The Concept of Effective Distribution Channels Illustrated By Oil and Natural Gas Mine Barnówko

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Abstract

The article presents the author's project of the distribution of raw materials exploited by the energy industry company PGNiG (Polish Oil and Gas Company) with ecological means of transport. The project has an investment character, and aims to change the transport technology used by PGNiG. Hence, the project stimulates changes in logistics distribution channels and enables to open up new markets for crude oil and natural gas. Technical and operational analysis was based on the determinants of the location of the PGNiG mine in Barnówko. However, the intention of the authors is to show the possibilities of implementing efficient logistic solutions in other locations.

Key words

distribution channels, logistics, transport economics, ecological efficiency

JEL Classification: R42, R40

Introduction

Mining in Poland is experiencing major changes associated with global changes on fossil fuels market. Large fluctuations in demand and market prices for coal, crude oil or natural gas has an impact on the profitability of energy industry. There is a natural market tendency to reduce costs, in terms of the fossil fuels extraction process and the subsequent distribution of them, e.g. lean logistics. In Poland, as in many countries cost-cutting policy stirs up a lot of emotions because often results in the reduction of employment. The technology changes in mining enterprises are less known to the public, though, play a key role in the increase of economic efficiency of production processes.

Cost accounting is the basis for valuation of the product, but for the final customer of crude oil or petroleum products the market price is not a reflection of the actual producer cost. Much more important are the political decisions in the field of global oil market supplies than the real costs of crude oil extraction and transport. Nevertheless, logistics costs are counted by all producers and are the basis for making market decisions.

In addition to direct logistics costs additional external costs associated with the negative impact of transport on the environment should be taken into consideration. These so-called social costs includes: the cost of the emission of greenhouse gases (GHG), noise costs or the costs of water pollution. These costs are partly borne by the mining industry in the form of administrative penalties or compensation fees, but majority of these costs are transferred to the society. However, you can observe a gradual

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incorporation into official budgets a full external costs accounting and there is the trend for increasing the financial burden on the entities generating social costs.

Distribution of energy resources, which are crude oil and gas are today one of the most important investment areas. Transport technologies are developed in order to minimize external costs. This means in practice a greater share of ecological modes of transport. This topic will be further analyzed on the example of the PGNiG (Polish Oil and Gas Company) in relation to mine in Barnówko in Western Poland. The purpose of analysis is to present the new concept of eco-oriented crude oil distribution channel, which has positive impact not only on logistics costs, but it allows opening up new markets of energy resources.

1 Methodology

The main objective of the article is analyse efficiency of distribution channel of oil products based on different means of transport. The case study analysis was implemented which allowed investigation of possible transport technologies and gave arguments for most efficient option. The location of the Oil and Natural Gas Mine Barnówko operated by the energy industry company PGNiG was chosen and following design research has been done:

1. The concept of river terminal in Kostrzyn/Odra River and the supplying pipeline.
2. The concept of adapting the inland vessel class BM-500 to transport liquid cargoes.
3. Benchmarking analysis of economic efficiency of available transport technologies.

The research study was based on a descriptive and comparative analysis based on multiple criteria of efficiency. Technical and operational determinants was taken into account. The scientific investigations included available literature sources in Poland and abroad. Great importance had direct experience of the authors in the field of transport and logistic. At the final stage, method of synthesis was applied on gained results, as to present the theoretical knowledge in the field of the efficiency of the distribution and logistics systems.

2 Results and Discussion

2.1 Description of new distribution channel

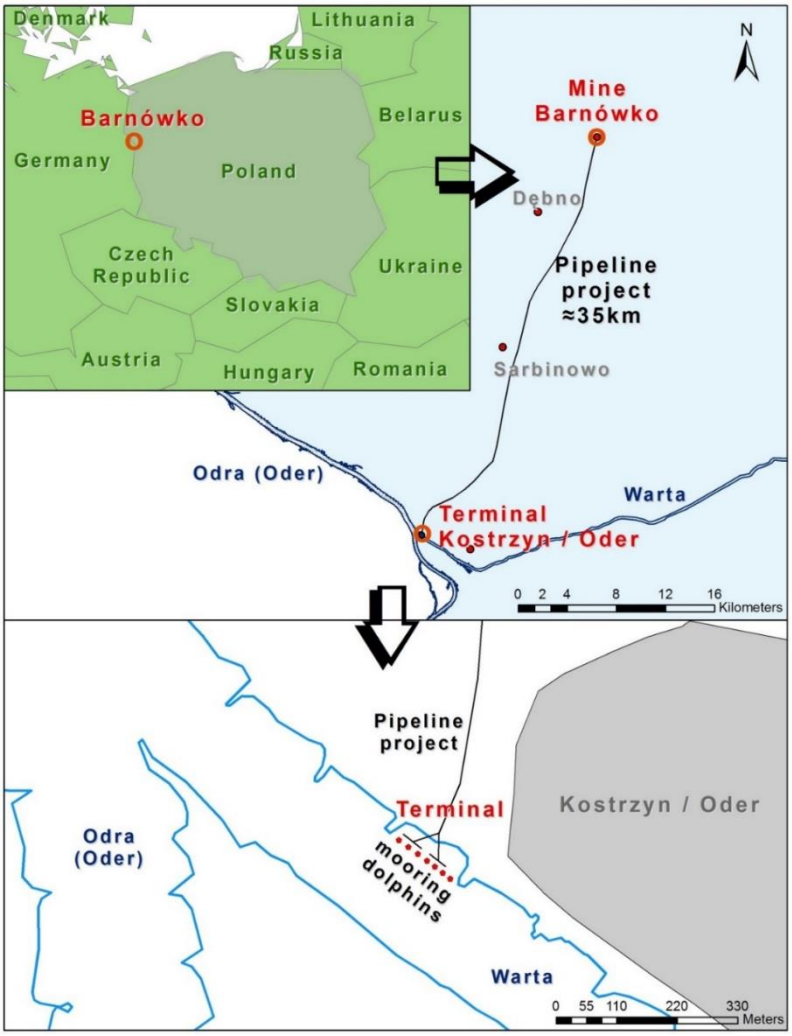
Currently the fossil fuels, e.g. crude oil, natural gas and liquid sulphur, exploited by the PGNiG company in Barnówko are distributed by railway transport. Safety and trade regulation limits the number of destinations to three refineries in Poland. The available railway transport technology includes following stages:

1. Loading at rail siding nearby Barnówko mine,
2. Short rail shuttle connections between Barnówko and railway hub in Kostrzyn/Odra River,
3. Shunting works at rail hub,
4. A long distance domestic railway connections to refineries.

These transport processes are not neutral to the environment, what is important because a large part of the Kostrzyn Region belongs to the protected area Natura 2000.

The key assumption of the proposed new distribution channel is the construction of a river port terminal for liquid fuels located in Kostrzyn/Odra River and pipeline infrastructure linking the terminal with crude oil and natural gas mine in Barnówko (fig. 1).

Fig. 1 Location of the PGNiG mine in Barnówko and River Terminal in Kostrzyn/Odra



Source: own development

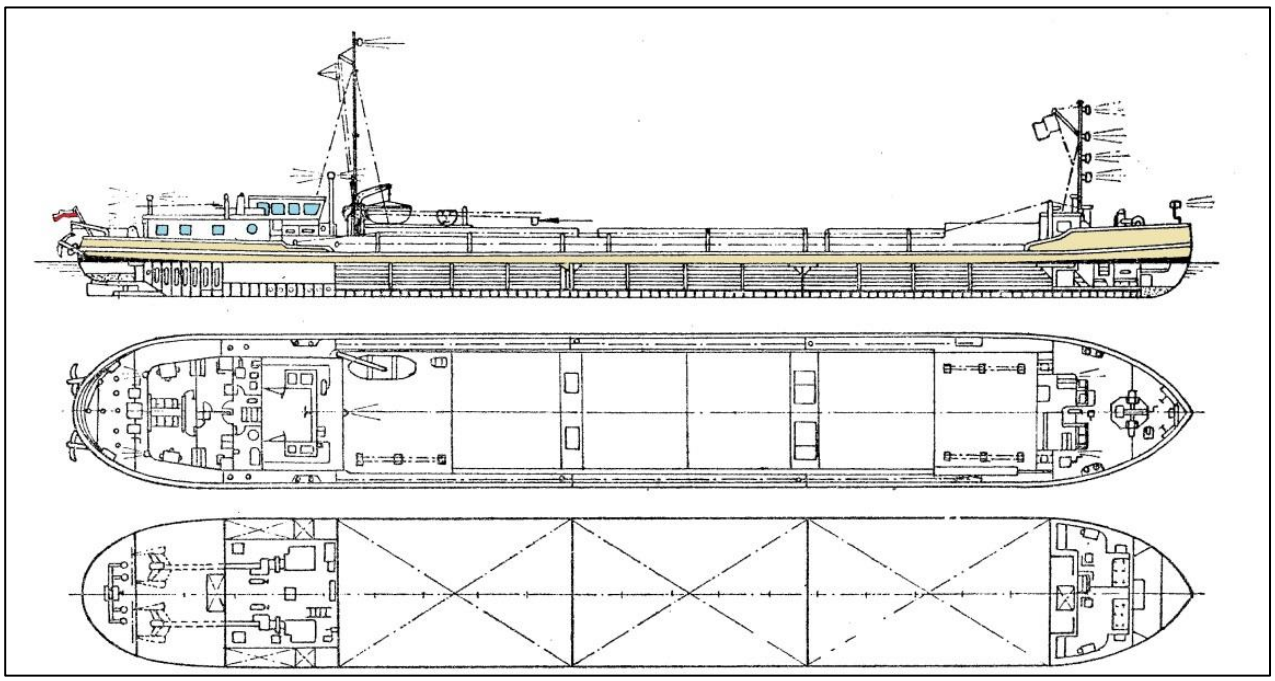
A large amount of extracted crude oil (0.3-0.4 million tonnes per year) justifies the use of pipelines technology in place of ongoing railway services. Significantly smaller mining of liquid sulphur (up to 30 thousand tonnes) requires an analysis of the profitability of construction of an additional dedicated pipelines. An important feature of the new logistic solution is the access to the Odra waterway. Oil supplies from the new terminal in Kostrzyn/Odra River could ultimately be offered for customers in Germany or the Netherlands and Belgium. Optionally, the terminal enables the efficient transportation of liquid sulphur for example to the Chemical Plant in Police near Szczecin Port.

The terminal construction should be cost-efficient and should guarantee the high level of reliability. The terminal should offer the traditional liquid cargo transhipment technologies. The most important demands are quick and safe handling of specialized

inland shipping vessels. The terminal infrastructure may consist of two mooring berths alongside dolphins, system of suppling pipes and land-based control house. Transport in relation mine-terminal will be provided by pipelines of a total length c.a. 35km, structurally adapted for oil cargo transport. Terminal in Kostrzyn/Odra River and supplying pipeline are presented on Figure 1.

The most common vessel adapted to the possibility of waterways transport in Poland is the motor ship BM500 with a capacity of 485 tons of cargo and a draft of 1.8 m (Żylicz, 1979). The silhouette of the ship BM500 is shown on figure 2. A vessel is designed to transport bulk cargo, however there are also models of tankers and ships adapted for container traffic. Barges adapted as a tanker should have bisected cargo space into several sections by transverse bulkheads and additionally one longitudinal bulkhead. This is mainly because of the aspects of safety, robustness and stability of the ship's hull. Currently being built barges are required to have double hulls, tight space of a double bottom and a protective bulkhead that separates the engine from the cargo area. Inland tankers are equipped with a special system of pipes that using their own pumping system allows loading and unloading. It is possible to control the order of unloaded and loaded cargo spaces, in accordance with the terms of the strength of the hull.

Fig. 2 An example of Polish inland shipping vessel BM 500 - load capacity of 485 tons



Source: H. Jędrzychowski, 2011, p.29

2.2 Issues of transport efficiency

Environmental impact of inland shipping

Long-time lack of investment in the Polish inland waterways has led to the deterioration of their operating parameters. Polish transport policy had to be changed after joining the community of nations of the European Union, which has laid great emphasis on the development of ecological branches of transport (Rydzkowski& Wojewódzka-Król, 2007). Tables 1 and 2 shows the advantages of inland waterway

transport compared to road and rail transport, including low carbon dioxide CO2 emissions, low energy demand relative to the amount of cargo carried and the low external costs of transport.

Tab. 1 Comparison of energy consumption and CO2 emissions

	The demand for energy in transport of goods Consumption of fuel per 100 tonne-kilometres [l]	The distance at which you can carry a ton of cargo at the same energy input [km]	Emissions of carbon dioxide CO2 [Gram to 1 tonne kilometres]
Inland Waterways Vessel	1,3	370	33,4
Train	1,7	300	48,1
Truck	4,1	100	164

Source: own compilation based IFEU (2013)

Tab. 2 Compilation of external costs of transport

The cost in euro per 100 tonne kilometers	Air pollution	Accidents	Noise, water pollution, soil pollution, etc.
Inland Waterways Vessel	0,17	0,005	0,005
Train	0,16	0,06	0,36
Truck	1,21	0,92	0,44

Source: own compilation based IFEU (2013)

Economic analyses indicate that the per unit cost of transport work are as follows: road 72, rail 19, and inland waterways 17 [EUR / 1000 tkm]. Despite this changes in transport policy implementation of inland waterway transport units are still difficult. One of the few "navigable" sections of inland waterways in Poland is the Lower Odra River and therefore it was decided to choose the location Barnówko. Inland Waterway at an altitude of Kostrzyn/Odra River has a III class of a navigability and complies with the minimum cost for the transportation of cargo by water (depth of 1.8 meters for 80% of the days in a year). The current operating parameters of the waterway enable cargo transport from Kostrzyn to the north to Szczecin and the Baltic Sea or west through Berlin and the German waterways into for example Magdeburg, Hamburg, Hannover, Dortmund, Rotterdam etc. The situation in Poland will improve after the implementation of the long-planned investment plan covering Odra waterway. It is planned to achieve III waterway class on the so called border Odra River providing regular floating navigation by ensuring 1.8m for 90% of the days in the year and will enable the transportation of goods west through another German waterway (Odra-Spree).

Poland will be able to take full advantage of connectivity to the network of European waterways. In the longer term it is planned to revitalize the rivers: Vistula and Warta. Inland waterways should therefore gradually take-over of the bulk cargo to large and medium distances, in particular dangerous goods. These can also be crude oil and liquid

sulfur extracted by PGNiG in mines lying a short distance from waterways, for example mine in Barnówko.

Allowing the use of inland waterway vessels to carry cargo from the mine Barnowko would be an innovative and pioneering action for the development of ecological and safe transport. Changes in distribution logistics enterprises will create new markets for energy resources. In the long term it is possible to use solutions described in other locations.

Safety of pipeline transport

Pipeline transport is the most reliable, safest and cheapest transport mean dedicated for large quantities of liquids cargo and medium to long distances (Omonbude, 2007). From the point of view of economic efficiency the essential is the fact that pipelines allow cargo transport almost without any break, i.e. 24 hours a day, for all seasons of the year and in all weather conditions. This high reliability and guarantee of service is an extremely important factor in the contemporary market competition. None of the alternative modes of transport can offer the similar conditions of transport services so beneficial for the clients. Other important advantages of pipeline transport include:

1. operational cost operating costs are low and mostly apply to the energy cost needed to power the pumps.
2. lack of exhaust and noise emissions and minimum ground occupancy,
3. significantly less labour is required comparing to other transport modes,
4. minimal safety risk mitigated by automated monitoring systems, e.g. leak detection system.

The above arguments are very favourable for pipeline transport choice. However, one should be aware of this mode of transport limitations. The most important is the high investment costs and low speed of cargo transportation. The first important economic factor must be taken into account at the planning stage of an investment. In practice, the profitability of pipeline transport system depends on the total cargo mass to be transported. The second operational factor is a significant constraint for elasticity of cargo supplies. In the case of crude oil in the pipeline flow velocity is 3-8 m/s, which means that this is the slowest mode of transport compared to road or rail transport (Cerda, 2008).

Pipeline transportation can be considered very safe, although this requires further explanation. Statistics from the USA transport market shows that spill-related incidents or other type of release of harmful substances incidents are relatively less frequent in the case of pipeline transport compared with alternative modes of transport (tab. 3). Unfortunately, any pipe untightness involves a large amount of cargo discharged. Hence the negative effects for the environment are usually enormous and very costly. Fortunately, in this type of events very rarely people are affected.

Tab. 3 Comparative statistics for petroleum incidents in USA in 2005-2009

	Transport volume [ton-miles per year]	Incidents per year	Incidents per mld ton-miles	Product realise [gallons per year]	Realise per incident [1000 gallons]
Road	34,8	695	20,0	477,5	0,7
Rail	23,9	50	2,1	83,7	1,7
Pipeline	584,1	340	0,6	6592,4	19,4

Source: D. Furchtgott-Roth, 2013

For the crude oil transport in Barnówko-Kostrzyn relation application of piping transport seems fully justified from economical pint of view. The determining factor is a cargo mass transported of up to 0.4 million tonnes per year. A short transport time is not required but continuity and certainty of delivery is rather required. Security, in the context of spillage prevention should be guaranteed with the most modern monitoring systems.

Conclusion

Efficient energy supplies are crucial for the effectiveness and safety of the entire economy. It is important to ensure continuity, flexibility and cost-effectiveness of the supply chain. However, it is important to minimize the negative impact of transport on the environment, measured in so-called external costs. Considering the liquid supply of raw materials (oil, liquid sulphur and natural gas) the highest efficiency provides transport via pipelines and then via waterways and rails.

The use of more sustainable modes of transport such as inland waterway transport is a direct adaptation to strategic trends of transport policy of the European Union, putting emphasis on increasing the share of environmentally friendly transport modes. The proposed solution is to adapt logistics schemes to this strategy in the economic area where this is particularly difficult, i.e. crude oil and natural gas mining industry.

The case study of PGNiG mine in Barnówko shows the possibility to achieve the benefits of lower transport costs of crude oil by usage of ecological branches of transport. The proposed new logistics chain allows to minimize the risk in the supply chain what is very extremely needed for the market of energy. Other economic benefits of the proposed changes in the supply chain include:

1. lower operational cost by reducing necessary labour,
2. no additional cost with obtaining high technological reliability,
3. minimum compensation cost associated with the harmful emissions.

There are possibilities of implementing efficient logistic solutions similar to one presented in other locations. The process of expansion or modernisation of existing factories and mines should aim to reach for new logistics opportunities like the adaptation of the available „green modes of transport", in the presented case the inland waterway fleet. What is important, the case shows that the achievement of the ecological strategy objectives are not necessary related to the large investment efforts.

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