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River – Sea Technology in Transport of Energy Products

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ABSTRACT: One of the key conditions to the smooth functioning of the state is its energy security. Most countries in Central and Eastern Europe are dependent on imported energy raw materials from one supplier. In connection with the growing importance of diversification of energy products, technologies and supply routes. Security of supply of strategic energy resources can be better ensured by using far less preferred alternatives. An example would be the use of inland waterways for delivery of energy products to the end consumers and enabling deliveries to places where the geographical, demographic or environmental specificities do not use traditional means.

1 INTRODUCTION

Already in 2005 the Parliamentary Committee on Economic Affairs has raised the issue of increasing Europe's energy dependence. The consequences of this dependence on imported energy resources have proven most obvious in January 2006 and 2009 when natural gas supplies from Russia via Ukraine were dramatically limited and have become an instrument of political respectively economics pressure. Even these cases confirm the fact, that energy security is one of the key conditions of smooth States functioning and globalization is essential to ensure the competitiveness of European economies. At present, only few European countries are energy self-sufficient: only Denmark, Norway, Russian Federation and United Kingdom produce more energy than they consume.

Efforts of European countries is to use as much as possible a wide range of domestic energy sources, but most of countries are reliant on imported oil and natural gas. In this context, it is a considerable problem for several countries of Central and Eastern Europe, which are absolute dependent on imported oil and gas from one supplier.

2 THE IMPORTANCE OF NATURAL GAS FOR ENERGY SECURITY OF EUROPEAN COUNTRIES

Natural gas is the world's second largest energy source. Its share in total energy consumption is now 23% per year, with its growth average of 1.6% per year. Experts estimate the state of natural gas reserves about 511 000 billion cubic meters with a lifetime of up to 200 years. However, there are three types of natural gas sources: proven natural gas reserves, probable natural gas reserves and potential natural gas reserves. There is a proven natural gas resource about 164 000 cubic meters, which its mining is currently available by nowadays economic and technical means with deliverability till 2060. 71.7% of these sources are in land and the rest 28.3% in marine shelves.

Probable reserves are reserves discovered on bearing, exhibiting a very high probability that they will be exploitable by economic and technical conditions similar to those in proven natural gas reserves. Bearings are not technically equipped yet. In addition to the category of proven natural gas reserves, with high probability, we may count with probable reserves. Just because of second resources category sectional transfer into the proven natural gas reserves, there is a still growing amount of proven natural gas reserve and its “lifetime”. The probable natural gas reserves represent more than 374 000 billion cubic meters. World gas reserve (the information of the International Gas Union), taking into account consumption and deliverability of proven and probable natural gas reserves, is 12 to 152 years.

Even EU countries adapt to the general trend of replacing fossil fuels such as coal, lignite and oil well by environmentally more friendly natural gas. The Majority share of the consumed gas in Europe comes from British, Dutch, Italian, Romanian, German and Danish resources. The significant part of the total gas imports come from Russia, Norway and Algeria.

One of the aims of European policy is to diversify sources of energy and transport routes. The most discussed is just the gas. The European Union supports the construction of the Nabucco pipeline, which is considered as a strategically important energy project. Nevertheless, its development is hampered by lack of funds and weak political pressure. Nabucco should have a length of 3400 kilometers and through Turkey, Romania, Bulgaria, Hungary and Austria it should deliver annually 31 bilion cubic meters of natural gas from Central Asia to the EU. Similarly, the BTC pipeline (Baku-Tbilisi-Ceyhan), bypassing Russian territory. It should be completed in 2013, but it faces fierce competition from the planned South Stream pipeline, which develops the Russian Gazprom. The contracted amount of gas, investments, and also agreements with South stream transport countries is the project South stream considerably further than the Nabucco. Even, there were speculations that both projects could be linked together.

The Imports of Russian gas represents about 26% of the total consumption of EU countries. For Central and Eastern Europe, Russian gas is 87% of total imports. For example Slovakia, Estonia, Latvia, Finland and Lithuania depend on 100% import from Russia, Bulgaria and Czech Republic Russian gas covers 94% or 82% of their consumption. In terms of energy for the EU is the primary effort to maintain access to Algerian natural gas reserves, which could reduce dependence on Russia. Algeria's economy is heavily dependent on exports of hydrocarbons (oil and natural gas) –what make up 97% of exports, contributing 30% of GDP and finance 65% of the budget. EU imports 62.7% of Algerian exports, what is 58% of total EU natural gas imports. The weakest link in the chain of gas path from source to final consumer is a long haul. Current technology for transporting natural gas allows long distances through pipelines or tankers in liquefied form. Wide branched European network of pipelines is preferred within the continental gas transport. In the recent past, it was annexed to the undersea pipeline connecting with the sites of customers in North Africa. (Melčák, 2010)

Most gas from Algeria and Nigeria to Europe is transported in compressed form (CNG, PNG) by sea tankers into offshore terminals, followed by distribution pipelines, marine, rail and road tankers. Transhipment and storage capacity of most of these terminals is already at its limits. The solution is either construction of the new ones or substantial increase in inland traffic flows. An appropriate alternative also could be to carry liquefied natural gas (LPG).

Already today, liquefied natural gas contributed 26% of the total trade in gas. Terminals for liquefied natural gas are located in countries with large natural gas reserves. For example: Algeria, Australia, Brunei, Indonesia, Libya, Nigeria, Oman and Qatar. The whole process of natural gas liquefaction is energy-intensive. Energy needed for liquefaction of natural gas equals 1/3 energy of gas liquefaction. However, the liquefaction of gas will achieve a substantial simplification of his carriage. The big advantage is the reduction of its volume in the liquefaction process: one liter of LNG is approximately 600 liters of gas in its natural form, and low storage pressure (up to 5 bar) compared to 200 bar pressure in transport compressed gas in normal tubular pressure tanks.

In 2005, there about 50 for LPG import terminals, worldwide. The biggest receiving terminals in the world are located in Japan, which covers more than half of the global trade in LNG. In Europe, eight countries - Belgium, France, Italy, Norway, Portugal, Spain, Turkey and Great Britain has at least one terminal for processing and storage of imported LPG. France occupies the first place, which imports from Algeria 10 billion cubic meters of gas annually. Further extension of the network of European import terminals are planned or just under construction.

3 SAFETY ASPECTS OF LNG TRANSPORT

LNG transportation safety could be assessed from two views. The first is the danger of explosion and subsequent fire. The second is the environmental aspect. LNG is transported at low pressure. Because of its low temperature, the gas is transported in double-wall tanks with vacuum Perlite insulation. Perfect insulation protects contents from heat and pressure, even if the container gets into fire and lose vacuum. There are known cases where cars transporting the LNG were burnt due to a malfunction of electrical installations, but the tank remained intact. Tanks are designed according to the regulations so they withstand even external fire. There had been no accident relative to explosion or fire in the content of LNG tankers.

There are not known any maritime disasters LNG tankers, which currently operates about 200, or several dozen river LNG tankers, which operates within Europe, in contrast with oil tankers. Compared with diesel and petrol, LNG is significantly safer, but it does not mean that LNG transport is completely safe. It may occur that large LNG amounts can escape from the ship into water. In that case RPT (rapitphasetransition) effect occur. If the liquefied gas, which has a temperature of about -163 ° C will suddenly appears in a warmer ambient temperature, the liquefied natural gas will quickly change over to gas. During this transition occurs massive release of energy, which may cause an explosion.

Ignition of liquefied natural gas needs evaporation in a significant heat input and consequently it is possible to ignite its mixture with air, but only in a narrow range of concentrations from 5 to 15% at 280°C ignition, which is considerably higher value as in the case of gasoline or diesel. Prevention of such cases is associated not only with designing ships for transporting LPG, but also employing skilled crews, trained specifically for such shipments.

Neither from the environmental considerations, LNG transport does not represent increased risk. When the tanker accidents, there is not direct water damage by gas, because it does not accumulate in the water. Damage results from the possible leakage of chemicals or oils, which are necessary for the operation of the vessel, not directly from the cargo content of the LNG tanker. From this perspective, the LNG tanker accident is comparable to any ship transporting cargo safe. Contrary, the part load is vaporized, it is estimated from 0.1% to 0.25% of total amount daily, it can be effectively used as fuel for the vessel. Thanks to that may be used up to 100% of this gas. (Chrz, 2009)

4 INLAND NAVIGATION - SOLUTION FOR COUNTRIES OF CENTRAL EUROPE

The most of the transport capacity of the current fleet of transoceanic ships carrying liquefied natural gas is made up of tankers with a capacity of 120,000 m^3 to 140,000 m^3. Construction of these ships is very complex and technologically demanding. Just only ten producers from all over the world have substantial experience with structures of this type. These include Finland (Kvaerner Masa), Germany (HDW), Italy (ItalcantieriGenoa, ItalcantieriSistri), France (Atlantique, La Ciotat, La Seine, La Trait), Japan (IHI Chita, ImabariHigaki, Imamura, Sakaide Kawasaki, Mitsubishi Nagasaki, NKK Tsu) North Korea (DaewooHanjin, Hyundai, Samsung), Netherlands (Bijlsma), Norway (MossMoss, MossStavanger), Spain (Astana, IZAR PuertoReal, IZAR Sestao), USA (GD Quincy).

Use of inland waterways for transportation of LNG is particularly relevant for landlocked countries of Central and Eastern Europe. Network of inland waterways of the European Union consists of approximately 37 000 km navigable rivers and canals. Interlinking Danube, Main and the Rhine by trans-European waterway was obtained connection of the Black and North Sea with a direct connection to a branched network of waterways of western France, Luxembourg, Switzerland, Germany and the Netherlands. This waterway has become one of the infra-structural priorities of European transport projects, taken within the European transport policy. The decisive goal of this priority is full of this important navigable waterway so that vessels can be transferred once as a group of goods from the North Sea to the Black Sea on the minimum weight of 3000 tons. Overall, the EU has earmarked for this task, the amount of 1 889 million € and from it 180 million € for the route Vienna – Bratislava. A significant amount is expected to use on the Lower Danube for removing ford sections with regard to the transport of heavy bulk items and also items containing dangerous cargo. An equally important activity for the Central European region in this direction is the effort to link the Danube with the North and Baltic Sea by canals and rivers Elbe and Oder. Czech, Slovak and Austrian investors, promote the implementation of project canal Danube - Oder - Elbe in the trans-EU and the European Agreement on main inland waterways of international importance. The aim of this project is connect the missing link in the waterway network and its implementation would allow countries of the region to maximize the gains from trade, including the extension of facilities for transportation of such commodities, such as LNG.

Vessels for LNG transportation by inland waterways have a capacity of 2000 - 4000 m^3, equivalent to 1.2 to 2.4 million m^3 of natural gas. Restrictions on the transport of liquefied natural gas associated with a sufficient bridges clearance on the waterway. Given the low density of LNG (0.45 t / m^3) issue draft of the vessel is negligible.

Maybe there is room for recovery in the recently neglected mixed river - sea technology, whose philosophy is based on the elimination of boundaries between sea and river, which means elimination of transhipment from marine vessels onto river vessels and back. The removing just one transhipment brings considerable economic and time savings. In this case there is no need to build (on the route) any pumping equipment and the ship can navigate from dispatch (liquefying terminal) to a port of destination. By conducted research can be concluded that the use of technology "river - sea" in comparison with separate technologies, "inland navigation" and "maritime navigation" is possible to reduce transport costs about 10% to 15%. Positive effects of this technology appear in connection with the organization of transport, particularly when they are introduced by providing logistical technological scheme "house to house".(Klepoch & Žarnay, 1998)

5 ROLE OF RIVER-SEA NAVIGATION IN THE EUROPEAN INLAND NAVIGATION SYSTEM

At the various international meetings relating to the further development of cooperation among the member countries of the Economic Commission for Europe (ECE) in the context of the AGN Agreement, attention is always given to the important role of river-sea navigation in developing the Pan-European inland navigation market. A number of studies suggest that the establishment of efficient coastal routes would have the following benefits: Transfer of foreign-trade freight traffic to river shipping; Completing the circle, currently broken in places, of category E waterways, linking the deep waterways of the European part of Russia to the network of European waterways of international significance and establishing a pan-European ring of trunk waterways around the whole of Europe; More effective use of the Rhine-Main-Danube trans-European trunk waterway and the pan-European transport corridors; Rendering transport operations more environmentally friendly and economically advantageous, since freight will be conveyed by inland waterways directly into the hinterland; Use of new transport and fleet management technologies and closer cooperation among the member countries of ECE in these matters; Promoting river-sea navigation on the waterways of France, Portugal, Spain and Italy.

The sea section of Don-Dnieper-Danube route is already widely used by Ukrainian and Russian combined river-sea navigation vessels, thanks to the favourable navigation and hydro meteorological conditions along the route during most of the year. Both in Ukraine and in Russia, river-sea vessels have basically been constructed in accordance with the class rules set down in the register of inland navigation vessels in the Russian Federation (the Russian River Register), although there are also a number of models of river-sea vessels which have been built to classes of the Russian maritime register and those of other classification societies.

Thought the closed circuit pan-European waterway system lays also at western part of Europe, the river-sea navigation does not have any tradition there, except in Netherlands. The most of classification organisations of Europe, Germanisher Lloyd, Norske Veritas or Buro Veritas does not have any vessel class designed for mixed river-sea navigation. They have very sophisticated system of classification, but only for river, or maritime vessels.

In the report of the standardization of ships and inland waterways for river-sea navigation, the Permanent International Association of Navigational Congresses (PIANC) recommended the following classes of vessels:

Table 1 Recommendation of basic dimensions of new conception river-sea vessels

River-sea class	Maximum permissible dimensions of vessels			Air clearance (m)
	Length (m)	Beam (m)	Draught (m)	
1	90	13	3.5 or 4.5	7 or 9.1
2	135	16	3.5 or 4.5	> 9.1
3	135	22.8	4.5	> 9.1

In fact, the Russian and Ukrainian vessel types listed above correspond fairly closely to those suggested by PIANC, although a draught of 4.5 metres is unacceptable for the inland waterways along the route in question. Most of the river-sea vessels operated in the Russian Federation and Ukraine do not fully comply with all the height and draught limitations on certain waterways along the route of the future waterway ring around Europe. Accordingly, there is a need to develop new types of river-sea vessels with dimensions that meet the requirements for navigation both along the combined deep-water network of the European part of Russia and the Dnieper, and along the Rhine-Main-Danube route. (Klepoch & Žarnay, 2001)

6 CONCLUSIONS

Energy security is a key condition for the smooth functioning of states and is essential for the competitiveness of the economies of European countries. One of the primary energy sources is becoming a gas. Ensure its stable supply is one of the most contentious issues currently.

Europe has an extensive network of inland waterways that offer relatively inexpensive, efficient, clean and reliable mode of transport. Making more extensive use of LNG systems would enable European countries to take full advantage of the rapidly growing global market of natural gas, to make substantial long-term saving on their energy bill and to optimize storage and back-up capacities to compensate for shortages at peak times or to minimize energy supply shortfalls. Countries with well developed river and canal network, could envisage the development of LNG transportation to end users via inland waterways and thus creating a virtual network of pipelines, which avoids congestion and allows the LNG supply to urban areas, where geographical, demographic or environmental specificities are not suitable for the traditional laying of pipelines.

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