Introduction of green logistics into energy supply chain in Poland

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Abstract: - The concept of green logistics is based primarily on protecting the environment and more efficient use means of transport. Due to the fact that the Polish energy sector has a negative impact on the environment and within its supply chain mode of transport is used which has a negative impact as well, the sector is under investigation in this article. Briefly presents the essence and characteristics of green logistics in Polish energy sector. Then bulleted items in the supply chain were to have the greatest negative impact on the environment. The rest of this article describes the proposals to implement the solution that will meet the practical implementation of green logistics objectives.

Key-Words: - logistics, green logistics, supply chain, power plant, energy sources, cola, lignite

1 Introduction
Green logistics is still a new concept, for the first time this term has been used in the 90-ies of the last century. Up until now, has not been formulated, one specific and current definition of the term. Scientists from many countries give different dates and the terms determining what green logistics is. Most green logistics is defined as non-harmful logistics system and the running efficiently system on tasks and processes occurring in it without too much interference [1]. Some define green logistics as caring for the environment a system that not only performs assumptions green logistics in the process of supply, production, storage and distribution, but it also applies to the so-called reverse logistics, which deals with the subsequent stages chains from waste or worn things [2]. American Reverse Logistics Executive Council (RLEC) defines green logistics as: „attempts to measure and minimize the ecological impact of logistics activities” [3]. RLEC compares the green logistics with reverse logistics, according to the idea that a reverse logistics is the process of movement of products and their packaging of their place of consumption to the point of their creation, and its main aim is to re-granting of such products or processes subject to the disposal or redeployment. However, the above comparison it can be assumed that the reverse logistics is part of the green logistics, as green logistics, in its essence covers the entire supply chain - both the traditional, from the acquisition of raw materials to the point of delivery to the end users as well as their consumption back to the place of their formation.

Some of the researchers, make a connection between the green logistics and sustainable development conception, which allow to define a green logistics as „process of plan, manipulation, management and implementation for logistics system by advanced logistics technology and environment management oriented at the aim of reducing pollutants emission and resources consumption” [4]. However, the main pillar of green logistics concerns the environmental protection and more efficient use of transport.

Having this in mind, it can be assumed that the concept of green logistics offers solutions that can be implemented in the supply chain of Polish energy sector, the characteristics of which are presented later in this article.

2 Energy Supply Chains in Poland
Polish energy sector relies heavily on coal and lignite, caused by the fact that Poland has huge deposits of these sources, also energy produced from coal is relatively cheap. On the other hand, the production of electricity based on coal and lignite, has a large and negative effect on the environment. The share of energy which is environmental friendly is less than 5%, but by the 2020 Poland will be trying to realize the aim of increase this share up to 15%, and by 2030 this share is expected to be 20% [5]. Despite the fact that the consumption of coal in
energy production is reduced every year, it still differs from the average of the European Union. These differences apply to all energy sources, but the biggest difference is seen for the use of coal and lignite, it is clear that in Poland, this is the main source of energy. Other energy sources used to produce energy are gas, water and wind energy. The current use of water in energy production is about 1%, and despite the fact that it is estimated that the potential of rivers for energy production in Poland is not high, it is used only in 17%. In addition, the forecasts of energy, do not show that the use of water as an energy source would be increase. In the European Union, the largest share of energy carriers such as nuclear energy, gas, water and coal (average of about 20% each) [6].

The large percentage of coal use in the production of energy in Poland, leads to the production of vast amounts of atmospheric pollutants and solid waste. In addition, there are some amounts of the isotopes of uranium and thorium which come to atmosphere and contribute to the contamination of the environment. However, when such a large amount of carbon is burned, they might cause an increase the radiation in the environment.

The most commonly used renewable energy source, in Poland, is biomass. Biomass is the oldest and most widely used at the same time a source of renewable energy. Historically, biomass has been utilized for centuries in the rural economy as firewood or as organic waste. Biomass is a waste from households or seasonal pruning residues greenery. Biomass is an organic matter, which includes all substances of plant or animal that are biodegradable. Biomass also includes residues from agriculture, forestry and industrial and municipal waste [7].

Due to the fact that coal and lignite are the most commonly used raw materials for the production of electricity, the structure of energy supply chain is presented below.

![Supply chain in energy sector](own elaboration)

As mentioned earlier the main raw material used to produce electricity and heat in Poland is coal and lignite. It is mined in the mines, where the highest density is located on the southern Poland, due to the fact that these areas are rich in these sources. After mining, coal is prepared for transport and sent to the power plant. The most common mode, used for transportation, is car or rail. Rail transport is used when both, the mine and the power station, have its own railway siding. However, even if the siding is, at present, the main mode of transport used for the carriage of coal is road transport, for reasons such as the lack of an adequate offer addressed to the power station and mine. Road transport also allows for a very detailed planning of deliveries resulting in a smaller amount of raw material that is stored and as a decrease in costs associated with the storage of raw materials. Then the coal goes to power plants, which is subjected to a combustion process which result is a heat and electricity. A by-product of this process greenhouse gases and ash as a waste. The last step is the distribution of electricity and heat to businesses and individual customers.

### 3 Negative Impacts on Environment Caused by Power Supply Chain

Structure of the Polish energy system and associated supply chains, is characterized by its negative impact on the environment. These negative developments are taking place in the first cell of the supply chain:

1. The environmental degradation caused by mining activities. Extracting coal mines has negative consequences not only in water but in the whole structure of the soil which may interfere with the process flow or groundwater storage. In general, the activities of the mines can significantly affect the underground water tanks and as a result lead to drying and hence the difficulty in obtaining water, both industrial and drinking water.

2. Mine activity also affects the surface of the Earth. Due to the fact that the Polish mines are principally engaged in underground activities, contribute to the movements and changes in the structure of the Earth and cause the changes on the surface. This, in turn, leads to a breach of the foundations of the buildings, the formation of landslides and the collapse of the road or sidewalks.

3. With the mines activity mines waste are strongly connected. Wastes arising from the extraction and processing of coal can be divided into two groups [8]: Mining waste, or waste rock mined during the preparatory mining work, allowing for access to the mining of coal; Tailings, waste rock or derived from the floor-mounted railways and roof
coal, and from coal hypertrophy. The amount of waste generated during mining and processing of coal is directly proportional to output, for each 1 ton of coal mined for about 0.4-0.4 mg of waste. In Poland, formed about 16-30 million per year of waste from coal mining. The data for the year 2010, produced 41.408 million Mg of waste, of which 75.8% came from coal mining.

4. Water pollution caused by the extraction of raw materials and their subsequent purification. Extraction process not only results in huge water consumption but also contributes to an increase in the amount of process water. Water pollution is generally caused by: a) mining activities, b) rinsing raw materials, c) leaching of rocks, d) mines waste. All these factors make the water that enters the large amounts of heavy metals and other pollutants, which then has a negative impact not only on crops and animals but also on humans.

5. Air pollution is mainly caused by the gases which are formed by the combustion of raw materials for the production of electricity or heat. These compounds are carbon dioxide, dust, oxides of sulfur and oxides of nitrogens. In 2010, the volume of carbon dioxide emissions caused by the activities of the Polish energy sector amounted to around 192 598 tons. Emissions of other compounds are shown below:

![Fig. 2. Air pollution caused by polish energy sector in 2010 [9].](image)

The above figure shows that the largest share of air pollution are sulfur oxides and the smallest ashes.

6. All energy source materials are transported by road transport. This mode of transport, in addition to the advantages such as high road density and the ability to accurately determine the time of transport, it also has many disadvantages, including land consumption, environmental degradation caused by the construction of new roads and threats to the species. However, the negative impact of road transport on the people is manifested exposure to noise and vibration caused by trucks. In addition, road transport emits large amounts of compounds into the atmosphere, where the amount in 2010 is shown in the following figure:

![Fig. 3. Pollutant emission from road transport in 2010 [9].](image)

And the level of carbon dioxide emissions caused by transport in 2010, amounted to 26,403,760 tons.

After analyzing the supply chain, it can be highlighted the places where the implementation of green logistics elements can bring tangible results and benefits.

### 4 Green Logistics Main Elements in Energy Supply Chain

Despite the negative impact on the environment, caused by Polish energy sector, Poland cannot completely abandon coal and lignite as the main raw material used to produce electricity and heat. This is due inter alia the presence of rich deposits of gas, which causes that the energy produced from coal is the cheapest energy today. A view of the fact that Poland is still a developing country, the cost of mining, energy production and distribution is still the determinant of the use of conventional energy resources. This causes the implementation of the solution of "closing the mines and stop all mining operations" is now impossible. It also causes that despite the increasing share of renewable resources for energy production, the main raw material are coal and lignite. However, in spite of the energy supply chain, we can identify the place where it is possible to implement solutions which are compatible with the concept of green logistics:

1. Recultivation and restoration of land through appropriate technical and biological treatments, and so restoration, which includes: formation of embankments, fertilization and cultivation, introduction of green vegetation, afforestation, regulation of water, construction of access roads.

2. Mines waste can be transfer red to the enterprises which is dealing with this type of waste. One of the products obtained by the company as a result of mining waste are aggregates, which are...
characterized by low water absorption and low frost resistance. Obtained from the processing of extractive waste, aggregates are used [8]:
- In civil engineering – the construction of embankments and hydraulic transport, earthmoving, and strengthen the exchange of land, construction of water reservoirs and embankments settlers;
- In the cement industry;
- In the production of building ceramics;
- The reclamation of degraded land;
- To construct, and cover the bowl layered landfills;
- To backfill excavations.
Aggregates can also be used to build into layers and layers of improved surface roads reinforcing heavy traffic load.

In addition there are new directions how the mining waste can be used. These directions, has not yet been fully utilized, but it offers the potential to increase the waste stream which will be subject to the process of recovery:
- underground mining techniques:
  a) hydraulic backfills,
  b) elimination of unnecessary excavations,
  c) reconsolidation rubble infarct,
  d) caulking gobs,
- Production of lightweight aggregate,
- The foundations of roads,
- For hydraulic structures,
- Use as elements of mortar, concrete and pavement,
- As a raw material filling materials,
This waste can also be used in the prevention of fire due to the low level of flammable substances.

3. In order to reduce the level of pollutants in the atmosphere, dedusting, desulfurization, reduction of nitrogen oxides and the exhaust gas to the atmosphere, can be used. In thermal power plants, the following types of equipment and dust collection are mostly used:
- electrostatic,
- mechanical dust collectors,
- multi-stage dust collectors.
One of the major limitation of emissions of sulfur oxides in energy sector is desulphurization of flue gas. Depending on the method of desulfurization of sulfur emissions can be reduced by 30% -40%. The methods can be divided into non-waste, waste of useful and useless waste.

In order to reduce the formation of nitrogen oxides, the temperature of the flame kernel is reduced, to reduce the oxygen content in the combustion zone and to shorten the residence time of fuel in the high temperature zone rule. One method of reducing emissions of nitrogen oxides is also appropriate adjustment of the combustion process in a boiler system [10]. Reducing nitrogen oxides can be achieved in two ways: by reducing the amount of nitrogen oxides produced in the combustion process (primary methods); and caused by the removal of nitrogen oxides from the flue gas before entering the boiler to the chimney (secondary method). Through this process reduces NOx emissions by as much as 50%.

4. The use of cogeneration systems that promote environmental reflecting the application of the principle of best available technology does not cause excessive costs.
They provide both cost savings – fuel savings and environmental [11] – lower fuel consumption is equivalent to a lower emission of greenhouse gases from combustion of fuels, as well as other products, such as ash and slag.

To produce the same amount of electricity at power plants and heating plants need heat to 50% more fuel than cogeneration. Production of electricity and heat in cogeneration power plants will enable the reduction of emissions and related costs due to fewer consumed in the production of coal.

5. In the case of transport [12] used to transport raw materials, the following solutions can be entered:
- The adoption of an appropriate strategy which seeks to minimize the negative impact of transport on the environment - they can rely on for example the introduction of combined transport - use of rail and road transport together;
- Adequate loading and transportation of energy resources, adequate safeguards to prevent losing a cargo capacity levels are not exceeded;
- Creation a local energy distribution centers [13], which would be collected supplies from local suppliers (for biomass) and then assembled into a larger shipment, and transported to the final power plant. Such a distribution of energy resources can be located near the railway traction which would allow at least partial use of rail transport;
- The implementation of appropriate systems, which would be responsible for the planning and delivery of shipments;
- From the regulation, the elements of green transport logistics include EURO standards that are imposed on carriers that use road transport to reduce emissions of pollutants into the atmosphere. In 2013 the new standard will be introduced EURO 6 which imposes obligations to reduce emissions of nitrogen oxides by more than 60% and hydrocarbons by 23% compared to current Euro 5.
4 Conclusion
The above solution, cause not only reduce the negative impact on the Polish energy sector natural environment, but also in part implement the concept of sustainable development objectives - because the end result of these actions will also have positive effects on the economic and social development. Rehabilitation of degraded lands will improve the quality of life the next social environment. Companies operating in the extractive waste management could achieve positive economic effect as well. However, the assumption of a green logistics is all about protecting the environment and efficient use of transport. The practical implementation of the above proposed solutions in large part enable it to practical use.

References: