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Hydrogen at the Gates: Towards a New Chapter in the EU-Russia Energy Relations

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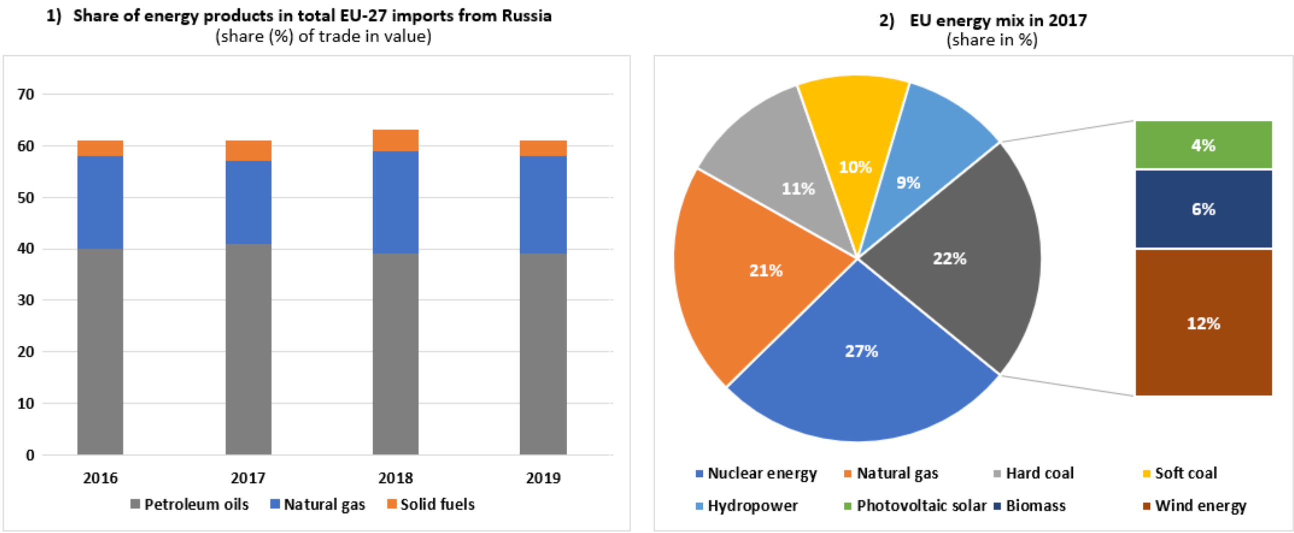
Having ratified the Paris Agreement, the European Union (EU) pledged to substantially lower the level of its carbon emissions and become climate-neutral by 2050. In this respect, hydrogen (H_2) – an energy source that could prospectively substitute conventional hydrocarbons – is viewed as an important element in achieving these ambitious targets, as it could revolutionize the energy industry. Here, though the EU puts specific attention to the build-up of H_2 generation based on renewables, the cheapest way of its current large-scale production is using natural gas as a feedstock – the fuel imported primarily from Russia. This tradeoff between costs and climate commitments makes the future of the EU-Russia energy relations particularly tricky.

EU's Hydrogen Strategy vs. Russia's 'Hydrogen Roadmap'

Since energy production and consumption are the largest sources of CO_2 emissions in the EU-27[1], meeting the climate targets will necessitate a comprehensive transformation of the energy sector. Nevertheless, the energy industries in most European countries are still extensively reliant on hydrocarbons, in general (*Figure 1*), and natural gas, in particular, most of which is supplied by Russia. That is why, shifting the European economic paradigm towards sustainability is likely to necessitate the review of the EU-Russia energy relations, since Russia's little focus on climate policy.

[1] EEA (2013)

Figure 1: EU energy imports from Russia and energy mix[2]



Though, within the EU, reaching climate neutrality – i.e. the economy with net-zero greenhouse gas emissions – is generally viewed through decarbonization (the substitution of fossil fuels by renewables)[3], the intermittency of wind and solar power necessitates finding a way to store large volumes of energy for a long time so that they could be integrated into the energy system[4]. Here, despite the development of batteries, energy storage in a form of chemical substances is currently regarded as the most promising[5]. Since hydrogen is one of the few chemicals not emitting CO_2 when used[6], both net energy exporters (e.g. Norway and Australia) and energy importers (e.g. Japan and Germany) started developing their hydrogen sectors[7]. The EU Hydrogen Strategy from July 2020 assumes H_2 to be 'essential to support the EU's commitment to reach carbon neutrality'[8] and the EU views H_2 as a core element in the consolidation of Europe's energy sectors[9].

Despite such important developments in its crucial energy market the export to which generates a third of the state budget[10], Russia has not issued its own hydrogen strategy[11] and its Energy

[2] Eurostat (2018) and Ru-Stat (2020)
[3] European Environment Agency (2019)
[4] European Commission (2020b)
[5] Ausfelder et al (2017)
[6] US Department of Energy (2019)
[7] Lambert (2020)
[8] European Commission (2020a)
[9] European Commission (2020c)
[10] RBC (2019)
[11] Kardaś (2020)

Strategy does not list H_2 among the key priorities[12]. Instead, with the 'Hydrogen Roadmap', an action plan adopted in October 2020[13], Russia's approach towards H_2 could be dubbed as a 'short-term *reactive adaptation* to market development rather than long-term proactive strategic behaviour'[14]. This, however, does not imply that the country is planning to leave the EU energy market altogether, as it wants to maintain its dominance over there. Here, though the EU prioritises decarbonised H_2 over any other, the current legislative uncertainty about what kind of hydrogen could be allowed into the EU makes Russia's prospects quite promising.

Since greater use of H_2 for the 'green' transition would generally be viewed as a 'challenge' to the Russian energy security[15], the newly adopted 'Hydrogen Roadmap' declares an ambitious goal to turn the country into a world leader in H_2 production[16]. However, this could also be perceived as a declaration rather than a coherent strategy backed by economics and technology[17]. To check the feasibility of these plans, this paper explores the strengths, opportunities, weaknesses, and threats associated with Russia's H_2 potential.

Hydrogen Production Methods

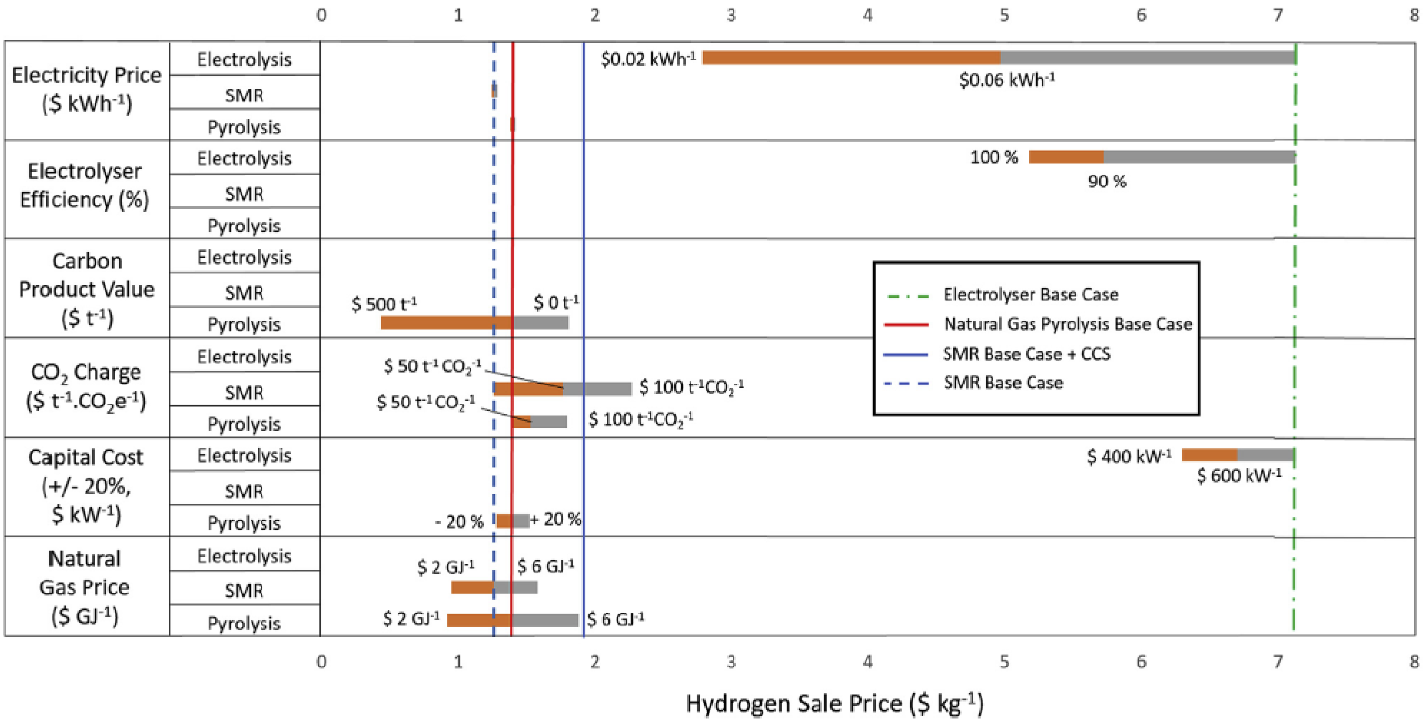
There are various ways to produce hydrogen and, depending on the technology used, it is labelled with different colours, while retaining the same properties. *'Grey'* hydrogen refers to H_2 produced from fossil fuels with CO_2 emitted in the process[18]. If the emissions are sequestered via carbon capture and storage (CCS)[19], such hydrogen is called '*blue*'. Finally, *'green'* hydrogen is zero-emission H_2 produced by renewables via water electrolysis[20].

Apart from these common colours, one could refer to *'purple'* H_2 – the electrolysis-based hydrogen generated by nuclear facilities[21]. Additionally, though being at the pilot stage, the technology of molten metal pyrolysis allows for the production of *'turquoise'* hydrogen, where solid carbon is the byproduct[22]. Here, since each 'type' oh H_2 is associated with a specific

12 Government of the Russian Federation (2020) and Bieliszczuk (2020a)
13 Ministry of Energy of the Russian Federation (2020)
14 Mitrova and Yermakov (2019, p.10)
15 Ministry of Energy of the Russian Federation (2019)
16 Ministry of Energy of the Russian Federation (2020)
17 DW (2020)
18 World Energy Council (2019)
19 ibid
20 ibid
21 Euractive (2020)
22 TNO (2020)

feedstock, technologies, production costs and thus prices (*Figure 2*), Russia's energy sector has certain advantages and limitations, which could impact its relations with the EU.

Figure 2: Estimated minimum sale price for different H_2 types



Source: *Parkinson et al (2018)*

Russia & H_2: Strengths and Opportunities

- **Economic**

Russia possesses significant *economic* potential for the production of 'grey' hydrogen from natural gas: it has its world's largest reserves[23]. Additionally, many of its developed gas fields have very low production costs and established infrastructure – e.g. the Yamal-Europe and Urengoy-Uzhhorod pipelines[24]. With these advantages, Russia could theoretically deliver its cheap hydrogen to the EU, if it is first generated at the gas production site and then transported as a blend with natural gas.

[23] GECF (2020)
[24] Umbach (2017)

In practice, using natural gas pipelines for the transportation of pure hydrogen is often seen as problematic due to the challenge of embrittlement owing to H_2's specific features[25] (the pipelines could potentially be damaged). Hence, its delivery through the gas infrastructure pieces is more often mentioned in the context of a mixture with methane where the expected H_2 concentration for the existing and the Nord Stream 2-type pipelines would not surpass 20 and 70 percent, respectively[26]. This is promoted by Gazprom's 'three-stage approach' for the EU's decarbonization[27]. According to it, in its shift to hydrogen, Europe should first move to Russia's natural gas and then its mixture with H_2. Russia would thus secure the deliveries of both natural gas and hydrogen-gas blend for the mid- and long-term perspectives[28].

In fact, the existing pipelines to Europe together with Nord Stream 2 could carry more than 243 billion cubic metres of fuel per year[29]. This can make Russia more attractive than other H_2 suppliers. For instance, if CO_2 intensity is not considered, Norway (currently augmenting its CCS potential to supply Europe with 'blue' hydrogen[30]) will incur greater expenses, as its gas production costs are over twice those of Russia (at least according to the official data from both countries)[31].

Despite having the potential to tailor its depleted oil and gas fields to the CCS purposes, Russia has not mentioned any sound plans for the development of 'blue' hydrogen, apart from launching some research pilots on low-carbon hydrogen production[32], which indicates the low probability of its development[33]. However, 'blue' could be substituted by 'purple', since the country's 'Hydrogen Roadmap' mentioned Rosatom as a stakeholder. In fact, some Russian nuclear power plants (NPPs) do not operate at full capacity (e.g. Leningrad and Kola NPPs) and thus could potentially generate 2-3.5 million tonnes of H_2 per year[34]. Moreover, most of

[25] Witkowski et al (2018) and Hafsi, Mishra, and Elaoud (2018)
[26] RCC (2020)
[27] Gazprom (2020)
[28] ibid
[29] The estimated transit capacity of each pipeline is as follows: Yama-Europe - 33 billion m3/year, Urengoy-Uzhhorod – 100 billion m3/year, Nord Stream and Nord Stream 2 – 55 billion m3/year each. See: Analytical Centre of the Russian Government (2020)
[30] Global CCS Institute (2018)
[31] Bellona (2016)
[32] Higher School of Economics (2017)
[33] Ministry of Energy of the Russian Federation (2019) and Ministry of Energy of the Russian Federation (2020)
[34] Kholkin et al (2019)

Russia's NPPs are located in the European part, which makes them suitable for the H_2 export to the EU distance-wise (*Figure 3*).

Figure 3: Russia's NPPs

Source: *World Nuclear Association (2020a)*

Nevertheless, developing 'purple' hydrogen will necessitate extending the transport infrastructure to connect the production facilities to the EU customers, which will generate further expenses[35]. Hence, this scenario seems to be less economical than the natural gas-based one.

- **Political**

Generally, Russia enjoys a strong political backing among some of the key EU economies, which can be transformed into maintaining close energy cooperation in the future. For instance, despite EU's green policy undermining Russia's position, Germany is lobbying for further

[35] Atomic Expert (2020)

cooperation, since at least a quarter of its energy import comes from Russia[36]. As many highly energy-intensive industries contribute to Germany's economy, using cheap imported fuel with decent environmental features is often viewed as a competitive advantage for its businesses[37].

At the same time, the EU cooperation with Russia goes well beyond the natural gas import, as the EU member states appear to be the largest investor in the country's economy even despite the current sanctions[38]. For example, with the termination of several joint Arctic energy projects, the involvement of some EU countries still includes joint investments (e.g. French Total's stake in the Yamal LNG project)[39]. Hence, a pro-Russian energy lobby could be viewed as Russia's advantage in promoting a shift from natural gas to the new 'grey' hydrogen feedstock. It requires just minimal adjustments of the economy and could be used to justify to finish Nord Stream 2.

These sentiments in some of EU's key economies are often assumed to form the core of Nord Stream 2's support[40]. One of the most recent examples hinting at the pipeline's backing at the highest level is the German government's justification of the need to complete the project that was based on the gas demand projections submitted by Nord Stream 2 AG itself[41]. Following this, even despite the growing anti-Nord Stream 2 attitude after Navalny's poisoning, there is still a firm certainty that the German leaders will further favour the pipeline[42] emphasising that it could later switch to the hydrogen-gas blend[43]. If so, together with leveraging the existing pipelines, Gazprom would be able to use a new piece of infrastructure for the build-up of its hydrogen presence in Europe[44].

This rationale of delivering new product to the already explored markets seems to be mobilizing the H_2 lobbies within Russia itself. In fact, Gazprom and Novatek, the country's natural gas producers, as well as Rosatom, the nuclear monopoly, were among the key H_2 enthusiasts discussing its potential for Russia at least a year before the adoption of the 'Roadmap'[45]. Hence,

[36] Clean Energy Wire (2020a)
[37] Forbes (2018)
[38] European Commission (2019)
[39] Bieliszczuk (2017)
[40] Popławski (2016)
[41] Heilmann (2020)
[42] Bieliszczuk (2020b)
[43] Clean Energy Wire (2020b)
[44] Pipeline Technology Journal (2020)
[45] RBC (2020c)

Russia's intention to export hydrogen seems to have significant domestic backing. However, since the hydrogen export has not been officially regulated yet (unlike Russia's external supplies of natural gas), letting Rosatom take its own share in the H_2 market will most likely require an orchestrated distribution of roles among the stakeholders and potential tensions between them cannot be ruled out[46].

- **Social**

In Russia, the country leaders do not have to cope with protests against nuclear or gas investments. In fact, until recently, the very idea to reduce greenhouse gases found little support among the country's academics[47]. Besides, since most of the recent energy-related accidents were associated with either oil[48] or coal[49], insignificant salience and low public interest in the climate change issues made 'grey' and 'purple' hydrogen generation projects unlikely to irritate the general public.

Though the European Green movement opposes increasing imports of Russia's gas and the build-up of the related infrastructure[50], after Fukushima, *social* acceptance of this fuel and its derivatives in many EU economies has been higher than the one for nuclear energy[51]. Hence, Russia's pure or blended 'grey' hydrogen delivered to Europe may be viewed even more positively than the country's natural gas, as it would stimulate the EU energy transition[52]. Currently, at a local level, countries like Germany who are greatly favouring hydrogen markets are looking forward to importing Russia's natural gas. For instance, in 2020, the chiefs of its Eastern federal state governments unanimously supported the completion of Nord Stream 2[53].

Here, a new narrative describing CO_2 emissions as those being 'outsourced' to Russia may emerge. Though it remains unclear whether this may ultimately terminate the 'grey' hydrogen endeavour, Russia's gas companies have already offered an alternative option of the EU-based

[46] Izvestiya (2020)
[47] Kiryushin, P. (2014)
[48] E.g. the 2020 diesel oil spill at the Nadezhda plant on the Taymyr peninsula (Greenpeace, 2020)
[49] E.g. the 2020 accident in the Vorkutinskaya mine (Gazeta.ru, 2020)
[50] European Greens (2016)
[51] Wang and Kim (2018)
[52] Oil and Gas 360 (2020)
[53] Formuszewicz (2020)

‘blue’ H_2 generation from the imported Russian gas with local European under-sea CCS[54]. However, since CCS remains a highly contentious issue for the political establishment of Germany and Russia’s other EU energy partners[55], replacing this project with Rosatom’s ‘purple’ H_2 may be more attractive in the long run.

- **Technological**

Though, technology-wise, Russia is lagging behind in e.g. some drilling technologies, CCS, electrolysis, the country has significant experience in operating and managing conventional gas and nuclear facilities. Steam methane reforming, in its turn, i.e. the main method of hydrogen production from natural gas, has been the core technology for Russia’s industrial H_2 since the Soviet times[56]. Its maturity and scalability made it possible for the gas companies to consider large-scale hydrogen generation for export[57].

In the long-term, Russia could further exploit its hydrocarbon endowment to produce ‘turquoise’ H_2[58]. Though such projects are still piloted, Gazprom has long been working on this technology[59] and already announced interest in its future development[60]. Similarly, despite focusing primarily on power generation, Rosatom has ambitious plans to export electrolysis-based H_2 to the EU and Japan[61].

In contrast to the gas companies, Rosatom’s pro-environmental agenda seems to be clearer, as it is officially planning to enter new markets of renewables and energy storage[62]. While it could use excess power generation capacities to produce ‘purple’ H_2, it is also considering to build new reactors that would augment the existing facilities[63]. This means that, in the long run, for the H_2 generation, Rosatom could use not only the surplus capacity of its existing NPPs[64] but also of the new ones.

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[54] RBC (2020b)
[55] Green Energy Wire (2020)
[56] Makaryan et al (2020)
[57] RBC (2020a) and S&P Global (2020)
[58] Petroleum Economist (2020)
[59] H_2 International (2020)
[60] Interfax (2020)
[61] Rosatom (2019) and Rosatom (2020)
[62] Bieliszczuk (2018)
[63] World Nuclear Association (2020b)
[64] Kholkin et al (2019)

Russia & H_2: Weaknesses and Threats

- **Economic**

Though the natural gas that is to be pumped through Nord Stream 2 will not significantly differ in calorific value from the one transported to Europe through Belarus and Ukraine[65], the ultimate expenses are not the same[66]. In particular, the gas exported through the existing pipelines comes from the long-exploited depleting fields of West Siberia with low production cost, whereas the one dedicated to Nord Stream 2 originates in the new and more expensive Arctic Yamal fields with insufficient infrastructure[67]. In fact, given the significant distances that need to be covered[68], the Yamal project is often viewed as heavily subsidized and thus of greater political rather than economic value[69].

Due to Gazprom's pipeline monopoly, Novatek launched their own Yamal LNG terminal in 2017[70]. However, the gas price decline forced the company to cease paying dividends to its shareholders in 2018[71]. With the pandemic pushing the prices deeper, the company reported losses for RUB 30 billion already in the first quarter of 2020[72]. That is why, though the feasibility of such 'grey' H_2 projects would depend on the overall feedstock prices, large distances and high dependence on transport (pipelines or vessels) may weaken the economic rationale of Russia's H_2 on the EU market, if the competitors offer a comparable product.

With the plans to install at least 40 GW of electolysers to generate 10 million tonnes of 'green' hydrogen by 2030, the EU Hydrogen Strategy aims to focus solely on decarbonized H_2 by mid-century[73]. Since the falling costs of renewable energy production and electrolysers are expected to be able to compete with hydrocarbons in a decade[74], Russia's advantage of cheap 'grey' H_2 may not look that impressive in the mid-term. With EU's suggested carbon boarder tax, it may

[65] Zhitenko (2017)
[66] Umbach (2017)
[67] Gazprom (2019)
[68] Umbach (2017)
[69] Lunden and Fjaertoft (2014)
[70] Novatek (2020)
[71] Pravda URFO (2019)
[72] Neftegaz.ru (2020)
[73] Morgan Lewis (2020)
[74] Energy Voice (2020)

become less competitive even sooner[75]. Hence, given the uncertainties, the perspectives of 'purple' H_2 may look more promising, if Rosatom develops a transportation strategy.

- **Political**

Future energy supplies via Nord Stream 2 may be crippled by the US sanctions[76]. Though the fate of the project is unclear, the pro-Russian lobby has been using the narrative of its H_2 transportation potential to argument in favour of its completion[77]. This, however, could potentially be addressed by the EU countries that oppose the dependence on Russia. In 2019 they were able to push through the amendments to the EU gas directive impeding the use of Nord Stream 2 in Gazprom's monopolistic practices[78].

Additionally, further development of the EU Guarantee of Origin initiative[79] and its application to the hydrogen market may change the structure of Russia's H_2 exports. In these circumstances, a greater share is likely to be allocated to Rosatom's 'purple' hydrogen than to the H_2 from Gazprom and Novatek, as their CCS does not seem to be mature and profitable enough[80]. Additionally, such players as Norway – a natural gas exporter with its own H_2 strategy[81] reliant on CCS – may become more powerful[82]. Though this scenario may be postponed due to Norway's natural gas delivery commitments, in the long run, the EU might prefer the 'blue' Norwegian H_2 over the 'purple' one from Russia, especially since Rosatom has to construct its export infrastructure from scratch.

- **Social**

Despite possessing rich deposits of natural gas that would allow for its export to various nations, Russia is currently not using this resource at its full capacity when it comes to the needs of the country's own population: natural gas has only been supplied to around 70 percent of the

[75] BCG (2020)
[76] Forbes (2019)
[77] Handelsblatt (2020)
[78] Bieliszczuk and Zaręba (2019)
[79] FCH (2019)
[80] NEFT (2020)
[81] Norwegian Ministry of Petroleum and Energy (2020)
[82] Rokke (2020)

citizens mostly residing in urban areas[83]. Furthermore, even Russian experts recognize that at least ten percent of Russia's communities will never be gasified due to economic 'unattractiveness'[84]. Hence, launching H_2 initiatives to deliver cheap and 'clean' fuel to the more well-off Europe might be regarded by the common Russians not as a business issue, but rather a matter of 'social justice'[85].

These negative sentiments are likely to be strengthened with Gazprom's recent announcement that the company will raise the natural gas price for domestic users[86]. In these circumstances, the pressure on gas companies to address these challenges needs to come from the top leaders, but they seem to ignore it. In these conditions, from a pure social perspective, Rosatom – a corporation whose current export-oriented subsidiaries are not significantly linked with domestic electricity users – may look like a better candidate for the development of hydrogen export.

- **Technological**

Russia has some obvious advantages in hydrogen technologies: many enterprises (e.g. gas processing plants and oil refineries) generate 'grey' H_2 on their daily basis. However, this hydrogen is mostly used for their own technological processes, and thus is not produced at export quantities[87]. Hence, even if Russia's 'grey' hydrogen is going to be produced at an industrial scale by the established facilities after the augmentation of their capacities, new H_2 delivery infrastructure will have to be developed to connect the H_2 generation sites with pipelines or terminals.

Despite Gazprom's plans to use its pipelines for the H_2-gas blend[88], none of them has been tested for the capability to safely and efficiently carry this fuel over long distances[89]. Ironically, each of the mixture's gases requires a different compressor system: reciprocating piston compressors vs. radial compressors[90]. Additionally, the drive capacity applied to hydrogen

[83] ibid
[84] DW (2019)
[85] Neft Kapital (2020)
[86] Lenta.ru (2020)
[87] Mitrova, Melnikov, and Chugunov (2017, p.48)
[88] JDEC (2019)
[89] Mitrova, Melnikov, and Chugunov (2017)
[90] Gas World (2020)

needs to be almost three times of that applied to natural gas[91]. Apart from complicating the development of infrastructure for the transportation of ‘purple’ H_2, this makes the option of methane-to-hydrogen conversion near the customer (already suggested by Gazprom) more attractive[92]. In fact, a joint effort on presenting a scalable technology for separating hydrogen and natural gas has already been launched by Linde and Evonik[93].

Additionally, while possessing its own electrolyser manufacturers, Russia seems to be only trying to catch up with the EU and China in developing large-scale installations for H_2 generation. While China’s electrolysers are the world’s cheapest, Europe is the world’s technology leader in large-scale electrolysis-based ‘green’ hydrogen production[94]. For instance, the REFHYNE project (planned to be launched in 2022 in Germany) is claimed to become the world’s largest electrolyser capable of generating 1,300 tonnes of H_2 per year[95]. In comparison, Russia’s biggest electrolysers are able to deliver only around 215.5 tonnes of H_2 per annum[96]. Hence, to be able to compete on the EU market with its ‘purple’ H_2, Russia will need to either intensify research or transfer technology from Europe, which does not look easy in the environment of current and possible future sanctions.

Despite possessing a number of advanced research projects on decarbonized H_2 generation, most of them still appear to be at the pilot stage[97]. That is why it is unlikely that they will be scaled up in the short-term. This is so not only due to financial constraints and budget limitations, but also reduced international cooperation hampered by sanctions[98].

Perspectives

As seen, while possessing economic, political, social, and technological advantages for hydrogen generation, Russia’s greatest H_2 potential lies in ‘grey’ and ‘purple’ hydrogen. However, a different set of challenges poses threats to the Russian hydrogen export to the EU. Here, since the EU Hydrogen Strategy aims to decarbonise the H_2 sector, in the mid- and long-

[91] ibid
[92] TASS (2020)
[93] Chemical Engineering (2020)
[94] Janssen (2020)
[95] REFHYNE (2020)
[96] Hydrogen weighs 0.082 kg per cubic meter (Aqua-Calc, 2020)
[97] Russian Academy of Sciences (2017)
[98] Dezhina (2020)

term, the deliveries of Russia's 'grey' hydrogen are likely to be blocked. In the short- and mid-term, this leaves space for the EU's import of 'purple' H_2 as well as 'blue' hydrogen production within the EU from the imported Russian natural gas. These options, in turn, are likely to be affected by the following trends:

- The falling costs of renewables and the costs and scalability of electrolysers within the EU undermining the attractiveness of Russian hydrogen;

- The support of Nord Stream 2 by some EU countries and the construction of the gas-to-hydrogen conversion plant in Germany serving as an anchor for the export of Russian feedstock for the EU 'blue' hydrogen industry;

- The controversies within EU around CCS as well as carbon boarder tax and Guarantee of Origin initiatives complicating Russian H_2 export;

- The European green lobby and energy justice concerns within Russia inhibiting the promotion of new natural gas and H_2 projects;

- Technological progress in 'turquoise' H_2 production and hydrogen transportation methods (including pipeline and maritime transport) helping Russia to solidify its position in the EU market;

- Technological progress in 'green' H_2 production stacking the odds in EU's favour.

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