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The Decarbonization of Natural Gas and Europe's Energy Security

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ABSTRACT

The purpose of this working paper is to delineate the correlation between decarbonization and security of supply, and to assess the sequential effect of these notions on the EU's external gas relations. It first discusses the contribution of the gas sector to the EU's decarbonization efforts. It then goes on to determine: a) The role of the Union's external suppliers in today's liberalized internal market, as well as in the changing reality for natural gas amidst decarbonization developments (independent variables), b) Whether this twofold role prompts the emergence of a new paradigm for the EU's relations with its key gas suppliers (dependent variable).

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Executive Summary

The purpose of this working paper is to delineate the correlation between decarbonization and security of supply, and to assess the sequential effect of these notions on the EU's external gas relations. To do this, it relies on the Energy Union's two-stage policy objective to:

a) Promote the extension of Europe's gas network infrastructure wherever it is still exigent to treat security of supply issues until 2030. It is by that year that a positive unabated gas demand outlook is forecast.

b) Direct attention to the challenges that gas is likely to face as a result of the ongoing transition to the carbon-neutral economy of 2050, as envisioned in the European Commission's (EC) long-term strategy (EC 2018a) and its proposal for the first European Climate Law (EC 2020a).

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a) The role of the Union's external suppliers in today's liberalized internal market, as well as in the changing reality for natural gas amidst decarbonization developments (independent variables).

b) Whether this twofold role prompts the emergence of a new paradigm for the EU's relations with its key gas suppliers (dependent variable).

It primarily argues that, upon completion of its conventional gas market integration, the EU will have to identify its suppliers' potential role during the 2030-2050 period, given the "insourcing" characteristic of green gases. Owing to the penetration of these gases into Europe's fully methane-based gas system, the ritualized supply and demand patterns that served the gas industry to date may gradually erode, the deeper we get into the 21st century due to the decentralization of the energy system. In this context, it is argued that gas sector decarbonization could alter the energy security motif established after World War II into one of geopolitical competition over the production of energy resources, rather than over mere access to them; this is exemplified by the unfolding battle between the EU and China over global supremacy in electrolyzer manufacturing.

Assuming that certain imports are going to be needed, this paper argues that, due to the open-ended evolution of pertinent technologies and the relatively sketchy mapping of coalitions that the EU can make with external suppliers at this point, it may be of value to advance coordination with non-EU countries via hybrid governance models involving both the EC and the Council. In what concerns non-EU countries, in particular, it argues that, on the road to 2050, the trade in green gases, is poised to reshape Europe's geopolitical energy map, triggering the emergence of new suppliers, previously serving as transit states in terms of oil and gas flows to the EU, like Belarus and Ukraine.

1. The pillars of conventional gas market integration

Natural gas represents about one quarter of the gross inland energy consumption of the EU-28 (Eurostat 2019a). The industry, the residential and commercial sectors (for heating) and the power generation sector is where gas demand is mostly concentrated. EU gas demand generally displays a strong seasonal behavior, since both production and consumption tend to be 1.5 times higher during wintertime than during warmer periods of the year (Artelys 2019). After a series of Russian gas transit cuts via Ukraine during the first decade of the 21st century, the EU flung itself into safeguarding uninterruptible and secure gas flows, the evenhanded application of competition rules and a more diversified supplier portfolio, which would curb the use of energy as a leverage over political decisions, a common bone of contention in its external gas relations.

From the market model of the Third Energy Package (TEP), whereby vertically integrated undertakings would not be allowed to simultaneously control production, supply and transport activities, to the subsequent adoption of its Network Codes, the EU has strived to establish a well-interconnected market with:

a) Multiple entry-exit zones and reverse flows.

b) Mature and liquid hubs in poorly liberalized areas, notably Southeastern and Central and Eastern Europe (SEE/CEE), by the finalization of vertical (South-North) and horizontal (East-West) gas infrastructure corridors, as well as by the expansion of flexible, short-term LNG trading which enables different market operators to balance their positions and fosters inter-Member State (MS) price convergence.

c) Enhanced solidarity and regional coordination, in order to attenuate the repercussions in the event of a malfunction of the gas system in one or several M-S.

The acquis on the internal gas market takes on added importance when diffused to membership aspirants, or simply partner countries, of the Western Balkans and Eastern Europe through policy and funding initiatives in the context of the Energy Community (including through the Central and South East Europe Energy Connectivity – CESEC - initiative) and the Eastern Partnership Energy Panel.

2. Decarbonization as an Energy Union dimension

Meanwhile, the EU is also committed to compliance with the Paris Agreement targets, which require world governments to constrain greenhouse gas (GHG) emissions to levels that equate to global warming remaining well below two degrees above pre-industrial levels. To this end, it has listed decarbonization among the five closely related and mutually reinforcing Energy Union dimensions, abreast of energy security, internal market, research, innovation and competitiveness (EC 2015). Abidance by the Paris targets necessitates the achievement of carbon neutrality by 2040 in the electricity sector and by 2050 in all sectors.

For the gas sector, this translates into power generation running on high shares of green gases (ENTSO-E and ENTSOG 2019). For the moment, the Clean Energy for all Europeans Package (CEP) has introduced efficiency and renewable (RES) targets for 2030, both likely to be revised upwards as part of the European Green Deal's Climate Law,[1] as well as an improved electricity market design aimed at facilitating the greater integration of RES. As for gas, CEP subsumes the security aspect associated with the utilization of existing and incremental pipeline capacity, whose deployment mostly hinges upon the Union's external suppliers, within the Integrated National Energy and Climate Plans – NECPs (EC 2019a).

3. Security of supply in an electron-molecules system

3.1 Defining sector coupling

The aforementioned attempts to evenly complete the conventional gas market integration, jointly with regulation for an electron-driven future, will formulate Europe's security of supply architecture towards 2050. It is a fact that domestically generated RES does not come with supply security implications, in contrast with the natural gas market which has transitioned to a more commoditized pattern. However, the demanding task associated with European gas – to sustain its flexibility in the thick of decarbonization - gives prominence to a cross-sectoral market and system approach, involving both electricity and gas transmission infrastructures. Sector coupling pertains to a deeper interlinkage between the gas and electricity sectors with the intention of broadening the potential for RES development. It has been broached by the 2013 Trans-European Energy Networks (TEN-E) regulation and the 2015 Gas Target Model, among other EU documents, and is going to form the core of the upcoming Gas Decarbonization Package. Before examining the particular concept, it is important to succinctly refer to the gas demand outlooks for 2030 and 2050.

[1] As of the time of writing, the EU Council has agreed on reducing greenhouse gases by 55% by 2030 (from 1990 levels), rather than 40% (2030 climate and energy framework - existing ambition). The new, more ambitious goal was tabled by the EC. The European Parliament (EP), which has yet to debate on this updated target, has voted for a 60% cut.

3.2 Gas demand outlook for 2030 and 2050

Except for a high of 502BCM (billion cubic meters) recorded in 2010, due to historically low temperatures and an uptick in economic growth (Dupont 2015, pg. 128; Tagliapietra 2016, pg. 45), the EU gas consumption was in decline throughout the financial crisis years, until 2014. In 2018, overall gas consumption in the EU-2018 reached 474BCM, down 1.8% to the 483BCM consumed in 2017 (EC 2019b), but it was then that import dependency rose to an all-time high of 77.9%, with 15 M-S even reporting a 90% import dependency (Eurostat 2019b). It was also in that year that Russian gas exports to Europe (under contracts of Gazprom Export and Gazprom Schweiz) reached a record high of 201.9BCM (Gazprom 2018). According to the ENTSOs' joint Scenario Report for the TYNDP 2020 (2019), decarbonization will decrease the EU's primary energy import dependency to circa 20%-36%, but imports of competitive natural gas resources outside the EU territory are expected to bear an impact on the future energy supply until 2030. Unabated natural gas demand will fluctuate around the threshold of +/-400BCM. The exact volumes will be conditional on the EU's economic progress, natural gas price competitiveness versus RES in the power sector and the market share of RES and electricity storage by that time. Under all ENTSOs' scenarios consistent with the Paris Agreement, gas demand in 2050 is forecast to fall to around 4,000TWh (410BCM), comprising green gases, while unabated gas will reach zero (Boorsma and Chaniotis 2020).

Table 1: Green gases classification used in this paper

Biogas	Renewable gas produced through the anaerobic digestion of biodegradable materials.
Biomethane	Biogas upgraded to a standardized specification that can be injected directly into the natural gas grid / Renewable gas produced via thermal gasification.
Natural gas (NG)-sourced hydrogen	Hydrogen produced from natural gas combined with CCS.
Renewable electricity (RE)-sourced hydrogen	Hydrogen produced from the electrolysis of water using renewable electricity / Methane produced through the methanation of renewable electricity-sourced hydrogen.

Source: Moraga, J. L., Mulder, M. and Perey, P., 2019. *Future Market for Renewable Gases and Hydrogen: What Would Be the Optimal Regulatory Provisions?* Brussels: Centre on Regulation in Europe.

Taking these projections into account, it is deduced that, by 2030, gas-fired generation can offer a cost-effective way to reduce CO2 emissions and a needed back-up to RES, especially during peak demand periods, given the progressive phase-out of coal under the Emissions Trading System (ETS). The relatively low capital costs of new plants and its ability to ramp generation up and down quickly – a fundamental feature in systems with abundant solar and wind power - are the main advantages of gas for power generation. By

2050, unabated gas may provide a low-carbon option if converted to hydrogen (NG-sourced hydrogen), via carbon capture utilization and storage (CCUS). Moreover, surplus renewable energy can be converted to hydrogen through electrolysis and methanation (RE-sourced hydrogen), known as power-to-gas (P2G). Lastly, there are also the locally nurtured biogas production and biogas-to-biomethane upgrading techniques, like anaerobic digestion and thermal gasification.

3.3 Green gases and natural gas infrastructure

Biomethane is the purified form of biogas that possesses the same qualities as natural gas, albeit with a lower heating value, and can be injected into the existing gas network without major technical upgrades. Nevertheless, its production costs for the most part vary across countries and projects and are overall higher than the current natural gas price (Moraga et al. 2019). According to industry assessments, biomethane production will rise from the current output of 2BCM/a (billion cubic meters per annum) to 50BCM/a by 2030, representing a 10% share of the EU gas market (Eyl-Mazzega and Mathieu 2019). The cost-effectiveness and scalability of the biogas/biomethane technologies rest on a possible revival of natural gas prices from their present historical lows and a clearer picture on the 2030 EU gas demand.

Hydrogen is a versatile energy carrier that efficiently supplements electricity. Even so, its energy density is only about a third of methane, resulting in an inferior product (as per its energy content) with a substantially higher cost, after its blending into the natural gas stream (Losz and Elkind 2019). Hydrogen blending into existing infrastructure and end-user equipment across Europe varies from 0.01 to 20% without affecting the gas grid or end-user equipment. In all, 35 percent of M-S currently allow or accept hydrogen blending (EU ACER 2020). An upsurge in carbon pricing could be a boon to the viability of CCUS infrastructures and value chains, although limited public awareness remains a thorn in their side (Tcvetkov et al. 2019). P2G's large-scale commercial development has been brought into sharper focus as a result of the temporal profile of RES vis-à-vis instantaneous electricity demand. Therefore, green hydrogen is poised to hold the top spot in regions of Europe where there is excess renewable electricity production. Costs of both CCUS and P2G might be reduced the more commercially widespread the technologies become.

The ENTSOs (2019) foresee an increase from 13%, in 2030, to 54%, in 2040, in the share of green gases in the EU energy mix, but they do not elaborate on the specific technologies with which these gases will be produced. A study on the impact of the use of the biomethane and hydrogen potential on trans-European infrastructure conducted for the EC (van Nuffel at al. 2019) concludes that “the EU potential for sustainable biomethane is limited, while the technical potential for hydrogen and synthetic methane production based on renewable electricity is large enough to also substitute the natural gas demand." Regardless of the type of green gas, chances are that European regions and M-S will follow distinct decarbonization paths, bringing about the fragmentation of the network and restrictions on cross-border gas flows because of the different gas quality standards. Still, in a sign of the bolstered security of supply that ensues from the gas sector being part of the future energy system, the indigenous processes concerning the output of green gases prompt the creation of a more decentralized energy system with numerous vectors and, hence, alone able to cope with supply shocks.

According to Navigant (2019), Europe's gas network comprises nearly 260,000km of high-pressure network, of which 200,000km are principally operated by transmission system operators (TSOs), plus approximately 1.4 million km of medium and low-pressure pipelines operated by distribution system operators (DSOs).[2] This network is gradually extended through midstream investments featuring on the EC's Projects of Common Interest (PCI) lists. It can safely transport unabated gas and, after 2030, biomethane and hydrogen admixtures over long distances (interconnectors) and manage the temporal and intermittent nature of renewables in order for demand to be met (storage facilities). As soon as P2G becomes available at network scale, renewable electricity could be gasified and then stored or transported via the very same gas infrastructures, either to be used in this form or to be re-converted into electricity by gas-fired power plants. All these elements lie at the heart of sector coupling. The medium-term role of gas particularly in the EU's mobility and industry sectors will provide the reliable, baseload demand that can underpin upstream and midstream activity by European and third-country firms in favor of an even geographical dispersion of the last natural gas capacities in Europe's network, ahead of the decarbonization era.

4. Natural gas decarbonization – Key issues for consideration

Gas market decarbonization presupposes wide-reaching value chain cooperation, so that networks and customers become receptive to green gases. In this sense, existing and proposed gas infrastructures, which have been supported or paid for by the EU for security of supply and market integration purposes and can ship appreciable volumes to remote areas, should be exploited, instead of being turned into stranded assets. The new EU energy policy paradigm should also not undermine the internal market principles. Accordingly, emphasis should be placed on the elucidation of regulatory issues, such as:

a) The applicability and/or need for adaptation of the unbundling requirements of the TEP to new circumstances, with reference to the access of TSOs and/or DSOs to the system. Clarifications should be

[2] There is also 1,100 TWh of underground gas storage capacity, along with 29 import facilities in 11 Member-States with 210 BCM/a of regasification capacity and 10 million cubic meters (MCM) of storage capacity (IEA 2020).

made over whether green gases are eligible to compete with methane-sourced gas on a level playing field, and over whether electrons-to-molecules transformation activities performed by network operators can be classified as production of new energy. Should network operators be allowed to engage in the production of green gases, ownership of the obtained fuels by them would be possible either with a law change or with short-term derogations granted by the EC for the development of demonstration/small-scale projects (Le Fevre 2019).

b) The operation of P2G facilities deployed by TSOs or DSOs under the Third-Party Access (TPA) rules (Eurogas 2020).[3]

c) The inclusion of P2G projects in future integrated TYNDPs, set up through transparent and sound processes with the strong involvement of DSOs (ibid.).

d) The gathering of DSOs, whose experiences and learnings with gas decarbonization surpass those of TSOs', under an EU-DSO entity for gas, analogous to the one for electricity established by CEP, which could potentially assist in the drafting of a Network Code on the decentralized injection of decarbonized gases (EU ACER and CEER 2019).

e) Possible modifications of the Network Codes on Capacity Allocation Mechanisms and on Harmonized Transmission Tariff Structures, so that TSOs are able to consider the involved expenses and the specifications of bids while working out their regional investment plans, as soon as these will end up covering the future gas grid, which will be capable of accepting either biomethane or hydrogen, or a mixture of both, along with unabated gas.

f) Transparency and non-discrimination in connecting renewables to the gas network and evaluation on the part of M-S of the need to extend their grids for this purpose, in line with the recast RES Directive – RED II (2018).

g) The management of domestic and cross-border trade restrictions, arising from different gas quality standards, with the help and/or revision of the Network Code on Interoperability and Data Exchange, and/or with the incorporation of a binding target for green gases in the Gas Decarbonization Package that could be satisfied through NECPs. Regulation of the variations in gas qualities at the TSO/DSO level and between networks operating with diverse gas mixes is critical for

[3] The views of the NRA and the TSO communities on the (over-)regulation of the early competitive activity related to investments in green gases, as well as on whether TSOs and DSOs owe to play a kick-starting role in that phase, are analyzed in Section 5.

security of supply. In this regard, the re-evaluation of the parameters set out as part of the mandate to the European Committee for Standardization in the field of gas qualities bears special importance for producers and final consumers alike (EC 2007).

h) The replication of a standardized guarantees-of-origin (GOOs) system, like the one already in place for electricity, upon which certificates enabling the tracing of renewable gases for the purposes of a smooth subsidization process will be based. GOOs will shed light on the wide range of terminologies relating to green gases. They will also ensure transparency and tradability across the EU (Eurogas 2020), as well as between the EU and third-country suppliers.

i) The adjustment of the solidarity principles provided for by the 2017 Security of Supply regulation, so as to handle possible shortages of the new products, to be carried by national and regional networks.

j) The regulation of gas-on-gas (GOG) competition, generated through traded hubs, in the early decarbonization phases, when clean gas sources will still be scarce. After all, an illiquid gas market model would throw a spanner in the works of the EU industry to preserve its competitiveness and of the EU consumers to keep accessing reliable and affordable supplies.

k) In the field of infrastructure planning, alignment of the PCI lists with the EU Green Deal implies that the lifecycle of future selected gas projects will have to be born in mind and that future-proof investments that could afterward promote green gases' penetration should be given priority. The same goes for LNG projects who have higher emissions that a typical pipeline gas counterpart and will have to recover their costs before the 2030 decline in European gas demand, since their re-use for the production of hydrogen from regasified methane through CCUS and its transportation by tankers in liquefied form appear a lot costlier (Stern 2019; Mitrova et al. 2019). Alternative uses of infrastructure already in place should also be mulled over ahead of retirement. Amendments to the TEN-E guidelines[4] to broaden the range of investments eligible for inclusion to TYNDPs and for future PCI candidacy would support a healthy investment environment throughout the energy transition (EU ACER and CEER 2019). The preparation of Important Projects of Common European Interest (IPCEI) lists specifically for hydrogen (Chatzimarkakis 2019), along the lines of plans launched for battery research, is another positive step towards the same direction.

[4] As of the time of writing, the EC has released its proposal for a revision of the TEN-E Regulation. See Section 5 for a brief assessment of the treatment of (unabated and green) gas investments in this proposal.

5. Where do we stand? – An overview of the Hydrogen Strategy[5]

The EC's Hydrogen Strategy (2020b) does some rudimentary groundwork for the anticipated "light" gas regulation. It sets a binding target regarding the installation of 40GW of electrolyzers for 2030 and a further 40GW in the EU's Eastern and Southern neighborhood for the same year. It also foresees the development of a global hydrogen market in which the fuel will be traded as a liquid commodity denominated in euros.

While clearly prioritizing RE-sourced hydrogen, the Strategy recognizes that solutions at a lower technology readiness level, like CCUS and pyrolysis, have to be incentivized until upscaling to electrolyzers in the case of gigawatts is achieved. Tenders for Carbon Contracts for Difference (CCfDs), a demand-stimulating scheme proposed in the Strategy which typically relates to RES generation, can mitigate risks primarily for low-carbon hydrogen investors, in light of RE-sourced hydrogen's currently higher costs. This downstream-sector policy ensures a minimum CO2 price and therefore supports long-term low-carbon investments, providing a hedge against a hike in CO2 costs in the ETS.

Table 2: Summary of steps towards "light" gas regulation as per the EC's Hydrogen Strategy (2020b)
Revision of TEN-E Regulation.
Review of internal gas market legislation for competitive decarbonized gas markets.
Common quality standards or cross-border operational rules to ensure interoperability of markets for pure H2.
Review of the Alternative Fuels Infrastructure Directive & revision of TEN-T Regulation.

5.1 Unbundling and third-party access

The Strategy does not elaborate on the applicability and/or need for an amendment of unbundling rules, but does highlight the need for the development of non-discriminatory TPA rules to reduce the undue burden on market access. It also emphasizes the need to repurpose the pan-European infrastructure for large-scale cross-border hydrogen transportation. Hydrogen produced close to the point of electricity/natural gas source requires dedicated pipelines or trucks, whereas de-centrally produced hydrogen (i.e., hydrogen produced close to the consumption point) needs limited infrastructure for local storage and distribution (Cihlar et al. 2020). Production of hydrogen close to demand points is especially important for hard-to-abate sectors, like industrial clusters. The development of both blending[6] and pure hydrogen solutions

[5] For a detailed analysis see: Liakopoulou, M., 2020. *Towards an EU Hydrogen Economy: Policy and Energy Security Perspectives.* Athens: Hellenic Foundation for European and Foreign Policy. Available at: https://www.eliamep.gr/wp-content/uploads/2020/11/Policy-Paper-Liakopoulou-43.pdf [Accessed December 14, 2020].
[6] According to the Strategy, "blending risks fragmenting the internal market if neighboring M-S accept different levels of blending and cross-border flows are hindered." To prevent fragmentation, re-evaluation of the parameters set out as part of the mandate to the European

during the early market stage focuses attention on the role of TSOs and DSOs along the hydrogen value chain.

ACER (2019) sees no reason why TSOs or DSOs should get involved in hydrogen facilities, beyond a kick-starting role. It also considers regulated TPA to be relevant for large-scale (“backbone”) hydrogen networks and not for point-to-point infrastructure. On its part, the TSO community equally highlights the” kickstarting” investor role that electricity and gas TSOs may play in the emerging hydrogen market, “on the condition that this is in the public interest and does not distort the market” (ENTSOG 2020). It also states that “it should be clarified and allowed for the gas TSOs to own, plan, build and operate dedicated hydrogen networks both at EU level and in the M-S – including repurposing of existing gas infrastructure to ensure the cost-effective development of a hydrogen backbone”, seeking for a similar provision to apply to DSOs, SSOs and LSOs (ibid.) Eleven TSOs, representing nine EU M-S, have already made a start by releasing a paper looking into the potential for the gradual development of a dedicated hydrogen and a dedicated (bio)methane network, accessible “by all interested market parties under equal terms and conditions” (Wang et al. 2020).

Overall, it can be deduced that it is vital that network operators do not exploit their position regarding the ownership and/or operatorship of installations such as P2G conversion plants, unless NRAs can verify that there are no market-based investment options over the horizon. Striking the right balance between compliance with sectoral rules and maintenance of a market-driven approach remains a challenge through the development of a backbone of low- and zero-carbon gas investments.

5.2 Guarantees of Origin

The Strategy also discusses the introduction of a low-carbon threshold/standard for the promotion of hydrogen production installations based on their full life-cycle GHG performance, which could be defined relative to the existing ETS benchmark for hydrogen production, as well as a comprehensive terminology and Europe-wide criteria for the certification of renewable and low-carbon hydrogen. Support certification schemes, like GOOs[7], are required for policies which remunerate the consumption of green gases. It is therefore important to safeguard their intra-EU interoperability and conversion from one carrier to another. RED II focuses on support and targets for renewable gases (biomethane, RE-sourced hydrogen) and Guarantees of Origin (GOs); it does not cover NG-sourced hydrogen, however.

Committee for Standardization in the field of gas qualities (see Section 4), revision of national gas quality standards and reinforcement of instruments securing cross-border coordination and system interoperability for an unhindered flow of gases across M-S should be given “careful consideration.”

[7] The role of GOOs, as well as of the carbon-border adjustment mechanism (CBAM), as “security valves” built by the EU legislation with the aim of safeguarding the sustainability of imports of green gases by third countries will be further analyzed in Section 7.

5.3 Tariff regulation

Hydrogen tariff regulation could also be based on a revisited RED II. At the same time, it also has to be born in mind that existing and prospective (pipeline and storage) gas infrastructure is to initially accommodate hydrogen and biomethane admixtures and that the Third Gas Directive (2009) does not necessarily cover pure hydrogen in scope – although it can be interpreted as applying to natural gas/hydrogen blends.[8] Therefore, a review of the gas market regulatory framework by 2021 "so as to facilitate the uptake of renewable gases […], whilst ensuring an integrated, liquid and interoperable EU internal gas market", as per the EC's Energy System Integration Strategy (2020c), constitutes another tool for tariff regulation. However, in the absence of a mature industry for green gases within which capital could be quickly and massively allocated and absorbed, and within which market failure could still be experienced, owing to economies of scale or natural monopolies in networks, strict adaptation of gas legislation to facilitate the penetration of green gases in the energy system may prove a rather tricky task.

Overall, discounts on network access tariffs could spur large-scale gas sector decarbonization. In contrast, high tariff levels risk provoking a chain reaction of subdued consumption and scarce operator revenues. Market participants – hydrogen investors among them - should have a clear picture of the whole system price signals, including the alignment needs between gas and electricity grid tariffs. Finally, establishment of a "technology-neutral, level-playing field" between different carries is also necessary, "so that they face equivalent categories of costs in network tariffs and levies" (EU ACER and CEER 2019).

5.4 Revision of the TEN-E Regulation

As already mentioned, the Strategy (2020b) considers the repurposing of pan-European gas infrastructure for "large-scale cross-border transport of hydrogen" as an "opportunity for a cost-effective energy transition in combination with (relatively limited) newly built hydrogen dedicated infrastructure", after 2030. In its current version, the TEN-E framework does not include either hydrogen infrastructures or power-to-gas.

On December 15, the EC (2020d) released its proposal regarding the revision of the TEN-E Regulation with the aim of enhancing infrastructure planning for energy system integration. In relation to gas infrastructure, the proposal states that "new and repurposed hydrogen transmission infrastructure and storage as well as electrolyzer facilities" should be included in the TEN-E policy and

[8] Directive 2009/73/EC Article 1.2: "The rules established by this Directive for natural gas, including LNG, shall also apply in a non-discriminatory way to biogas and gas from biomass or other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system."

the Union-wide TYNDPs. Furthermore, in line with the Strategy, it refers to "repurposed" hydrogen networks[9] and P2G facilities with a cross-border relevance – i.e., aiming to supply at least two M-S. Emphasis on cross-border relevance assuages concerns over the small-scale nature of transmission and storage projects for green gases that could possibly call into question their right to simplified permits and funding from the EU's Connecting Europe Facility (CEF) upon their inclusion into TYNDPs and, later, in PCI lists. Lastly, the creation of a new infrastructure category, called "smart gas grids"[10] opens the door for the transition from unabated gas investments to the so-called "future-proof" gas investments, that is investments able to prove their ability to integrate biogas/biomethane and hydrogen at a later stage. This paper argues that a broader optimization of the EU toolkit may be essential in order to promote innovation in relation to projects with few to zero cross-border implications enhancing interoperability of flows between the distribution and transmission levels.

6. Completion of the internal natural gas market[11]

Until European policy-makers manage to refine the gas decarbonization policy components, the EU has to proceed with certain shorter-term measures touching upon the overhaul of its conventional gas market. Against the backdrop of the reduction of the excessive number of carbon allowances under the reformed ETS and the drop in indigenous output due to the Groningen gas caps, M-S are bound to remain reliant on gas imports from third countries like Russia, Norway, Algeria and the Caspian littoral states. That's why supply diversification has to stay at the fore of the EU gas strategy by 2030.

6.1 The hardware

Implementation of transboundary infrastructure projects (interconnectors and LNG terminals) is what matters the most for vulnerable areas of Europe (M-S of SEE and CEE, the Western Balkan accession aspirants and the Energy Community contracting parties). It in these countries that gas demand is set to grow due to the displacement of coal and that single-source dependency

[9] According to the proposal, "repurposed" hydrogen networks encompass: hydrogen transmission pipelines and related equipment such as compressors, storage facilities, and facilities for liquefied hydrogen.

[10] According to the proposal, the term "smart gas grid" refers to "a gas network that makes use of innovative digital solutions to integrate in a cost-efficient manner a plurality of low-carbon and renewable gas sources in accordance with consumers' needs and gas quality requirements in order to reduce the carbon footprint of the related gas consumption, enable an increased share of renewable and low-carbon gases, and create links with other energy carriers and sectors."

[11] See Annex to Section 6 for figures on average gas demand and dependency on Russian gas imports in SEE, a map of the Southern and Vertical Gas Corridors and progress on the implementation of the gas market acquis in the Energy Community.

apprehensions trump economic concerns over the protracted low commodity price cycle (see Annex). It is also in these regions that the market pattern of Northwestern Europe, per which price formation has to transition from oil indexation to GOG competition, is aimed to be exported, in view of the approaching expiry of long-term contracts (LTCs), concluded between European companies and third-country producers at the onset of the 21st century. LTCs were a way of making governments appear more reliable in guaranteeing security of supply, while public fears of an imminent gas deficit were far from receding. According to the former Deputy Director-General of DG Energy, Klaus-Dieter Borchardt, a halt has to be put on the EU gas industry's legacy of LTCs, because this kind of supply deals "could jeopardize the 2050 (decarbonization) targets" (Witkop 2020). Of course, the slow-paced rate of short-term capacity bookings and the allotment of their associated tariffs in a manner whereby no hindrance to trade is caused remains a pending issue under consideration, as LTCs are fading into history (EU ACER and CEER 2019).

Once the Southern Gas Corridor (SGC) and Vertical Gas Corridor (VGC) supply chains, which encapsulate the above-indicated interconnectors and LNG terminals, become operational, bottlenecks troubling SEE and CEE will be eased and Europe as a whole will gain access to alternative (Caspian, US and Black Sea) gas supplies (see Annex). Consequently, the solidification of a "fully interconnected and shock-resilient gas grid by 2020 or shortly thereafter", as described in the Fourth Report on the State of the Energy Union (EC 2019c), comes closer to fruition.

6.2 The software

Aside from the hardware, the EU should also systematically monitor the adoption of the internal gas market acquis by M-S and membership hopefuls alike, in order to seamlessly depoliticize its external gas relations (see Annex). The open-ended transposition of the TEP Network Codes and Guidelines for both electricity and natural gas into the Energy Community legal framework is proof of this pedantic endeavor (Energy Community 2018), while complementary locally-targeted policy proposals could, on an ad-hoc basis, mitigate inherent structural limitations to market liberalization.

Therefore, it is first and foremost essential for the discussed markets to finalize their conventional gas market integration striving for liquidity, competition and price integration, even if the decarbonization acquis is to marginally change the broader market landscape. For instance, as the EU has to guarantee access for green gases to existing gas infrastructure, completion of unbundling, as the majority of TSOs are still part of vertically integrated companies and have opted only for functional unbundling, far-reaching implementation of TPA and competition will all be vital, especially in isolated and poorly liberalized markets in the CEE and SEE, in order to make sure that there's a level-playing field for all market actors involved in the decarbonizing gas market.

In this context, the first challenge for the EU's key gas suppliers is to conform to the state of play in the internal gas market, which dictates an even geographical dissemination of software and hardware precepts. The second is for them to maintain their presence in the post-2030 internal market, in the face of the replacement of imported unabated gas by indigenous electrons, that is, RES produced within the EU.

7. Towards a new external gas policy paradigm for the EU

Response to the first challenge is running smoothly, as infrastructure bottlenecks and antitrust probes, primarily in SEE and CEE, are being sorted out. The resolution of long-standing commercial tiffs, most notably the settlement of the EC's antitrust case against Gazprom without fines (EC 2018b), confirm the latter's recognition of the intensifying competition between LNG and pipeline gas and its inclination towards a more flexible, destination-free marketing approach. This is further buttressed by the spot indexation of a tangible amount of Gazprom's LTCs and the launch of its Electronic Sales Platform in late 2018 (Burmistrova 2019). Response to the second challenge entails greater complexity.

7.1 The new energy security motif

Historically, the EU and other multilateral coalitions, like the International Energy Agency and the Energy Charter, have correlated their economies and diplomacies with the availability of secure hydrocarbon supplies. While the post-World War II geopolitical literature was centered on competition over petroleum resources, the new literature revolves around the idea that countries will gain or lose geopolitical advantages as a consequence of the energy transition, with major hydrocarbon producers, such as Russia and Saudi Arabia, running the risk of turning into holders of stranded geopolitical assets (Overland et al. 2019). It is, thus, evident that decarbonization may, to a certain extent, depoliticize interstate energy relations, as it is likely to limit geopolitical competition for access to fossil fuel reserves and supply. This holds true particularly with regard to the envisioned emergence of Europe's less concentrated energy system that will alone be able to demonstrate greater flexibility in stress incidents. The local, small-scale production of biomethane fed into the gas distribution networks is an example of this type of decentralization.

At the same time, the energy transition narrative puts into question the conventional energy security motif. According to its definition for importers, energy security is all about adequate and reliable supplies at reasonable prices, whereas for exporters, it has to do with their reputation as reliable suppliers, as well as with guaranteed revenues from end-markets (Yergin 2006). In this context, key threats such as politically or economically motivated regional conflict have been identified as underlying disruption incidents which affect importers and exporters alike. Decarbonization could alter the current energy security motif into one of geopolitical competition over the production of energy resources, rather than over mere access to them; this is exemplified by the unfolding battle between the EU and China over global supremacy in electrolyzer manufacturing (Amelang 2020).

7.2 The hybrid governance model

Still, the volatility in domestic debates on the speed of decarbonization and the right course of action about it make it more difficult determine the nature of Europe's energy relations with third countries over the long term. This raises the issue of the optimum governance model for certain third-country energy dossiers associated with preferences of one or several M-S on their energy mix and infrastructure connections to non-EU suppliers. The Treaty on the Functioning of the EU (TFEU) foresees the possibility of cooperation between the EU and third countries on promoting projects of mutual interest and on ensuring interoperability of networks – Article 171 (3). The Treaty also grants M-S freedom of choice in aspects of their energy supply, including their extra-EU imports and associated infrastructures. The Lisbon Treaty (2007) formalizes the EU's competences on energy policy, including its external aspect. This means that the Energy Commissioner, to whom the EC's Directorate-General for Energy (DG ENER) directly reports, is the person playing a key role when it comes to cross-border infrastructure projects of strategic importance to the EU, involving external supplier countries, while the High Representative for Foreign Affairs and Security Policy can only intervene as a supporting actor advocating common EU positions in the field of energy.

Given the open-ended evolution of technologies related to green gases and the relatively sketchy mapping of coalitions that the EU is in a position to make with external suppliers at this point, it may be of value to advance coordination with non-EU countries even by slightly diverging from the above format. For instance, a potentially composite pattern, involving the Energy Commissioner and the High-Representative complementing one another under the auspices of the Presidency of the Council, may prove beneficial in order to keep the policy and regulatory dialog open with third-countries interested in exporting green gases to the EU.

7.3 The emergence of new energy suppliers

As mentioned, the Hydrogen Strategy foresees the installation of another 40GW of electrolyzers in EU's Eastern and Southern neighborhood by 2030. Imports of green gases from outside the EU may be of relevance, given the high production potential in neighboring regions and countries (van Nuffel et al. 2019). Factors such as production locations (i.e., abundant resources and cheap production costs), transport technologies (i.e., availability of ships for liquid hydrogen or ammonia and pipelines for gaseous hydrogen) and the distance from – and infrastructure at - reception points will determine which countries will assume exporting roles and sustain dynamics comparable to those of the oil and gas markets, including the likelihood of geopolitical confrontation. Such a perspective restores the usual supply security implications, but not necessarily with regard to the EU's external traditional suppliers.

For instance, an Ecofys study (van Melle et al. 2018) suggests that Ukraine and Belarus, two countries with existing pipeline connections to the EU, could contribute up to 20BCM/a of biomethane to the intra-EU output. Ukraine's nuclear sector uses hydrogen technology, albeit in small volumes, to cool generators (Kyiv Post 2020). Thanks to its already developed gas network, Ukraine could help the EU in its quest for hydrogen partnerships in its immediate vicinity. In fact, Ukraine was recently identified by Energy Commissioner Kadri Simson as one of Europe's potential partners with respect to the hydrogen trade (Abnett and Eckert 2020). According to the CEO of the newly established transmission system operator of Ukraine (GTSOU), Sergiy Makogon, there is interest in the delivery of both biomethane and hydrogen to the EU and this is a market opportunity currently analyzed by GTSOU (Makogon 2020). Therefore, the trade in green gases, is poised to reshape Europe's geopolitical energy map, triggering the emergence of new energy suppliers, previously serving as transit states in terms of oil and gas flows to the EU.

Moreover, a cross-border renewable hydrogen trade could moreover foster diplomatic relations between the EU and North Africa, Spain and other Mediterranean M-S that could turn into hydrogen transit hubs, and Australia, which offers a reliable shipping route. For example, Germany has signed a cooperation agreement with Morocco concerning methanol production from hydrogen (Federal Ministry for Economic Cooperation and Development, n.d.).

7.4 The outlook for traditional gas suppliers

This subsection will briefly look into the role that the EU's pivotal (quantitively and strategically) gas suppliers may hold amidst the aforementioned decarbonization developments.

Russia views significant potential in production of hydrogen and its export on a global scale, something which is actively discussed as part of the innovation strategies of its major energy companies. In contrast with its "Energy Strategy 2035" that determines Russia's hydrogen export potential at 2 million tons, the Russian Energy Ministry forecasts that this potential may extend to tens of millions of tons (Chizhevsky 2020). In theory, Russian firms could respond to demand for green gases by decarbonizing at the extraction points and by shipping to Europe through the existing and under construction (Nord Stream 2, second string of Turk Stream, Yamal LNG) infrastructures (Borchardt and Konoplyanik 2018). According to Gazprom Export, modern pipelines, similar to the type used in Nord Stream, could accommodate up to 70% hydrogen blended into natural gas (Mitrova et al. 2019). Nonetheless, all this implies time-consuming shifts in Russian producers’ export business models, and in Russia’s domestic market itself, which could provide the impetus for deliberations on the level of the EU-Russia Gas Advisory Council and/or other formats. For instance, technologies for hydrogen production via pyrolysis, already pondered by Gazprom (RBC 2018), could sustain European gas import demand and minimize the need for expensive CCUS investments, but they’re still stalled at their R&D stage, while uncertainty prevails over the technical modifications required to pipelines. On the other hand, the cost-competitiveness of Russian RE-sourced hydrogen is more uncertain, due to low solar radiation and wind speeds.

Meanwhile, Norway’s Equinor, in light of the lifecycle of its North Sea assets, vigorously collaborates with international oil companies (IOCs) on the deployment of CCUS practices. Indicatively, the idea of Equinor, Shell and Total on the very first cross-border CO2 storage project, originally linking Eemshaven in the Netherlands and Teeside in the UK with Norway’s Northern Lights storage site, won the support of a number of industrial companies during the first European high-level CCS conference, organized in Oslo (Gassnovasf 2019). According to the executive Vice-President for sustainability at SINTEF Nils Anders Røkke (2019), Norway could convert about 850-950TWh (out of the 1,400TWh of natural gas it currently exports to Europe) into NG-sourced hydrogen, stored in the country.

Similar portfolio diversification strategies are also shared by the hydrocarbon-rich Caspian countries, the first gas from where (Azerbaijan’s Shah Deniz 2 project) is scheduled to reach Europe in 2020 via the Trans Adriatic Pipeline, the SGC’s European segment. Two TAP shareholders, Snam and SOCAR, have signed a cooperation agreement providing for research on the possible construction of anaerobic digestion plants for production of bio-gas and biomethane, as well as for research on hydrogen production (Snam 2020). A plausible explanation for Caspian littoral states’ relative hesitancy to actively promote green gas investments to date has to do with their ill-explored deep-sea acreage, made all the more unattractive to IOCs due to the appeal of the short-cycle shale hotbeds and to public pressure to decrease their GHG footprints. This is topped by the region’s complex geopolitics, involving US, Russian and Chinese influence over the riparian players that have so far prevented the already available gas volumes from getting to Europe, preferably via a subsea Trans Caspian pipeline (Liakopoulou 2020). The SGC’s ability to carry hydrogen admixtures will ultimately depend upon which hydrogen production and delivery technologies may be implemented on a larger scale in the countries that the project crosses, as well as in those countries that are going to supply the SGC network. Decisions about this would determine the levels of investment that the project consortia would need to commit, in order to re-purpose the SGC’s various segments for the conversion, transmission, storage, and distribution of green gases.

7.5 Regulatory “security valves”

Last but not least, practical questions naturally surround the sanctity of the contracts already into force between the EU and each of its principal gas suppliers, in terms of likely violations of provisions safeguarding the quality of the gas delivered. Such violations can bring about either an outright refusal of the final product or fines by purchasers and/or TSOs. It is for this reason that, for example, Gazprom explores alternatives for the production of methane-sourced hydrogen right after the transportation of unabated natural gas through the pipeline and values the particular hydrogen market in Europe at EUR153bn by 2050 (Mitrova et al. 2019). The setting of clear-cut targets referring to the injection of green gases into the grid, in step with the afore-described policy recommendations, will facilitate the conclusion of such supply contracts in the future.

In this context, and in order for politics not to prevail over sustainability in EU’s energy relations with third countries, the EU legislation can build a set of “security valves” safeguarding compatibility of traded gases with GHG standards. First, GOOs can ensure that green gases imported into the EU are able to demonstrate that they meet specified EU GHG criteria. For this reason, certification methodologies outside the EU will also have to be recognized in an objective, non-discriminatory manner (Piebalgs and Jones 2020). Second, introduction of a carbon border adjustment mechanism (CBAM), as part of which CCfDs could also be adopted, is listed among those measures promoted to address carbon leakage by enabling the price of imports to the EU to reflect their CO2 component and, thus, by pressuring third countries to eventually limit the amount of CO2 exported to the EU (Mete and Reins 2020).

Conclusions

The decarbonization of the EU economy by 2050 is set to bring about non-negligible changes in the internal gas market, where a homogeneous fuel is presently distributed via a uniform grid. The Gas Decarbonization Package promises to give a greater sense of direction to policy-makers and consumers apropos of regulatory questions around sector coupling.

During this transitional period the EU is prompted to address relations with its key external gas suppliers by:

a) Ensuring finalization of strategic infrastructures, symmetrical geographic dissemination of the acquis and seamless depoliticization of gas trade by 2030,

b) Identifying its suppliers’ potential role between 2030-2050. These could act either producers (and exporters) of green gases, or as mere providers of the infrastructure that will be used to transport these gases, given the “insourcing” characteristic of green gases in the context of a less concentrated energy system.

In case intra-EU generation of green gases renders imports from third countries obsolete, the ritualized supply and demand patterns that served the gas industry to date will gradually erode the deeper we get into the 21st century and decarbonization will depoliticize energy provision in terms of geopolitical competition for access to reserves and supply, to the long-term benefit of Europe’s energy security. At the same time, decarbonization could alter the current energy security motif into one of geopolitical competition over the production of energy resources, rather than over mere access to them; this is exemplified by the unfolding battle between the EU and China over global supremacy in electrolyzer manufacturing.

Moreover, given the open-ended evolution of technologies related to green gases and the relatively sketchy mapping of coalitions that the EU is in a position to make with external suppliers at this point, it may be of value to advance coordination with non-EU countries by implementing hybrid governance models involving both the EC and the Council.

The EU’s relations with external suppliers are, therefore, set to tighten thanks to the positive stimulus to unabated gas consumption by 2030, because of the phase-out of coal, the declining European production and the need for a complement to fluctuating renewables. This is why Europe is compelled to evenly promote gas market integration to its most vulnerable geographic areas in order to safeguard security of supply. On the road to 2050, the trade in green gases, is poised to reshape Europe’s geopolitical energy map, triggering the emergence of new energy suppliers, previously serving as transit states in terms of oil and gas flows to the EU, like Belarus and Ukraine. Ultimately, factors ranging from the outcome of gas market decarbonization in the EU to corporate and political developments in supplier countries will determine the ability of the latter to deliver sustainable, secure and clean energy products.

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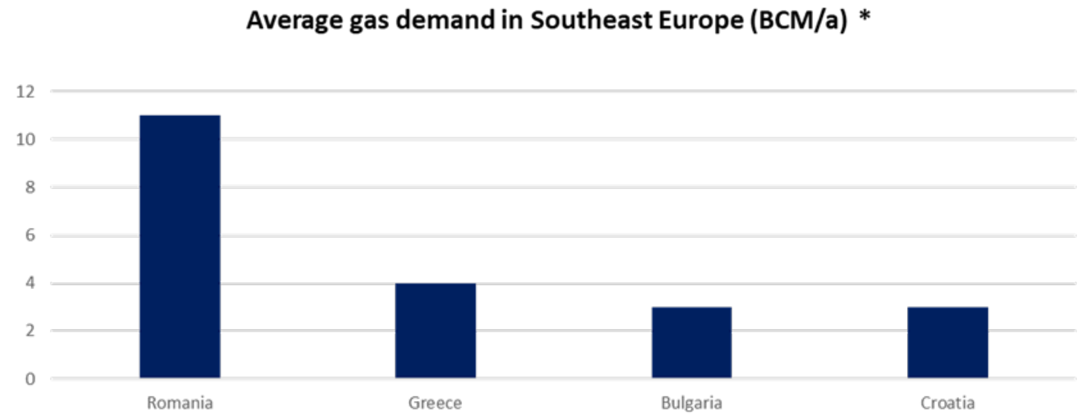
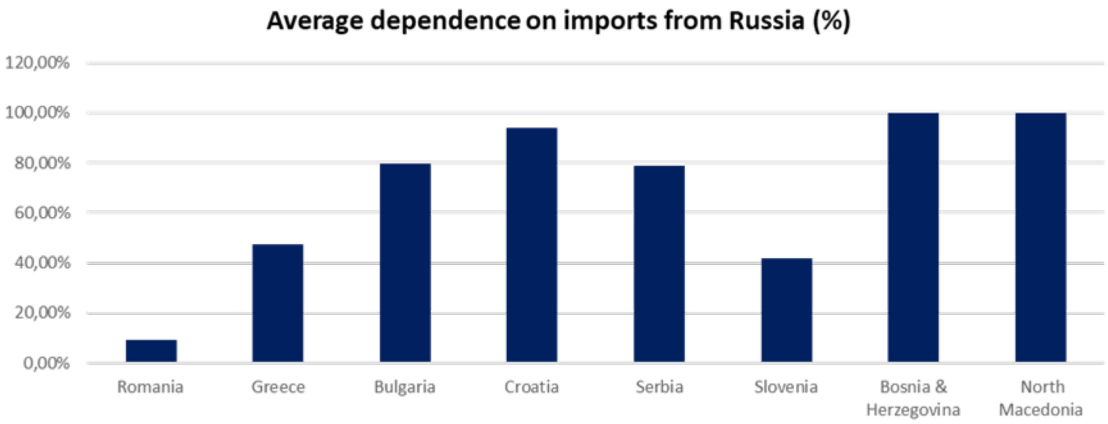
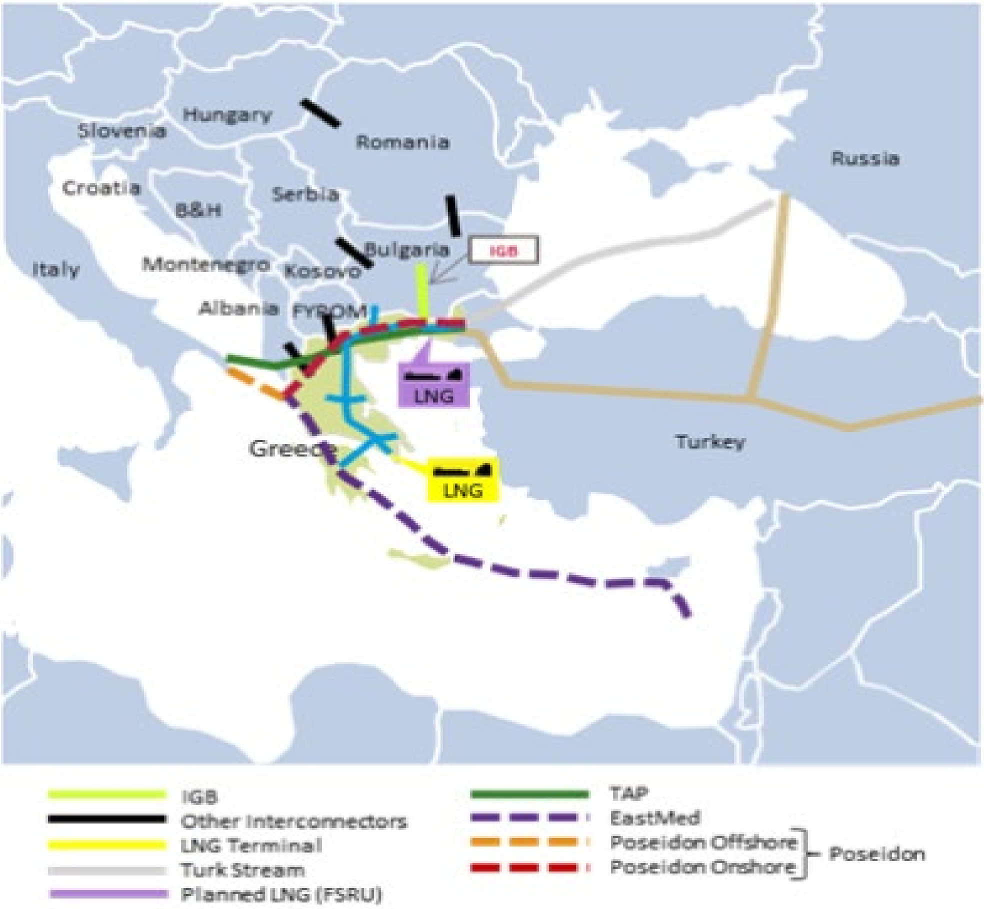
Annex to Section 6

Average gas demand and dependence on imports from Russia in the SEE (2010-2018). Source: Liakopoulou, M., 2020. Gas Supply Security and Decarbonization in SEE and CEE. In: R. M. Cutler, A. Sabadus, M. Liakopoulou, C. Widdershoven, 2020. *NATO-Area Energy Security: The Southeast European Flank*. Toronto: NATO Association of Canada (NAOC) Webinar Series [online]. Available at: https://www.youtube.com/watch?v=cBShlPbpHGU&t=4404s [Accessed December 14, 2020).





** Turkey excluded, no gas markets in Albania, Kosovo, Montenegro. Sources: BP Statistical Review of World Energy 2020, Energy Community, IEA, Gazprom Export, Statistical Office of the Republic of Serbia, US Department of Commerce, Author's Analysis.*



Map of several of the Southern and Vertical Gas Corridor-related infrastructure projects. Source: DEPA International Infrastructures.
** FYROM → Republic of North Macedonia, as of February 2019.*

Status of implementation of the EU gas market acquis across the Energy Community Contracting Parties. Sources: ECS and author's personal notes kept during the 15th Gas Forum of the Energy Community. Presented in: Liakopoulou, M., 2020. Gas Market Integration and Decarbonization in SEE and CEE. In M. Ydreos and M. Liakopoulou, 2020. *Gas Market Integration and Decarbonization in SEE and CEE*. IAEE Webinar Series [online]. Available at: https://www.iaee.org/en/webinars/webinar_liakopoulou.aspx [Accessed December 14, 2020].