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DEVELOPMENT OF LIQUEFIED NATURAL GAS FACILITIES IN THE BALTIC SEA PORTS: A GEOGRAPHICAL PERSPECTIVE

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ABSTRACT

This paper presents an overview of the liquefied natural gas (LNG) facilities development in the Baltic Sea. The value of the paper lies in its seek to demonstrate how the process of interaction between the shipping and energy networks unfolds through infrastructural developments of ports. The analysis is based on mapping, cartographic and spatial contextual methods. The mapping of gas supply networks, LNG facilities and traffic patterns establish the originality of this research. It shows that factors motivating the development of LNG terminals in the Baltic ports come from areas of energy and maritime policy. Moreover, in future, the emerging LNG infrastructure may have an effect on port competition in the Baltic Sea Region.

KEYWORDS: *seaport, LNG, energy, maritime transportation, the Baltic Sea.*

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Introduction

The relationship between energy and shipping is twofold. On the one hand, energy is required for vessels' propulsion. To date, fossil fuels remain the main way of enabling maritime transportation and concepts of carbon-neutral/free vessel remain a matter of future technological development. On the other hand, shipping is a key service that allows transportation of energy resources from production to processing sights and to final consumer markets. For instance, oil tankers transport some 2.900 mln tons of crude oil around the world by sea including 50% of U.S. oil imports (crude oil and refined products). So, as natural gas is expected to become an increasingly important part of the global energy mix, transportation of gas to regions far from gas extraction sites becomes pivotal (Haidar, 2015). Since most part of LNG is supplied by sea, construction of LNG facilities in ports is central to development of LNG infrastructure all over the world. At the same time, LNG can be used as transportation fuel that offers environmental advantages in comparison to commonly used oil-based fuels (Gritsenko, Serry, 2015).

The Baltic Sea is very transport-intense. Different types of cargoes and maritime transport technologies can be found in the Baltic trade, although some restrictions stem from navigational limitations (shallow depths, archipelago, sea ice, high number of vessels at sea).

The transportation volumes in the Baltic Sea have increased significantly in recent years. Indeed, transportation of containerized cargoes has been intensively developing over the last decades. In 2012, the total amount of cargo handled in the ports bordering the Baltic Sea was 839.4 million tons. Maritime traffic is dominated by liquid goods (about 40%). The second largest group of cargoes is dry bulk (less than 30%) and the final group, called "other cargo", includes break bulk and other general cargoes.

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There are three factors that explain the rapid growth: the world economic growth, important geopolitical changes in the region that have opened the eastern shore to the market economy, and the fact that Russia needs the Baltic Sea ports' capacities. The Baltic Sea Region (BSR) was facing a major economic restructuring, thus efforts to achieve more integrated and multimodal transport has appeared. The BSR is mainly connected to Europe (less than 10 regular container lines to the rest of the world) so there is a transshipment concentration in the Northern Range using a feeder system. In this context, the Baltic Sea ports are now hierarchized. Moreover, maritime sub-regionalization is important and produces several ports facades with a very integrated one, the eastern Baltic range (Serry, Lévêque, 2016).

One of the latest developments within the Baltic ports is the increased interest towards expansion of the liquefied natural gas (LNG) facilities (Liuhto, 2013). Though elsewhere in Europe and particularly in the North Sea, LNG terminals are widely spread, the Baltic ports started planning their activities only in 2010. Therefore, this makes the Baltic Sea a particularly useful investigation subject: the LNG infrastructure is being under development and it is important to anticipate potential unintended consequences. The LNG terminal development seems favourable for the eastern Baltic Sea countries, as it will allow decreasing energy dependency by increasing gas supply diversification. Moreover, this terminal provides regional shipping with an alternative type of low-emission marine fuel (Gritsenko, Serry, 2015).

A geographical approach is used to investigate where future LNG terminals will be constructed and how their location may affect the dynamics between the ports in the range. The mapped maritime and port reality is a useful tool to put under scrutiny commonly accepted assumptions regarding the LNG facility development, and also provide a visual image of connecting relation between energy and shipping in the Baltic Sea.

The research was carried out as a desktop research and is also based upon mapping methods, cartographic and spatial contextual analysis. The author uses visualization as a tool for analysing links between infrastructural objects and the role of flows in establishing the LNG-related governance networks. The paper gives an overview of the current situation and possible future scenarios with the development of the Baltic ports as regional pioneers in LNG bunkering, as well as discusses the implications of different scenarios on the three central aspects of public well-being: economic, environmental and social. In particular, it seeks to understand how a network of the emerging LNG infrastructure reflects (and potentially affects) the maritime transportation patterns in the region.

The paper proceeds as follows: Section 1 focuses on the LNG technology, LNG use development and LNG logistics, paying a particular attention to the Baltic Sea region; Section 2 gives an overview on the development of LNG facilities in the Baltic ports and presents their typology.

1. Background and LNG context

1.1. State of LNG in the maritime sector

In literature, scientists have reviewed how adoption of LNG and increase of its trade can change energy markets, in particular natural gas markets, by offering flexibility of supply and unleashing energy independence for many energy-dependent countries (Thomas, Dawe, 2003; Costantini, 2007). Also, LNG for maritime use has been a matter of academic investigation on bunker pricing, technological innovation, and sustainability (Hyvättinen, Hilden, 2004; Wang, Notteboom, 2013; Blikom, 2012; Burel et al., 2013). This paper aims to give an overview of the current situation and near-future developments of the LNG facilities in the Baltic Sea Region (BSR).

Even though, the LNG technology has been available for several decades and LNG has been in regular use since 1960s, its role in natural gas logistics remained marginal until the so-called 'shale gas revolution' (Stevens, 2010). In Europe, the escalation of political tensions between major gas-producing and gas-consuming countries increased attention to investment into the LNG technology.

LNG terminals are complex infrastructural installations with multiple functions (reception of the LNG tankers, discharging of the LNG cargos, tanking and storage, regasification and injection to pipeline system, supplying for further use as fuel, including bunkering). Some LNG terminals are built as extension of the existing port facilities, whereas others are built purposefully as new ports with focus on the LNG import/export functions. Types of LNG terminals range from onshore installations (tanks and (re)gasification facilities) to offshore solutions (floating storage barges and (re)gasification plants on an artificial island). The analysis of literature has drawn attention to two major drivers for the development of the LNG facilities in the Baltic Sea ports. First, LNG is seen as a way out of energy dependence by diversification of gas supply allowing more flexibility in natural gas logistics (Liuhto, 2013). The second rationale for increased interest to LNG in the Baltic Sea is its potential to serve as marine fuel compliant with the latest air emission regulations (Burel et al., 2013). Since 1st of January, 2015, the Baltic Sea and the North Sea were designated as Sulphur Emission Control Areas (SECA) under MARPOL Annex VI, resulting in more stringent regulation on air emissions applied in these areas. Also, the EU sulphur directive (2012/33/EU) aims at ensuring a substantial reduction of SO_x in ship exhaust to the benefit of coastal communities and the marine environment. In order to meet the SECA regulation, several compliance options have been proposed: a) use of low-sulphur fuel (MDO/MGO); b) use of exhaust gas cleaning systems (scrubber); (c) use of LNG (Kalli et al., 2009). LNG seems to be a viable option as it offers a number of advantages with respect to conventional maritime fuels, including significant reduction of SO_x , NO_x , CO_2 and PM emissions in ship exhaust. It should be also noted that some ports may be better suited than others for LNG bunkering (e.g., emergency response might prove difficult in densely populated areas). Large ports are often located in proximity of densely populated areas and construction of LNG terminals may provoke sceptical and rejecting attitudes within local population (NIMBY); we can observe this in case of Turku port in Finland.

Two remarks should be made at this stage. First, the influence of port infrastructure on energy innovation in shipping (related to global energy transitions) is far from being novel. A historical example can be drawn from the early 20th century when steam engines were developed and many ship owners refused the change due to lack of oil bunkering facilities and abundance of coal in ports. Yet, once infrastructure was developed, coal-engine propulsion became obsolete and shipping secured a major market for oil-based fuels (Rodrigue et al., 2013). Second, the relationship between the large-scale LNG facilities meant for the natural gas grid and related to LNG for maritime use is not always synergic. Some LNG terminals are built as extension of the existing port facilities, some as new ports with focus on the LNG import/export functions, some with focus on storage and large-scale distribution. Thus, not all LNG facilities in ports are meant to be used for bunkering.

The LNG logistics is complex. Large scale LNG logistics is connecting gas production and nation-scale gas consumption (wholesale distribution via pipeline grid) through LNG hubs (usually located in deep-sea ports where large LNG vessels arrive, capacity of 100.000 m³ or larger). Mid-size LNG facilities occupy a role of intermediaries in the LNG distribution process (receive the LNG feeder vessels and further distribute LNG to end-users; capacity of few thousand m³ to close to 100.000 m³). Small scale LNG operation are part of the retailing chain that often relies on single-purpose LNG terminals, e.g., for bunkering or power generation, and can be a bunker ship or a local tank, capacity tens of cbm (Gritsenko, Serry, 2015).

1.2. LNG in the Baltic energy mix

Natural gas is an important source of energy in Europe in general, and in the Baltic Sea region in particular. The nine Baltic littoral states can be grouped in three groups: net gas suppliers (Russia), net gas importers (Estonia, Finland, Latvia, Lithuania, Sweden), gas producers and importers (Poland, Germany, Denmark). It shall be noted, that among the Baltic net gas importers, until recently, four countries were fully dependent on Russian supplies.

The construction of LNG terminals is important to the diversification of the countries' gas supply, since, before December 2014, 100% of gas consumed by Estonia, Finland, Latvia and Lithuania originated from Russia (see Table 1). The respective share for Germany is 30-40% and for Poland it is 60% (Liuhto, 2015).

Table 1. Gas in the economy of the Baltic Sea countries and EU 28*

Country	Own production	Norway	Russia	total net	% in energy mix
Denmark	56	4.2	0	35.8	17
Estonia	0	0	7	7	9
Finland	0	0	36.8	36.8	8
Germany	115.8	225.0	436.0	956.0	22
Latvia	0	0	15	15	28
Lithuania	0	0	28	28	31
Poland	49.4	0	102.3	178.5	14
Sweden	0	1.1	0	12.4	2
EU 28	1699.7	1046.1	1332.3	4996.0	23

* Source: Eurogas Statistical Report (2014).

Note: 1 TWh = 0.0923 bcm.

The recurrent EU-Russia energy crises make the issue of energy dependency particularly relevant and the desire for diversification particularly strong (Liuhto, 2013). The gas market in the Baltic Sea region is quite diverse internally, but until recently, it was characterised by a lack of connectivity with the rest of Europe and a lack of supply diversity in most countries (Liuhto, 2015).

Today the logistics of natural gas in Europe is largely dependent on grid connections (gas pipelines). In the EU, 86% of natural gas is imported through pipelines and only 14% in form of LNG (Eurogas, 2014). Gas pipelines remain the most cost efficient way of gas transportation, but they require extensive initial investment. They are spatially bound and do not allow flexibility in supply choices. LNG allows a greater volume to be stored at smaller facilities as it takes up about 1:600 the volume of natural gas and requires only 1/3 of the volume occupied by compressed natural gas (CNG), the traditional form of gas storage.

Overall, the outlook for LNG trade is positive as global consumption prompted by several potential LNG uses is set to increase at a faster path than the demand for natural gas. The UNCTAD Maritime Transport review 2014 indicated that global LNG shipments are expected to rise by 5.0% in 2015. With a global price competitive with oil and the environmental and logistic characteristic superior to oil-based fuels, LNG has rapidly spread in the US and Asian (Japan) energy markets.

To date, the import of LNG in the BSR is very limited: in 2015, Sweden imported 0.29 MTPA (from Norway), Poland 0.63 MTPA (imported through other terminals and transported to Poland by road) and Lithuania 0.33 MTPA (IGU, 2016). Foremost, this is related to the absence of infrastructure. By building capability to import LNG, the gas importing countries will have an opportunity to create complex multi-supplier portfolios (Rozmarynowska, 2012), including gas import from Qatar, Malaysia, Algeria and other major LNG producers. For instance, Lithuania has signed a contract with Qatar and with Norwegian Statoil, whereas Polish state-controlled company imports from Qatargas.

1.3. LNG as bunker fuel

The motivation to use LNG as bunker fuel is a result of significant reduction of SO_x, NO_x and PM emissions in ship exhaust it allows. This property of LNG fuel is particularly important in Sulphur Emission Control Areas (SECA) under MARPOL Annex VI, resulting in more stringent regulation on air emissions applied in these areas.

The promise of LNG bunkering (before the oil price drop in late 2014) was instigated by projections of a future global average LNG base price of \$10–15/mmBTU (LNG Bunkering website, 2015). The outlook for LNG presented by gas analysts suggests that during the next several years LNG markets will become more volatile, whereas the price is likely to remain rather low. Yet, the LNG ‘naked commodity’ price as a benchmark for LNG bunker can be somewhat misleading as intermediaries are required between the large LNG

import terminals and bunkering vessels/stations (Bourgeois, 2014). The price of LNG that ‘enters’ a terminal and that of ‘entering’ an LNG-fuelled vessel can differ due to logistical cost (Gritsenko, Serry, 2015).

There are three technologies presently used for LNG bunkering. Truck-to-ship bunkering is the most flexible solution that can be used in any terminal, yet, it is considered reasonable when the bunker volume does not exceed 200 m³. Ship-to-ship bunkering is suitable for vessels requiring a volume of ca. 100 m³ and above, yet, some difficulties are indicated in ice-covered waters (relevant for the most part of the Baltic Sea). Finally, bunkering directly from the terminal to a ship via a pipeline, facilitated by a special installation is most suitable for large bunker volumes and is expected to be developed most, once LNG will occupy a significant portion of the bunker fuel market. For the time being, ship-to-ship seems to be a preferable option, and it works best if the source of LNG is available in the port (e.g., exists the LNG import facility).

Whether an LNG import/export terminal will (and shall) engage into bunkering or whether construction of a separate small or medium sized LNG bunkering facility is required depends on several issues. First, availability of LNG for maritime use for the time being is not conditioned by the existence of an LNG import terminal: some ports decide on storage facilities and LNG is supplied by truck. Second, economic considerations may join in when large LNG-supply terminals will lack economic incentive in filling up smaller ships at frequent intervals (TradeWinds, March 17, 2011). Demand from non-maritime users (e.g., road/inland navigation/industry/power generation) is seen as a crucial incentive to supply LNG to ships for any large import terminal (LNG Bunkering, 2015). Third, safety and environmental concerns play an important role, because LNG as transportation fuel is (relatively) new to all the actors in the process: maritime industry, suppliers and the government.

Notwithstanding the environmental benefits, academic studies indicate several problems with LNG as the alternative marine fuel. In particular, lack of infrastructure is identified, as well as other regulatory and technical uncertainties are pointed out (Acciaro, Gritsenko, 2014).

2. LNG in the Baltic ports

2.1. Development of the Baltic LNG infrastructure

LNG can be expected to occupy a significant niche as bunker fuel for shipping within the emission control areas like the Baltic SECA. The structure of the Baltic maritime transport, which is characterised by high volume of intra-Baltic shipping, is supportive of LNG to become an attractive SECA compliance option. Yet, the market uptake of LNG as bunker fuel in the Baltic Sea, as well as elsewhere in Europe, has been slow.

The development of LNG bunkering has been typically regarded as a “chicken and egg problem”: absence of bunkering facilities undermined investment in LNG-powered ships, whereas lack of demand for LNG reduced incentives to develop LNG fuelling facilities. The stumbling stone of the whole LNG project is the infrastructure that needs to be built and requires substantial investment. As Figure 1 indicates, currently (as of January 2017) the coverage of the LNG infrastructure is rather poor, but by 2020 wide availability of LNG in the BSR can be expected. A growing number of medium- and small-scale LNG facilities is driven by LNG end-use markets with rapidly growing potential and supportive of LNG uptake for maritime use (Jankowski et al., 2014).

Since most of the LNG projects in the Baltic Sea region are at the initial stage, it follows that we first zoom in the three existing terminals (Nynäshamn, Klaipėda and Świnoujście) in order to understand that the working LNG seaport facilities are within both the energy and maritime networks. The analysis is extended by placing other facilities on the map by matter of their resemblance.

Nynäshamn, the Port of Stockholm’s most southern harbour, made Sweden a pioneer in the Baltic LNG development. This mid-scale facility is a prime example of how small volumes of LNG can be distributed to the multiple end users. Nynäshamn sells LNG, most of which is sourced from the Linde-built natural gas liquefaction plant in Stavanger (Norway), to various municipalities without direct access to the gas grid in

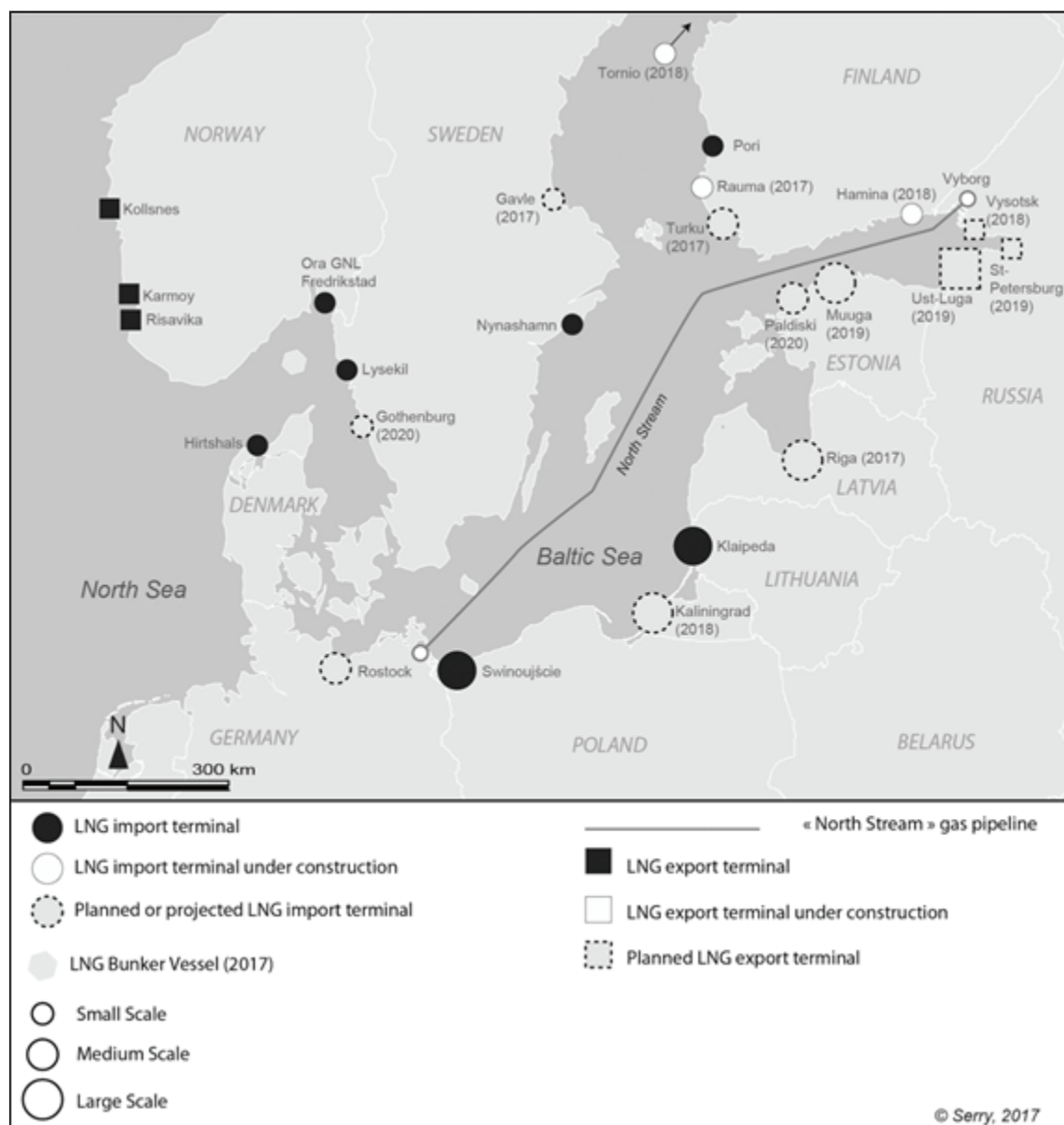


Fig. 1. LNG facilities development in the Baltic ports, as of January 1, 2017

the Eastern parts of Sweden. Moreover, it provides LNG as fuel for natural gas vehicles in the region, supplies LNG by truck to a storage facility in Stockholm, from which the bunkering ship *Seagas* sources LNG to the passenger ferry *Viking Grace*. The terminal was initially thought to serve multiple local needs as a local scale actor. Its moderate capacity (0.3 MTPA, 20.000 m³) indicates that Nynäshamn does not have an ambition to be a major player in the Swedish energy policy. Plans for further development of the Swedish LNG facilities in the Baltic region follow the same logics. In autumn 2014, a new import terminal for LNG in Lysekil has officially started operations with a goal to meet local demand in course of energy transition and transport-induced air emissions mitigation (Ship Technology, 20 October, 2014). The Port of Gothenburg is currently constructing an LNG terminal with bunkering facilities (Port of Gothenburg, 2015). The need for SECA-compliant fuel is presented as the main reason for constructing this LNG facility. The project of an LNG terminal at the Port of Gävle was approved and construction started aiming at a new facility that will

allow the bunkering of LNG-fuelled ships, as part of the Sweden's and EU's efforts to provide more infrastructure for the maritime use of LNG.

In Lithuania, a share of natural gas in primary energy consumption is of about 30%. In autumn 2014, the first terminal in the Eastern Baltic Sea, the floating LNG barge with a symbolic name "Independence", was commissioned in Klaipėda allowing Lithuania to fulfil its energy diversification goal (as Table 1 shows, Lithuania was most dependent on Russian gas among the BSR countries). The terminal, leased from Norway's Hoegh LNG at a daily rate of USD 189.000, has the capacity to supply 4 bcm of gas annually, covering not only Lithuanian needs but also about 80% of the total Baltic States' consumption. Though the primary rationale for "Independence" is energy independence, the existence of an LNG terminal in Klaipėda may impact its future development as a multi-purpose port. Today Klaipėda is a "mid-range" port in the eastern Baltic range, involved into intra-regional trade and transshipment, rather similar in terms of international trade volume to the port of Riga located in close proximity. Klaipėda is well-connected in the container network, but not a major node. Its Ro-pax operations are stable but not as large as in some other ports of the eastern range. The newly acquired LNG infrastructure may give it a competitive advantage, among others over the port of Riga. The Lithuanian terminal brought some significant commercial benefits almost immediately. Some of them were expected: Lithuania managed to renegotiate its contract with "Gazprom" and to receive a 20% discount for the Russian pipeline gas (Liuhto, 2015).

The Świnoujście LNG terminal consist of some 5 billion bcm per annum of natural gas upon full facility completion, and it is enough to provide 50% of national gas demand. The terminal has unloading jetty for large LNG tankers, two storage tanks and a regasification train.

The new terminals enable a diversification of both the sources and the routes of the gas supply. They also make it possible to supply in aggregate 7 bcm of LNG annually and to boost competition on the regional market. The LNG supplies via Klaipėda make possible the diversification of gas supplies to Estonia (it bought gas from the Lithuanian terminal already in 2015) and have opened up the same option to Latvia. The launch of the terminal in Świnoujście has similar results.

For instance, the first small-scale (LNG) reload operation at the Port of Klaipėda in Lithuania took place on January 2, 2017. The cargo was transported to one of the small-scale LNG terminals in the Baltic Sea. The Lithuanian LNG terminal is currently the only facility in the Baltic Sea that can reload natural gas to smaller LNG carriers, according to LitGas. SkanGas earlier said that the LNG reload in Lithuania could be a natural next step to further increase the support for the development of the small-scale market in Northern Europe.

2.2. Typology of the Baltic LNG infrastructure

In order to better understand the path of LNG uptake for maritime use in the Baltic Sea Region (BSR), the author suggests a need for mapping the emerging LNG facilities (see Figure 2). Based on the analysis of energy and shipping agendas, the author adopts a simple two-dimensional model for understanding of the LNG infrastructure networks. The axes represent two dimensions of the LNG technological uptake: local-to-transnational scale of energy policy and economic-to-geopolitical rationale of terminal development.

Figure 2 shows that though all LNG terminals in the BSR are different, a typology may be proposed. The classification includes such parameters as a country's position in the energy, in particular natural gas, the market is seen as a continuum between a need to diversify gas supply (geopolitical rationale) and a need to serve local industries (economic rationale). At the same time, the scale of projects may range from local to national and transnational (Gritsenko, Serry, 2015).

The Baltic States and Finland are dependent on Russia, therefore are mostly interested in developing larger import facilities at a prompt timetable; the same applies to Poland. Bunkering facilities are seen in these ports as a complement that will come as soon as LNG bunkering will become important. In Finland, active expansion of LNG both for local use and as a geopolitical asset is expected. The SkanGas' Liquefied Natural Gas (LNG) facility in Pori began commercial operations on September 12, 2016. The terminal of 30 thousand m³ capacity comprises an LNG tank, loading docks, process units, a flare torch, three loading

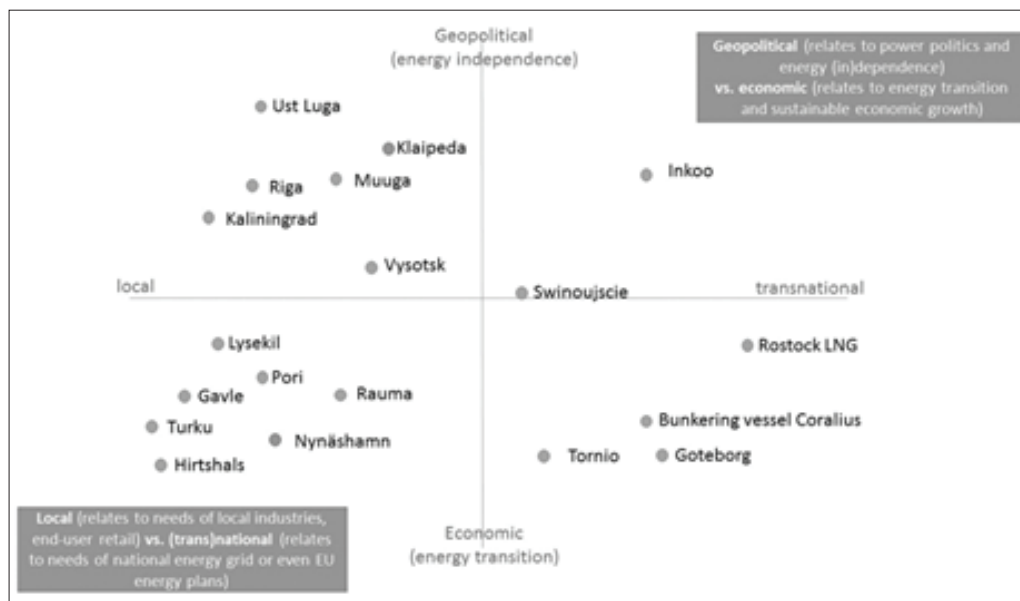


Fig. 2. Mapping the LNG terminals in the Baltic Sea Region

Source: D. Gritsenko and A. Serry (2015).

docks for road tankers, a transformer building and a heat production unit. Until 2020, four terminals should be constructed: Inkoo, Turku, Rauma, and Tornio in the Bothnian Gulf.

Unlike the countries where LNG facilities are planned to solve the energy dependency issues (both of supply and demand), LNG facilities in countries that feel rather 'comfortable' with their gas supply are more related to the national energy solutions (energy transition, small-scale retail to local industries, including bunkering). In Sweden and Denmark, energy dependence does not dictate the logic of the LNG proliferation. However, in 2014, SkanGass opened the Liquefied Natural Gas terminal in Lysekil, Sweden, supplied via a pipeline by tankers berthing at the Preem's harbour in Brofjorden. Since February 2017, SkanGass has been providing the Liquefied Natural Gas ship-to-ship bunkering with the help of the 5.800 m³ bunker vessel *Coralius*. However, Denmark with its own production has not invested in any larger LNG projects, as well as Germany with rather diversified import and a special relationship with "Gazprom" (due to Nordstream) also does not fear 'gas wars' or anything similar to the Ukrainian crisis. In Denmark, Fjord Line, the Port of Hirtshals and HMS Naturgas have signed a letter of intent seeking to build a Liquefied Natural Gas plant in the Danish port, and the funds for the planning stage have already been allocated too.

Furthermore, the German Baltic ports of Rostock and Lübeck showed interest towards LNG terminals. A potential for LNG bunker stations is being investigated in Lübeck, whereas in Rostock a memorandum was signed between "Gazprom Germania" and the Port of Rostock; they seek to develop facilities enabling the use of LNG as road and ship fuel (Baltic Transport Journal, July 24, 2014). In these cases, the development of LNG facilities is slower and their bunkering use is thought through from the beginning. On February 27, 2016, the company "Gazprom Germania" fuelled at one of the Rostock port's quays the LNG-powered bulk carrier *Greenland* using a tank truck.

Special attention needs to be paid to the three emerging hubs: part of critical national (Ust Luga) or even transnational (Swinoujscie and Inkoo) infrastructure. The Świnoujście's LNG terminal was built with a clear goal to cut its reliance on gas imports from Russia. The terminal will be the only installation of that size in Central and Eastern Europe, thus, it is expected to affect the entire regional gas market.

Finally, in Russia, at least three LNG terminals are expected in the nearest future. One terminal for production and transshipment with capacity 660,000 t annually is to be constructed in Vysotsk (Portnews, November 26, 2014). According to the renewed “Baltic LNG project”, another 10 mln production facility is planned in Ust-Luga (the plant will be supplied with gas via pipelines from Russia’s Unified Gas Supply System, granting a possibility to expand it up to 15 mln t). The Ust Luga facility will be the only major liquefaction plant in the whole BSR. In addition, Russia’s Federal Marine and River Transport Agency has given its green light to the investor LNG-Gorskaya for the set-up of an LNG production and export terminal in the port of St. Petersburg. The facility, planned for the late 2018, will comprise a plant to be assembled on three non-self-propelled barges, each with production capacity of 656 mln m³ (approx. 1.26 mln t of LNG/year), necessary land- and sea infrastructure (a gas pipeline, loading rack, and a jetty), as well as three bunkering barges (7.0 thou. m³ of tank capacity apiece).

Conclusions

As it was mentioned, two critical factors can be considered as the main drivers to develop LNG facilities in the Baltic Sea: 1) willingness to diversify the gas supply infrastructure; and 2) the need to provide low emission (in particular, SECA-compliant) marine fuel. The geography of the LNG facilities development in the Baltic Sea region suggests that, to date, the first factor has prevailed over the second one.

As the LNG market is demand-driven, LNG import/export and storage facilities in ports are built to meet the existing or emerging demand rather than to create it. Current demand for LNG in the Baltic region has been related to the energy policy goals of supply diversification. In particular, the Ukrainian events in 2014, which resulted in mutual sanctions between the EU and Russia, have created even stronger motivation to lessen the interdependences between parties involved in gas trade. Although, LNG terminals will allow importing countries to be less dependent on the Russian supply, Russia expects to find new customers by shipping its gas to alternative destinations. As a result, LNG terminals add flexibility both in terms of gas import and export. However, their potential to expand as bunkering facilities has not been utilised extensively.

The market uptake of LNG as bunker fuel in the Baltic Sea has been slow. It can be explained as a typical “chicken and egg problem”: absence of bunkering facilities undermined investment in LNG-powered ships, whereas lack of demand for LNG reduced incentives to develop LNG fuelling facilities. As the SECA regulation entered into force on January 1, 2015, most of shipping companies in the Baltic Sea switched to low-sulphur fuel. Due to the drop in oil price this change has had a relatively mild effect in comparison to the earlier predicted severe increase of the bunker price. LNG can be expected to occupy a significant niche as bunker fuel for shipping within the SECAs. The structure of the Baltic maritime transport, which is characterised by high volume of intra-Baltic shipping, is supportive of LNG to become an attractive SECA compliance option.

In fact, in the BSR, ports do not actively compete to attract LNG projects. Rather, impulses for the LNG terminal construction and subsequent investment come from energy companies and public authorities. This could explain a mismatch between those ports where LNG can be expected to be in need first (ports involved into the intra-Baltic trade such as Riga, Helsinki, Hamina-Kotka, Saint-Petersburg, and Tallinn serving major Ro-ro/Ro-pax and feeder/container lines) and those ports where terminals are being built (Rauma, Pori, Inkoo, Ust-Luga).

The increasing geopolitical role of LNG differentiates the development of the LNG infrastructure. Even though, mid-scale facilities can potentially serve both energy and maritime sectors, the logic of the two is significantly different. From the energy policy point of view, the supply *diversification* is the key word. Thus, a large terminal is most desirable as it gives a possibility to receive and store large amounts of gas, whereas the location is a matter of less importance (does not have to be a major port, even a special port can be built for the purpose if well-connected to the national energy grid). From the maritime sector point of view, *usability* is the key word. Thus, the most important thing is to have enough LNG for bunkering purposes in locations where it is most needed – in ports, where more vessels are expected to utilize the LNG bunker, as

the size of facilities matters less (can be of smaller scale or even a storage tank fuelled from the shore, i.e., not necessarily an import terminal). The main advantage of LNG bunkering in the SECA port is time-saving, stemming from performing the fuelling at the same time as cargo is being handled (loading/unloading) (Gritsenko, Serry, 2015).

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SUSKYSTINTŲ GAMTINIŲ DUJŲ NAUDOJIMO AUGIMAS BALTIJOS JŪROS UOSTUOSE. GEOGRAFINĖS PERSPEKTYVOS

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Santrauka

Šiame straipsnyje aptariamos suskystintų gamtinių dujų panaudojimo galimybės. Pateikiamos autoriaus įžvalgos, kuriose atskleidžiama laivuose naudojamų energijos šaltinių ir tam pritaikytos uosto infrastruktūros sąveika. Tyrimas atliktas naudojant žemėlapius, taikant kartografinę ir erdvinę kontekstinę metodiką. Pateiktas dujų tiekimo tinklų žemėlapis ir suskystintųjų gamtinių dujų terminalų vietos uostuose, tuo šis tyrimas yra išskirtinis. Siekiant paskatinti kurti suskystintųjų gamtinių dujų terminalus Baltijos jūros uostuose, šalyse reikia kryptingos energetikos ir jūros ūkio politikos. Nes tam būtinos ne tik didelės investicijos, bet ir šalies vyriausybės palaikymas, tam tikra energetikos politika.

Ateityje, suskystintųjų gamtinių dujų terminalas uoste gali būti jūrų uosto konkurencingumą didinantis pranašumas Baltijos jūros regione. Yra du esminiai veiksniai, kurie gali skatinti naudoti suskystintas gamtines dujas: pirma, noras diversifikuoti dujų tiekimo infrastruktūrą, antra, poreikis sumažinti laivų taršą jūrose. Atlikę geografinę Baltijos jūros regiono analizę matome, kad pirmasis veiksnys veikia ir antrąjį veiksnį.

Suskystintųjų gamtinių dujų terminalai tiesiogiai susiję su šalių energetikos politika. Pavyzdžiui, po Ukrainos įvykių 2014 metais, nustačius Europos Sąjungos sankcijas Rusijos Federacijai, dujų tiekimas buvo nutrauktas ar sumažintas. Taigi šalys skatinamos turėti ne vieną dujų tiekėją, kad būtų kuo mažiau priklausomos ir dujų prekyboje. Taigi suskystintųjų gamtinių dujų terminalai uostuose lemia laisvumą tiek importuojant, tiek eksportuojant dujas. Nors akivaizdu, kad suskystintųjų gamtinių dujų terminalas uoste labai naudingas, ne visi uostai tai supranta ir kuria tokią infrastruktūrą.

PAGRINDINIAI ŽODŽIAI: *jūrų uostas, suskystintos gamtinės dujos, energetika, Baltijos jūra, jūrų transportas.*

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