SELECTED ISSUES FOR CHAIN MANAGEMENT DELIVERY BIOMASS

WYBRANE ZAGADNIENIA DOTYCZACE ZARZĄDZANIA ŁAŃCUCHEM DOSTAW BIOMASY

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Abstract: The purpose of this article is to analysis of logistics processes in the supply chain related to the supply of biomass for energy purposes and an attempt to assess them in terms of effectiveness and efficiency of their operation. The authors are looking for the answers to questions concerning the improvement of delivery processes in the context of environmental impact, taking into account the environmental effectiveness, economic and market conditions.

Streszczenie: Celem niniejszego artykułu jest analiza procesów logistycznych w łańcuchu dostaw związanych z dostarczaniem biomasy dla celów energetycznych i wskazanie kierunków ich oceny pod względem skuteczności i efektywności działania. Autorzy poszukują odpowiedzi na pytania dotyczące poprawy procesów dostawczych biomasy w kontekście oddziaływania na środowisko, z uwzględnieniem uwarunkowań środowiskowych, ekonomicznych i rynkowych.

Key words: process, system, logistics process, biomass, supply chain, supply chain management
Słowa kluczowe: proces, system, proces logistyczny, biomasa, łańcuch dostaw, zarządzanie łańcuchem dostaw

INTRODUCTION

In 2011 began the process of creating a common energy market in the EU. Therefore, the third energy package, including the Directive market, transmission regulation and the regulation establishing the Agency for Cooperation of Energy Regulators (Directive of the European Parliament and Council Directive 2009/72/EC of 13 July 2009. Concerning common rules for the internal market in electricity and repealing Directive 2003/54 / EC (Acts. Office. EU. L. 211of 08/14/2009, p. 55) were introduced.

As one of the ways of monitoring the implementation of the Polish Energy Policy until 2030 analysis and monitoring indicators. Were indicated/pointed 7 indices were provided to assess the implementation of the objectives of the national energy policy, included in art. 13 of Energy Law, which concerns energy security, competitiveness and environmental protection. One of the indexes is associated with the share of energy from renewable sources, including biomass in final energy consumption.

The Treaty of Accession to the European Union Poland reported an increase in the share of renewable energy in electricity production up to 7.5% in 2010 and 15% in 2020 (Energy Law, Acts. U. of 2016. Item. 1165). Research shows that up to now Poland is meeting this commitment. The Energy Regulatory Office (URE) is working on the foundations of the authentication system of biomass, that is the National Authentication System of Biomass.

The aim of the Energy Regulatory Office in this regard is (The National Authentication System of Biomass, Systems Support Department, Energy Regulatory Office, Warsaw 2013, p.2.):

- streamlining and simplifying the process of issuing certificates of origin - the use of the support mechanism;
- authentication of the origin and quality of biomass;
- the elimination of potential irregularities on the biomass market.

One of the commonly used solutions in Poland, aimed at reducing CO_2 emissions is co-firing biomass with coal. These actions are based on the assumption that the amount of CO_2 emitted during the combustion of biomass is equal to the amount necessary for its production, which means the balance of the amount of CO_2 for that matter, is 0. Co-firing of biomass with carbon is carried out in boilers adapted for burning coal, and therefore the amount of biomass used may be up to 10% by weight of coal consumption. Larger amount of biomass could cause interference in the combustion process and reduce the efficiency of boilers. The use of larger quantities of biomass is impossible without the modernization of existing boilers (Szyszlak-Bargłowicz, Zając, Słowik, 2014, s. 354-358).

The use of biomass for energy purposes has a beneficial effect on:

- waste management,
- greater reduction in CO_2 emissions,
- higher energy efficiency.

Poland consumes energy for approx. 7 million tons of biomass (Górnik, 2012, s.6). J This is a huge logistical challenge in the supply chain of raw material.

The purpose of this article is to present the research in the analysis of logistics processes in the supply chain related to the supply of biomass for energy purposes. The article pointed out the various links of the supply chain of biomass indicating the areas that are making greater impact on the environment.

The author is looking for answers to management issues and improvement of comprehensive supply chain in the context of environmental impact, taking into account the environmental effectiveness, economic and market conditions. The applied research methods are adapted to the issues discussed. During the development of this article use the following research methods such literature analysis and normative and legal documents, synthesis, generalization, inference abstracting.

1. Biomass as a raw material for energy purposes

In connection with the need to achieve the objectives of Directive 2009/28 /EC (Directive of the European Parliament and Council Directive 2009/28/EC of 23 April 2009. *On the promotion of the use of energy from renewable sources* and amending and subsequently repealing Directives 2001/77 / EC and 2003/30 / EC (Acts. Office. EU L 140, 05.06.2009, pp. 16), the share of energy from renewable sources in final energy consumption is steadily increasing. Figure 1 the share of renewable energy in Poland, is shown against the background of the EU. In 2007, this share in Poland was 7.7%, in 2012 already 11, 04%, and in 2014 it was 11.45%. Progression in the years 2010-2014 and strategic planning for the coming years provide the basis to achieve the goal of 15% in 2020. Moreover, an important element in the implementation of development policy for renewable energy was the adoption by the Council of Ministers on 7 December 2010. National Action Plan for energy from renewable sources (KPD). The document presented actions aimed at reaching a 15% share of renewables in final energy in Poland with the division for electricity, heat and cooling and renewable energy in transport by 2020. For subsequent years renewable energy will be present in the energy balance of the country and the goals set for 2020. They will be maintained until 2050. However, without their further deepening. A possible increase in the share of renewables in the energy balance beyond 2020 will result from competitive advantages of the technology on the market, not from the mobilization of additional support tools (Energy Law, Acts. U. of 2016. Item. 1165).

In the power industry biomass is treated as all kinds of organic material of vegetable or animal origin suitable for combustion. A characteristic feature is the ability to rate a specific biofuel to the so-called green energy with zero carbon dioxide emissions (Szyszlak-Bargłowicz, Zając, Słowik, 2014, s. 356).

With biomass as a raw material producing primary energy is acquired. It is the energy contained in the media obtained directly from natural resources, renewable and non-renewable. The acquisition should be understood as the amount of energy obtained from natural resources (applies only to primary energy - Energy from renewable sources in 2014, GUS, Warsaw 2015 p.12-15).

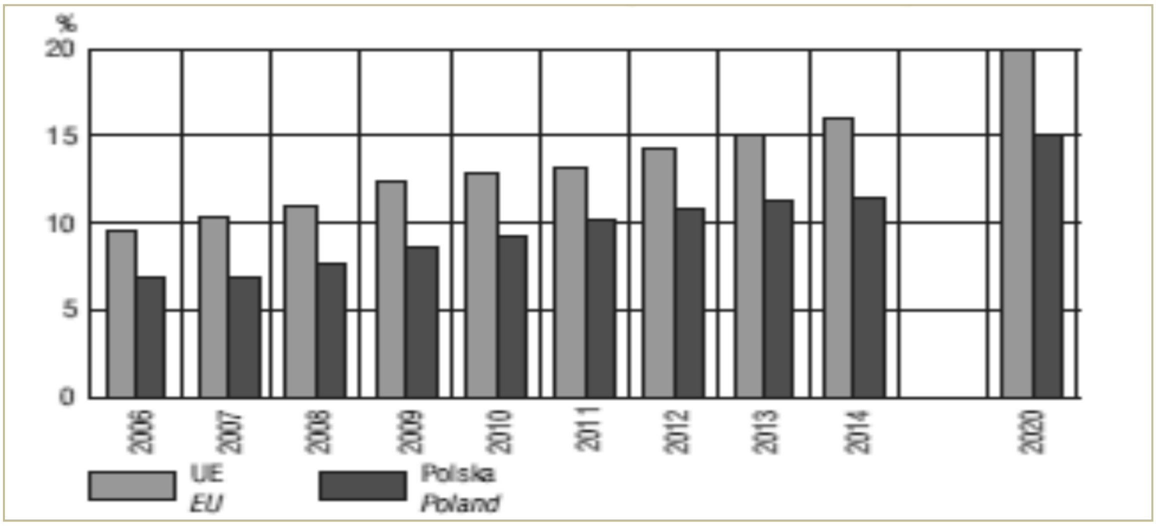


Fig. 1. The share of energy from renewable sources in gross final energy consumption in the years 2006-2014 with a forecast by 2020 in Poland as compared to EU (%)
Source: *Energy*, (2016), GUS, Warsaw, p.13.

The basic normative acts regulating the duties on the use of energy from renewable sources in Poland are:

- The Act of 10 April 1997. - Energy Law (D. At. of 2012. Item. 1059, as amended),
- Regulation of the Minister of Economy of 14 August 2008. On the detailed scope of duties to obtain and submit to the redemption of certificates of origin, the substitute fee, purchase of electricity and heat from renewable energy sources and the obligation to confirm the data on the amount of electricity generated from renewable sources energy (D. At. of 2008. No. 156, item. 969, as amended)
- The Act of 25 August 2006. Biocomponents and liquid biofuels (D. At. of 2014. Item. 1643, as amended),
- The Act of 20 February 2015. Renewable energy sources (D. At. of 2015. pos.478).

Polish Act of 25 August 2006 about biofuels and liquid bio-components (D. At 2016 pos. 266, 1165) defines biomass as solid or liquid substances of vegetable or animal origin, which are biodegradable, derived from products, waste and residues from agriculture and forestry related industries, as well as parts of other waste that is biodegradable, especially agricultural raw materials. Due to the need to increase electricity production from renewable energy sources, biomass is used for heat production, and biofuels for energy production.

The main features of biomass are (Ściążko, Zuwała, Pronobis, 2007, s. 141-160):

- low calorific value – ranges from 6 MJ/kg (municipal waste) (15-M6) MJ/kg (wood chips, straw); 18 MJ / kg (pellets),
- high content of moisture in the raw biomass (45-60)%,

- high content of volatile matter (2.5 times higher than in carbon),
- ash content in the lignocellulosic biomass it is small <1%,
- sulphur and nitrogen content in the biomass is low, but there is a large amount of alkaline compounds and chlorine particularly in straw, which creates a high risk of high temperature corrosion in the process of combustion.

Initially, for the production of electric energy we used biomass in the form commonly used for the production of food or feed that is starch, sugars, vegetable and animal oil. Such activities aroused much controversy of ethical nature, so the second generation of waste biomass was created. These include: lignocellulosic biomass, agricultural residues, cereals containing very little grain; wood industry waste; skin or pulp from fruit processing, etc. [Szyszlak-Bargłowicz, Zając, Słowik, 2014, s. 354-358]. In case of biomass for energy purposes, the most significance in 2020 should be attributed to energy crops and the agricultural biogas plants, to a lesser extent to the forest biomass and waste biomass "dry" from the timber industry and related (Polish Energy Policy until 2030, Annex to Resolution No. 202/2009 of the Council of Ministers of 10 November 2009., MG, Warsaw 2009, p. 1-57).

According to the Energy Market Agency in 2010 we used 4.5 million tons of biomass, which represents an increase compared to 2009 by 300 thousand tons. Nevertheless, Poland uses only approx. 7% of its potential in terms of biomass compared to an average of 20% across the EU.

Biomass energy is the least capital - intensive source of renewable energy. Energy from biomass accounts for 15% of global energy consumption, while in developing countries this share is larger and amounts to as much as 38%. Biomass combustion process is renewable and not causing an increase of CO_2 in the atmospheric (Postrzednik, 2014, s. 573-578).

Massive indicators for the acquisition of dry biomass in Poland are as follows (RES, 2013, s. 22-23): woodland area approx. 3 - 5 Mg/ha /year and energy plantations approx. 15 - 30 Mg/ha/year.

The most important component of the most of solid fuels is a combustible substance composed of C, H, O, N, S) and the so called ballast, which consists of: mineral matter (ash) and moisture, wherein the amount (content) of whitch may vary depending on weather conditions. Among these the most important components of the fuel is combustible substance mB (which in the dominant part is an organic substance).

In case of the use of non-forestry biomass (agro), which can be burned in biomass co-firing units and conventional fuels with a capacity exceeding 5 MW or in hybrid systems and biomass units with a capacity of over 20 MW we must prove that:

– it comes from energy crops, or
– is waste or residue from the agricultural production or from the industry processing products from agricultural production, or
– is a different kind of biodegradable waste excluding waste and residues from forestry production and the industry processing its products.

If the biomass is imported from abroad, is should have appropriate documentation issued by the authorities of the country of origin.

Biomass market in Poland is shows a developing tendency. There is a very large spectrum of opportunities both for producers of raw materials, plants and consumers of energy production as well as for the processing sector. In the coming years, the demand for biomass in power stations and small Power is likely to increase. According to estimates, Poland uses only approx. 7% of its potential in terms of biomass compared to 20% of the EU average. Table 2 illustrates the data relating to primary biomass resource in Poland, with the prospect of 2030.

Table 2. Energy use of biomass in Poland forecast 2030

Kind of biomass	Energetic utilization of biomass in year				
	2010 (estimated)			2020 (prognosis)	2030 (prognosis)
	[mln m³]	[mln t]	[PJ]	[PJ]	[PJ]
Forest large timber	5,3	3,7	63	69	76
Other forest firewood	5,2	3,4	55	61	69
Industrial wood wastes	4,6	2,7	40	43	50
Timber from Energy plantation	2,0	1,0	14	28	56
Timber from orchards and planting	3,0	2,0	29	33	36
Post-use wood	2,1	1,4	23	25	27
Straw and green plans	-	0,7	10	15	22
Peat coal and other plant solid biomass	-	0,5	7	8	9
Solid biomass in total	-	-	241	282	345
Liquid biomass (ethanol, bio-diesel, other)	-	-	37	58	90
Gaseous biomass (biogas and other)	-	-	12	30	75
Biomass in total	-	-	290	370	510

Source: Wójcik Z. (2012), *The importance of biomass and other renewable energy resources*, Problems of agricultural engineering, no. 4 (78), pp. 5-13.

Compared to 2010, growth in 2020 should reach an average of 28%, and in 2030 an average of 76%. The share of wood in 2020 should reach 70%, and in 2030 62%, while the share of straw and other solid biomass should remain at 6%. The greatest potential for biomass is found in forestry resources and in the biomass of agricultural origin. Potential shows the production of biomass from energy crops. A significant amount of energy is possible to acquire from the processing of straw, whose surplus in agriculture is waste. It is estimated that currently more than 11 million tons of straw per year may be transferred to the energy needs.

Data from the General Directorate of State Forests shows that the direct use of energy possible is putting 6.1 million m≥ of wood per year. This balance includes only the biomass not raising any doubts about the possibility of allocating it to the energy needs. The potential of biomass is much higher if biomass intended for animal feed is taken into account (hay, grain, potatoes), food products (cereals, potatoes), vegetable and landscape values (cane, wood) (Szostak, 2013, s. 80-82).

Obligations resulting from the climate package show that by 2020 Poland is obliged to obtain at least 15% share of renewables in energy consumption. The desire to increase the share of these sources in the balance of electricity production in the country due to the high investment costs, requires the application of appropriate support systems, which are the guarantee of their systematic development.

Figure 2 show converted trends in the development of renewable energy sources, including solid biomass. The analysis of the data shows a systematic increase in the interest in this resource in the years 2008-2016.

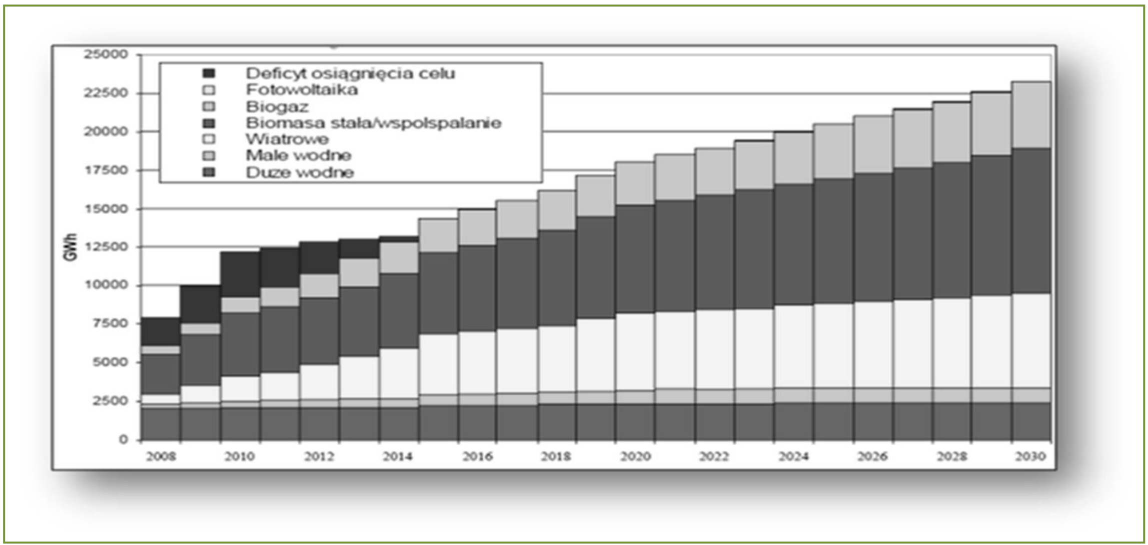


Fig. 2. The potential of renewable energy in Poland with regard to biomass
Source: Bocian J. (2012), *Analysis of the demand for forest biomass in the perspective of 2020, the materials of the conference "forest biomass"*, Łagów, 9.

Energy Regulatory Authority takes action to verify forest biomass and agriculture through control of the origin of supplies based on the implemented enterprise quality assurance systems according to PN-EN 15234-1:2011. Many entrepreneurs have not yet taken appropriate measures which should be considered highly disturbing.

2. The supply chain of biomass for energy purposes

Biomass can be used for energy purposes in the process of direct incineration or co-incineration of solid biofuels (eg. wood, straw, sewage sludge), converted into liquid fuels (eg. esters of rapeseed oil, alcohol) or sparkling (eg. agricultural biogas, biogas from sewage wastewater, landfill gas). Conversion of biomass into energy sources can be carried out by physical, chemical or biochemical methods. Depending on whether the main product of the process is a gas, liquid fuel or solid fuel are speak about respectively, the combustion of gasification, pyrolysis or biochemical (Assessment of implementation of Polish Energy Policy until 2030, Annex 1 to the Polish Energy Policy until 2050, MG, version 05, Warsaw 2015, pp. 1-57) processes.

For the needs of individual customers and small heating systems, biomass is converted into the form of briquettes or pellets. Briquettes generally contain no binders - are formed by compression of sawdust or wood chips under high pressure. Briquettes and pellets are usually produced from willow wood chips. These plants grow quickly and give a yield of up to 30 years. It is estimated that it is possible to obtain from 25 to 45 tons of chips per hectare. Prior to pressing the chips are subjected to drying to a moisture content of approx. 15% (Szyszlak-Bargłowicz, Zając, Słowik, 2014:356).

Wood shavings are pressed in close, small rolls, containing no additives because of its natural properties. Another source of biomass can be fast growing poplar or willow. With regard to energy, the equivalent of 2 tons of biomass are from 1 to 1.5 tons of coal.

The use of biomass for energy purposes can meet the stringent environmental standards, particularly in terms of CO_2 emissions, SOx, NOx, dust, dioxins, chlorine, heavy metals. In accordance with the provisions relating to the protection of the environment and imposed a statutory requirement for the share of renewable energy in the production of energy for power plants a mixture of coal and biomass is considered as ecological fuel. The use of blends of coal and biomass limits mainly emissions of SO_2 to the atmosphere. CO_2 emission balance is zero, because during the combustion as much CO_2 is dissipated into the air, as the plants earlier downloaded from the environment. Due to its low nitrogen content in the biomass NOx emissions to the atmosphere as compared with coal combustion is reduced (Szyszlak-Bargłowicz, Zając, Słowik, 2014, s. 356).

The total contribution of biomass co-firing technology in power plants, coal-fired power plants is the largest of all renewable energy technologies approx. 40% in total energy sales from renewable sources. The most commonly used variant of co-administration relies on giving biomass to coal feeding system. It does not require any interference in the construction of the boiler. In the majority of power plants in Poland pulverized coal fired boilers designed to burn coal are used. Administration of biomass together with carbon reduces the boiler efficiency by at least 1%. The proportion currently used is 4-15% of biomass feedstock, relatively to coal. The larger the share of biomass relates to the investments in changing the system of grinding and replacement burners (RES, 2013).

To get the effect of high energy biomass it must be:

- dry,
- be prepared by compressing, briquetting or fragmentation,
- incinerated in suitably adapted boilers.

Because of the diversity and properties of the biomass its utilization for energy purposes can also be different. And thus, the ashes of different types of biomass are significantly different in their chemical composition. Highly variable chemical composition and differences in physical and chemical properties of different types of biomass necessitate continuous laboratory monitoring.

Due to the specific requirements of biomass as a raw material, logistics should contain a series of processes interacting with each other. The final effect of the logistics operation is to ensure a stable raw material base to entities involved in producing conventional energy from biomass. In many cases, the acquisition of biomass is difficult because of the dispersed nature of its availability. For these reasons, it requires large expenditures on collection, transport, storage and processing. Therefore, you should develop an efficient logistics system aiming at maximum reduction of the cost of transport and further processing.

Factors to be considered in the logistic system must include among others: (Osiak, Dwórznik, 2016, s. 63):

- type of biomass,
- of physico-chemical and mechanical characteristics biomass,
- the availability of the raw material,
- the number of suppliers of a given type of biomass,
- technical possibilities of transportation,
- storage capacity,
- the possibility of pre-treatment before the conversion process,
- economic legal and environmental conditions, etc,
- location of energy production.

In connection with the Energy Regulatory Office work on the National System Authentication Biomass (KSUB), it is important to develop the assumptions underlying the development of quality procedures and take control of the origin of the supply of biomass for energy purposes. Figure 3, is a schematic diagram of an authentication system for biomass unprocessed and processed throughout the supply chain.

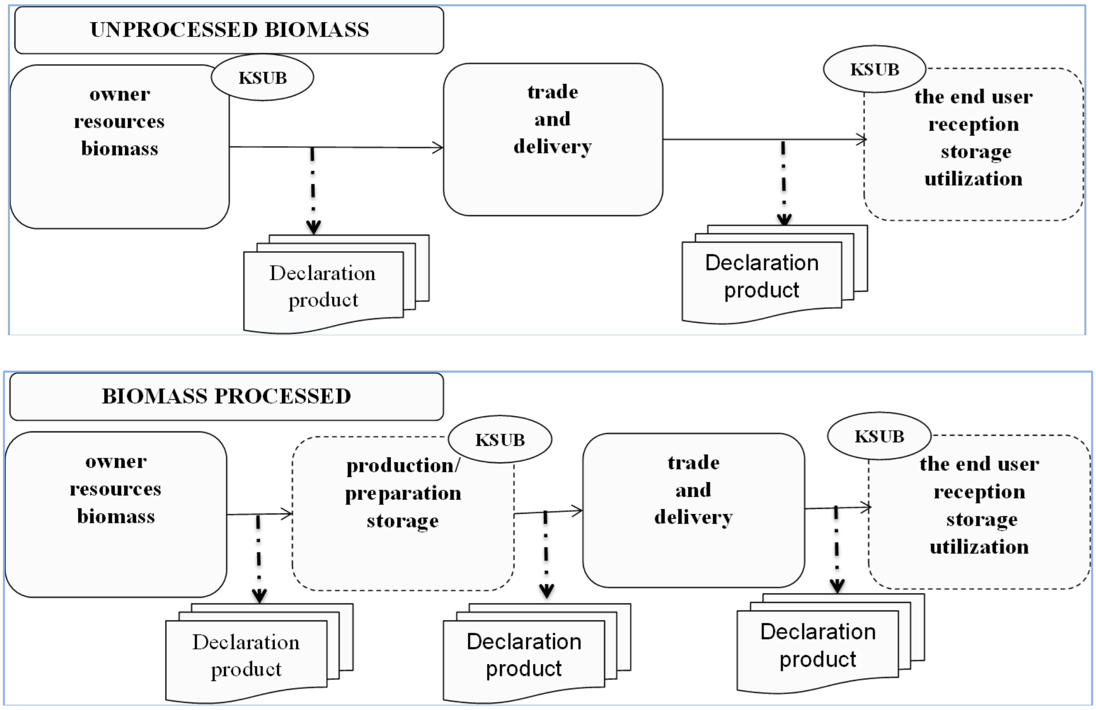


Fig. 3. Scheme authentication system in the supply chain of biomass
Source: *The National Authentication System Biomas,*(2013), Systems Support Department. Energy Regulatory Office, Warsaw, p.1.

The use of biomass for energy purposes requires action throughout the supply chain including production, distribution and use of biomass. The activities are focused on the acquisition of raw materials, the organization of the system of storage and distribution, and ensure the efficient use of biomass.

Taking as a criterion the source for energy production, we distinguish two groups in renewable energy technologies (Logistics management in the renewable energy sector, 2014, s.13) of the management in logistics:

- a complete supply chain management (CSCM) with liquid and solid biomass,
- as a source of energy,
- the management of partial supply chain management (PSCM) of solar energy, wind, geothermal, tidal/wave, hydropower.

A complete supply chain (CSCM) covers the procurement process, namely the supply of raw materials for energy production and maintenance process of energy production and distribution process. With a limited supply chain (PSCM) we have a limited supply process to the supply of parts and materials to maintain production.

Energy products, ie. different kinds of biomass are the end products, delivered to meet the energy demand. From the point of view of logistics processes, it is important that the energy is the primary mass product which is supplied continuously. For this reason, the management of a complete supply chain refers to all the processes of the integration chain, including supplier-customer relationship (Logistics management in the renewable energy sector, 2014, s.13). Table 2 show the supply chain components of both groups.

Table 2. Summary of elements of the supply chain in the renewable energy technologies RES

ELEMENTS OF THE SUPPLY CHAIN	**CSCM**	**PSCM**
Supply	yes	limited
Production,	yes	yes
Distribution,	yes	yes
Energy source	biomass	sun, wind, geothermal, others

Source: own study based on *Logistics management in the renewable energy sector*, e-course, Elompres LDV Transfer of Innovation Lifelong Learning, iSpring Suite 8.1 bsw.edu.pl., 2014, 13.

Chain architecture takes into account the three zones which are linked together in order to add the value to the stream of material flowing through the chain.

The structure of the supply chain depends on the nature of the renewable energy source and the technology used to produce energy. In case of biomass a preliminary zone includes, preliminary processing and preparation of raw materials to more usable forms (eg. shredding, drying). However, in the intermediate zone raw material is processed into the final product (energy). In a descending zone, a network operator or a network distributor implements customer demand.

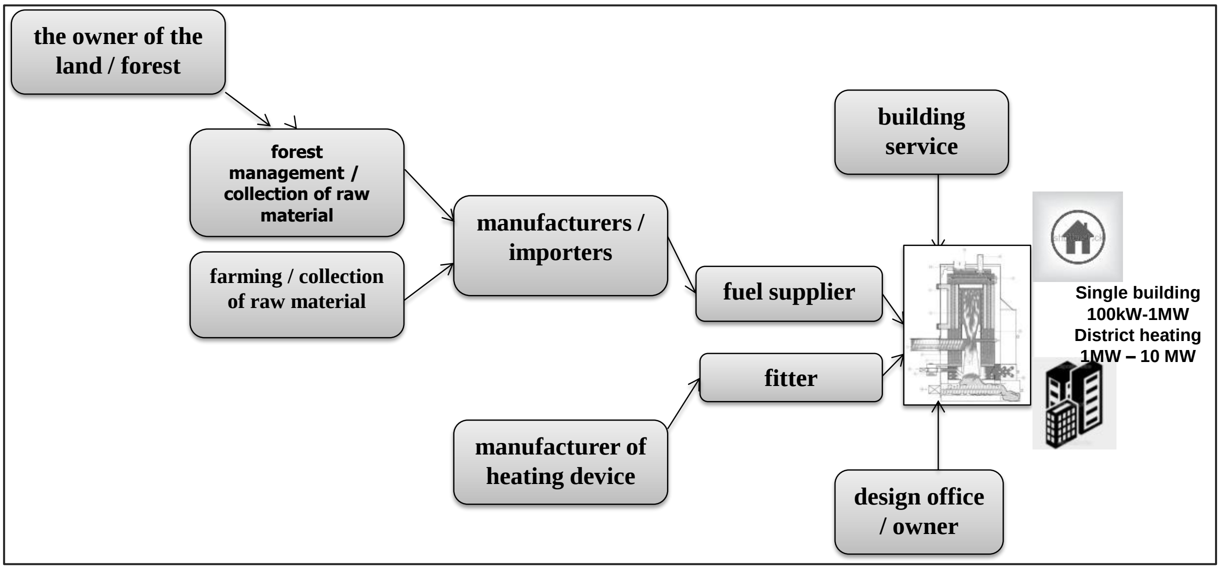
The objective of supply chain management is to increase productivity while reducing storage and operating costs and adapting energy production to customer needs. This includes four main elements (Węcław-Solny, 2012, s.26):

- delivery (management of supply commodities, relationship with suppliers, supplier base)
- operations (demand management, inventory control, production process)
- logistics (design of the supply chain/distribution, customer relationship management),
- integration (risk management, measurement, productivity, environmental protection).

With regard to the directions of energy development set out in the Polish Energy Policy until 2030, which included the promotion of the use of energy from renewable sources, including biomass, more and more attention is paid to the quality assurance systems of biomass. It consists in supporting the implementation of standards of quality and sustainability, which can be assessed on the basis of the specific requirements included in the certification systems.

The implementation is based on the requirements of the PN-EN 15234 (PN-EN 15234-1:2012 Solid biofuels. Quality assurance. Part 1: General requirements, PKN, Warsaw 2012), which specifies the procedures to meet the requirements of quality (quality control) and describes the actions that assure meeting the specifications of biofuels (quality assurance). Independent verification of certification should cover the entire supply chain, from the manufacturer to the final distributor of biomass.

Logistics processes rely on the delivery of biomass with appropriate parameters, in the right quantity, right condition, right place, right time, for the right customer, at the right cost. A typical diagram of the supply chain of biomass and potential business relationships which can



be established are shown in figure 4.

Fig. 4. Scheme of the main business relationships within the supply chain biomass

Source: *Success through cooperation. Tools support the development of biomass used for energy purposes* (2011), Forest. Development of effective rules in the supply of biomass, Gdańsk.

It includes:

– the supply of raw materials,
– production.
– distribution.

The composition of these processes may include activities such as:

- preparing the ground,
- planting / sowing,
- agronomic crops,
- crop/harvest (acquisition from field/forest)
- handling and transport to a place where you can apply a road transport,
- storage (seasonal availability) - points of storage on agricultural farms, in the forest, at separate locations or in power facilities,
- conversion of biomass to improve its operating efficiency and density for transportation,
- transport and use of fuel in the energy facility.

In each of them the quality parameters are taken into account and the critical control points (NCPs) are determined. These are the points in the process or between processes, where it is relatively easy to evaluate individual properties, and actions to improve quality can be most effectively implemented. Many different types of cooperation and business models may emerge from the supply chain.

Processing of biomass aims at improving its efficiency by increasing the density in the process of baling, briquetting and pelletizing and improving fuel quality. The processing can occur at any stage of the supply chain, but the most common is a process prior to transport. Storage of biomass poses new challenges in the supply chain of biomass. The main reason why you should turn on the storage process as an intermediate in the chain of biomass is the need to match supply and demand for biomass. Most types of biomass is characterized by seasonal availability, plus scattered geographic distribution of biomass results in the need for storage, to ensure a continuous supply of raw material for bio-energy. High moisture content in the biomass also affects the cost of obtaining it. Often, biomass is handed over to the place of combustion to further regions of the country, and water content and therefore a higher weight of biomass, results in higher transport costs. The use of wood waste for energy purposes, as well as straw, is cost-effective only at the short distance for transporting of raw materials. In addition, the processes of storage should ensure efficient unloading, properties of biomass and storage safety.

3. Summary

Analyzing the data on biomass for energy and logistics processes in this area, we can say that so far these issues have not been addressed in a broader and longer perspectid while programs for the use of renewable energy sources, there have always been based on unambiguous methods for the assessment of biomass resources.

When considering the use of biomass for energy purposes a number of important elements should be taken into account:

- the need to ensure a constant supply of domestic biomass,
- lower content of sulpfur and nitrogen compared with coal, which causes lower emissions of sulpfur and nitrogen oxides into the atmosphere,
- the balance of carbon dioxide emissions is zero; it is assumed that during the combustion as much carbon dioxide is emitted to the atmosphere as the plants took up earlier from the environment,
- in power plants co-firing biomass of natural origin, with coal is advantageous,
- high moisture of biomass, density and mass cause an increase in transport costs (preferred location close to the source of the biomass)
- ash resulting from the combustion of biomass does not contain harmful substances and it can be used as a mineral fertilizer.

There is a need for new directions of development of the logistics of biomass that can be implemented in rural areas, providing at the same time minimizing the burden on the environment. The aim should be to create optimal organizational and logistics models to ensure a stable supply of biomass and sustainable rural development.

In order to prevent the movement of large masses of biomass over long distances, it is reasonable to establish local markets for biomass, balancing supply and demand, and logistics systems to minimize the costs of harvesting, transport and storage of biomass. Reducing transportation costs translate into environmental benefits. Sustainability criteria for biofuels should be an integral part of the logistics operation, providing a stable base of raw materials. A considerable cost reduction is possible by optimizing the logistics activities.

Given the relatively short period of support system operation for renewable energy sources RES, the current impact of the current renewable energy sector to improve energy security can be assessed as moderate and necessary for further development due to economic and ecological reasons. High hopes may be linked with certified quality assurance systems of biomass. This will, to a large extent, have a positive effect on the security of supplies of raw material (which is) so diverse in its characteristic.

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