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Prologue

In 2021, I (Anna Mikulska) wrote a chapter on security of gas supply for the volume entitled *The Future of Energy Consumption, Security and Natural Gas: LNG in the Baltic Sea region* (Liuhto 2021). As a measurement of security of supply of natural gas in the region, I have used the Residual Supply Index (RSI), suggested by Agency for the Cooperation of Energy Regulators (ACER). Per ACER, a country (or region) has secure supply of natural gas if it has access to at least three different suppliers and the RSI exceeds 110%. This means that that a country or region at any given time should be able to access gas supply that equals or is greater than 110% of its demand, excluding that country's or that region's largest supplier.

Little that I knew, the security of supply in natural gas for the region would be severely tested shortly after the book's publishing with gas relations in the region transformed entirely as Russian exited the region following Russia's invasion on Ukraine. This includes Germany, the country that has heralded access to cheap Russian gas with direct pipeline access under the Baltic Sea via Nord Stream 1 (NS1) and Nord Stream 2 (NS2). As such, the theoretical scenario that RSI assumes—an immediate exit of the largest supplier—has materialized. It ceased to be a simple exercise, but instead it could serve as a way to determine how energy security in the region has been affected by recent decisions on supply diversification.

This newer iteration of my work, this time undertaken with a doctoral student and graduate fellow at the Baker Institute, Luke (Leelook) Min, also modifies some of the conditions that guided my earlier effort. In particular, while I excluded Germany in some of the scenarios I have proposed before, this should not and cannot be done any more given the country's inability to procure Russian gas in the most immediate future and its outsized effect on the region and the EU as a whole. In fact, together with Luke and several other of our colleagues at the Baker Institute we have been working on a separate research project on the German natural gas supply, which will inform some of what we describe in this report.

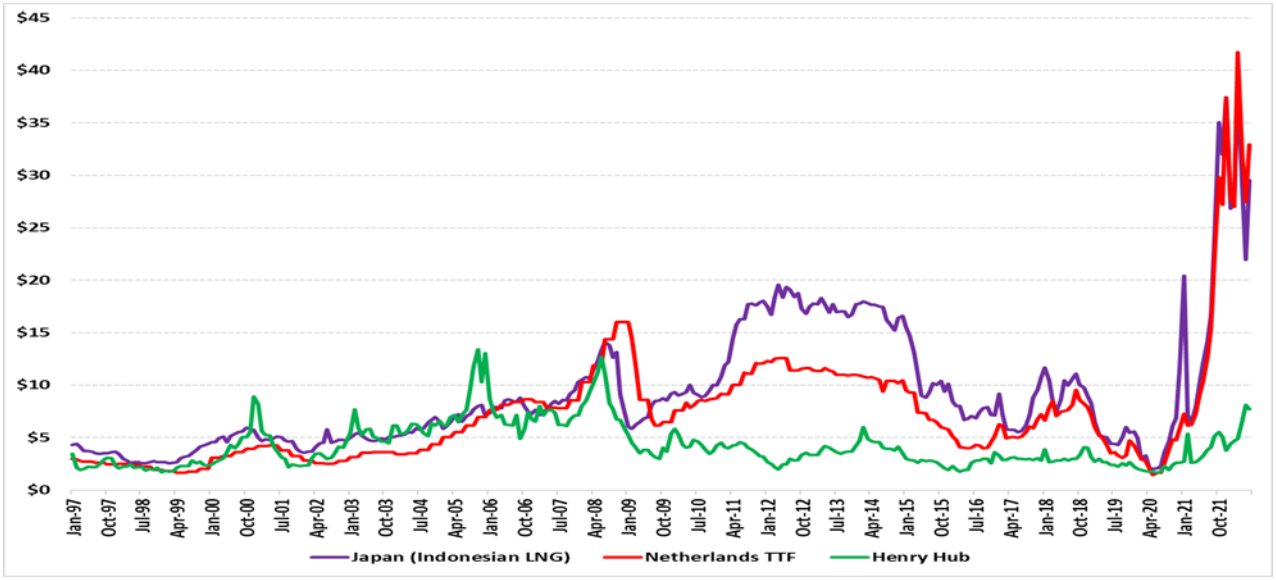
Key words: Baltic Sea Region, Energy Security, Energy Supply, Natural Gas, Russian Invasion on Ukraine, LNG

Introduction

Natural gas market in the Baltic Sea region has been traditionally defined by high dependence on Russian supply and lack of balancing mechanisms with little to no infrastructure connecting the countries. For some countries this had its roots in the common Soviet past; as part of the Soviet Union as the three Baltic republics of Estonia, Latvia, and Lithuania or as a Soviet satellite state like Poland, or East Germany. Lacking direct measures, after the Iron Curtain fell, Russia used the dependency on natural gas supplies to apply geopolitical pressure and extract economic rents (Collins 2017). This experience has pushed the countries in the post-Soviet bloc to pursue diversification away from Russian supply. In contrast, for the non-Soviet countries in the Baltic Sea region countries, the issue of dependency on Russian gas has been of secondary (if not of tertiary) importance either because of low reliance on natural gas (Finland, Sweden) or sufficient domestic gas resources (Norway, Denmark).

In the most extreme of cases, Germany, the dependence on Russian gas has not only grown but was in fact actively encouraged, with the country supporting the construction of subsea pipelines NS1 and NS2 to deliver Russian gas directly to its territory under the Baltic Sea while disputing need for other supply, i.e., via liquified natural gas (LNG) terminals as too costly and/or redundant. This strategy has backfired in a spectacular fashion when 2022 Russian invasion on revealed Russia's willingness to use the dependency on its gas as a weapon not only against the EU as a whole but also against Germany, it is the largest and arguable one of the most dependent customers. In effect, this inability to procure gas that could replace Russian supply, has led to supply shortages and skyrocketing prices all over the world but particularly in Europe that, in order to acquire additional volumes of gas from the global market, has had to bid over other natural gas buyers on the more liquid (no pun intended) and competitive LNG market. See Figure 1 for time line of prices of natural gas across three main hubs: 1) Henry Hub (HH) in the U.S.; 2) TTF in Netherlands; and 3) Indonesian LNG as a marker for Japan (and rest of Asia).

Figure 1. Natural gas prices in Europe, US, and East Asia, January 1997-October 2022 ($/MMBtu)



Note: Million British thermal units (MMBtu). Source: Collins, Mikulska, and Miles (2022).

This report attempts to reassess the levels of security supply in the Baltic Sea region in the light of the second Russian invasion on Ukraine and virtually complete exclusion of Russian gas volumes from the region's market. As such we will consider the steps toward diversification of natural gas suppliers and increasing interconnectedness of the markets that have taken place before and after the Russian invasion. The latter have been particularly impressive and quick-progressing in Germany and include new floating storage and regasification units (FSRUs) that could bring nearly over 33 bcm of natural gas per year to German shores (Cedigaz 2022). But can it result in security of gas supply to Germany? Or the region?

Defining the terms: The region

We follow the definition of the Baltic Sea region from Mikulska's (2021) chapter upon which this report is based. Hence, we include: the three Baltic States of Estonia, Latvia, Lithuania as well as Denmark, Finland, Germany, Norway, Poland, and Sweden. The definition is consistent with Klemeshev et al. (2017) work that includes all Baltic Sea's littoral states. The one modification excludes Russia from the list given the miniscule connection of the latter to the Baltic Sea shore (via Kaliningrad and via the Gulf of Finland) and, probably more importantly, the fact that the region energy security, including but not limited to natural gas supply, stands in direct opposition to Russia's revealed goals and geopolitical motivations. That being said, while in the previous reiteration of this research, the Mikulska has considered scenario possibility of regional energy security that would exclude Germany, as mentioned earlier, such consideration is no more possible.

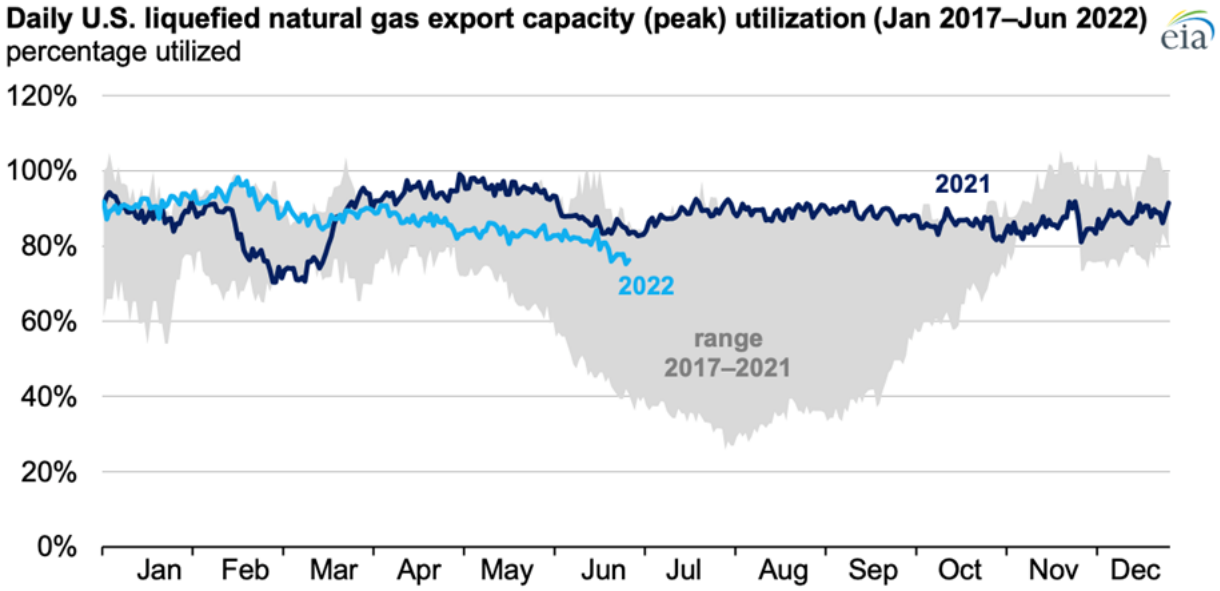
Defining the terms: Energy security

We stay with the "***four A's"*** approach to energy security as defined by: 1) availability, 2) accessibility, 3) affordability; and 4) acceptability of energy supply. As before, we acknowledge that more expansive definitions of energy security exist including for example, climate change and local pollution (Czerp and Jewell, 2014). However, the more rudimentary concept of the "***four A's***" lends itself better to conceptualization and quantitative operationalization and hence is more informative. In addition, the "acceptability" dimension of the definition of energy security could actually be expanded to include acceptability of energy use that relates to climate change and/or local pollution.

All in all, much has changed in the region with respect to the specific value of each dimension of natural gas supply for the region in general, and for each country specifically.

To begin, the volumes of natural gas ***available*** for the region have been severely constrained by cut to Russian gas supply to and via Poland and to Germany via NS1. The cut in transit and supply to Poland has related to Poland's refusal to pay with roubles as well as Gazprom halting all deliveries via the Yamal Pipeline that crosses Poland delivering gas to Eastern Germany as part of Russian sanctions against "unfriendly countries" (Afanasiev 2022). German supply has been affected further on by steady decreases on the NS1 flows that culminated in a complete shutdown of gas deliveries on August 31st, 2022. In the meantime, global supply has not been able to fill in for the total Russian deliveries lost. It is simply impossible to add global gas supply that would equal lost volumes of Russian gas in an immediate fashion. Unlike some of crude supply that can be brought moved to tankers, piped natural gas from Russian fields has nowhere else to go but to Europe. Attempts have been made in the short-term by pushing the limits of productivity or capacity, including increases in gas production from Norwegian fields, delaying maintenance, as well as pushing limits of liquefaction capacity in the US (see Figure 2) in the winter of 2021/2022 (Miles et al 2022). And although, the June 8th, 2022 fire at the Freeport LNG has challenged that effort and additionally tightened global LNG supply, China's economic downturn in the face of no-Covid policy has allowed for some flexibility and redirection of global LNG volumes to Europe over winter and the summer of 2022 (Collins, Medlock, Mikulska, and Miles 2022) as the continent frantically searched for natural gas to fill its storage in expectations of difficult winter season 2022/2023 (EIA 2022), Going forward the tightness of the market may exacerbate as Europe strives for filling its storage over the next summer season, especially if China's demand picks up and as Russian is expected to be absent throughout the entire 2023 as opposed to only the second part of 2022.

Figure 2.



Source: EIA (2022).

There have also been significant challenges on the side of the demand as EU's infrastructure has not been sufficient to accept sufficient supply if/when that supply becomes available, indicating lack of ***accessibility***. This includes in particular LNG import infrastructure as well as interconnectors that can help balancing the market. In this respect lots of progress in the recent years has been made in the Baltic Sea region on the post-Soviet countries' side. However, the same cannot be said about the rest of the region, especially about Germany, which disregarded the need to back up Russian supply completely. In effect, the country had to move quickly to instal several FSRUs to be able to replace at least some of the Russian gas volumes going forward.

The redirection of supply in a tight market environment has also not been without cost, of course. In fact, some of the most profound changes have been to ***affordability*** of gas supply flowing to Europe. As per Figure 1 above, the wholesale prices of natural gas have skyrocketed. Consumer prices have been following, although not at as much of a steep incline. High prices have resulted in decrease in demand, particularly in industry, as well as fuel switching, with either coal or renewables picking up the slack and nuclear power generation extended in Germany despite legal provisions to the contrary. With higher demand for coal, prices of this fuel have also multiplied within the EU and the region, a spill over effect of high uncertainty of natural gas supply in the region.

Lastly, what is ***acceptable*** has also changed, particularly for non-Soviet bloc countries, which have been either neutral toward or supportive of Russian gas supply. After Russian invasion on Ukraine, this attitude has changed dramatically with almost all European stipulating decreasing reliance on Russian energy sources, including natural gas. Even Germany, decided to forgo its long awaited NS2 pipeline as it cancelled the finished project not waiting for it to gain (disputed) EU certification to operate. If awarded the certification, NS2 would be able to fill more than half of Germany's natural gas demand. In fact, together with already functioning NS1, NS2 would be able to more than satisfy the entire gas demand in Germany, allowing for the country's exit from nuclear (in 2022) and coal (in 2038). Russian invasion made such solution unacceptable. In contrast, even if in a short-term, it made acceptable use of coal and nuclear power at an either much larger scale (coal; and especially most polluting lignite) and over a longer period than planned (nuclear).

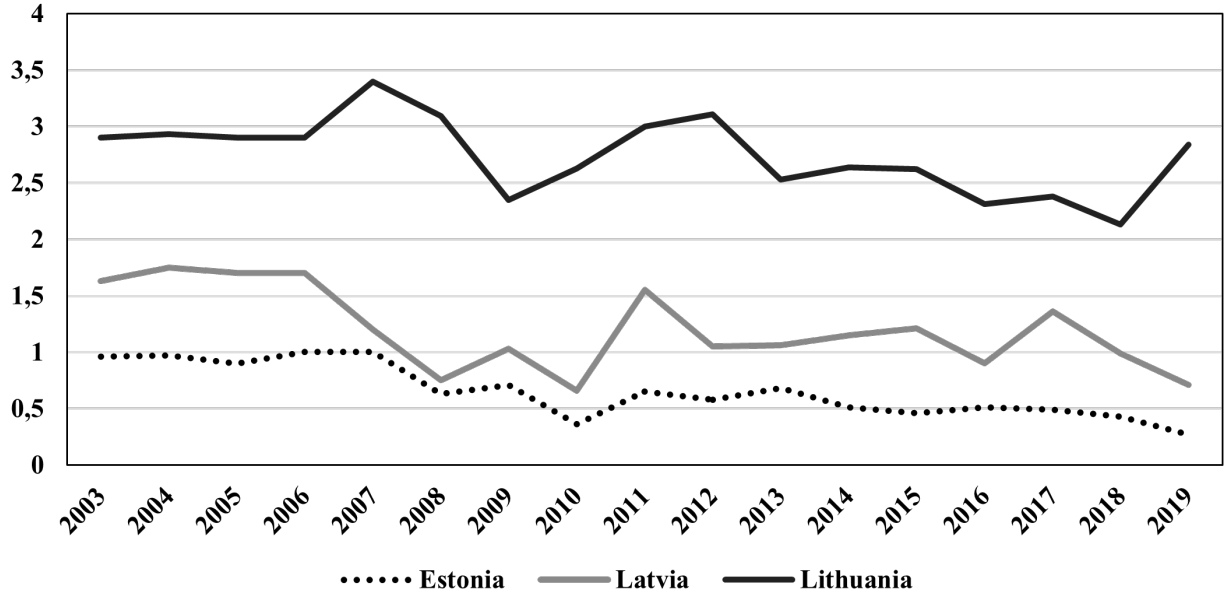
Supply diversification and market balancing: The successes

The Baltic Sea region has seen arguably some of the biggest success stories but also some of the biggest failures when it comes to ensuring secure supply of natural gas as revealed by events that ensured after Russia's invasion on Ukraine.

Beginning with the successes, one has to point particularly to Poland and Lithuania, both of which were able to ensure infrastructure build up and replace Russian gas volumes in a relatively smooth fashion mid-2022 when Russian use of natural gas as geopolitical weapon against the EU has become evident. For both countries, their respective LNG terminals in Klaipeda (Lithuania) and Swinoujscie (Poland) have been a source of newfound independence from Russian supply that has been additionally extended by the Gas Interconnector Poland-Lithuania (GIPL) that in 2022 connected both of the countries. This should allow for more effective use of the capacity of each of the LNG terminals, but especially the Klaipeda terminal, utilization rate of which has been relatively lower when compared to that of the Polish terminal. In addition to its already existing LNG import capacity and the GIPL interconnector, Poland has also been able to complete the Baltic Pipe, which by November of 2022 has been working at full capacity (of 10 bcm annually) bringing Norwegian gas directly to Poland. The country is also in the midst of LNG terminal expansion from 3.8 mmtpa (about 5 bcm/y) to about 5.7 mmtpa (about 8 bcm/y) that should be completed by end of 2023. The terminal could be expanded even further to the maximum of 10 bcm/y if needed (Czyżewski 2020). The country is also planning an FSRU in Gdansk for additional 4.6 mmtpa (about 6 bcm/y) maximum capacity that could be completed at the beginning of 2028. The additional capacity and the expected ability to balance the market that includes access to the underutilized FSRU in Lithuania has allowed Poland to disconnect fully from Russian supply even before its long-term contract was set to expire (in May rather than at the end of 2022). Similarly, Lithuania was able to refuse Russian gas given that the Klaipeda terminal's maximum capacity exceeds the country's gas demand.

In fact, if utilization of the Klaipeda terminal is maximized, the FSRU can be a sufficient source of supply for all three Baltic republics (see Figure 3 for pre-Covid19 pandemic volumes), which since 2020 are able to use Balticonnector to balance their markets and includes Finland. The balancing mechanisms allowed those countries to accompany Lithuania in completely cutting off Russian gas supply in April 2022 (Aljazeera 2022).

Figure 3. Natural gas consumption in selected Baltic Sea region countries (bcm)



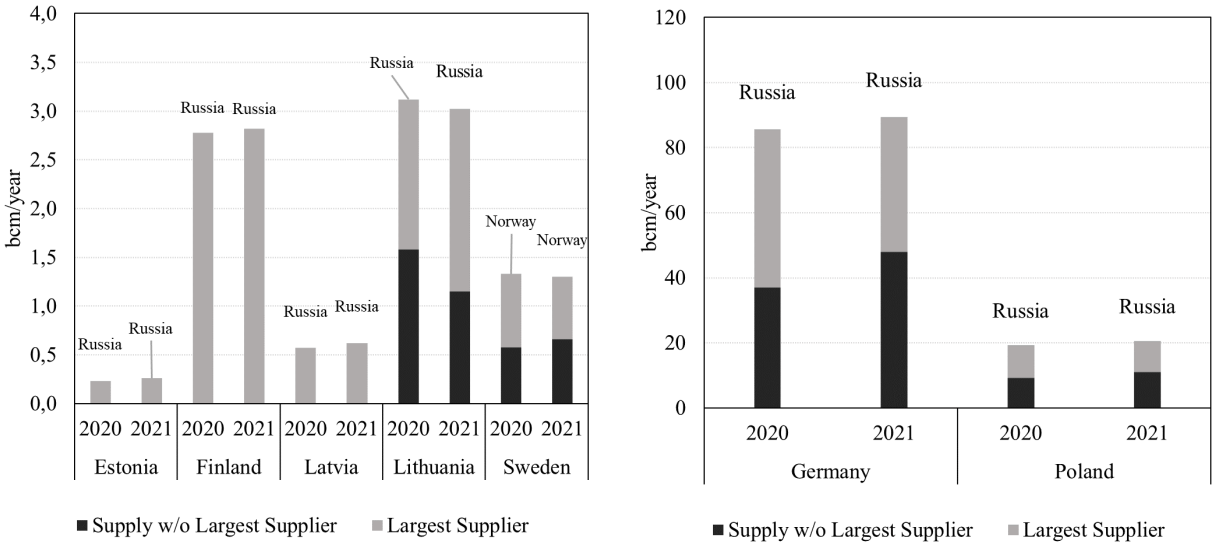
Source: Cedigaz, Authors' rendition.

In addition to infrastructure that helps in balancing their markets, the remaining Baltic republics of Estonia and Latvia have tried to pursue their own ambitions of LNG import terminals. These efforts have, however, not been successful so far, given their small market size and the fact that this additional capacity would likely be redundant given the capacity of the Lithuanian FSRU. That being said, the high level of uncertainty around gas supply that the Russian invasion has introduced have given another chance to some of those projects. This includes the Paldiski LNG terminal in Estonia as well as most recent addition; a joint FSRU project between Estonia and Finland in the Finnish port of Inkoo, that is expected to be completed already this winter. In Latvia, the Skulte LNG terminal is expected to begin construction in early 2023. Based completely on private investment, he terminal would be connected to the expansive storage the country possesses, Incukalns, which should for it to be mostly utilized as regasification unit rather than storage and provide the project with competitive edge (Argus Media 2022).

Supply diversification and market balancing: What Germany did and did not do?

Lack of significant developments in terms of access to natural gas in Nordic countries is understandable given their traditionally small reliance on gas and – for Norway and Denmark – status of natural gas exporter. This cannot be said, however, of Germany, which has consistently been Europe largest consumer and importer of natural gas. In the Baltic Sea region, the country has been absolutely dominant when it comes to natural gas demand (see Figure 4).

Figure 4. Baltic Sea region, natural gas demand/supply by country, 2020-2021



Note: billion cubic metres (bcm). Source: Cedigaz, Authors' calculation.

In 2021, Germany imported 95% of the 96 bcm of natural gas it consumed that year, a 4% growth in gas consumption over 2020. Before the market irregularities related to the Covid-19 pandemic ensued, in 2019 Germany consumed 98.0 bcm, produced 5.7 bcm, imported 134.1 bcm, and re-exported 41.8 bcm of natural gas. Most of Germany's gas imports came from Russia (56.3 bcm), followed by Norway (31.3 bcm), and Netherlands (24.1 bcm). The rest (mostly re-exports, including re-exports of Russian gas) was delivered from a mix of other European countries (Austria, Belgium, Czechia, Denmark, France, and Hungary). Households have been the largest source of natural gas demand at approximately 41% in 2020, with most of the demand occurring during winter season for heating purposes. Approximately half of Germany's heating capacity is based on natural gas. Use of natural gas in all buildings (including residential, services, and agriculture) in 2021 amounted to 44% of consumption. Power sector consumed approximately 21% of total natural gas supply while industry accounted for 30% that year (Enerdata 2022). This number has fallen precipitously (approximately by 1/5) in recent months as high prices of natural gas caused industrial demand destruction (Reuters 2022).

Until the Russian invasion on Ukraine, Germany imports were geared directly toward Russian gas supply, with the prospects to double once the twin pipelines of Nord Stream 2 would be complete. They would replace most, if not all, Russian gas transiting via Ukraine and some of the supply from Netherlands that was being phased out in the Groningen field. Germany was counting on the new route to provide a reliable supply of the "bridge fuel" for its own version of energy transition- the Energiewende – that has already seen quick growth in renewable power (mostly wind but increasingly solar power as well) while phasing out (prematurely) country's nuclear and coal generation (by the end of 2022 and 2038, respectively) (EPRINC 2022).

Before 2022 Germany's admittedly relaxed attitude toward Russian gas was grounded in several factors. The long history of trade and tight relations between Gazprom and German natural gas utility companies were underwriting Germany's exclusive bid on Russian gas. Gazprom was allowed shares in some of the utilities and was able to own significant share of German natural gas storage. This supported the idea of Ostpolitik (Politics of the East) that has become ingrained in the minds of the German policy makers. According to Ostpolitik by engaging Russia in trade, not only would Germany make Russian aggression less likely, it would also be able to influence Russia geopolitically. "Wandel durch Handel" or "change through trade" the saying would go (Chang 2014).

But beyond long history of Russian gas imports Germany's position as well-established and large natural gas demand centre also seemed (!) to insulate the country and help avoiding the dependency trap experienced by many other Russian gas-importing countries. The country's gas pipeline network is relatively well-developed but also well-integrated as part of the Western European so it could quite smoothly balance its market through arranging gas flows from other Western European countries. And as Russia's largest European customer, Germany has over the years enjoyed a strong bargaining position, leading to lower natural gas prices charged by Gazprom compared to other countries in the region (Hinchey 2018).

Given how comfortable Germany was with Russian gas dominating its supply, any plans for liquified natural gas imports were vague and highly uncertain. The most advanced LNG terminal in Germany, an FSRU in Wilhelmshaven was eventually scrapped in 2021 with plans for hydrogen operations only. No final investment decision was reached on two other potential locations, Stade and Brunsbüttel (that is until recent developments with Russia made all those projects indispensable for Germany's ability to import gas from non-Russian providers in 2022).

The system unravelled in 2022 as Russian invasion on Ukraine ensued. But first cracks could be spotted already in 2021 when Gazprom constrained its gas flows to Europe to only contracted volumes and decided to leave its EU-based storage virtually empty for the 2021/2022 winter season. Much of this storage was located in Germany constituting approximately 20% of total German storage capacity. After the invasion, in an effort to prevent similar situation for the coming winter, Germany took over control of the storage away from Gazprom Germania. The move underscored close to complete breakdown in German gas relations. It followed Germany's decision to indefinitely freeze the already completed NS2 as a response to Russia recognizing the separatist territories of Donetsk and Luhansk in eastern Ukraine as independent republics only two days before the military invasion began.

From then forward, Germany became acutely aware of the uncertainty surrounding the Russian gas supply and the ability as well as propensity of Russia to use it as an energy weapon. NS1 continued to flow initially at full capacity. Then, Vladimir Putin's demand for gas payments being made in roubles constituted first attempt at European unity and support for Ukraine but failed to achieve Russia's goal. The demand made some countries exit the trade completely (Bulgaria, and Poland). Others set up a two-account scheme to process the payments. The strategy has been accepted as the necessary evil by all EU members. Importantly, no change in the EU's policy direction or cracks in the European unity when it comes to support for Ukraine ensued.

At the same time, both the EU as a whole as well as each of its members individually began to set up plans that would allow them to survive another winter with limited supply of natural gas and, in somewhat longer term, wean itself completely off of Russian gas via the REPowerEU Plan. Most immediately, the EU established legally binding levels of 80% by November 1, 2022 and 90% by November 1st for all years thereafter. Germany, has made those goals even more ambitious with new law requiring 85% of storage to be filled by October 1st of each year and 95% fill required for November 1st.

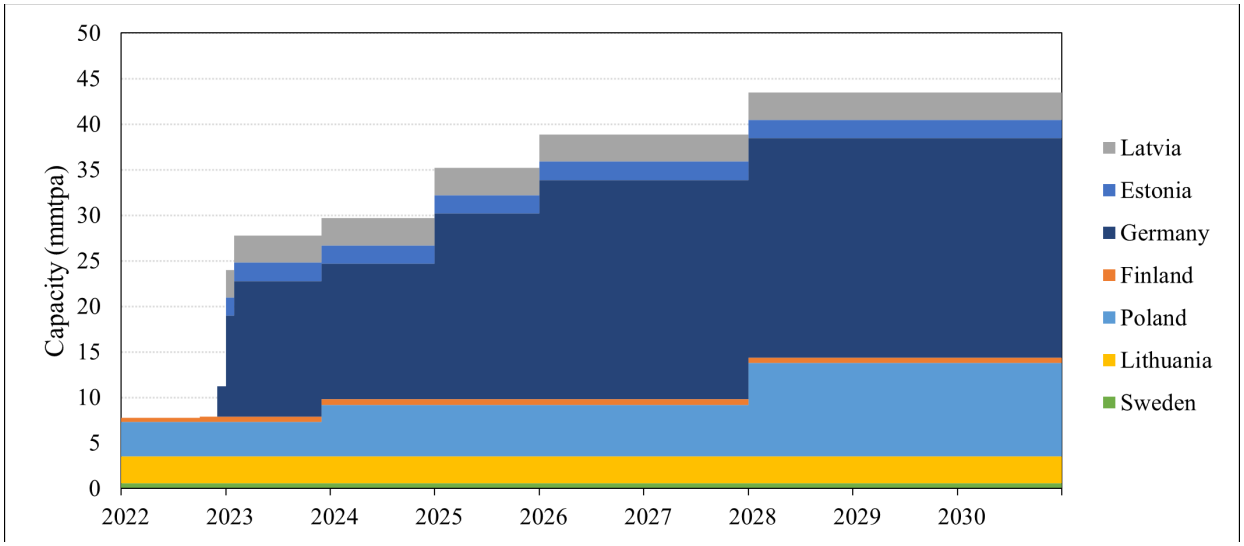
Surely, it would have been imprudent to assume that, as Europe tries to come up with ways to eliminate (and ideally replace) Russian gas from its supply, Russia would continue sending gas to Europe without a glitch. And indeed, glitches have become a notorious feature of Russian gas supply in the second half of 2022, especially with regard to NS1 system. To begin, Gazprom has decreased gas flows via NS1 to 40%, following by another decrease to 20% of capacity, finally cutting the entire NS1 supply after unscheduled maintenance commenced on August 31, 2022. All cuts in supply have been thinly vailed as technical and, in the discourse coming from Gazprom tied directly to sanctions that the EU and its allies have imposed on Russia. The final cut to all NS1 volumes was a reaction to both, the G7 cap on Russian oil price and an announcement by the EU that it has been filling its natural gas storage ahead of schedule. This included Germany, with storage levels filled above the 85% prescribed level already on September 4, 2022 and with over 90% currently in stocks well on their way to meet or exceed the November 1st deadline of 95%.

But even though full storage is necessary condition for ability of Germany to meet demand for natural gas during winter, it is not sufficient to guarantee it. At 100% fill, the stored gas could cover only about two and a half months of demand at average weather conditions (Deutsche Welle 2022). Something else needed to be done quickly. The German government has pushed for a quick instalment of floating LNG import terminals.

Today, the Germany's ability to weather this and future winter is well dependent on its ability to complete construction of those terminals as soon as possible and filling them with LNG shipments, i.e., ensure both accessibility and availability of gas supply in the energy security equation. The first terminal, in Lubmin, that become operational on November 25th, 2022, has been undoubtedly a success given the record pace of construction. In addition, two FSRUs are expected to begin operations in 2023 in Wilhelmshaven. One FSRU is imminently expected to begin operations in Brunsbüttel and one more should follow in Stade shortly after.

If all these plans are indeed realized, the LNG intake capacity for the entire Baltic Sea region would be increased significantly as per Figure 5, with Germany as the main reason for the growth (see Figure 5). That being said, these developments will not able to replace Russian gas supply, neither imminently nor in the medium-term (through 2030). At about 33 bcm in total added regasification capacity, they only 2/3 of the supply the country was receiving via NS1 before the war in Ukraine ensued and less than a third of what Germany would have been able to receive if NS2 began operations. Hence, there will be need for other solutions. In the most immediate term, these will be related to efficiency measures, energy saving, and rationing with the latter most visible in the industrial use of gas where high prices have already seen reduced demand that in some cases could even lead to demand destruction.

Figure 5. Current and projected LNG import capacity in the Baltic Sea region through 2030



Note: million tons per annum (mmtpa). Source: Authors' rendition, based on Cedigaz, Infrastructure – Regasification.

The Baltic Sea region and security of natural gas supply right before Russian gas exit

As mentioned earlier, we decide to use RSI as a measure of security of supply in the region as it applies to most recent year for which the data is available (2021) and right after which the largest gas supplier in the region, Russia exited the market entirely.

Per ACER, for supply of natural gas to be considered secure a country has to have access to at least three different suppliers and the RSI needs to exceed 110 % i.e., at any given time a country must be able to ramp up gas supply in excess of 110 % of its demand, excluding its largest supplier. The ability to immediately access this level of alternative supply constitutes "credible threat" (Medlock 2014) to the position of the largest supplier, making that supplier less likely to renege. In addition to capturing the 'credible threat' concept, RSI also reflects bargaining power of suppliers, under conditions of tight markets. If supply from other sources is rigid, i.e., cannot be ramped up to provide additional volumes when needed, then even small supplier with can exercise considerable market power that can result in higher prices and/or ability to exert geopolitical influence. In this case, technological or other failure in the supply infrastructure (e.g., the 2017 Baumgarten incident) can have serious, detrimental effects to countries' security of natural gas supply.

Since not all countries have access, ability, and/or resources to build additional import infrastructure that provides enough diversification in gas supply, ACER also recommends assessing RSI at the regional level. Regional approach allows countries in the region to combine their market power and use each of the countries' comparative advantage so each source of gas available to each country is maximized. This recommendation is consistent with and adds weight to the idea behind the integration of the Baltic region where newly constructed and planned natural gas import infrastructure can provide flexible source of gas supply throughout the region if market's interconnectedness exists. But the assumption of fully integrated market in the regional approach might overestimate bargaining power of countries if such connections do not exist or are not in place yet. Therefore, we also consider individual approach for countries in the Baltic Sea region.

Following ACER, we use the following equation:

$$RSI_{it} = (Total\ Supply_{it} - Largest\ Supplier_{it}) / (Total\ Demand_{it})$$

Where: $Total\ Supply_{it}$ is defined as country *i*'s total gas consumption plus any unused capacity of gas-importing infrastructure (which is "the credible threat") in year *t*; and $Total\ demand_{it}$ is defined as country-level consumption in year *t*.

The issue of supply security relates directly to the lack of domestic supply sources to cover domestic demand. As such, the analysis can only apply to countries which are considered net-importers of natural gas in the region, which excludes Norway and Russia as well as Denmark.

As per Table 1, in 2021 countries in the Baltic Sea region received gas from a total of 18 exporting countries, with six from the region itself (Norway, Denmark, Sweden, Finland, Germany, and Lithuania)[1] and four being major gas exporters (Russia, the Netherlands, Norway, and the US). Exports from Austria, Belgium, Czechia, France, Hungary, Germany, and Lithuania have been generally re-exported volumes of previously imported gas.

Based on these numbers, a major takeaway is that ACER's formal requirement of at least three suppliers to ensure energy security has been met for the region, but not for each of the countries separately. Estonia and Latvia have only had one supplier (Russia) in 2021. And, Russia remained the largest exporter to the region for the total of 56.57 bcm (43% of the region's imports), of which only 6.28 bcm in the form of LNG.

For the purpose of calculating the RSI for the region, we operationalize the variable **Largest supplier** as Russian pipeline imports, with Gazprom as the sole Russian company allowed export of natural gas via pipelines. We treat LNG imports from Russia as akin to other LNG flows given that they are traded on a global and quite liquid LNG market.

1 Six if Russia is included as part of the region.

As we point out earlier the regional RSI can only be used to assess the level of "diversification of supply" if the assumption of "perfect interconnectedness" is made i.e., that the countries in the Baltic Sea region can move natural gas across the market in an unobstructed manner. But even though countries in the region have improved their interconnectedness with the beginning of operations of GIPL, Balticonnector or the Baltic Pipe, much remains to be done. Hence, the assumption of perfect interconnectedness is, of course, a simplification; one that is focused on estimating the minimum requirements of diversification of supply that need to be met for interconnectedness to work. Next step would be to combine the two factors to see what levels of diversification require what level of interconnectedness for energy security to be achieved.

Table 1. Trade indicators for net gas importing countries in the Baltic Sea region, 2021 (bcm)

Importer country	Exporter country	Pipeline	LNG	Largest supplier
Estonia	Russian Federation	0.26	0.00	Russian Federation
Finland	Lithuania	0.00	0.07	Russian Federation
	Norway	0.00	0.01	
	Russian Federation	2.63	0.19	
Germany	Austria	0.70	0.00	Russian Federation
	Belgium	4.90	0.00	
	Czechia	0.10	0.00	
	Hungary	2.50	0.00	
	Netherlands	25.50	0.00	
	Norway	31.80	0.00	
	Russian Federation	41.40	0.00	
Latvia	Russian Federation	0.62	0.00	Russian Federation
Lithuania	Egypt	0.00	0.09	Russian Federation
	Equatorial Guinea	0.00	0.09	
	Russian Federation	1.59	0.28	
	Trinidad and Tobago	0.00	0.14	
	United States	0.00	0.89	
Poland	Czechia	0.30	0.00	Russian Federation
	Germany	1.60	0.00	
	Qatar	0.00	2.38	
	Russian Federation	9.60	0.00	
	United States	0.00	1.48	
Sweden	Belgium	0.00	0.00	Norway
	Denmark	0.64	0.00	
	Finland	0.00	0.24	
	Netherlands	0.00	0.11	
	Norway	0.00	0.09	
	Poland	0.00	0.01	
	Russian Federation	0.00	0.21	
TOTAL		124.14	6.28	

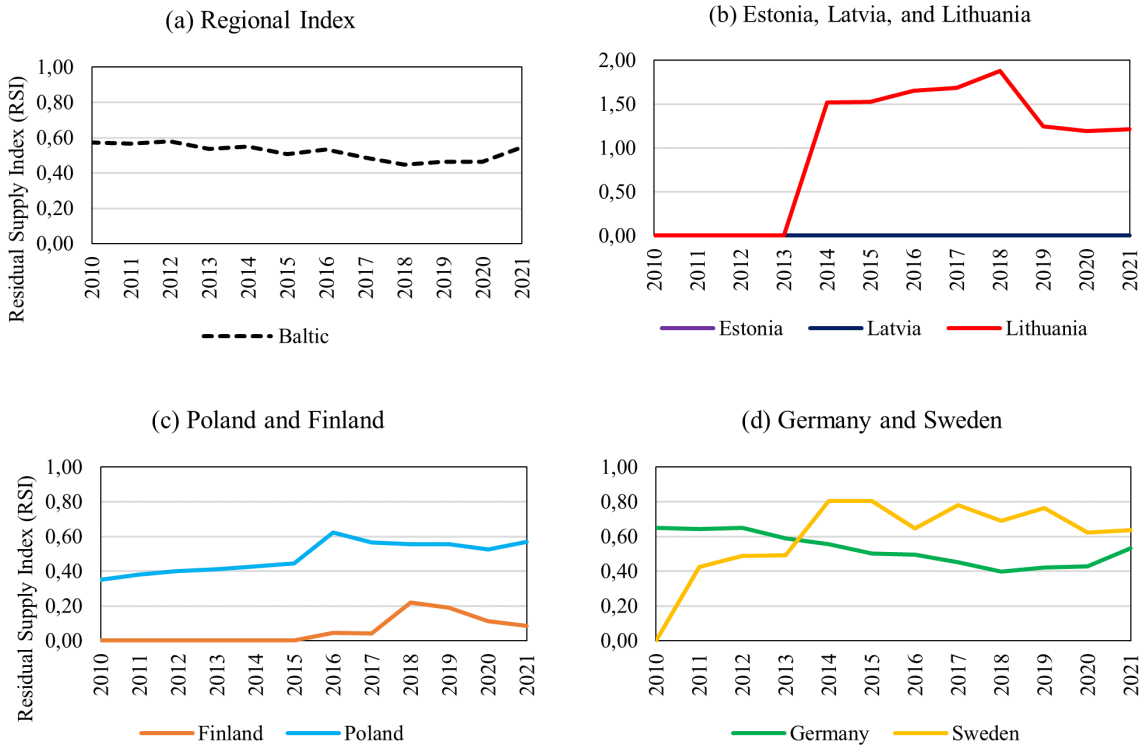
Source: Author, based on Cedigaz, Trade – Annual Flows.

To also keep in mind, is that RSI over time is mostly driven by the largest gas consumer in the region, Germany. As shown in Figure 4 earlier, Germany consumes more gas than all the other countries in the region combined. Thus, to tease out the distinct effect, we calculate individual RSIs for each country as well. By doing so, we can analyze which countries individually have improved their energy security while the region as a whole has been evolving over time.

The RSIs for the region and each country are provided in Figure 6. The RSI for the region in 2021 is 55%, which is far below the ACER's mark of 110 % required to reach supply security, indicating that even under ideally interconnected market and with current LNG infrastructure the region would not achieve energy security in 2021. The infrastructure is important as it diversifies the suppliers, but it is not sufficient to ensure the diversification level in terms of potential for volume which is far below the ACER's mark of 110 % required to reach supply security, indicating that even under ideally interconnected market and with current LNG infrastructure the region would not achieve energy security in 2021. The infrastructure is

important as it diversifies the suppliers, but it is not sufficient to ensure the diversification level in terms of potential for volume replacement. The regional index in Figure 6a, however, stayed almost unchanged over time since the Germany's in Figure 6d changed by very little, which calls for analyzing each country on their own.

Figure 6. Residual Supply Index by region and country, 2010-2021



Source: Cedigaz, Authors' calculation.

Two of the Baltic States, Estonia and Latvia, entirely depended on Russian gas in 2021 and thus their indices show no change at all. On the other hand, Lithuania is the only country in the region that has met the goal of 110% since 2014 as they started to import LNG. Poland and Finland in Figure 6c also show some improvements, as their LNG terminals operate at relatively high levels of utilization, although this is not enough to surpass 110%.

Conclusions

Our calculations of RSI indicate that in 2021, the Baltic Sea region has not been ready for the challenges to security of its gas supply of 2022. Neither the region as a whole, nor countries separately were able to reach the RSI at 110% as required by ACER to ensure security of supply. Germany has had outsized role here as it not only failed to diversify its supply among different providers but also actively supporter increases in Russian supply their dominance on the country's market. This stood in contrast with the position of countries from the former Soviet bloc, which have worked hard to both, diversify its sources of gas supply away from Russia and create more interconnected and balanced market system. Those efforts have included successful operation of new LNG terminals, new interconnectors (Balticonnector and GIPL), a new pipeline connection to Norway (Baltic Pipe) as well as several other projects still under constructions or being planned. Some old and new projects were also motivated by the invasion. This relates in particular to FSRU projects in Germany, which are being completed at a record pace.

Some of those projects have been able to begin operations in 2022, including GIPL, Baltic Pipe, and new FSRU on the Baltic coast of Germany in Lubmin. As such, the situation currently is not as grim as the 2021 calculations would indicate. Even if one assumes 2021 gas demand, adding all FSRUs planned by Germany brings its RSI to a much better, though not yet secure 90.8% level while increasing RSI for the region to 68.9%. Poland's Baltic Pipe brings this country nearly in line with the supply security benchmark at 109.4%. The RSI for the region is then at 58.8%. If both German FSRUs and Baltic Pipe are added the RSI for the region increases to 73.2% indicating that more needs to be done within the entire region.

If one considers that 2022 gas demand, and demand for the following years, will be lower than the 2021 demand due to aforementioned efficiency gains, savings, replacement by other fuel sources but also due to demand destruction and potential economic recession, the RSI for 2022 is likely to be higher indicating higher security of demand. However, one should note, that the two latter developments are not the reasons to celebrate. Destruction of demand and economic downturn can hardly be a positive development under any conditions and the Baltic Sea region should strive to make sure that its secure in its energy supply so it can support economic growth. Hence, while RSI can and should be considered as a useful indicator, such consideration needs to be done within the context of the countries, the region, and the EU and their needs, ambitions, and goals.

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