CHANGES IN ENERGY SUPPLY STRUCTURE AS AN EXAMPLE OF GREEN LOGISTICS CONCEPTION REALIZATION IN POWER PLANTS

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Abstract: In a classic view, logistics processes occurring in the energy sector are often presented in the form of the supply chain whose beginning is a power plant. This causes that the issues related to the "green logistics" and "sustainable development" are usually refer to processes such as energy production by power plant, distribution and final recipients - households and companies. One of the pillars of the "green logistics" concept is the issue of air emissions; this article presents the essence of "green logistics" in relation to biomass, which is the energy source from the group of renewable energy sources used for energy production. However, is characterized by a small participation in the general structure of energy resources used by polish power plants. Biomass as an energy source constitutes the object of the procurement process, which main aim is to provide an energy source for power plants, and is also the subject of energy in the manufacturing process which produces waste and pollutants emitted to the atmosphere. The following article presents how a change in the structure of energy sources used to produce energy, can lead to a positive effect of expressing the change in the level of pollution and waste generated by power plants.

Keywords: logistics, Green logistics, biomass, energy sector, waste, emission

1. The essence of Green Logistics

Traditional logistics is considered as managing processes aimed at moving products within the supply chain. Of course, there are many various definitions of logistics, but take it in a simply way - in the case of common products or goods, the supply chain starts at the point of extraction of raw materials needed to produce the final products or goods, from the original supplier. Then, moved to the production stage and the distribution which leads to the point where the products or goods reach the final users and after their use are become to be a subject of reverse logistics. Logistics activity includes the transport, warehousing, inventory management, material management, together with all other processes.

Typically, logistics is seen as the actions of which the objective is to minimize costs and maximize profits. The term was used mostly in purely business areas exhibiting companies and in financial reports. But, for many years, the term logistics is used in conjunction with the "green" by creating "Green Logistics" - the term containing costs, yet do not appear on financial reports and on the environment and society. Over the past 40 years, "Green Logistics" represent a lot of nature trails, the most distinguishable as follows:

- Reduction in transport costs,
- Urban logistics,
- Reverse Logistics,
- Logistics strategy for the company's environmental,

- Green supply chains

Currently, the term "green logistics" is often used interchangeably with "reverse logistics", but in contrast to the reverse logistics, green logistics „*summarizes logistics activities that are primarily motivated by environmental considerations”.*

Fig. 1. Comparison of reverse logistics and green logistics.

Research conducted by J. P. Rodriguez revealed that the terms "green" and "logistics" very often stand in opposition to each other. The term "logistics" strategy involves leading companies to minimize the cost of logistics processes, and this often results that the issue of environmental protection is often overlooked. An example is the use of air transport as the fastest way of goods movement and commodities, allowing to minimize storage costs, but at the same time, this type of transport generates huge amounts of carbon dioxide into the atmosphere. Another example would be the use of packaging which are produced at a low cost, but after its use, they reach landfills where they break down for hundreds of years, for example - plastic bags in supermarkets. This causes that between "green" and "logistics" some paradoxes have occurred, which in addition to these examples, refer to the cost, time, availability, size, storage, and e-commerce.

The research conducted in the area of logistics, green, usually focus on three dimensions:

1. Public to private - initially most of the research was conducted by government agencies, they were forced by the lobbyist organizations that wanted to force governments to act to mitigate the negative effects of transport. Apart from the state sector concerned in this subject, the company from the private sector have joined, also engaged in research on Green Logistics. At that time, corporate strategies have been formulated for the protection of the environment, both for the company and its activities in the area of logistics,
2. Operational to Strategic - a trend that has extended the involvement of companies in the Green Logistics, initially, they have committed to several changes aimed at protecting the environment, and ran toward the implementation of important issues concerning the environment strategy for the whole area of activity,
3. Local to global - in the years 1960-70 main problem was the extent to which local businesses affect the environment - air pollution, noise, vibration and traffic accidents. However, the same issue but on a global scale, was not discussed. However, in 1970, some models of climate change led to conclude that the Earth is waiting another ice age. Acid rain and the widening ozone hole that not only vindicated the logistics but also other aspects of the business may affect the environment globally. Currently, the impact of logistics on the environment on a global scale is a major goal of current research.

However, particularly the green logistics concept is based on reducing the level of pollutant emissions into the atmosphere as well as the use of more efficient transport modes, which is also reflected in the level of emissions generated by the transport means.

Later in this article, will be presented characteristics of the Polish energy sector and the results of studies carried out in two power plants will be presented. The research are connected with the increase of energy from renewable energy groups used in the general structure of energy resources share and their impact on the level of pollution caused by energy production.

2. The characteristics of polish energy sector

The energy sector is a very important component of national economic activity, and to fulfill energy needs is one of the conditions for its development. However, despite the importance of electricity, it is not a good accessible to everyone, energy is a product and the final recipients are the customers on the electricity market.

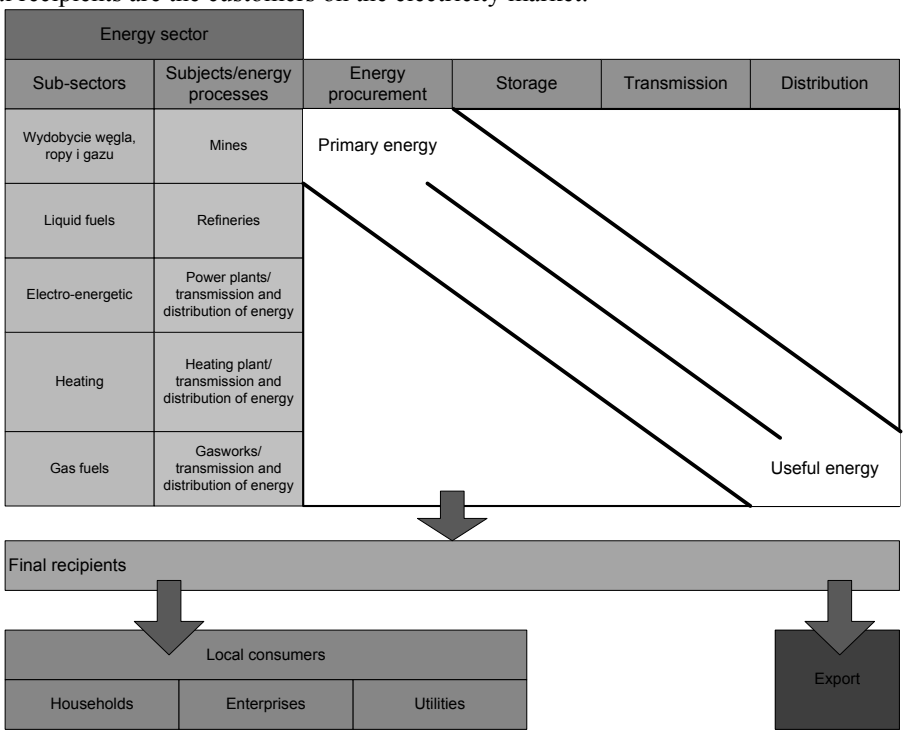


Fig. 2. The Polish energy sector scheme.

The figure above shows subsectors connected not only with the various types of energy sources but as well as the scope of activities by various energy subsectors has been presented. Since this scheme takes into account the resources and the energy produced by national power plants, the imported fuels have not been taken into account.

In Poland, the energy market was established at the time of the entry into force of the Energy Law in 1997. This Act defines the principles of the national energy policy, introduces the principles and conditions for the supply of energy and the use of fuels used in the energy sector. The Act also specifies the authorities that deal with issues of fuel and energy. The purpose of this Act is to "create the conditions for sustainable development of the country, ensuring energy security, economical and rational use of fuels and energy, the

development of competition, the negative effects of natural monopolies, integrating environmental protection requirements, obligations under international agreements and balancing the interests of energy companies and consumers of fuels and energy. "
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%. 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.

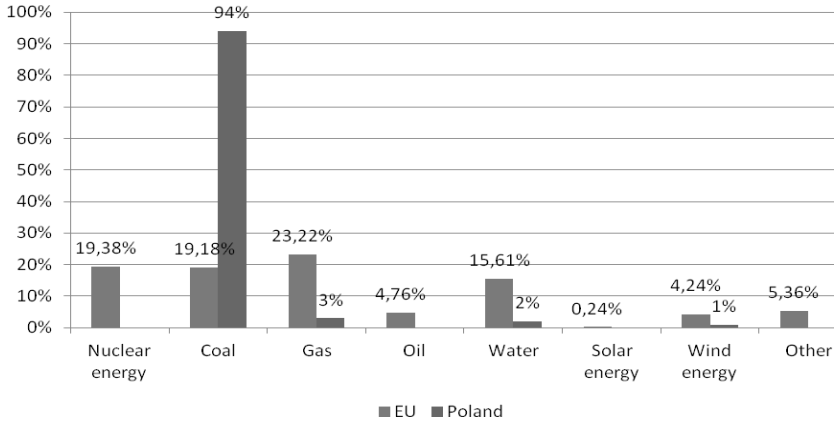


Fig. 3. The share of energy sources used in Poland and EU countries (2010).

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).

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.

Due to the above fact and the fact that Poland has committed itself to achieving the

objective: "Reducing greenhouse gas emissions by 20% - to that end, to a minor target 20/20/20: besides the above reduction in greenhouse gas emissions by 20%, also includes increasing the share of energy from renewable energy sources by 20% and 20% increase in energy efficiency", biomass as an energy source has been the subject of the research, presented in the further part of this article.

3. The impact of increased share of biomass on the pollutant level emission

To conduct the research, two polish power plants were chosen, both of them use coal and lignite as the main energy sources and the share of biomass using does not exceed 10%. The first Power Plant was designed as a power room, professional condenser, block and intercooled steam superheater. Currently, it has six power units with a total capacity of 1200 MW. In the near future, the deep modernization of power generation equipment will be processed.
The second Power Plant has 6 power boilers and 5 turbines in the solar system, the equipment should include FGD wet. The installed capacity of the power plant is 248 MW.

Table 1. Energy sources structure used by the Power plants

	Power Plant 1		**Power Plant 2**	
	Percentage share (%)	Quantification (Th. Tonnes)	Percentage share (%)	Quantification (Th. Tonnes)
Coal	97,2	5 832	86,75	3 650
Biomass	2,5	150	13,21	550

And the level of pollutants, caused by energy sources burning, is presented below::

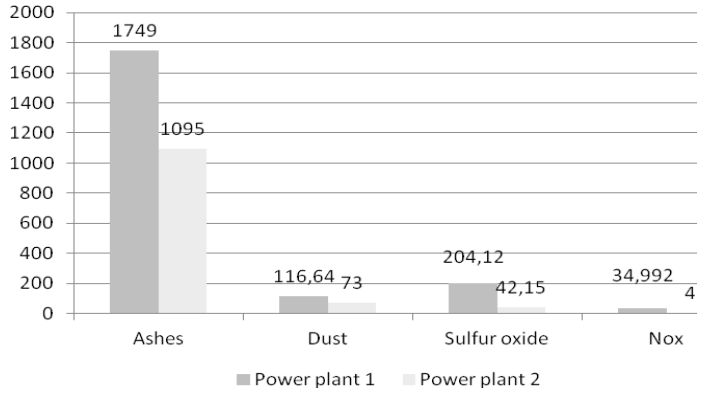


Fig. 4. The level of pollutants caused by coal burning during the process of energy production (in thous. tons).

As is apparent from the figure above, the major part is ash which is a waste produced by the burning of coal. As waste is managed as a building material for the production of concrete and cement, also it is exported to Germany. In the case of emissions to the atmosphere, the largest share is sulfur oxide and the dust has a second place. And the nitrogen oxides has a last place.

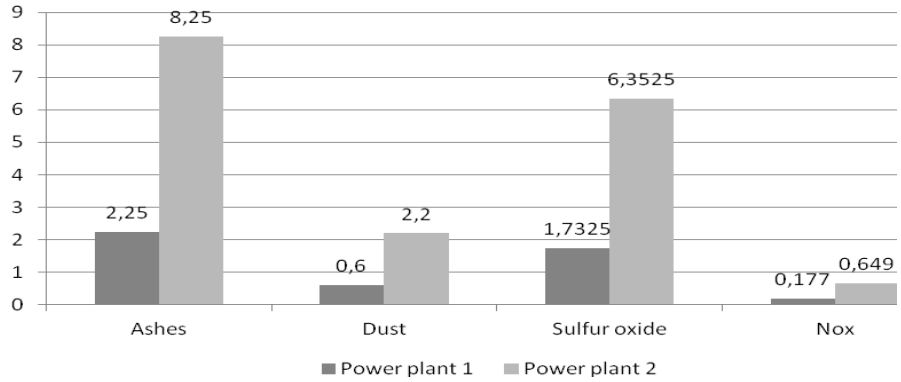


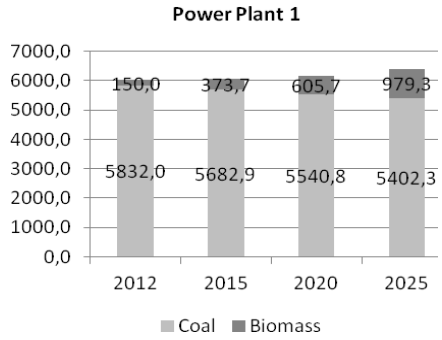
Fig. 4. The level of pollutants caused by biomass burning during the process of energy production (in thous. tons).

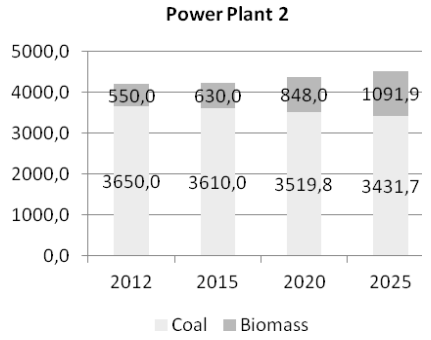
Also in the combustion of biomass, ash is produced and the same as in the case of coal combustion, the formed compounds, such as sulfur dioxide, nitrogen oxides and particulates.

These figures show the situation of the year 2012, with the participation of 10% of the biomass. Subsequent studies have shown changes in the sizes of waste and pollution associated with the increasing share of biomass in the overall structure of the used energy sources. Assumed that in subsequent years the total biomass in the structure of energy source used by the Power Plant 1 will rise to the level of 5%, 10% and 15% and in the Power Plant 2 - 15%, 20% and 15%.

Table 2. The share of coal and biomass in overall energy sources structure (bln. Tonnes).

Power Plant 1				
Years	2012	2015	2020	2025
Coal	5 832	5682,9	5540,8	5402,3
Biomass	150	373,6	605,6	979,3
Power Plant 2				
Years	2012	2015	2020	2025
Coal	3650	3610	3519,7	3431,7
Biomass	550	630	848	1091,9





As can be seen from the presented figures, over the years, with the increasing share of biomass, the level of energy use by the tested plants will be increasing as well. It is worth mentioning that the proportional increase in the share of biomass will not be equal to the same reduction in coal use. This is because the calorific value of the biomass is much lower than the calorific value of coal and is at a level of 19 MJ /kg and the heating value of coal - 32 MJ/kg. This implies that in order to maintain the same level of energy production with increasing biomass share to the target level, the share of coal must be reduced in such a way that the production capacity of energy remain on the same level.
Knowing the likely amount of biomass used, it is possible to show how it will impact the level of emissions and waste resulting from the combustion of coal and biomass.

As can be seen from the above figures, the increase of biomass in the overall structure of the energy sources used, in this case - at the expense of reducing the share of coal, will not only lower the amount of waste generated in the form of ash but also will reduce the emission of pollutants such as sulfur dioxide, nitrogen oxides and particulates . For waste, this decline is 7% for sulfur dioxide will be at a level of 3% in the case of particulate matter and oxides of nitrogen by 5%.

A similar situation will take place in the Power Plant 2, where, as far as increasing the share of biomass at the expense of coal, it can be concluded that both the amount of waste and pollution emissions will be reduced. The quantity of ashes will be reduced by 6%, a 3% decrease in pollution levels for dust and oxides of nitrogen, and 2% decrease is noted for sulfur dioxide.

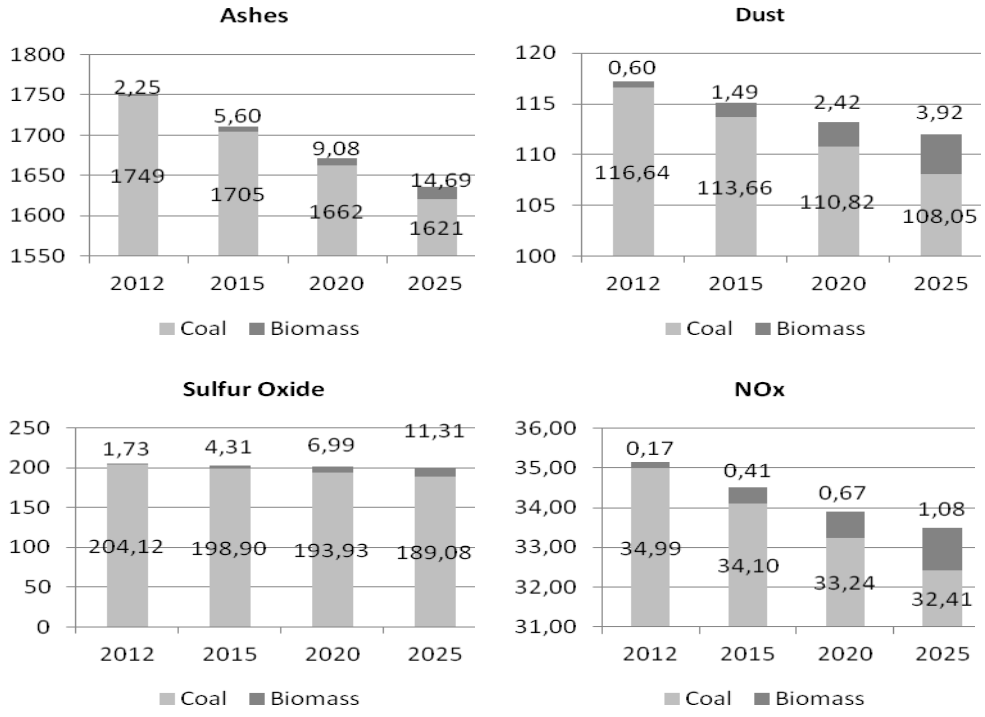


Fig. 5. The amount of waste and pollution arising from the combustion according to the adopted the share of biomass in the total structure of energy resources in the Power Plant 1 (in thous. tons).

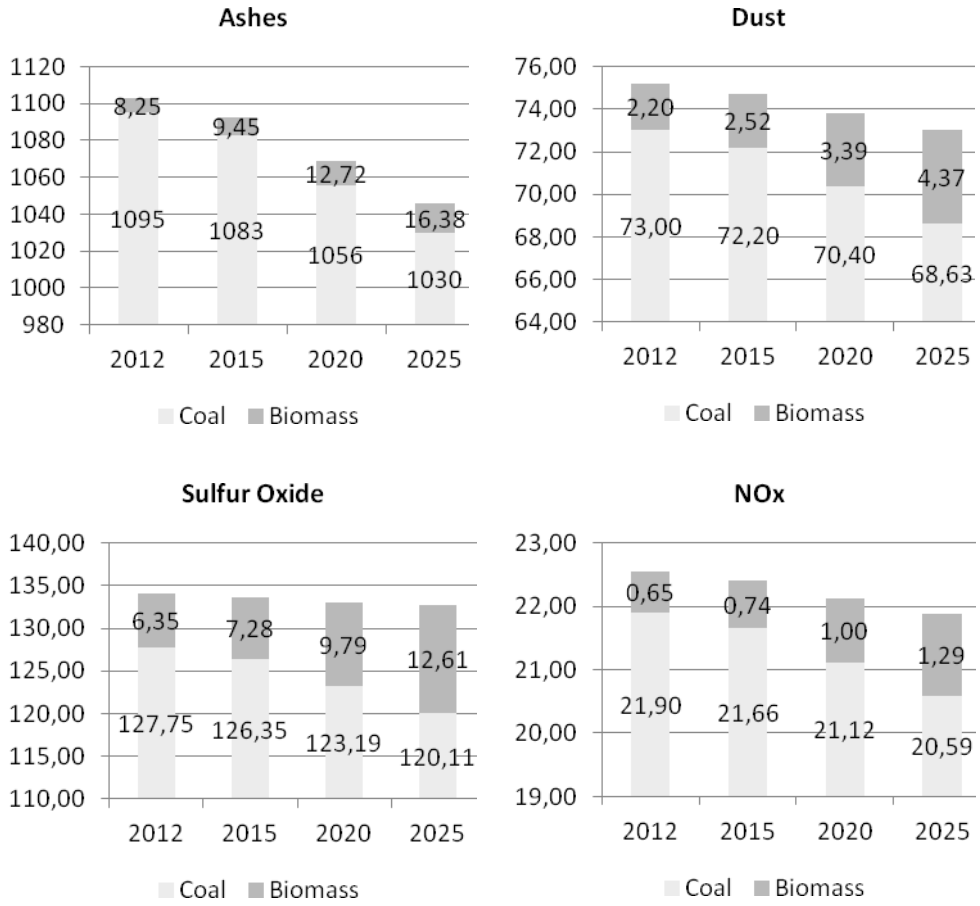


Fig. 6. The amount of waste and pollution arising from the combustion according to the adopted the share of biomass in the total structure of energy resources in the Power Plant 2 (in thous. tons).

Conclusion

Green logistics concept based on the objective to reduce the amount of waste produced and the general decrease in pollution. There are two factors that have a measurable, negative impact on the environment and which are present in almost every manufacturing process. The study of selected two Power Plants that produce electricity mainly from coal as energy, show that increasing the share of biomass as an energy source from a group of renewable energy sources, allows a measurable reduction in the amount of waste and emissions into the atmosphere. This material is the subject of logistics processes such as procurement, transport, storage and production. It is so distinctive element of the supply chain for the supply chain of the energy sector. Presented in this article, the study focused primarily on the impact on the level of emissions and the amount of waste generated by the production of energy. Looking at the perspective of the development of the sphere of

logistics, it can be assumed that increasing the share of biomass in the total structure of energy resources may bring tangible results in logistic processes, which include:

- Procurement processes - to increase the share of biomass will automatically increase demand which will increase the number of companies engaged in the manufacturing, will contribute to the professional activation and also may contribute to reductions in areas that are currently out-of-use,
- Transport processes - looking at the above section on biomass producers, its increasing will also cause the greater use of transport. However, in contrast to coal, which is often transported by rail, in biomass transport the car mode transport is used the most often, which reflected the negative impact of air emissions and degradation of green areas,
- Storage processes – in regards to this process it can be assumed that increasing the amount of biomass will contribute to greater use of storage, causing the need to build new warehouses, will increase employment and may cause for further developing and implementing solutions that may enable to store the biomass without compromising on its quality.

All these processes create a sphere of logistics, and on the basis of the above conclusions, it can be assumed that the increase in the share of biomass, can greatly contribute to the development of the whole sphere of logistics. This may result in positive changes, such as more enterprises, expand the logistics network, and, negative as well, for example emissions to the atmosphere and degradation of the environment. However, these are the points which should be fully investigated, and the final results, author hopes to present in the next article.

References

1. Bajdor P. „Comparison between sustainable development and Green logistics – the literature review", Polish Journal of Management Studies, Czestochowa University of Technology, Czestochowa 2012,
2. Europe 2020. A European Strategy for smart, sustainable and inclusive growth, Bruksela 2010,
3. Dobroczyńska A., Juchniewicz L., Zaleski B., „Regulacja energetyki w Polsce", Wyd. Adam Marszałek, Toruń 2001,
4. Kolcun, M. – ŠÚŇ, M.: The Support of Renewable Energy Sources, In Distributed Power Generation Systems, Pernink, ZČU Plzeň, Czech Republic, 2004, pp. 41-49. ISBN 80 –7043– 283 - 7. (In Slovak),
5. Kot S., Ślusarczyk B., „Aspects of Logistics in Biomass Supply for Energy Production", w: CECOL 2012. III Central European Conference on Logistics, Trnava, Czech Republic 2012,
6. Rodrigue J.P., Slack B., Comtois C., "Green Logistics", Elsevier, London 2001,
7. Starostka – Patyk M., Grabara J., „The Conceptual Base and Chosen Technological Aspects of Generating Energy from Waste", Śląskie Wiadomości Elektryczne, nr 6, Katowice 2011,
8. Starostka-Patyk M., Grabara J., „Managing of Energy Production Waste in Polish Power Plants, w: PE 2010. X Międzynarodowa Konferencja Naukowa. Prognozowanie w Elektroenergetyce. Planowanie rozwoju, eksploatacja i zarządzanie w elektroenergetyce. Częstochowa 2010,
9. Ulfik A, Nowak S.: Determinanty tworzenia subregionów gospodarowania odpadami

a zarządzanie energią pozyskaną w procesie ich termicznego przekształcania. [w:] Kaproń H. (red.) Zarządzanie energią i teleinforamtyka ZET 2012 : materiały i studia :. - Lublin : Wydaw. Kaprint, 2012,
10. Ustawa z dnia 10 kwietnia 1997r Prawo energetyczne, art. 1.2,
11. „Założenia Polityki Energetycznej kraju do 2030 roku", Minister Gospodarki, Warszawa 2007,
12. http://www.eunec.vlor.be

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