanges (TTF) and the price signals of statistical offices.

Earlier we showed that in serving the growing import needs of Europe, increasing LNG imports become the prime competitor of Gazprom. Accordingly, we inspected the impact of the Nord Stream 2 under a 2020 reference scenario assuming that about 100 bcm LNG is arriving on the continent. In our reference we slightly altered the existing European gas infrastructure of 2015: in parallel with the expansion of the Nord Stream, we inserted into the model the bidirectional line connecting Czechia and Austria (BACI) with a daily capacity of 195 GWh[38]. All other conditions (especially the marginal price of the Russian contracts, demand, pricing of external sources, and the tariff of the infrastructure access) reflect data as observed in 2015.

The 2020 reference scenario characteristics are the following:

- The supply of global LNG rises in Europe: approximately 100 bcm of LNG is imported to the continent versus the 50 bcm in 2015. From the perspective of Europe, this does not entail additional investment costs, only the utilisation rate of the currently operating terminals must increase.

[38] At the time of this modelling run, the BACI project was highly publicized and lobbied for by Gazprom and by the Austrian and Czech TSOs that were promoting the project. Later it turned out that Gazprom used this new project idea to negotiate better transport tariffs with the Slovakian TSO (eustream). As soon as the Slovakian TSO realized, that Gazprom is ready to book reverse capacities on the existing Czech-Slovak and Slovak-Austrian point for 20 years, they immediately gave a tariff discount. The agreement has put and end to the short lived BACI project idea.

- European demand increases by 7 % between 2015 and 2020 – based on the „grey" scenario of the TYNDP 2016 of the ENTSOG.
- Gas production in Europe declines by 15 % between 2015 and 2020.
- Investments in possession of a final investment decision (in 2015) are implemented by 2020.
- Concerning the price of oil, a major driver of the price of long-term contracts, we assumed a 2020 price level of 50 USD per barrel.

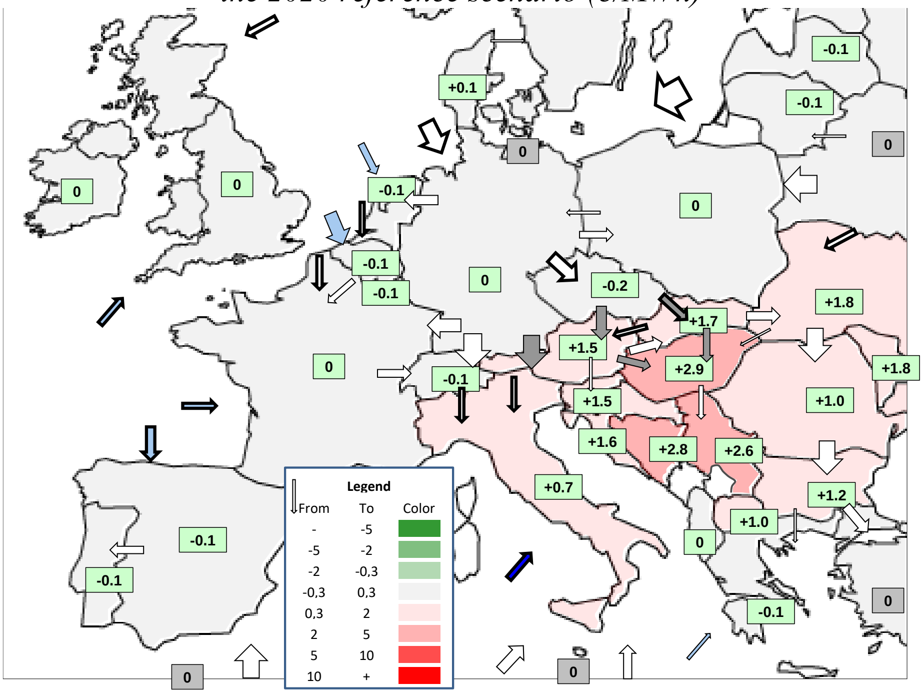
The Russian long-term contracts in effect in 2015 are included in the 2020 reference scenarios with unchanged conditions.

7.3 Modelling results

7.3.1 Impact of Nord Stream 2 on prices and gas flows

Under the 2020 reference scenario the modest price difference between Eastern and Western Europe persists, even increases a little, since the cheap LNG satisfying surplus import needs is available primarily to Western European countries with regasification terminals. Along this reference framework once again we modelled the impact of building Nord Stream 2, with the above-described assumptions. As depicted by Figure 44, the CEE region is more heavily burdened by the construction of the infrastructure, while in the Western European countries we can expect close to zero change in benefits.

Figure 44. The price impact of Nord Stream 2, price change compared to the 2020 reference scenario (€/MWh)



Note: The rectangles represent the price change compared to the reference scenario as a result of Nord Stream 2.
Source: REKK modelling

Our hypothesis, according to which the Nord Stream 2 – by making bottlenecks more severe – will further increase the price difference between the Western and Eastern markets of Europe, is confirmed by the modelling results. This situation is further impaired as a much larger portion is reserved for the capacity required by contracted gas, leaving lower capacity for short-term (spot) gas competition. As an illustration, we show the transmitted volumes through the most important cross-border pipelines of the region (German-Austrian, Czech-Slovakian, Austrian-Hungarian, and Slovakian-Hungarian border). The short-term (spot) flows arrive in the region through the German-Austrian and the Czech-Slovakian borders.

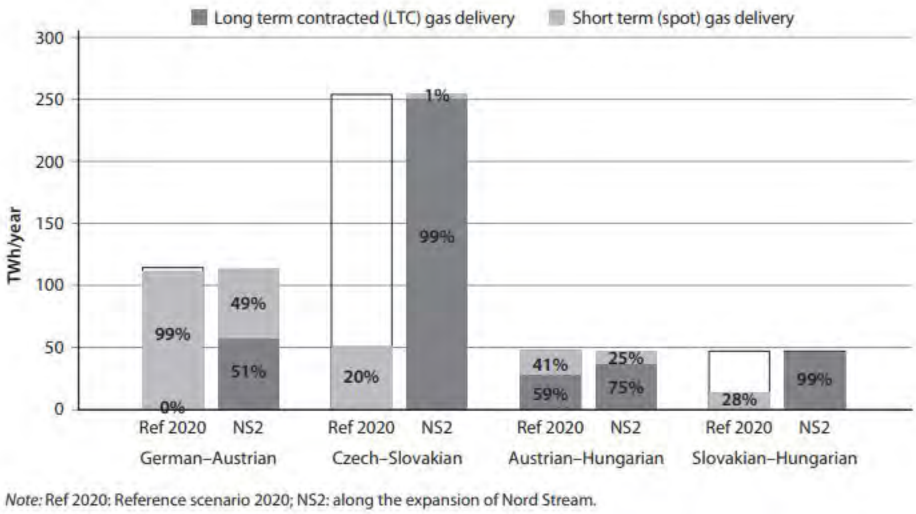
99% of the full capacity of the German-Austrian pipeline is reserved for short-term (spot) flows, and 1% is dedicated to flows connected to a long-term contract. [39] Following the expansion of the Nord Stream, the Austrian contract, formerly delivered through Ukraine, would be diverted to this

[39] The contract delivers Norwegian, not Russian gas to Austria. By the 2020 reference this contract expires.

border, therefore almost half of the pipeline would be reserved for long-term contracts, reducing short-term flows to the other half of the total capacity.

We find a similar impact for the Czech-Slovakian and the Slovakian-Hungarian cross-border pipelines: under the reference case capacity utilisation is a mere 20%, made up exclusively of short-term (spot) flows, while after Nord Stream 2 is constructed, capacity utilisation jumps to almost 100%, representing exclusively flows under long term contracts (see Figure 45).

Figure 45. Long-term contracted flows and short-term (spot) gas flows with and without Nord Stream 2, 2020



Note: LTC: long-term contracted gas delivery; Spot: short-term gas delivery; Ref 2020: Reference scenario 2020; NS2: along the expansion of Nord Stream (Kotek, et al., 2020, p. 12)

As depicted by Figure 45, without Nord Stream 2 and the related contract amendments, the capacity utilization of the selected pipelines from West to East is much lower than in case the expansion happens. This is because the Slovakian, Hungarian, Serbian, and Bosnian contracts delivered through Ukraine get relocated to these borders. At the Austrian-Hungarian border – vital for Hungary – the 40% share of short-term (spot) flows is halved. The modified route substantially reduces the access of the region to liquid gas markets, and it hinders integration.

The modelled increasing gas market prices do not reflect the interrelation according to which the pricing of Russian contracts would depend on the negotiating position of the purchasing country – stemming from the diversification of import and transmission structure. This impact cannot be explored under the current modelling framework, since the model covers a one-year cycle. Nevertheless, presumably, the pricing strategy of Gazprom may change in the medium term due to declining short-term trade, since short-term (spot) gas cannot be delivered to the destination country, as the capacities have already been reserved for Russian long-term contracted volumes.

7.3.2 The impact of the construction of Nord Stream 2 on social welfare

Next, we inspect the impact of Nord Stream 2 from the perspective of social welfare. The change in welfare includes any shift in consumer surplus, or producer surplus as well as the change of the net income of infrastructure operators and traders. [40]

Modelling provides a nuanced view of the welfare impacts of the investment (Table 16). From the perspective of consumers, the investment does not achieve a positive balance in Western Europe either, since under the 2020 reference case we assumed abundant LNG supply on the global markets. The arrival of the new LNG source in itself considerably increases welfare in Western European countries and under these boundary conditions, Nord Stream 2 affects prices less and increases consumer surplus to a low extent. Due to diverted flows, the net income of infrastructure operators increases in the case of Western European transmission system operators and declines in Eastern Europe. Overall, the project reduces European welfare, and even the welfare change of Western European market participants takes a negative turn.[41]

[40] We do not consider Gazprom as the owner of the long-term contract, but its European contracted partner. Today in Hungary this is owned by MVM. Within the modelling exercise we do not inspect the net income of Gazprom.

Table 16. Welfare change for different market participants in selected Western European and Eastern European countries compared to the 2020 baseline (m€)

	Change of net consumer surplus	Change of producer surplus	Change in the net income of traders	Change in the net income of infrastructure operators	Total welfare change
All of Europe	–1551	442	–279	–761	–2148
Western Europe	–239	–6	–312	381	–176
– Germany	25	1	–18	217	225
Eastern Europe	–1312	449	33	–1142	–1972
– Bulgaria	–48	–53	–245	–65	–411
– Greece	3	0	–128	0	–125
– Hungary	–240	32	156	–9	–61
– Slovakia	–91	0	68	–125	–148
– Ukraine	–588	339	133	–877	–993

Source: EGMM modelling results

7.3.3 Evaluation of the returns of projects of common interest

The impact of the expansion of Nord Stream is compellingly conveyed by the change in the investment need for the European natural gas transmission infrastructure. Below we assess the welfare change of completing the current PCI infrastructure relevant for the Central Eastern European region under two assumptions: in case the expansion of Nord Stream happens and in the absence of it.

We inspected the welfare impacts of the planned projects of common interest with and without the expansion of the Nord Stream. Since Nord Stream substantially raises the prices and lowers the consumer welfare in the Central Eastern European countries, we analysed the infrastructural elements of the projects of common interest relevant to this region. The technical parameters of the projects (such as the investment cost and the capacity) have been compiled based on the PCI publications of the Commission (EC, 2016).

Table 17. The parameters of the modelled PCI

PCI name	Source country	Target country	Capacity (bcm/yr)	Capacity (GWh/day)	CAPEX (m€)	Planned length (km)	Diameter (mm)	PCI nr	Planned year of completion
Polish-Slovakian	PL	SK	5.7	152.4	586*	371	1000	TRA-N-190 TRA-N-275 TRA-N-245	2019
	SK	PL	4.7	126.0					
Greek-Bulgarian pipeline (IGB)	GR	BG	5.0	134	220	185	800	TRA-N-378	2018
	BG	GR	5.0	134					
Trans-Adriatic gas pipeline (TAP)	GR	AL	13.0	348	1500	871	1200	TRA-F-051	2020
Romanian-Hungarian	RO	HU	4.2	113.7	550	n. a	n. a.	TRA-N-126	2023
Bulgarian-Romanian	BG	RO	0.5	562	550*	185	800	TRA-N-431 TRA-N-379	2023 2018
Bulgarian-Serbian (IBS)	BG	RS	3.0	80	220*	185	813	TRA-N-137	2018
Slovenian-Hungarian	SI	HU	1.3	34.8	145	174	500	TRA-N-112 TRA-N-325	2020
Croatian-Hungarian	HR	HU	2.8	76	370	308	1000	TRA-N-075	2019
Croatian LNG		HR	4.0	108	300	-	-	LNG-N-082	2019

* *Estimated value based on the (ACER, 2015) report.*
Source: own data collection form European Commission's PCI factsheets

Projects listed in Table 17 were evaluated as standalone items and in clusters as well. Clusters include projects that complement each other. We considered the welfare impact of the new infrastructure as the benefit of the investment, while the one-time investment cost (CAPEX) stands on the cost side, and we assumed that the latter takes place during the year preceding the completion of the investment. The operating costs (OPEX) of the investment are covered by the access tariffs according to current business models. Since the model considers actual transmission fees, their impact is included within the welfare indicators (TSO revenue of the system operator), therefore it does not have to be considered as a separate cost item when the investment is assessed. The welfare change – as already described – includes the change of both the consumer surplus and the producer surplus, as well as the change of the net income of infrastructure operators and traders. Based on the modelling results of the 2020 reference scenario, the welfare change has been assumed to be constant for the whole lifetime of the investment. The lifetime of all infrastructural investments has been assumed to be 25 years, and the net present value was calculated with a 4% real discount rate.

According to the modelling results, from the perspective of the countries of the examined region,[42] the projects of common interest indicate notably higher welfare impacts when gas from Russia arrives in the region through Nord Stream. In other words, in this environment even some of those investments break even that in the absence of Nord Stream would not have covered investment costs from the perspective of social net present value as they would not have carried substantial flows; put differently, the market price among the countries would have levelled off even without their existence (up to the level of the cross-border tariff).

Table 18 reveals the net present value and the benefit/cost ratio of the most important projects and project clusters. In addition to the net present value, the benefit/cost ratio is an important indicator because in the case of investments with a slightly positive or negative net present value it shows the extent to which the capital investment of the project generates a profit. In case of a benefit/cost ratio that is close to one, with a low positive net present value, the investment cannot be regarded as necessary from a welfare perspective (e.g., the Croatian-Hungarian pipeline with the high tariff).

[42] Austria, Bosnia and Hercegovina, Bulgaria, Czech Republic, Germany, Croatia, Hungary, Moldova, Romania, Serbia, Slovenia, Slovakia and Ukraine

Table 18. The net present value and benefit/cost ratio of the infrastructural investments of PCIs with and without Nord Stream 2 (m€)

	Net present value (m€)		Benefit/cost ratio	
	without Nord Stream 2	with Nord Stream 2	without Nord Stream 2	with Nord Stream 2
Polish-Slovakian	–521	–456	0.00	0.13
Polish-Slovakian with low Polish LNG tariff [a]	–702	–514	–0.35	0.01
Greek-Bulgarian pipeline (IGB)	261	1145	2.28	6.63
IGB + Bulgarian-Romanian	–262	495	0.58	1.80
IGB + Bulgarian-Romanian + Romanian-Hungarian	–680	77.3	0.35	1.07
IGB+ Bulgarian-Serbian (IBS)	–46	1296	0.89	4.19
IGB (along with the Adriatic gas pipeline)	236	1677	2.16	9.25
Croatian LNG	373	857	2.40	4.21
Croatian LNG + Croatian-Hungarian with high tariff	44.4	528	1.07	1.89
Croatian LNG+ Croatian-Hungarian with low tariff [b]	64.7	1267	1.11	3.13
Croatian LNG with low tariff + Croatian-Hungarian with low tariff [b]	717	1625	2.20	3.73

[a] *The regasification tariff of the Polish LNG is 1 EUR/MWh*
[b] *The Croatian-Hungarian transmission tariff is 1 EUR/MWh at entry and 1 EUR/MWh at the exit*
[c] *The regasification tariff of the Croatian LNG is 1 EUR/MWh, the Croatian-Hungarian transmission tariff is 1 EUR/MWh at entry and 1 EUR/MWh at the exit.*

If Nord Stream was not completed and the Russian transit would continue to take place through the traditional route across Ukraine, then with the construction of the Greek-Bulgarian pipeline (IGB) (with or without the construction of the Trans-Adriatic gas pipeline)[43] and with the construction of the Croatian LNG terminal (especially if the market protecting tariff applied toward the Hungarian direction is reduced to an average level) the backbone network of market integration could be considered as completed within the region.

[43] The Trans-Adriatic gas pipeline is considered only in this scenario.

If, however, the Russian long-term contracted gas captures the capacities originally built for competing for spot flows to promote the security of supply and market integration, then unblocking the artificially created West-East bottlenecks will require the construction of additional capacities. Due to the higher price level, the additional infrastructural development related to the Greek-Bulgarian pipeline (Bulgarian-Romanian, Romanian-Hungarian, Bulgarian-Serbian) will also turn into profitable investments. The construction of Nord Stream 2, therefore, indicates almost 1 billion EUR of additional investment need in the region. It is important to highlight that while these investments boost the integration of European gas markets, and are also profitable for the investors, they essentially restore the situation before the construction of Nord Stream 2, and they are unnecessary in the absence of Nord Stream 2.

7.4 Discussion of the modelling results

Based on the modelling presented in this chapter we can conclude that due to the resulting bottlenecks, Nord Stream 2 increases the already existing price difference between the Eastern and Western regions of Europe. The modified route of the Russian long-term contracts notably deteriorates the access of the Central Eastern European region to the cheaper Western European gas markets, thereby impeding the integration. With the cessation of the Eastern gas supply route, there is a risk that the prices of the South-East European region stay permanently higher.

The welfare impacts of Nord Stream 2 are overall negative for Europe. Central Eastern European consumers and system operators suffer the largest loss. The main beneficiary is the German transmission system operator, and to certain extent German consumers also benefit.

Our results indicate that if due to the modified routes the Russian long-term contracted gas captures the capacities originally built for the security of supply and market integration, then managing the artificially created West-East bottlenecks will require the construction of additional capacities. As a result, in addition to the Greek-Bulgarian pipeline and the line that delivers

Croatian LNG to Hungary, building the Bulgarian-Romanian-Hungarian and Bulgarian-Serbian routes will also become profitable. In total, the construction of Nord Stream 2 will require almost one billion € of supplemental investments in the region. These investments restore the conditions that existed before the construction of Nord Stream 2, without which they would not be necessary.

Modelling results of this chapter explicitly outlined already in 2016 (when the first short paper was presented) that the Nord Stream 2 project is diving Europe: besides the obvious benefits for the German gas industry it is damaging the overall European strategy to build a resilient and integrated EU gas market. Those countries that were negatively impacted (east and south from Germany) became opponents of the project, and the European Commission was also never in favour of it.

The European Commission, the ACE, and the national regulatory authorities – other than firmly enforcing the execution of the prevailing European regulatory requirements – do not have any tools to prevent this investment. The available regulatory tools, particularly the auctioning of the capacities reserved for short-term trading can ensure that competition continues at least with the current intensity, despite Nord Stream 2.

In August 2016, referring to its market analysis, the Polish office of competition (UOKiK) concluded that the construction of the pipeline would endanger the gas market competition in Poland and would further improve the negotiating position of Gazprom toward consumers in the Polish gas market. This is why the planned consortium – comprising of Gazprom and its five European partners to build Nord Stream 2 – could not be established. Following the news, the Western European companies supporting the investment, but also with stakes in the Polish market, withdrew from the consortium. The determination of Gazprom backed by Russian energy strategy – as described in Chapter 1 of this dissertation – led to Gazprom continuing building of the pipeline despite later introduced US sanctions, and against various authorities hindering the project, like the Danish administrative obstacles in the licensing process of the pipeline route in Danish waters. These actions could cause serious delays, that prevented the pipeline to harvest the earnings for some important years. With the decarbonization agenda hitting with an unexpected speed with the new Commission in 2019 the era of gas (as fossil fuel) can be counted in two but maximum three decades. As usually a pipeline investment returns at about the same time, any delay can turn the project economics negative. In February 2021 the US sanctions policy - that prevented Nord Stream 2 to be finalized although only a small section was missing to connect to the German system – was in the spotlight again, as the new US administration of President Joe Biden was about to normalize Atlantic–EU relationship after the Trump era. Pipeline politics and Nord Stream 2 sanctions seemed to be at the core of the discussion. Independent from the political agreements that might have been reached or how the technicalities and the regulatory framework might have been set up, the Nord Stream 2 has lost its economic rationale already by 2020 as the core assumption of its economic necessity was an increasing EU gas market. As some experts even calculate with a phase-out of gas in Europe by 2040 (von Hirschhausen, et al., 2020) any delays at the beginning of the lifetime of the new gas infrastructure project are crucial. The same applies however not only to Nord Stream 2 but to the European PCI pipeline projects as well.

In the long run, the regulators should be very cautious with any new investment as that might end up as a stranded asset that – as part of the regulated asset base – consumers will have to pay for. In the short and mid turn nonetheless, the achievements of the single gas market in Europe should be carefully maintained: instead of individual resolutions, the key to market competition may rest with ensuring that new sources of supply (mainly LNG) reach the region and harmonised regulation is established at the borders of the EU as well.

8 Discussion and policy conclusions

This dissertation discussed the power politics surrounding the natural gas pipeline projects in and around the EU. The analysis focuses on the security of supply pillar most out of the three main pillars of the EU energy strategy: competitiveness, energy security and sustainability. The already established rules of the internal market (the Third Package entered into force in 2009) fostered competitiveness but at the same time contributed to the resilience of the gas system. The timeline of the dissertation was 2009-2020, which was the era when the security of supply-related legislation forming dominated the EU legislative agenda in the natural gas sector. The sustainability agenda emerged with higher speed from 2015 when the Paris agreement as a legally binding international treaty on climate change was signed, and challenged the role of natural gas in the EU energy mix, directly threatening the commercial viability of new pipelines and other infrastructure element related to natural gas. The geographical coverage of the analysis was the territory of the European Union plus the Energy Community Contracting Parties[44], Russia, and Turkey. The aim was to assess the success and the limits of the EU infrastructure development toolbox against power politics in the upstream and the conflicts with the Russian pipeline strategy.

Using the interdisciplinary analytical framework described in Chapter 3, this discussion chapter summarizes the lessons learned on the Russian and European pipeline strategy of the analysed decade 2010-2020 building on assessment of the legal and regulatory developments, political and geopolitical analysis and economic modelling results.

First we look at the economic rationale of the project, second we discuss how the legal and security of supply driven legislation of the EU addressed the Russian pipeline strategy, third we consider the geopolitical issues around the pipelines. The conclusions answer the three research questions that were posed at the Introduction part of the dissertation. Finally a complementary

[44] The Energy Community is an international organization between the EU and neighbouring countries that aim to implement the energy acquis as listed in the Treaty establishing the Energy Community. The Energy Community has nine Contracting Parties - Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, Georgia, Moldova, Montenegro, Serbia and Ukraine.

subchapter 8.6 reflects on the on the events that happened since the draft dissertation was submitted, asking: How does the Russian-Ukrainian war alter the conclusions?.

8.1 Economic rationale

Since 2014 Gazprom and the Western European investors of Nord Stream 2 (Engie, OMV, Shell, Uniper and Wintershall) have consistently and powerfully lobbied for the project and convinced German politics about the clearly business nature of the project. German high-level politicians understood the benefits of the project for the German economy and were reluctant to reconsider their narrative of domesticating Russia via mutually beneficial economic ties is the best way to build peace and cooperation.

The Russian position on the project has been more geopolitical than economical. The objective to bypass Ukraine and to avoid the transit risk resulted in a costly alternative route but with limited demand growth potential in terms of market share, would the original Ukrainian route be abandoned. Even if the market share would be maximized using the new and old routes alike, this would not increase the profit on Russian sales proportional to the volumes. In fact, Russia would have to offer cheap gas to the EU if it wanted to crowed out LNG. The growing global competition of the LNG suppliers pushed prices down in the oversupplied EU market especially in 2020, during the COVID pandemic. The prospects of the EU gas market from a sellers' point of view are also poor given the falling demand of the EU and the commitment of the block to decarbonize its economy by 2050. Russia invested into the new Turk Stream 1-2, Balkan Stream and Nord Stream 1-2 pipelines altogether about 20 billion €, and laid approximately 2200 km of pipeline with a throughput capacity of 140 bcm/yr. As a result, the Ukrainian system could be neglected. Strategically it would have been most probably a better investment to diversify away from the European market to the growing Asian market.

8.2 Law and governance around pipeline politics

European institutions according to the founding Treaties are supposed to be watchdogs on market functioning and not to play geopolitical cards. Any attempt to use existing EU legislation against a specific project has been heavily criticised by academic scholars, but also by certain member states. (Goldthau, 2016)

Despite the liberal economic nature of the union, according to Fischer (2016) there was – already in 2016 -, a surprisingly strong consensus in Brussels, supported by actors from the foreign, security, and environmental policy communities, that Nord Stream 2 should be stopped by political actions rather sooner than later. The problem was that there was no legal ground for the Commission to do so. Finally, the Commission proposed in 2017 an Amendment to the Gas Directive (Directive (EU) 2019/692, 2019) that was clearly targeting to set rules on pipelines from third countries with the aim to enforce legal unbundling and third party access rules. Interview with a legal expert with a good overview on the Commission's efforts to meet the request of CEE countries suggested that there has been long scrutiny by the Commission legal services that doubted the workability of any amendment of the Directive. When the Amendment was discussed in Coreper, opposition on lower levels, via a coalition formed by Germany successfully secured the blocking minority so the proposal did not make it to the Council meeting, until a sudden breakthrough by the Romanian presidency in February 2019. According to participants of the meetings and high-level ministry officials Germany has approached several smaller states to keep up the blocking minority – among them Hungary as well – but this was considered non-negotiable on the highest political level. The amendment was approved in the Agriculture and Fisheries Council 15/04/2019 without votes against with the abstention of Bulgaria. Gazprom strongly opposed the adopted rules, opened a Case to annul the decision, and it is now in appeal (Case C-348/20 P, 2020). The EU rules on new pipelines support only politically agreed large projects by exempting them from the EU legal framework (e.g., unbundling rules, TPA, regulated tariffs) or by directly financing them through gas transmission tariffs and in case of PCIs often from CEF funds for the CAPEX. The Russian pipeline projects did not fit into this framework and there is no governance structure in place to mitigate mutually acceptable solutions.

8.3 Geopolitical consideration[45]

Nord Stream 2 became an emblematic symbol of the clashes between all possible actors. It is often called the most divisive project within Europe.

Ukraine was keen to preserve the old transit route. Natural gas transit served as a steady flow of revenues (estimated to be around 2 bn USD/yr) but also as a bargaining chip against Russia. After the 2009 gas crisis the parties coupled the new long-term gas transit contract deal with a deal to allow for Russia to use the Crimean port to host their warships. Between 2014-2019 the transit disputes over the transit at the Stockholm Arbitration Court could not result in enforceable decisions: the issue of the Ukrainian transit was not an economic debate between companies (Naftogas and Gazprom) but a power demonstration between Russia and Ukraine. In the Ukrainian narrative Nord Stream 2 was a geopolitical and military threat for Ukraine. Ukrainian participants in energy conferences first only in corridor talks later also in podium speeches referred to the substantial risk of military attack by Russia would the full transit divert form the Ukrainian route.

The position of the United States as openly hostile against the Nord Steam 2 independently of the person of the president. The foreign policy administration considered the rerouting of transit as a strategic threat to the region and tried to convince the European allies to abandon the project. Besides diplomatic means the most powerful tool was the sanctioning of Russian pipeline investments. The sanctions law CAATSA[46] was signed by President Trump on 2 August 2017, which law put a constant threat on companies involved in the construction of Nord Stream 2 and TurkStream, but was not put into effective operation until December 20, 2019. The

[45] Parts of the subchapter are based on Borbála Takácsné Tóth (2020): Coalitions of V4 countries in gas security of supply IDN Conference Book p 486-506.Parts of the text of these publications have been taken over without modification in this chapter

[46] H.R.3364 – Countering America's Adversaries Through Sanctions Act

accusation however, that the US political opposition of Nord Stream 2 intended to pave the way to US LNG cargoes to the European market was completely vague as the US cargoes could trade LNG since export from the US started in 2016 on a higher price in the Asian markets. The unused LNG regasification capacities of Europe between 2016-2020 show that it was not the pipeline politics or any infrastructural constraint that prevented US LNG from entering the EU market but the economic rationale.

The Central Eastern European standpoint on the seriousness of risks related to Russian gas dependency and the need to put more emphasis on the security of gas supplies was the main common denominator of the V4[47] energy position since the 2009 Russian–Ukrainian gas crisis. A particularly important branch of legislation put in place mechanisms to coordinate EU energy infrastructure development, preparedness for security of supply incidents and transparency of actions. Between 2010 and 2020 this happened with sometimes unusual speed and reached unanimous consent by the votings[48]. The only exception from the unanimous voting was the gas security of supply regulation, where Hungary voted against. Poland proposed coordination among Members States about the Russian long-term contract conditions, to prevent Russian negotiators to divide the EU buyers by offering side deals to some countries. Hungary could not agree with the need for more transparency of the Russian long-term contracts, which indicates that side deals are attached to gas contracts.

The fact that the European Energy Security Strategy was drafted (European Commission, 2014) and later in the Energy Union strategic document (European Commission, 2015) security of supply has become one of the 5 pillars, followed by the Decision 2017/684 on how intergovernmental agreements on energy had to be communicated to the other EU members (European Parliament and the Council, 2017) were all pointing to the same

[47] V4 stands for the cooperation of Poland, Hungary, Slovakia and Czechia to represent a jopint position in the EU decision making in areas that are commonly agreed. The formation is called Visegrad countries.

[48] In this regard the adoption of Directive 994/2010 (European Parliament and Council, 2010) and later Regulation 2017/1938 (European Parliament and Council, 2017) on gas security of supply; the Regulation 347/2013 (European Parliament and Council, 2013) on energy infrastructure and the accompanying Connection Europe Facility Regulation 1316/2014 (European Parliament and Council, 2013) were the most prominent.

direction: the framework was set to coordinate EU interest better and help to speak in one voice in energy matters. The two prominent persons being committed to push this agenda that EU must step up against natural gas dependence and related vulnerability were politicians from the V4: Donald Tusk (Poland), and Maroš Šefčovič (Slovakia).

Western European countries did not oppose Nord Stream 2 like Eastern European countries from the former Soviet bloc did. Germany and Austria became clear supporters of the project on high political level, while France and the Netherlands became more a silent supporter. (Fischer, 2016) Later in the final stage of negotiations on the Amendment of the Directive in 2019 France distanced itself from the project and Germany lost the blocking minority.

Intense pressure from the USA on Germany to oppose the pipeline did not help to change the original German standpoint. But the increased US threat of sanctioning the Nord Stream 2 project in 2019[49]– with direct effects on European interests as well, lead to tensions between western allies (EU vs US). France provided support for Germany against American pressure on sanctions and in exchange for the approval from German side of the proposed directive amendment. (Simon, 2019) The coincidence with the German-US clash on sanctions underpins this reasoning (Lohmann & Westphal, 2019). The German "business project narrative" was challenged in domestic German politics at the time of the Annexation of Crimea. In August 2020 when Russian opposition leader Navalny was poisoned, international pressure strengthened. This has been reflected in increasing support of German Members of Parliament throughout the voting on European Parliament resolution of 17 September 2020 on the situation in Russia: the poisoning of Alexei Navalny (2020) (Koch & Stratmann, 2020). Change in German political attitude was however too late to prevent the project, Nord Stream 2 construction was almost complete. Discussion in Germany shifted toward considering the German decisional power on Nord Stream regulatory framework as a potential tool to put pressure on Russia. The business project

[49] Protecting Europe's Energy Security Act (PEESA), the sanctions act of the US was finally enacted 20 December 2019

suddenly turned into a tool to exercise political leverage on Russia. (Westphal, et al., 2020)

Russia used gas pipeline politics as a foreign policy tool in the years discussed here (2009-2019). High level Russian politicians together with CEOs of Gazprom visited regulatory the European capitals and negotiated the rerouting of old contracts to a new route coupled with some price discounts or side deals to the contracts. They also used pipeline related deals to undermine commitments to competing pipelines (like the Nabucco). Gazprom had an immensely powerful lobby campaign in Europe ranging from financing German football clubs and sponsorship of the Champions League to offering lucrative side deals to opponents of the project. In the Central European transit countries, it happened in the form of long-term capacity bookings on the Czech and Slovak gas transmission system, which has weakened opposition in those countries. Hungary has benefited from unusual flexibility from the Russian side on adjusting long term gas supply contract terms 2013-2019, and parallel negotiations related to nuclear power plant investments made strong opposition of Nord Stream 2 incredible. Poland has been the only country opposing Russian pipeline politics consistently and based on political sentiments rather than based on economic considerations (Weiner, 2018).

8.4 Conclusions

Developments on the global level challenged the status quo on natural gas markets in the EU in the analysed period of 2009-2020. The US was pushing for more space for its LNG exports and Russia was trying to protect its established position in the EU markets based on a reshaped pipeline infrastructure that is bypassing Ukraine. The dissertation discussed whether and how liberal economic regulation could help to balance between these interests for the benefit of the European consumers and where the limits of the current regulatory settings are. Using economic modelling in the analytical part, the dissertation investigated what strategies Russia and the EU could play in terms of pipeline investments and what are the consequences and outcomes of these strategies. Applying economic modelling to evaluate the strategic choices of EU and Russia contributes to understand the underlying economics and can support identifying lines for compromise. The analytical work was closed by March 2021. Main findings of the dissertation are related to the research questions of the dissertation:

Question 1: How would Russian Gazprom use the Ukrainian infrastructure under different combinations of availability of the new routes (Nord Stream2, TurkStream 1-2 and Balkan Stream) if it were a profit maximizing actor?

1. The impact of the Russian route diversification strategy influences the Central Eastern European countries negatively, as in most scenarios the wholesale prices increase slightly whereas in Western Europe prices stagnate or somewhat even decrease. Germany is the main beneficiary of the Nord Stream2 project as significant flows are diverted from the historical route via Eastern and Central Europe to Germany. According to the modelling results Germany always gains in terms of socio-economic welfare change when Nord Stream 2 is implemented: consumers benefit from the price decrease in Germany, while the German TSO benefits from the increased transit flows.
2. The reason for the price increase in the CEE countries is the congestion on the west to east pipelines in case the Ukrainian system is not used for Russian gas shipments. The actual booking patterns observed at the first coordinated capacity auction on the European system in 2017 support the modelling results.
3. Investing into the pipelines to bypass Ukraine was a political decision of Russia, but rational for transit risk mitigation. Modelling in the scenarios, which assumed the continuation of the use of the Ukrainian system could not confirm the economic rationale for the project. When we assumed that Russia builds Nord Stream 2, Turk Stream 2 and the Balkan Stream, the Russian profit could not grow in parallel with the volumes sold. This means that Russia can only gain market share when it is selling gas at lower prices. With the new infrastructure

in place Russian share of the EU's gas import could grow from the current 35-38% to 50% by 2030.

Question 2: How successful was the EU its pipeline strategy in infrastructure planning (2013-2020), in selecting and implementing the right projects of common interests to improve the resilience of the EU gas markets to supply shocks and growing market power of upstream supplies?

1. The liberalization model to build a single European market has been a successful strategy against upstream market concentration. Market can react most efficiently to the changing supply and demand patterns. The regulatory framework in the EU has set the scene for competition in the wholesale segment especially by providing the two prerequisites to a functioning market: (1) due to the price signals of the hubs and to their liquidity, wholesale trading can rely on volumes available under transparent price conditions, (2) the infrastructure has sufficient capacity and is accessible under transparent conditions in a non-discriminatory manner. Consistently applied scrutiny through the competition policy supported the change of long – term contract terms by abolishing restrictions on destination, pipeline and LNG contracts alike. Despite the growing share in EU's imports Gazprom's ability to abuse this market position has not grown by time, on contrary: it never really existed in Western Europe and diminished in the 2010s also in the Central-Eastern European region.
2. Legislative efforts to create obstacles to building Nord Stream 2 were partially successful, as the Gas Directive amendment was successfully passed in 2019. The decision-making power on infrastructure building is still national, remains in the hands of German institutions and politics. Regulatory obstacles applied by other member states however delayed the project beyond 2020, resulting in a new Russian – Ukrainian transit contract for 2020-24. In the domestic politics of Germany perceptions about Russia as an illiberal actor grew, opposition against the pipeline increased by time especially after poisoning of Navalny. During geopolitical developments in 2021 the German government first delayed

the licencing of the Nord Stream 2 project later when Russia attacked Ukraine in February 2022 it suspended the procedure.

3. Security of supply related infrastructure investment supported by the EU has contributed to security of supply, market integration and increased competition. The network structure as developed by 2020 was a resilient and robust one, that could serve the consumers from multiple sources in a flexible way, thereby contributed not only to the security of supply but also to competitive prices for the benefit of EU consumers. The extreme situation of the war started by Russia on Ukraine on 24 February 2022 is beyond a regular supply risk and will be discussed in the follow up chapter 8.6.
4. Coalition forming of V4 in energy related EU legislation was one of the priority areas of the group in the 2009-2020 timeframe. The security of supply related legislation adapted between 2013 and 2019 in the field of natural gas was a successful cooperation, and they have performed outstanding good in securing EU funding for their projects. Two third of the gas infrastructure work funds of the Connecting Europe facility were related to priority projects in CEE countries, especially to those of Poland and Hungary.
5. Modelling results of the commissioned and under construction PCIs shows that CEF funding was allocated to the projects that served best the European interest.
6. Cooperation between Member States on institutional level especially in network planning and cooperation in emergency has increased, however when it comes to implementation of projects of EU interest, Member States tend to follow their national interests. This leads to delays in projects where national interest on the two sides of the border do not fully coincide.

Circumstances and assumptions changed by time, which impacted the outcome of the modelling. In Chapter 7.3.2 the overall EU welfare change due to the Nord Stream (without full cut of Ukrainian transit) was negative, while it was positive in Chapter 5.3.2. The reason for that is that in the first case modelling was performed in 2015, and in the second one in 2019.

Important drivers of the results changed in those 4 years: the Dutch gas production of the Groningen field was drastically reduced, global LNG supply became abundant and was heading towards Europe in large quantities, the European gas consumption forecasts turned form slightly increasing to gradually decreasing due to decarbonization. The infrastructure setup was also different, in 2015 Nord Stream 2 was a clear priority of Russia and South Stream was just cancelled, while in 2019 Turk Stream 1 came already online, while Nord Stream 2 was seriously delayed. Some of these factors support the need for Nord Stream 2: the less domestic production, and in some countries the increased gas consumption due to coal to gas switch. Change in assumption between 2015 and 2019 in some other factors weaken the above described negative effects of the project: e.g., the decarbonization agenda reduces EU demand, therefor the congestion effect of the rerouting of supplies diminishes, and access LNG can reach also the Eastern European markets. This means that between the two dates the EU policy responses and global market developments reduced the negative effects of the planned Russian pipeline strategy, most importantly the increased global LNG supply. The results of the modelling hence very much depend on the changing geopolitical and market reality and assumptions of the future energy market. As market circumstances quickly change, the need for a scenario-based modelling to support policy or company level decisions will certainly increase.

Question 3: How did the European and the Russian pipeline strategies influence each other under a worsening geopolitical EU-Russia relationship 2009-2020?

1. The dissertation found that growing political tensions and lack of coordination between Russia and the EU led to additional investment need on both sides and resulted in building future stranded assets. Building surplus capacity is however not entirely useless. For Russia the alternative pipeline routes mitigated the transit risk and helped to negotiate better terms with Ukraine and with Turkey. The strong links on the Russian side between Gazprom and the Kreml shaped the

investment decisions often leaving business considerations behind political ones. The southern route was a secondary priority for Gazprom, confirmed by the economic analysis of the route from Russian perspective as described in subchapter 5.1. Building Turk Stream 2 did not reduce Russian profits, but additional investments on EU side are needed to decrease internal bottleneck in the Balkans. It has been the struggle around the Nord Stream 2 that has pushed Russia (again on political level) to speed up investments on the southern route. Having Turk Stream1-2 in place in 2021 but not Nord Stream2 is a very unfortunate outcome of the original Russian plans. From the EU perspective surplus capacity also makes economic sense: Russia gas has a growing share in the EU gas supply as domestic production is falling.

2. The competition of alternative sources -LNG and pipeline from other sources - on the easily accessible internal EU market is a key factor to prevent monopolistic pricing of Gazprom. This, by definition, can only be achieved by surplus capacities, which will not be highly utilized during their lifetime. The competitive pricing of the commodity has to be paid for throughout the infrastructure tariffs. The amount of surplus capacity seemed to be though oversized for both the EU and for Russia if we consider on both sides not only the existing projects but also those where investment decisions were already taken in the low price environment of 2019. This has been the results of the cost benefit analysis revealed in the chapter 6.3. Sensitivity analysis in subchapter 6.3.3. showed, that the additional LNG terminals are necessary in case of a high price environment to ensure that LNG can reach the EU gas markets.
3. Lack of communication between the European institutions and Gazprom / Russia was partly the reason for the escalation of the problems. Gazprom did not consider the need to coordinate on EU level the pipeline strategy, instead counted on the strength of a German – Russian bilateral cooperation that was supposed to implement an “economic” project against the will of opponents that are negatively impacted. Germany has lost on its diplomatic

credibility when it has pursued its national interest against a common European standpoint.

8.5 Policy implications

Based on the results above the following policy implications follow:
European institutions' efforts to apply strategically the market surveillance tools jeopardize the image of the institutions as an impartial watchdog on fair trade and competition. The geopolitical challenges should therefore be addressed politically by strengthening the foreign policy powers of the EU. Conflicting interest within the EU reduce the EU's ability to manage challenges arising from external actors. Security concerns motivate national governments to empower the EU on energy issues, while local or federal economic interest might undermine these efforts. In the light of the recent energy crisis / energy war, it is of utmost importance to strengthen the foreign policy and energy diplomacy on EU level.
Russian strategy to strongly connect natural gas export to foreign policy has failed to produce a long-term vision of mutually beneficial cooperation with its core EU market. Emphasizing bilateral relations instead of intergovernmental level coordination led to a *divide et impera* policy, which divided Europe and prevented the de-politization of the Russian pipeline policy. Nord Stream2 became a symbolic project of Russian geopolitics. The continuous tensions around natural gas and the Nord Stream 2 project especially have ruined the trust in Russia as a reliable supplier and increased negative sentiments in consumers against natural gas.
The US entrance to the global natural gas arena via LNG has brought new trading strategy. This relies on market-based decisions of private companies' contrary to the Russian model of strong connection between Gazprom and the Kreml. The impacts are already visible in the change of contract pricing and spot cargoes worldwide. The decisions of the US private companies on where to ship their gas will depend on market signals in the future as well. The use of natural gas as a political weapon did not work for Russia, the US should not try the same. The sanctions policy applied against Nord Stream 2 has been

a successful tool to stop pipeline building. However, it has partly backfired as the narrative became widely spread, of a selfish US pushing for market shares in Europe for its uncompetitive LNG gas.
The EU's ability to act as a global player is limited by the constraints that some member states contest the EU authority. This was particularly difficult when two powerful external actors (Russia and the USA) both take the issue (in this case the Nord Stream 2 pipeline) to a symbolic level and the EU as an actor could not take a standpoint. Pressure on allies in Europe did burden the relationship on highest levels.

8.6 How does the Russian-Ukrainian war alter the conclusions?

Since the closing of the draft dissertation (March 2021) the world has changed dramatically. On the 24th of February 2022 Russia started a war against Ukraine that escalades day by day, with extraordinarily little or no hope to have peace in the near future. Tensions started in the gas market, sadly confirming that the selected topic of the dissertation was very timely. Starting in September 2021 Russia discovered that in the "perfect storm" conditions on the global and European gas market it has gained market power that it did not have before (OIES, 2021). The key factors that contributed to this new reality were the sudden increase in demand due to the recovery of the industry from the Covid crisis, which could not be met by the reduced supply[50]. In this new global setup, with low LNG supply Russian supply withholding could directly impact the European exchange prices. Russian president Putin connected the Russian supply volumes to the German authorization of the Nord Stream 2 project, and openly blackmailed Europe with reducing supply volumes on the Yamal pipeline (ACER, 2021). By December 2021 for the first time in history the European traded gas prices surpassed the Asian ones. The European gas price left the "normal" 20-25 €/MWh rage and was above 300 €/MWh in August at the time when the European storages needed to be

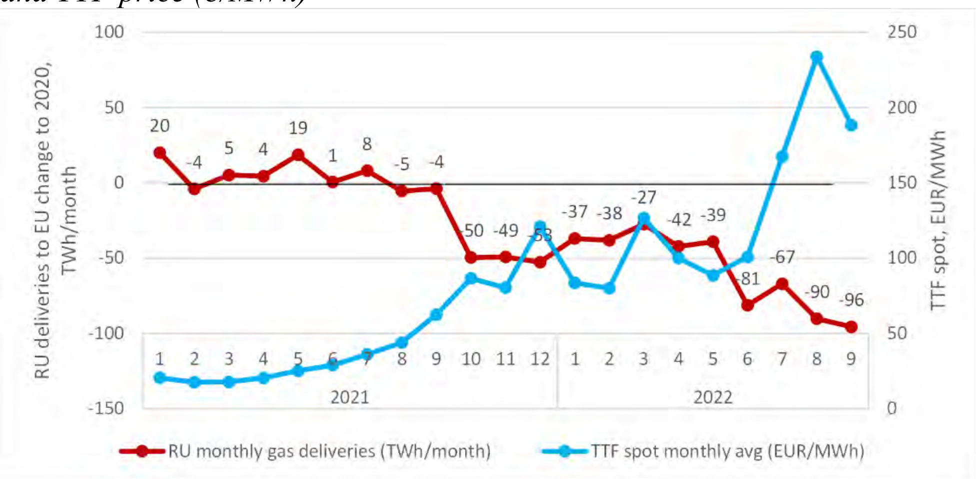
[50] In the COVID -19 pandemic the fossil industry suffered from low demand and hence very low prices. This led to reductions in production and postponing investments.

filled for the upcoming winter (Figure 46). Russian gas supplies continuously decreased on the decision of Russia for several reasons: denial of the buyer to pay in Roubles[51], maintenance on Nord Stream 1 etc., resulting in only 9 % of Russian supplies in the EU gas mix by August 2022. As Russian supplies decreased the prices of gas in Europe increased Figure 47.

Figure 46. European spot gas price on TTF 2018- October 2022, €/MWh

Source: EEX, TTF spot

Figure 47. Russian gas deliveries to Europe compared to 2020 (TWh/month) and TTF price (€/MWh)



Source: REKK market monitoring (Takácsné Tóth, et al., 2021)

[51] As a consequence of EU sanctions (following the attack on Ukraine) on Russian banks, Russia insisted that buyers shall pay in Rubels. Some buyers refused to do so, therefore Russia stopped supplying them. This happend first to Bulgaria and to Poland.

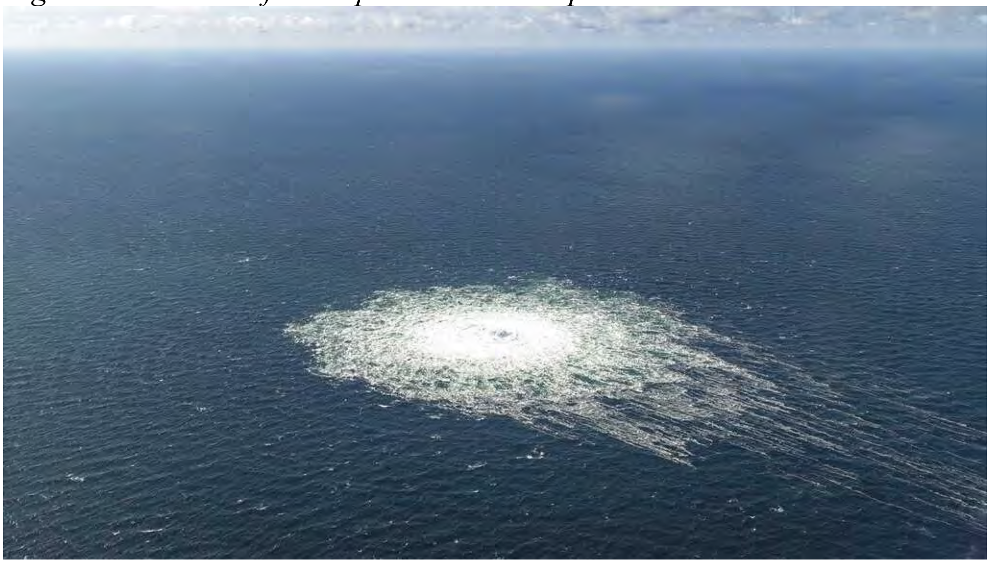
Since the European traders filled the storages following the obligation of Regulation (EU) 2022/1032 regard to gas storage (2022), the threat of Russian full cut does not impose an immediate danger to the European consumers, therefore prices started to drop. On 26 September of 2022 sabotage attack on Nord Stream 1-2 damaged three out of the four pipelines of Nord Stream 1-2 in the Swedish territorial waters (Figure 48)

It is unknown who did the sabotage, every actor is blaming the other, finding the truth will be a topic for a future thesis. Sad fact for the environment is however that the filled pipelines leaked enormous amount of methane to the waters and the atmosphere (Figure 49).

Figure 48. The Nord Stream 2 pipeline was exploded by a sabotage

Source: AFP

Figure 49. Picture of the explosion on 26 September 2022



Defence Command via AP, https://www.npr.org/2022/09/27/1125401980/nord-stream-leaks-explosions-russia-natural-gas-sabotage

Do we see things different now that the long contested and criticised Nord Stream has been blown and Russian supplies to Europe seem to halt? Certainly, much has changed in the perspectives of all stakeholders, but we restrict the answer to this question only related to the research questions of this dissertation.

Question 1: What is the most profitable marketing strategy of Gazprom to sell gas on the European market and how would it use the infrastructure under different combinations of availability of the new routes (Nord Stream2, TurkStream 1-2 and Balkan Stream)?

Modelling performed in the analytical part of this dissertation was never assuming a full cut of Russian supplies for more than a month. We might criticise, that scenarios did not provide a wide enough spectrum to cover even that extreme. There are good excuses, why it did not do so. First, the strong economic link of mutually beneficial trade of natural gas, a bond since the 1970s seemed to last despite the worsening of the relationship between the EU and Russia as discussed in the "Background" and in the "Geopolitics" chapters. A long-lasting war was not among the security of supply scenarios for any modelling team we are aware of. Second, neither of the parties – not any EU member State, but also not Russia – ever threatened with the complete halt of gas supplies on all routes suddenly and for infinite time. The Russian communication has been referring to itself as the "most reliable" supplier to Europe. European infrastructure was prepared to resist only shorter-term supply cuts and to provide competition to all suppliers to the EU. The economic rational above geopolitical considerations could set up the entire gas transmission infrastructure during the Cold War time, hence it was not too naïve to think, that the parties will find a compromise solution for the transit issue, especially that Russia has put in place so much additional capacity.

Second, Gazprom during the analysed period of 2009-2020 was adopting to the EU gas market rules and has always acted rational and followed a profit seeking attitude. As we discussed in chapter 2 and in chapter 3.2 it took two decades for the European competition law together with the internal market rules to corner the market distorting clauses of the Gazprom long-term contracts (in the famous Gazprom case) and enforce that Gazprom should not discriminate between buyers based on the buyers' ability to purchase from alternative sources. Gazprom did all it could to keep up the quasi-monopoly position in Central Eastern Europe in its core markets. We discussed cases of offering price discount to countries in exchange for not building additional infrastructure that could open the market for competitors. The examples where this strategy failed (e.g., the LNG terminal in Lithuania) resulted in competitively priced gas offered by Gazprom. The experience was therefore that Gazprom is a rational economic actor. Competes when it must and acts as a monopolist when weak regulation or market circumstances allow.

The main research question was to find the most beneficial strategy for Russia for marketing its gas. For a rational trader it is for sure not the best choice and is for sure not the most beneficial action to completely halt supplies. Selling no gas can only deliver zero revenue to Russia. Selling no gas at all also would annul the leverage in negotiations. It was for sure not the intention of Russia to arrive to this point. Building a new transmission system can either bring more gas to the same market or is at least could have substituted the old route.

Modelling results clearly show that Russian strategy was economically more rational when it assumed a complete halt of deliveries via Ukraine. Building Nord Stream 2 would result in a 3.5 billion €/yr profit increase for Gazprom. Comparing the profit change due to the Nord Stream 2 in a 2019 “pre-war scenario” the profit of Gazprom would increase by 0.1 billion /yr (Table 19). Therefore, it was a strong indication that Russia wanted to stop using the Ukrainian system.

Table 19. Reading the same results of Chapter 5

	TS1		TS1 and NS2		TS1, TS2, and NS2	
	(8) No transit	(3) LTC + spot	(4) No transit	(6) LTC + spot	(7) No transit	(9) LTC + spot
RU profit change billion €/year	-9.2	0	-5.0	0.1	-5.1	0.1
RU profit change billion €/year	0	9.2	3.7	8.7	3.2	8.3

Still these results do not indicate or explain an energy war. The geopolitical escalation of the situation is beyond pipeline strategy. It is more a future research question to evaluate the gas sanctions policy – who is losing more in terms of social welfare in a complete halt of Russian gas supplies? As it has been the Russian decision to halt supplies to the EU it is reasonable to suspect that (according to the Russian analysis) it is the EU who loses more – on the short term (1-2 years). On the other hand, the high gas prices coupled with the awakening of European politicians and consumers to gas dependency, and the vulnerability of the energy system speeded up the EU. It has taken unusual quick and strong steps to reduce its Russian gas dependency. Therefore, the hope for Russia to rebuild trust in Europe and return to its core business after the war ends fades away quickly. That makes Russia losing much more than the EU on the long run.

Question 2: How successful was the EU in its pipeline strategy in infrastructure planning, in selecting and implementing the right projects of common interests between 2013-2020 to improve the resilience of the EU gas markets to supply shocks and growing market power of upstream supplies?

Europe tested to be vulnerable to Russian withholding of supply on the short run. The European market was not deep and liquid enough to withstand the Russian manipulation of the prices. However, the price signal worked both towards the suppliers and the consumers. LNG has been delivered to Europe up to the maximum capacity of the LNG regasification terminals (except for the Iberian peninsula that is not well interconnected). The EU gas demand dropped by 10% during the first half of 2022, though it was the industry that reacted to high prices most.

The PCIs that were long delayed, suddenly enter the market in 2022 and will contribute to the supply in the 2022/23 winter. Therefore, we can conclude that they were worth to invest in. Results of the modelling of the 4th PCI list in the high gas price scenario seem to apply now: all LNG projects are beneficial under these high price and low supply condition.

Question 3: How did the European and the Russian pipeline strategies influence each other under a worsening geopolitical EU-Russia relationship?

Power politics overruled diplomacy. A failure, which cannot be discussed on pipeline policy grounds only, despite that the natural gas sector has been the battle ground. We stated earlier that it is not for the buyer to decide on the marketing strategy of the seller. Now we can add that it is also not possible to enforce a trade deal by power politics: Russian pressure on Germany throughout open blackmail form highest political level to licence Nord Stream 2 backfired and the project was put on halt two days before Ukraine was attacked.

The institutional governance on EU level has not been set up after the Cold war properly to help eliminate problems that escalated. A prominent problem was that from the Gazprom perspective the rulings on Russian pipelines jeopardized the impartial watchdog role of the European Commission: the South Stream infringement procedures, the OPAL case and especially the Amendment of the Gas Directive. When the authorities delayed the licencing of the Nord Stream 2 project on political grounds in Germany, the rule of law principle became doubtful. The trust of the partners vanished throughout the years and no institutional setup was in place to remedy the damages in trust.

The decarbonization agenda of the EU and the plans to forbid the long-term contracting of gas beyond 2040, as the methane strategy put it forward at the end of 2021 was a “red herring”, a verbal threat to Russia. It signalled an unfriendly, one-sided ending of the long-term cooperation on gas trade. Frankly speaking it was the EU who declared an infinite end of deliveries with a deadline. Indeed, the destructive geopolitical climate speeded up decarbonization efforts in Europe and with the war in 2022 the gas phase out and especially a Russian gas phase out became a European goal. There is no future for Russian gas in Europe, even if the war could end soon, the trust cannot restore in the near term. For the short and mid-term the problem to substitute Russian gas will provide plenty of room for research and analysis where scenario based gas market modelling can certainly add to the understanding.

Publications

In the order as they were used as a base for the dissertation:

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Annex

1. Description of the European Gas Market Model[52]

The European Gas Market Model consists of the following building blocks: (1) local demand; (2) local supply; (3) gas storages; (4) external markets and supply sources; (5) cross-border pipeline connections; (6) LNG infrastructure (7) long-term take-or-pay (TOP) contracts; and (8) spot trading.

1. *Local demand* is represented by demand functions. Demand functions are downward sloping, meaning that higher prices decrease the amount of gas that consumers want to use in a given period. The linearity and price responsiveness of local demand ensure that market clearing prices will always exist in the model.
2. *Local supply* shows the relationship between the local market price and the amount of gas that local producers are willing to pump into the system at that price. In the model, each supply unit has a marginal cost of production (measured in €/MWh). Supply units operate between the minimum and maximum production constraints in each month, and an overall yearly maximum capacity.
3. *Gas storages* are capable of storing natural gas from one period to another, arbitraging away large market price differences across periods. Their effect on the system's supply-demand balance can be positive or negative, depending on whether gas is withdrawn from, or injected into, the storage. There are three constraints on storage operation: (1) working gas capacity; (2) starting inventory level; and (3) year-end inventory level. Injections and withdrawals must be such during the year that working gas capacity is never exceeded, intra-year inventory levels never drop below zero, and year-end inventory levels are met.
4. *External markets and supply sources* are set exogenously (i.e. as input data) for each month, and they are assumed not to be influenced by any supply-demand development in the local markets. In the case of

[52] A detailed mathematical description of the model can be found in (Kiss, et al., 2016)

LNG, the price is derived from the Japanese spot gas price, taking into account the cost of transportation to any possible LNG import terminal. As a consequence, the price levels set for outside markets are important determinants of their trading volumes with Europe.

5. *Cross-border pipelines* allow the transportation of natural gas from one market to the other. Connections between geographically non-neighbouring countries are also possible, which allows the possibility of dedicated transit. Cross-border linkages are directional, but physical reverse flow can easily be allowed by adding a parallel connection that “points” in the other direction. Each linkage has a minimum and a maximum monthly transmission capacity.
6. *LNG infrastructure* in the model consists of LNG liquefaction plants of exporting countries, LNG regasification plants of importing countries, and the transport routes connecting them. LNG terminal capacity is aggregated for each country.
7. *Long-term take-or-pay (TOP) contracts* are agreements between an outside supply source and a local market concerning the delivery of natural gas into the latter. Each contract has monthly and yearly minimum and maximum quantities, a delivery price, and a monthly proportional TOP-violation penalty. Maximum quantities (monthly or yearly) cannot be breached, and neither can the yearly minimum quantity. Deliveries can be reduced below the monthly minimum, in which case the monthly proportional TOP-violation penalty must be paid for the gas that was not delivered.
8. *Spot trading* serves to arbitrage price differences across markets that are connected with a pipeline or an LNG route. Typically, if the price on the source side of the connection exceeds the price on the destination side by more than the proportional transmission fee, then spot trading will occur toward the high-priced market. Spot trading continues until either (1) the price difference drops to the level of the transmission fee, or (2) the physical capacity of the connection is reached. Physical flows on pipelines and LNG routes equal the sum of long-term deliveries and spot trading.

Equilibrium

The European Gas Market Model algorithm reads the input data and searches for the simultaneous supply-demand equilibrium (including storage stock changes and net imports) of all local markets in all months, respecting all the constraints detailed above.

In short, the equilibrium state (the “result”) of the model can be described by a simple no-arbitrage condition across space and time. Infrastructure operators (TSO, storage, and LNG operator) observe gas flows, and their welfare is not factored in the equilibrium.

Natural gas consumption

Table 20. European Countries natural gas market size (bcm/yr), import dependency and share of gas in the energy mix (%)

	Import dependency 2018	Share of gas in primary, % 2018	Gas market size, bcm/year 2018
EU - 27 countries (from 2020)	83.3	23%	343.2
EU - 28 countries (2013-2020)	77.4	24%	414.7
Euro area - 19 countries (from 2015)	87.2	24%	290.6
Belgium	100.6	28%	15.8
Bulgaria	98.7	14%	2.8
Czechia	96.8	16%	7.2
Denmark	-38.5	15%	2.8
Germany	95.9	24%	77.8
Estonia	100.0	7%	0.4
Ireland	38.8	33%	4.7
Greece	100.7	18%	4.4
Spain	101.4	22%	28.6
France	104.7	15%	38.8
Croatia	53.3	27%	2.4
Italy	92.9	39%	62.9
Cyprus	0.0	0%	-
Latvia	98.8	25%	1.2
Lithuania	98.9	23%	1.9
Luxembourg	100.0	18%	0.7
Hungary	77.9	31%	8.7
Malta	109.5	43%	0.3
Netherlands	15.0	42%	32.5
Austria	88.2	22%	7.8
Poland	77.6	15%	17.0
Portugal	101.1	22%	5.3
Romania	12.0	30%	10.5

Slovenia	98.1	11%	0.8
Slovakia	89.6	24%	4.3
Finland	100.3	6%	2.3
Sweden	100.0	2%	1.1
Iceland	0.0	0%	-
Norway	-1 948.0	18%	5.4
United Kingdom	49.4	39%	71.6
Montenegro	0.0	0%	-
North Macedonia	100.1	8%	0.2
Albania	0.0	1%	0.0
Serbia	82.1	14%	2.3
Turkey	99.6	28%	43.4
Bosnia and Herzegovina	100.0	3%	0.2

Source: Eurostat 2018

2. Detailed data of the analysed PCI projects

Tables below summarize the PCI projects which were analysed in the different scenarios of Chapter 6 EU infrastructure policy.

Table 21. The already commissioned PCIs included into the evaluation

List of completed PCIs						
PCI number	Pipeline	From market	To market	Maximum flow (GWh/day)	Year	Cost (m€)
5.2	PCI Twinning of Southwest Scotland onshore system between Cluden and Brighouse Bay (United Kingdom)	UK	IE	12.1	2016	93
5.16	PCI Extension of the Zeebrugge LNG terminal	LNG	BE	472	2020	208
5.13	PCI New interconnection between Pitgam (France) and Maldegem (Belgium)	FR	BE	270	2016	186
5.11	Reverse flow interconnection between Italy and Switzerland at Passo Gries interconnection point	IT	CH	429	2018	738
8.1.1	Interconnection Estonia - Finland [currently known as "Balticconnector"]	EE	FI	48	2020	250
8.1.1	Interconnection Estonia - Finland [currently known as "Balticconnector"]	FI	EE	48	2020	
6.3	PCI Slovakia – Hungary Gas Interconnection between Vel'ké Zlievce (SK) – Balassagyarmat border (SK/HU) - Vecsés (HU)	HU	SK	52	2015	170

6.3	PCI Slovakia – Hungary Gas Interconnection between Vel'ké Zlievce (SK) – Balassagyarmat border (SK/HU) - Vecsés (HU)	SK	HU	127	2015	
6.5.5	Compressor station 1 at the Croatian gas transmission system	HR	HU	13.6	2019	25
6.24.1	Pipeline Ruse (BG)-Giurgiu (RO)	RO	BG	1.8	2019	21
	Pipeline Ruse (BG)-Giurgiu (RO)	BG	RO	7.9	2019	
5.10	Reverse flow on TENP	CH	DE	172.8	2018	17.3
Total investment cost (m€, non-discounted):						1,708
Total annualized investment cost* (m€):						119

*Cost values are first discounted to 2020 than annualized.

Table 22. The PCIs from the 4th list with FID included into the evaluation

List of FID PCIs						
PCI number	Project name	From market	To market	Maximum flow (GWh/day)	Year	Cost (m€)
6.2.1	Poland — Slovakia interconnection	SK	PL	175	2021	143.4
6.2.1	Poland — Slovakia interconnection	PL	SK	144	2021	
6.5.1	Development of a LNG terminal in Krk (HR) up to 2.6 bcm/a– Phase I and connecting pipeline Omišalj – Zlobin (HR)EN 7 EN	LNG	HR	109	2027	234
6.5.1	Development of a LNG terminal in Krk (HR) up to 2.6 bcm/a– Phase I and connecting pipeline Omišalj – Zlobin (HR)EN 7 EN	HR	HU	82	2020	27.3
6.5.5	"Compressor station 1" at the Croatian gas transmission system	HR	HU	14	2019	25
6.8.1	Interconnection Greece — Bulgaria [currently known as "IGB"] between Komotini (EL) and Stara Zagora (BG) and compressor station at Kipi (EL)	GR	BG	90	2020	240
6.8.1	Interconnection Greece — Bulgaria [currently known as "IGB"] between Komotini (EL) and Stara Zagora (BG) and compressor station at Kipi (EL)	BG	GR	90	2020	
6.8.3	Gas interconnection Bulgaria — Serbia [currently known as "IBS"] (6.10 on the 3rd PCI list)	RS	BG	51	2022	48
6.8.3	Gas interconnection Bulgaria — Serbia [currently known as "IBS"] (6.10 on the 3rd PCI list)	BG	RS	51	2022	
6.24.1	ROHU(AT)/BRUA – 1st phase, including: - Development of the transmission capacity in Romani a from Podișor to Recas, including, a new pipeline, metering station andthree new compressor stations in Podisor, Bibesti and Jupa	RO	HU	47	2020	478.6

6.24.1	ROHU(AT)/BRUA – 1st phase, including: - Development of the transmission capacity in Romania from Podișor to Recas, including, a new pipeline, metering station andthree new compressor stations in Podisor, Bibesti and Jupa	RO	BG	43	2020	
8.2.4	Enhancement of Inčukalns Underground Gas Storage (LV)	Storage	LV	84	2019	88.2
8.5	Poland-Lithuania interconnection [currently known as “GIPL”]	LT	PL	58	2021	458.9
8.5	Poland-Lithuania interconnection [currently known as “GIPL”]	PL	LT	74	2021	
Total investment cost (non-discounted, m€):						1,743
Total annualized investment cost (m€):						108

Table 23. Other (non-FID) PCIs from the 4th list included into the evaluation

PCI number	Project name	From	To	Capacity (GWh/day)	Year	Investment cost, m€ (TYNDP 2018)
5.3	Shannon LNG Terminal and connecting pipeline (IE)	LNG	IE	86	2022	450
5.19	Connection of Malta to the European gas network — pipeline interconnection with Italy at Gela	IT	MT	56	2024	342
5.19	Connection of Malta to the European gas network — pipeline interconnection with Italy at Gela	MT	IT	56	2024	
6.2.13	Development and enhancement of transmission capacity of Slovak-Hungarian interconnector	HU	SK	102	2022	58
6.2.13	Development and enhancement of transmission capacity of Slovak-Hungarian interconnector	SK	HU	26	2022	
6.9.1	LNG terminal in northern Greece	LNG	GR	253	2020	300
6.20.2	Chiren UGS expansion (BG)	storage	BG	48	2025	226
6.20.3	South Kavala UGS facility and metering and regulating station (EL) and one of the following PCIs:	storage	GR	44	2023	320
6.20.4	Depomures storage in Romania	storage	RO	15	2024	87
6.20.6	Sarmasel underground gas storage in Romania	storage	RO	45	2024	133
6.23	Hungary – Slovenia - Italy interconnection	SI	HU	12	2023	113

6.23	Hungary – Slovenia - Italy interconnection	HU	SI	12	2023	
6.24.4	ROHU(AT)/BRUA –2nd phase	HU	RO	78	2022	69
6.24.4	ROHU(AT)/BRUA –2nd phase	RO	HU	76	2022	
6.26.1	Cluster Croatia — Slovenia — Austria at Rogatec	SI	HR	162	2023	76
6.26.1	Cluster Croatia — Slovenia — Austria at Rogatec	HR	SI	121	2023	
6.26.1	Cluster Croatia — Slovenia — Austria at Rogatec	AT	SI	105	2023	100
6.26.1	Cluster Croatia — Slovenia — Austria at Rogatec	SI	AT	167	2023	
6.27	LNG Gdansk (PL)	LNG	PL	138	2025	196
7.3.1	Pipeline from the East Mediterranean gas reserves to Greece mainland via Crete	CY	GR	110	2025	5200
7.3.1	Pipeline from the East Mediterranean gas reserves to Greece mainland via Crete	GR	CY	30	2025	
7.5	Development of gas infrastructure in Cyprus [currently known as "Cyprus Gas2EU"]	LNG	CY	40	2022	261
8.2.1	Enhancement of Latvia — Lithuania interconnection	LV	LT	54	2023	20.7
8.2.1	Enhancement of Latvia — Lithuania interconnection	LT	LV	63	2023	4.7
8.3.1	Reinforcement of Nybro — Poland/Denmark Interconnection	NO	DK	307	2022	290
8.3.2	Poland–Denmark interconnection [currently known as “Baltic Pipe”]	PL	DK	91	2022	485
8.3.2	Poland–Denmark interconnection [currently known as “Baltic Pipe”]	DK	PL	307	2022	
Total investment cost (m€):						8,732
Total annualized investment cost (m€):						473

3. Route assumption used for Chapter 7 modelling scenarios

Table 24. The volume and transmission route of Russian LTCs, TWh/yr

	Annual contracted volume (TWh/year)	Expiry	Point of delivery	Route	Route in case of Nord Stream 2
RU–AT	68.4	After 2030	Baumgarten	RU–UA–SK–AT	RU–DE–AT RU–DE–CZ–AT
RU–BA	1.3	annually extended	Zvornik	RU–UA–HU–RS–BA	RU–DE–CZ–SK–HU–RS–BA
RU–BG	28	2022–2024	Negru Voda	RU–UA–RO–BG	RU–UA–RO–BG
RU–GR	19.5	n. d.	Sidirokastro	RU–UA–RO–BG–GR	RU–UA–RO–BG–GR
RU–HU	73.6	2019–2021	Beregovo	RU–UA–HU RU–UA–SK–AT–HU	RU–DE–CZ–AT–HU RU–DE–CZ–SK–HU
RU–IT	218	several contracts with various dates of expiry	Baumgarten	RU–UA–SK–AT–IT	RU–DE–CH–IT RU–DE–CZ–SK–AT–IT
RU–MK	1.4	annually extended	Zidilovo	RU–UA–RO–BG–MK	RU–UA–RO–BG–MK
RU–MD	0.7	annually extended	Oleksiivka, Grebenyky	RU–UA–MD	RU–UA–MD
RU–RO	5.3	2030	Isaccea	RU–UA–RO	RU–UA–RO
RU–RS	15	2018	Kiskundorozsma	RU–UA–HU–RS	RU–DE–CZ–SK–HU–RS
RU–SK	63.5	2028	Velke Kapusany	RU–UA–SK	RU–DE–CZ–SK
RU–UA	66.7	2019	Sudzha, Pysarivka, Valuiky	RU–UA	RU–UA

AT: Austria, BA: Bosnia-Hercegovina, BG: Bulgaria, GR: Greece, HU: Hungary, IT: Italy, MD: Moldova, MK: Macedonia, RO: Romania, RU: Russia, SK: Slovakia, UA: Ukraine.
Source: Pirani–Yafimava [2016] and REKK compilation.