

## LNG fuel distribution strategy for the BSR v5

## Introduction

The land-based and the maritime LNG market will be closely connected in the future. With stricter emission restrictions, more ships will be built with LNG propulsion or will be retrofitted. Initially liner traffic and vessels with regular routes are going to be powered with LNG. The existing and planned LNG infrastructure will encourage the use of LNG as a fuel and for industrial purposes. Not only is LNG competitive in price and energy efficiency, but it is more environmentally friendly than traditional energy sources like oil or coal. Many governments, businesses and consumers are becoming aware of the advantages that the use of LNG can bring. The global LNG trade is constantly growing and therefore the establishment of designated LNG fuel distribution strategies is becoming more essential. In the following some LNG fuel distribution strategies for the Baltic Sea Region (BSR) will be suggested.

## Active LNG terminals and facilities

Within the Baltic Sea there are currently two active import terminals. One is in Swinoujscie, Poland and one in Klaipeda, Lithuania. Furthermore, there are some active small-scale LNG terminals in Pori (Finland), Nynäshamn and Lysekil (both Sweden) and in Risavika and Øra (both Norway). Additionally, there are a few active small-scale bunkering facilities in Denmark, Sweden, Finland and Norway, but overall most bunkering facilities in the Baltic Sea Region are still under construction or planned.



Figure 1 Active LNG import, small-scale terminals and small-scale bunkering facilities in the BSR

## Existing transport corridors for the BSR

The development of a LNG fuel distribution strategy requires a close look at the existing infrastructure that connects the neighboring countries of the Baltic Sea. The Trans-European Transport Network (TEN-T) is a European Union (EU) funded project aiming to connect all EU member states through a well-developed transport infrastructure. The EU member states work together to create coordinated road, inland waterways, rail and seaport corridors for an overall improved movement of goods. A total of nine corridors exist. The three relevant corridors for the Baltic Sea neighboring states are the Scandinavian - Mediterranean corridor running from Italy's south up north to Scandinavia, the Baltic - Adriatic corridor running from northern Italy through eastern Europe to the north of Poland and the North Sea - Baltic corridor which runs from the Netherlands North Sea coast through Germany, Poland and the Baltic States up to the southern tip of Finland.



Figure 2 Relevant section of the TEN-T network for the BSR

## Requirements for a LNG fuel distribution strategy

For the development of a LNG fuel distribution strategy it is essential to consider the directives and strategies that were created by the European Parliament and the European Commission. Within the Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure the European Parliament decided that:

*“The TEN-T Core Network should be the basis for the deployment of LNG infrastructure as it covers the main traffic flows and allows for network benefits. When establishing their networks for the supply of LNG to heavy-duty motor vehicles, Member States should ensure that refueling points accessible to the public are put in place, at least along the existing TEN-T Core Network, within adequate distances taking into account the minimum range of LNG heavy-duty motor vehicles. As an indication, the necessary average distance between refueling points should be approximately 400 km.”* (Official Journal of the European Union, October 2014)

As the directive of the European Parliament states future LNG infrastructure should be developed in accordance with the already existing TEN-T Core network. As the core network hosts most of the traffic, future LNG infrastructure would be made available to a large pool of potential LNG customers. Additionally, the EU clean fuel strategy also aims at having all maritime ports, that are part of the TEN-T core network, equipped with LNG refueling stations. The inclusion of LNG infrastructure into the TEN-T network will function as an incentive for new market players to build and run new LNG facilities. From the political side it is expected that a LNG infrastructure should be focused along the core TEN-T network.

### Future locations of LNG terminals and facilities

As the EU directives and the clean fuel strategy requires that every TEN-T Core Port needs to be equipped with at least a LNG refueling station the ports will most likely implement those requirements in the long run. The following map depicts active and planned LNG facilities.

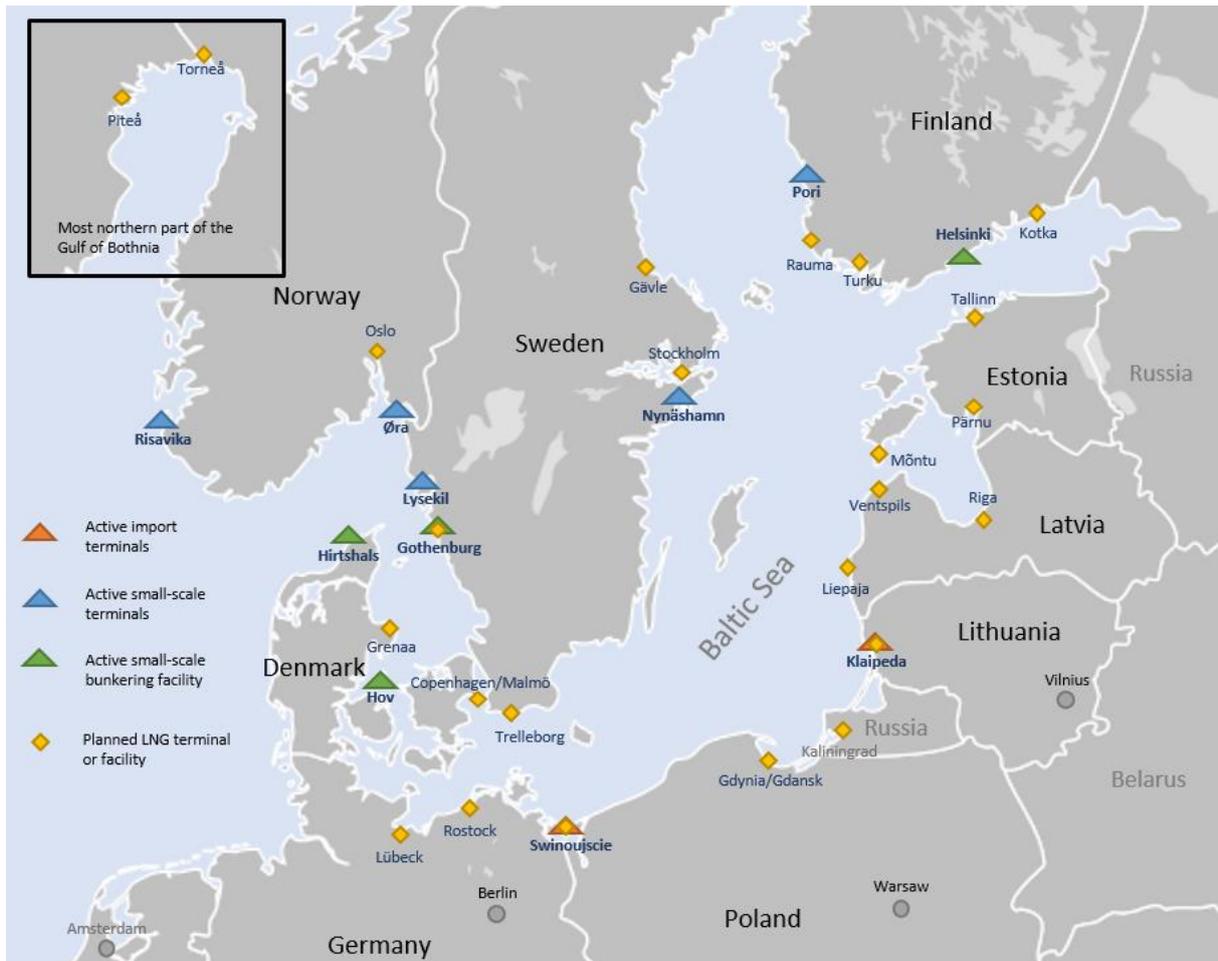


Figure 3 Active and planned LNG terminals and facilities

Figure 3 shows all the planned LNG terminals or facilities. All the Core Ports in the BSR will eventually be equipped with a LNG facility therefore being able to provide LNG as a fuel to major shipping traffic. The Core Ports and their TEN-T connections are also shown in Figure 2, where the relevant TEN-T corridors for the BSR are illustrated.

### Creation of a LNG fuel distribution strategy

After identifying active and planned LNG terminals and facilities in the BSR as well as illustrating the TEN-T corridors the next step is the identification of major industrial areas that are concentrated within the BSR. The locations of the Core Ports and the major industrial areas will facilitate in creating possible LNG fuel distribution strategies. The BSR is home to many industrial regions. Within those regions LNG could be used to power the industrial processes as well as being a production component. The map shows the locations of major industrial regions in the BSR.

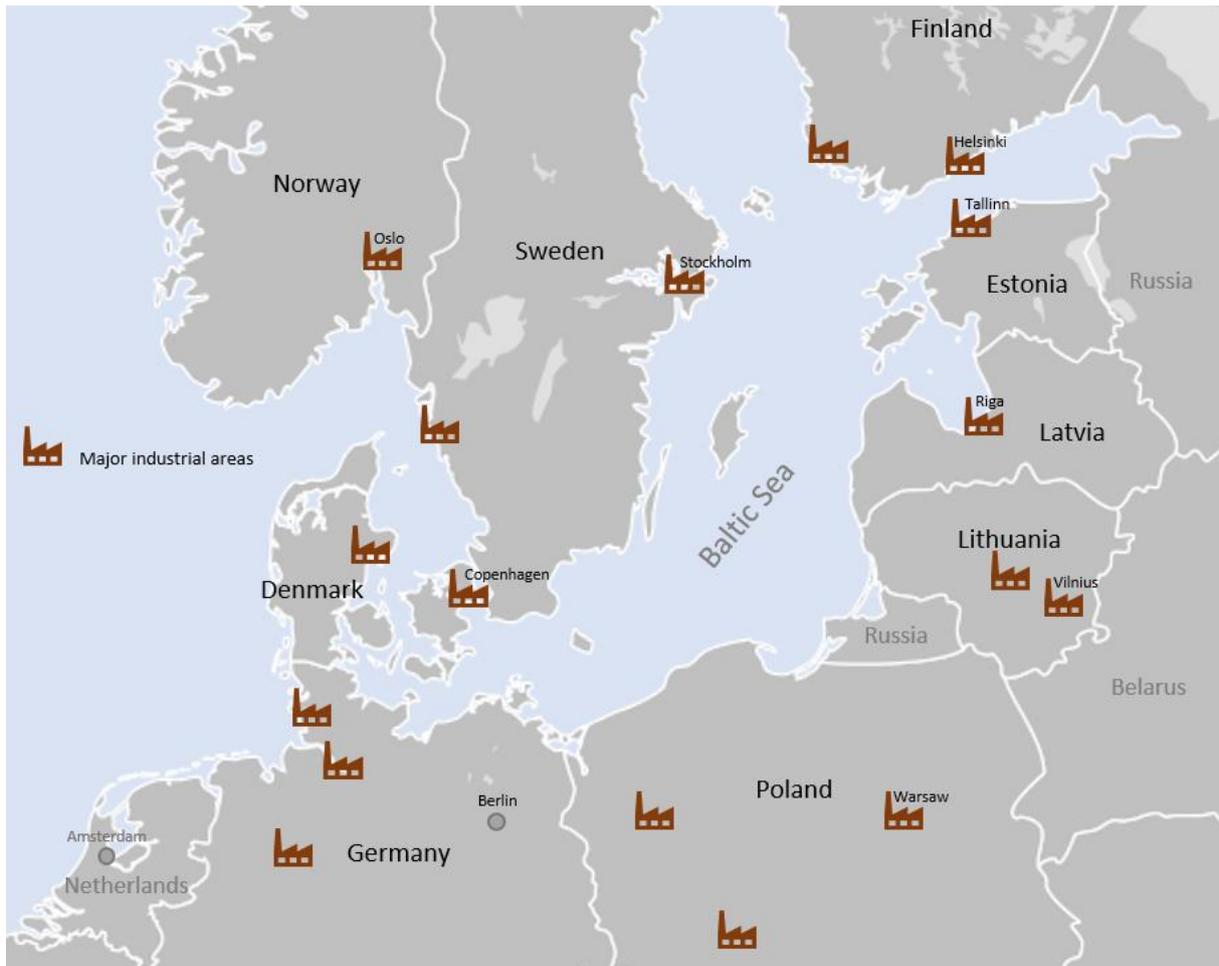


Figure 4 Major industries in the BSR

A LNG infrastructure that can supply the major industrial regions would, at the same time, be able to serve as a fuel distribution network for ship traffic. By linking the existing LNG infrastructure with the industrial regions in the BSR a distribution strategy can be created. In the following LNG fueling strategies for the BSR neighboring countries are identified.

## Poland

The import terminal in Swinoujscie is a very important facility for the BSR since it is one of only two import terminals. The biggest industrial areas in Poland can be supplied with LNG coming through Swinoujscie. From the import terminal LNG can be delivered by truck, train or pipeline to the Polish industrial regions in the Greater Polish Voivodeship, Mazovian Voivodeship and the Lower Silesian Voivodeship. Additionally, ships can use the Port of Swinoujscie to bunker. Imported LNG can be distributed from Swinoujscie and brought to other BSR Core Ports by ship.



Figure 5 Distribution routes for Polish industrial regions

The Polish sections of the TEN-T Baltic - Adriatic corridor and the North Sea - Baltic corridor (highlighted in yellow in Figure 5) play an integral role in the transportation of LNG. On this corridor LNG can be transported to other European countries by train (e. g. with a VTG LNG tank car) or by truck. As an example, LNG transports coming in from Swinoujscie could be brought by train using the existing sections of the Baltic - Adriatic corridor to Poznan and transfer to the North Sea - Baltic corridor going into Germany.

## Lithuania, Latvia and Estonia

Of equal importance as the import terminal in Swinoujscie the import terminal in Klaipėda can supply most of the Baltic countries with LNG. For the Lithuanian counties Vilnius and Kaunas, the import terminal in Klaipėda is ideal for supplying LNG to their industrial areas. There are already companies using LNG in Vilnius County (Lietuvos Dujų Tiekimas and Lietuvos energija).

The Latvian Riga Region and the Estonian Harju County can also be supplied by the import terminal in Klaipėda. The supply by truck, train or pipeline could be an option. Ships heading for or passing the Baltic States can bunker in Klaipėda.



Figure 6 Distribution routes for the Baltic States

The TEN-T North Sea - Baltic corridor serves as the major transport corridor in the region (highlighted yellow in Figure 6). It is on this corridor where LNG transports will be running, either by truck or by train. LNG that arrives in Klaipėda can be brought e. g. by LNG tank cars (train) to industrial centers in Vilnius, Riga or Tallinn.

## Finland and Sweden

Both countries have active small-scale terminals. For Sweden's industrial areas in the Stockholm region additional demand could be covered by the import terminals in Swinoujscie and Klaipėda, however pipeline or truck shipments from Norway could also be alternative options. The Finnish industrial regions in and around Helsinki-Uusima as well as the Western Finland region could also be provided by the two-mentioned import terminals but having their own import terminal would likely be a better option. The Finnish Port of Hamina will get a LNG receiving Terminal which can distribute deliveries to the national gas grid.



Figure 7 Distribution routes for Sweden and Finland

The TEN-T Scandinavian - Mediterranean transport corridor connects the two countries with each other as well as Norway and Denmark. In both countries the two economically strongest regions are connected to the corridor. LNG transports between the two countries or other neighboring countries will fall within this corridor.

## Denmark and Germany

Danish LNG demand could be covered by the existing Swedish small-scale terminals as well as by the import terminal in Swinoujscie. The major LNG traffic in Denmark will come be by ship or on the Scandinavian - Mediterranean transport corridor, which runs through the country. The industrial regions in and around Copenhagen are directly along the corridor. The industrial regions in and around Arhus are not directly connected to the transport corridor, but Denmark has a well-functioning infrastructure overall so that connecting that region should not be an obstacle.



Figure 8 Distribution routes for Denmark and Germany

For Germany LNG routes could be going from Swinoujscie towards the industrial regions in Schleswig-Holstein, Hamburg, Hannover as well as further into the country (not marked), however strong competition would come from the North-Sea side specially from Rotterdam and from an import terminal that is likely going to be constructed in Brunsbüttel. Germany, being in the center of Europe has two transport corridors running through its north. The Scandinavian - Mediterranean corridor connects the country to Scandinavia. The North Sea – Baltic corridor connects Germany to the North Sea including Rotterdam (a major import terminal for LNG) as well as to Poland. LNG transports from Swinoujscie could be transported along the North Sea - Baltic corridor.

## Strategic implementation

After looking at distribution strategies for industrial areas within Europe and possible supply routes for the Baltic Sea countries, the next section will offer concrete LNG implementation strategies. Existing infrastructure will be considered and needed infrastructure will be suggested. The strategies are given for three important means of transportation in Europe, transport by ship (Maritime), transport by truck (Road) and transport by inland water vessel.

### Maritime

In the maritime area the implementation of LNG should follow along the established TEN-T Core Port Network, this is already stated in the European Parliament directive and EU clean fuel strategy. The Core Ports are well distributed throughout the Baltic Sea. They are taking over important tasks, such as offering multi-modality and enhancing cross border connections. It is therefore necessary to create LNG Terminals at each of the Core Ports. They are often in better locations and offer more additional services than Comprehensive and non-TEN-T Ports. In most cases the Core Ports are also the busiest ports of the country. Therefore, LNG facilities at these Port would benefit from high traffic. The following map shows existing and planned LNG infrastructure and additionally displays Core Port locations.

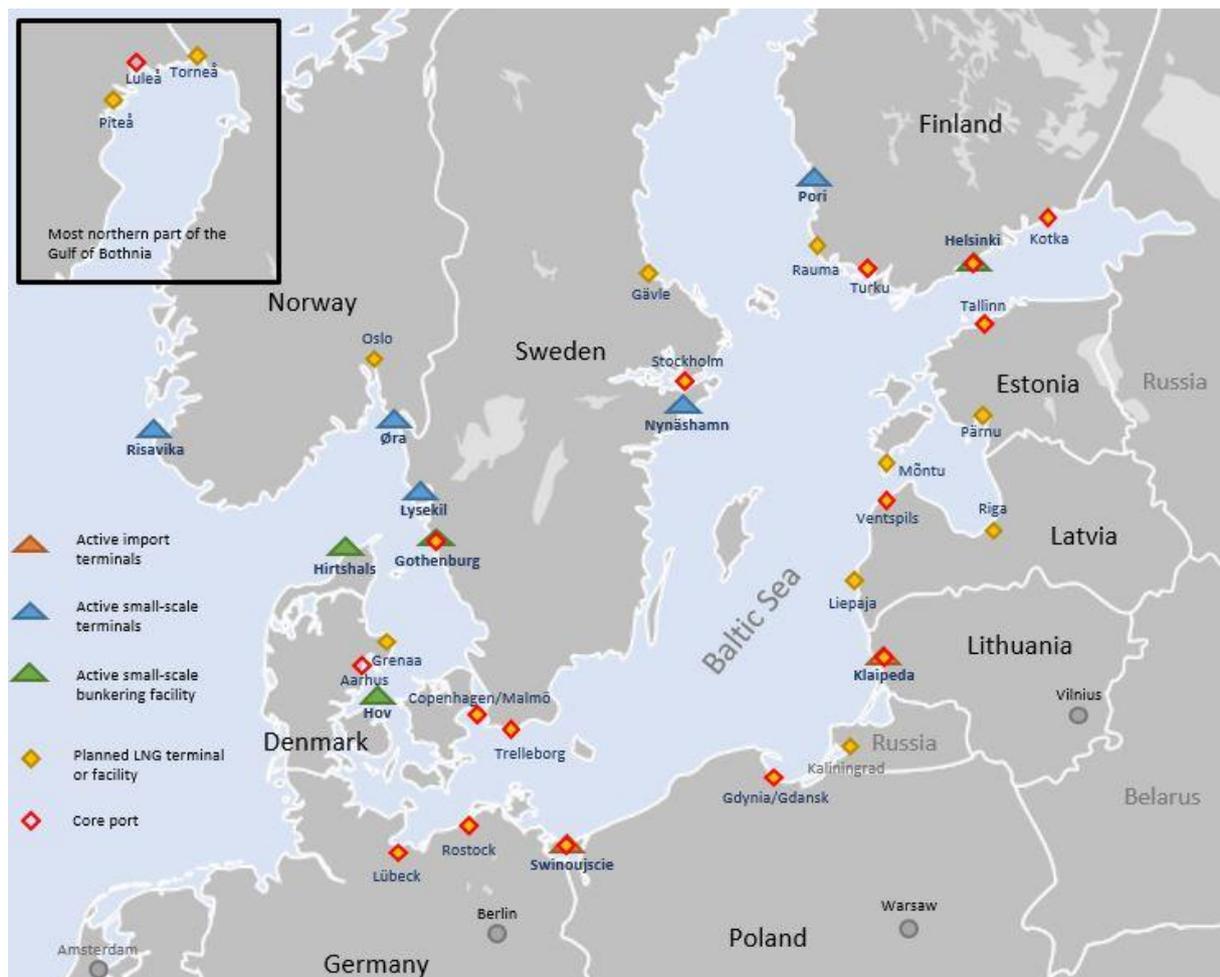


Figure 9 Core Port locations in the BSR

As can be seen on Figure 9, most Core Ports already have some kind of LNG facility installed or in planning. The two exceptions are Aarhus in Denmark and Lulea in Finland; however, both

have LNG facilities in close proximity and therefore the need to additionally build facilities in these two locations is not given.

LNG facilities should be implemented in all the TEN-T Core Port locations throughout the Baltic Sea. With that implementation the Baltic Sea Region would be ideally equipped for LNG traffic. At the same time distribution channels to the hinterland can be started through the Core Ports of each of the countries respectively.

## Road

For road transport it is equally necessary to follow the European Parliament's directive as well as the EU clean fuel strategy. A LNG infrastructure should be implemented along the TEN-T corridors. For road transport it is essential to have refueling points available at least every 400km. The following map shows the relevant TEN-T corridors as well as existing and planned LNG refueling points. Additionally, the refueling points in Bremen (Germany), Poznan (Poland), Klaipeda (Lithuania), Helsinki (Finland) and Stockholm (Sweden) display a radius of 400km. This is to exemplify that a handful of LNG refueling points can theoretically cover the required 400km radius as proposed by the European Parliament.



Figure 10 LNG refueling stations (Trucks) in the BSR; Radius 400km

To have LNG refueling points placed every 400km is sufficient for the basic supply in LNG road transport. However, a larger supply net would be of advantage. Not only would it serve as an incentive for trucking companies to buy LNG powered trucks, but it would also give trucking companies, which mostly serve short range transports, the opportunity to add and use LNG powered vehicles in their fleet. A larger (amount of refueling points) network of LNG refueling points would bring overall benefits for trucking companies, to ports which import LNG and ultimately the environment, because of lower emissions from LNG powered vehicles. The next pictures displays existing or planned and suggested LNG refueling points.

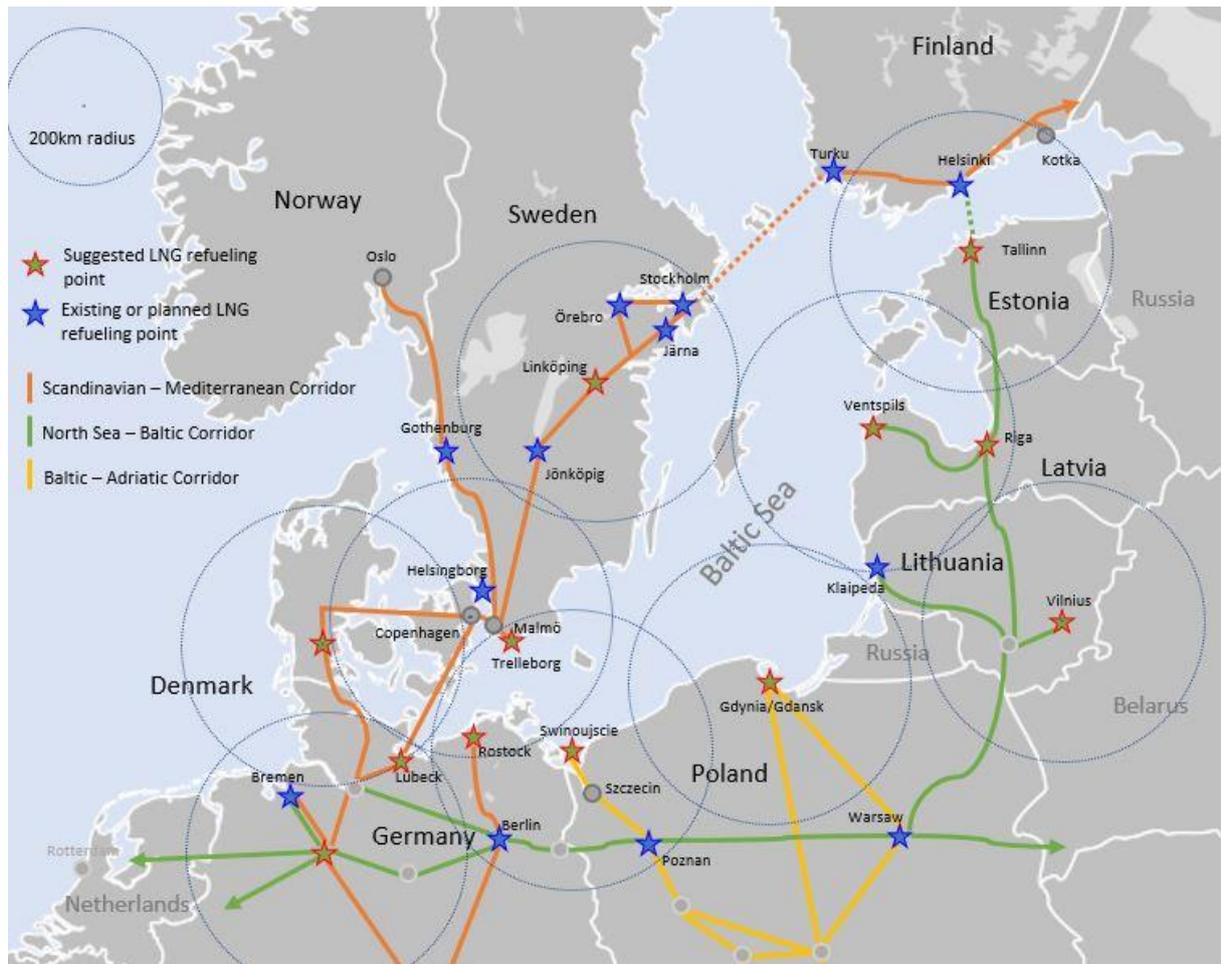


Figure 11 Existing or planned and suggested refueling points; radius 200km

Different to the previous figure here a 200km radius is displayed. Even though most sections of the relevant BSR TEN-T corridors are already covered with LNG refueling points in a 400km radius a 200km radius would bring several advantages as previously described. Besides the existing LNG refueling points it is suggested to build additional refueling points in the following cities:

- Swinoujscie and Gdynia or Gdansk, Poland
- Vilnius, Lithuania
- Ventspils and Riga, Latvia
- Tallinn, Estonia
- Linköping and Trelleborg, Sweden

- Somewhere in the region of Southern Denmark along the TEN-T corridor
- Lübeck and Rostock, Germany

The 200km radius for these locations shows the surrounding areas which, particularly in short distance transports, will profit from a LNG refueling point in their area. By establishing additional refueling points for road transport the flexibility and therefore the willingness for trucking companies to purchase LNG powered vehicles will be largely increased.

### Inland water ways

Inland water shipping coming from the BSR is of less importance than coming from the North Sea. Sweden and Finland have canals leading towards large lakes e.g. the Göta-Canal running from Gothenburg towards the east side of Sweden. In Germany the inland waterway system can be accessed from Lübeck by using the Elbe-Lübeck-Canal. In Poland the river Oder can be reached through Swinoujscie and in Lithuania the river Neman can be accessed, from which inland transports can reach Kaunas. The following map shows inland waterway areas in the BSR.

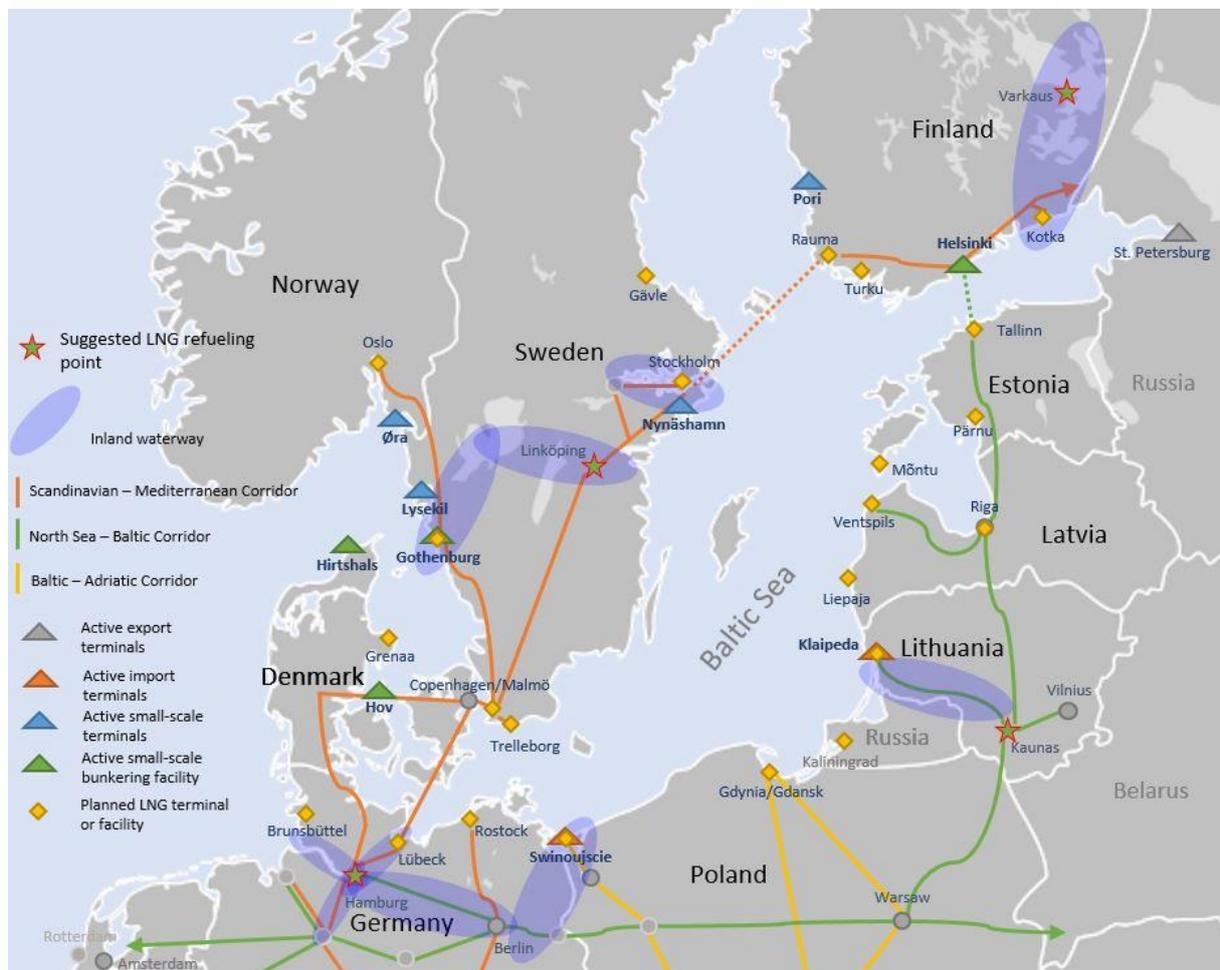


Figure 12 Inland waterway areas in the BSR

As can be seen on the map most inland waterway areas in the BSR are entered at points where a LNG facility is already in existence or is being planned. To build additional LNG refueling points for LNG inland water vessel that lie within the countries is therefore not

necessary. However additional LNG refueling stations will be of advantage and similarly as in the road transport situation, a well-established LNG refueling network will encourage transport companies to purchase LNG powered vessels. In Finland an additional LNG refueling point should be built in Varkaus. The city is an important economic center and of high value for the inland water shipping industry. In Sweden Linköping could serve as a location for a refueling station. Since this location was also proposed for road transport possible symbiotic effects could be achieved. In Germany Lübeck or Hamburg would be suitable for inland water vessel LNG refueling points. Continuing from those locations the vessel can enter the main, high traffic, inland waterways within central Europe. In Lithuania an additional LNG refueling point should be built in Kaunas, mainly for convenience and encouragement for inland shipping companies to take the step towards LNG powered vessel.