

INNOVATIONS IN THE USE OF WOODY BIOMASS AS A RENEWABLE ENERGY SOURCE – AN ANALYSIS OF SELECTED CASES

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Abstract. In the paper three cases are presented and analysed, which show innovations in the use of woody biomass for the production of heat and woody fuel (pellets). In two of the firms analysed woody biomass boilers were installed, and in the third case a technological line for the production of pellets was assembled. The analysis was made based on information acquired during interviews conducted in the companies. Pro-innovative people, who acted as “innovation motors” in the companies contributed greatly to the success of the innovative undertakings. The financing of the innovations was the most important problem in the realization of the undertakings, and a possibility to use public funding played a significant role. The successfully implemented innovations contributed to an increase in competitiveness of the companies, which allowed to use locally available woody biomass resources and to reduce the emissions of pollutants and CO₂ to the atmosphere.

Key words: innovation, renewable energy source, woody biomass

INTRODUCTION

The well-being and development of the world today requires not only a quantitative growth, as production can not be increased endlessly, due to the fact that e.g. natural resources are exploitable and finite. A further existence of civilization calls for qualitative changes in the first place, and so it requires a development and not just a growth. A prominent role in development processes in the economic environment is attributed to innovations.

Innovations, defined as a successful implementation of new, widely perceived solutions are a vital factor stimulating economic development. Such views were presented by Schumpeter [1911] who stated that the economic development is a result of new combinations of products, processes, markets, resources and organisational processes. Schumpeter defined the innovation as an implementation on new combinations of the means of production. Innovations are also a key element of the currently realized Lisbon

Strategy, as they have been recognized as a part of an activity serving the Strategy, playing a vital role in the process of creating a knowledge-based economy. It has become evident that human capital is a significant factor in innovative activities, which is also underlined by Szulczyńska [2005].

Today, a systemic approach is more and more important in research into innovations. The object of the research are systems of innovation, which comprise interactions and relations between various subjects that take part in creating innovations [Rametsteiner et al. 2006]. The object of the analysis are links between the subject introducing an innovation (e.g. a company) and various organisations, authorities, research and higher education organisations, advisory bodies and other companies. These organisations, combined with inter-relations between them constitute a system of innovations [Edquist 2001].

The innovation itself is a rather wide concept. Today, innovations are divided into product and process innovations (Fig. 1). The product innovations can lead to the creation of new types of goods or new services. The process innovations comprise technological and organisational ones [Edquist 2001].

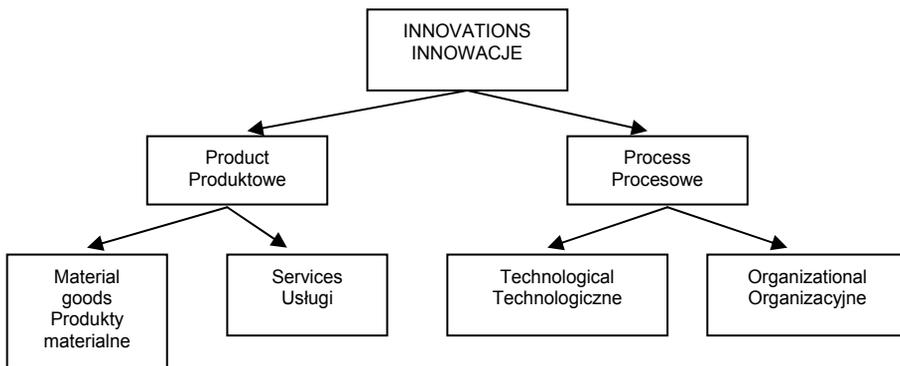


Fig. 1. A taxonomy of innovations [Edquist 2001]

Rys. 1. Schemat podziału innowacji [Edquist 2001]

Many of the newly implemented innovations can contribute to a sustainable development of the State. Among them, innovations concerned with the use renewable energy sources deserve special attention. Such innovative undertakings, apart of their important ecological value, have a far-reaching effect on the economic and social situations in different regions of the country. In Poland, biomass, especially that derived from wood and woody materials, has a special position among other various renewable sources of energy. According to estimates of the Renewable Energy Institute [Możliwości... 2007], in 2020 the largest potential of renewable sources of energy will be formed by waste, forest biomass and that from energy plantations. Its use for the production of energy will implicate a host of other advantages and benefits such reductions of CO₂ emissions and resulting climate protection, less dependence on finite fossil energy sources which to a large extent have to be imported from abroad, enhancement of local biomass markets and development of domestic economic and technological thinking. Hence, innovations in the scope of biomass use as an energy source are a factor stimulating the competitiveness of firms, well-being of local communities through job creation and regional development.

Research on innovation processes focuses on empirical realities of particular activities, trying to catch the interrelations and mechanisms present while realizing innovative undertakings. The purpose of the research conducted was to analyse innovative undertakings allowing to increase the use of woody biomass as a renewable energy source. The analysis comprised three innovative undertakings.

METHODS

The data were collected in the course of semi-structured personal interviews conducted in each of the firm analysed, in which innovative activities, concentrating on the use of woody biomass as a renewable energy source, were undertaken. The following enterprises and the following innovations were analysed:

1. The district heat production utility plant in Trzcianka in north-western Poland. The innovation comprised the establishing of a willow plantation, replacing old coal fuelled boilers with new biomass fuelled one, in order to provide the town with heat.
2. Orzechowo Plywood Works located about 60 km south of Poznań. In the course of the innovative undertaking old coal fuelled boilers were replaced with new biomass fuelled boilers, in order to produce technological steam.
3. Eko-Pellet Company in Przyłek near Nowy Tomyśl in western Poland. The company started producing woody pellets.

All three enterprises are located in the Wielkopolska voivodship and they were selected to show differences between both the types of the enterprises as well as the type of woody biomass used. The interview conducted in each of the enterprises comprised the same set of questions, which focused on the following matters:

- data concerning the enterprise (area/type of activity, history and type of ownership, staff, products/services provided, markets, customers)
- general information on innovative activities in the firm (R&D activities and budget, most important innovations in recent years – successes and failures)
- information on the innovation being subject to the detailed analysis; especially the following questions were asked:
 1. How was the idea of the innovation born? Why was the innovation process initialized?
 2. Who was involved in the innovative undertaking (people, other firms, institutions, research organisations, authorities) and what roles did these people, firms and organisations play?
 3. How was the innovation financed (costs, sources of funding, support programmes)?
 4. What was the effect of the innovation on the enterprise, what did it gain? What were the driving forces and hindering factors?

In each case the interview was conducted with a representative of the management of the enterprise and lasted about 2 hours. The interviews were conducted in the second half of 2008 and at the beginning of 2009.

RESULTS

As a result of the interviews, a great deal of important data were collected, which made it possible to notice certain regularities, which occurred while the innovative undertakings were realised. Below are the innovations analysed in the three enterprises.

Case 1. The district heat production utility plant in Trzcianka was established in 1999 as a company created from former state owned coal fired heat producers in Trzcianka, a town of 17 thousand inhabitants, located about 120 km north of Poznań in western Poland. Since 2004 the utility has been leased to Dalkia Poland, however the innovative solutions were introduced before that year. The utility plant has a mixed state/private form of ownership and the main partners are local machine manufacturers, a local housing estate cooperative and the town authorities. The utility employs 12 people and its main function is to supply hot water to the housing estate that is formed by a number of blocks of flats, to several manufacturing plants, the town magistrate and a few schools and kindergartens. The utility is covering 40% of the town's heat needs and the yearly heat production is over 74 TJ of energy.

For the time being the company is using dry and fresh wood chips and saw dust as the fuel for its boilers. Both the wood chips as well as the saw-dust are waste products from local saw mills and a local furniture factory. The main source of biomass for the boilers are wet and dry wood chips from local furniture manufacturing plants and saw-mills (55%), fresh chips from the woods (40%) and willow chips from the plantation (5%).

The biomass from the saw mills and the furniture factory is supplied by a number of independent forwarding agents. The energy stored in the biomass is transformed into heat at the utility plant and as such is delivered to its end users through the piping system.

The main innovative activities taken up by the utility in the recent years concentrated on the following:

- old coal fired boilers were replaced by two 5MW Polytechnik boilers fuelled with biomass
- a 136 ha willow plantation was set up in 2002, with the initial idea of covering 60-70% of heat needs with own biomass sources. In 2008 the harvesting was started, and 22 tons of willow material were harvested from an area of 22 ha
- a straw briquette manufacturing line was put in operation, and the straw briquettes are sold to a big power station in the west of the country.

The fact that as much as three innovative activities were taken up confirms a high innovative potential of the company. Each of the innovations proved successful, only in the case of the willow plantation major cultivation problems occurred. The utility plant has neither any R&D department or funds set aside for innovative activities. The utility staff and especially the chairman were named as essential sources of innovations. The significant role of public funds available for financing the innovative investments was stressed by the interviewed persons. In the course of the innovative activities a network of formal and informal links was established. The main actors involved were higher education institutions (Poznań University of Life Sciences, the University in Olsztyn), business companies (Energo-Efekt, Gros-Pol), the town authorities, local banks, and other partners with whom contacts had been established while visiting technology fairs and exhibitions. The flow of information in the network was realized

in business and town council meetings, at exhibitions and fairs, and through personal, often informal contacts. Books and professional journals were named as another important source of information concerning the innovative activities.

The most important innovative activity carried out at the utility plant was the installation of two biomass fuelled 5MW Polytechnik boilers in 2002. The idea of this innovation resulted from the market analysis, which showed a rapid coal price increase (old boilers were fuelled with coal), the need to exchange old boilers and relatively low land prices (hence the idea to establish a plantation and produce own fuel). Also, possibilities of preferential financing in the field of renewable energy sources appeared. The human factor was the main driving force behind the innovative activity, with members of the company board and especially the chairman playing the decisive role. The other main actors that took part in the innovative activity were: companies which provided the technical support and know-how, like Energo-Efekt (consulting), Gros-Pol (installation of the boilers) and Polytechnik from Austria (boiler manufacturer); public institutions like the Eco-Fund, the Provincial Fund for Environmental Protection and Water Management and the Bank for the Protection of the Environment (Bank Ochrony Srodowiska); higher education institutions (Poznań University of Life Sciences and the University in Olsztyn).

The innovation was financed with a grant from the Eco-Fund (70%), a preferential loan from the Provincial Fund for Environmental Protection and Water Management in Poznań (17%) and with own financial resources (11%).

The successful completion of the innovative activity allowed to replace old inefficient coal boilers with new biomass fuelled ones; it helped avoid SO₂, N₂O and dust emissions, especially in the area near the utility company, where institutions like schools, kindergartens, a hospital, and a vast residential area are located; it made it possible to use locally produced willow (plantation) and waste biomass (from saw mills and a furniture factory) and finally it allowed to use financial means set aside in Poland for promoting the protection of the environment.

Case 2. Another interviewed enterprise was the Orzechowo Plywood Works located about 60 km south of Poznań. The company is a fully state owned one; it was established 110 years ago and it employs 500 people. The company is one of the most important plywood manufacturers in Poland; apart from plywood it manufactures veneered chipsboards, door blockboards and natural sliced veneers. It processes about 500 thousand cu.m. wood per year, mostly birch and alder bought in different parts of the country. The timber is manufactured into plywood and boards, and the waste wood is used for the production of technological steam (needed for pressing and drying) and for heating the company buildings. The company is the final user of the energy it produces.

Although the company has no separate R&D department in its structure or any specified innovation policy, it constantly cooperates with scientific institutions like the Institute of Wood Technology in Poznań, Poznań University of Life Sciences and with the Wood Based Panels Producers Association of Poland. The access to information and information transfer are essential to innovative practices at the enterprise. The most important sources of information are contacts with research facilities, visits to fairs and exhibitions, branch journals and higher education programmes (MBA, post-graduate study programmes) through which the top management of the company deepen their knowledge.

In recent years the company undertook several innovative initiatives, the most important of which was the replacement of old coal fuelled boilers with new ones, fuelled

with biomass in the form of waste wood from manufacturing processes. Other innovative activities concentrated around plywood manufacturing processes themselves.

As mentioned above, the replacement of three old coal fuelled boilers (12 MW) and consuming 20 thous. tons of coal per year with two new biomass boilers was the main innovative activity in the recent years. The new boilers, one a 5 MW Polytechnik and the other a 8.5 MW Schmidt, produce 261 TJ of energy in the form of technological steam. The first of them was installed in 2000, the other in 2006. The main impulse to the innovation was a need to lower the emissions of sulfur, coal oxide and dust to the atmosphere. The high demands concerning the protection of the environment and the newly introduced strict standards put a barrier to any further use of the old coal fuelled boilers. Another factor that stimulated the replacement of the old boilers with new ones was the market situation. The plywood production costs had to be reduced in order not to deteriorate the market position of the company. A third factor stimulating the innovative activities was an increase in coal prices. The above mentioned factors stimulated the board of the company. The knowledge and information necessary to make the decisions about which boilers should be installed were gained through business contacts and meetings, conferences on investment financing organized by banks, through literature study and from professional periodicals. In the process of implementation intensive cooperation was undertaken with consulting companies (business plan preparing) and financial institutions (Eco-Fund and the National Fund for Environmental Protection and Water Management). The innovation was financed in 70% with the financial means of the Eco-Fund and NFEP&WM and in 30% with own resources.

As a direct result of the innovation, a significant reduction of toxic compounds emitted to the atmosphere was achieved. The costs of the technological steam production were lowered by 30-40% due to avoiding the purchase of coal. The company became self-supporting in the energy for the technological and heating purposes.

A possibility to use public funds for financing the innovative activity was mentioned as the main factor that can contribute to implementing innovative activities in the field of renewable energy. Also, the human capital, especially the quality of top management was regarded as the main driver for innovative activities and the most important factor in project coordination.

Case 3. The Eko-Pellet Company in Przylęk near Nowy Tomyśl in western Poland was the third enterprise that was the subject of the analysis of innovations in woody biomass used as a source of energy. The firm was established in 2007 and is a young private enterprise owned by three partners. The direct stimulus that contributed to setting up the firm was a possibility to utilize wood waste in the form of pallets and saw dust. The firm employs six people and has the appropriate permits for collecting wood waste. The yearly throughput is 150 thousand tons, bought from all over the country. The waste wood is chipped to produce wood chips for the manufacturing of chip boards and woody pellets (7-8 thousand tons per year). The firm does not co-operate on a daily basis with any research institution or with other businesses. The basic sources of information are the Internet, professional journals and visits in other businesses (e.g. the wood processing company in Barlinek), as well as visiting fairs and exhibitions.

The pellet machine that was purchased and put in operation was manufactured by the Italian P System S.r.l. and its capacity can reach up to 1 ton of pellets per hour. The investment was financed entirely with the firm's own financial means. Although the firm had applied to the NFEP&WM, it did not obtain any financial help. The pellets that are produced are of high quality (a certificate issued by the Wood Technology Institute

in Poznań), and they are sold all over the country, all year round. The pellet buyers are mainly private households and furniture industry drying departments. In the opinion of the Eko-Pellet enterprise the factors that are conducive to innovative activities in woody pellet production is the ecological awareness of the society and areas without the natural gas infrastructure that would make it possible to use natural gas for heating purposes for inhabitants living in those areas. The pellets proved to be a cheaper fuel than heating oil and coal, and due to a relatively low ash content (0.34%) are convenient in use. On the other hand, still too low ecological awareness about the advantages of biomass for heating purposes was suggested as a factor hindering innovations in manufacturing refined woody fuels. Other hindering factors named by the interviewed person were difficulties in convincing users of heating installations fuelled with fossil fuel to change for biomass, and insufficient advertising of pellet use for heating purposes. The successfully implemented innovations enabled the firm to improve its competitive position on the market.

Selected information about the cases described above is presented in Table 1. In all cases the human factor played the key role in the initiating of innovative activities. There were people in the analysed companies who acted as sources of new ideas and acted like motors when it came to implementing them. In two of the three cases the replacement of the coal fuelled boilers was a necessity, though the direct reasons for doing so were different. In one case old boilers were inefficient and rising coal prices called for their rapid replacement while in the other case, in order to meet the new emissions standards new boilers had to be installed. In the case of the enterprise manufacturing pellets, a market niche was made use of, as the demand for pellets was increasing and wood waste that could be transformed into a woody fuel became available.

Table 1. Sources and factors involved in the innovative undertakings in the surveyed enterprises
Tabela 1. Źródła i czynniki zaangażowane w działania innowacyjne w analizowanych zakładach

Source Factor Źródło Czynnik	Direct heating utility in Trzcianka MEC Trzcianka	Plywood manufacturer in Orzechowo Zakłady Sklejek w Orzechowie	Manufacturer of pellets Eko-Pellet Producent peletów Eko-Pellet
1	2	3	4
Form of ownership Forma własności	mixed: private/state mieszana: prywatna/państwowa	state państwowa	private prywatna
Subject of innovation Przedmiot innowacji	willow plantation, production of fuel wood chips, installation of biomass boilers plantacja wierzby i produkcja zrębków opałowych, instalacja kotłów na biomasę	installation of biomass boilers instalacja kotłów na biomasę	production line for pellets instalacja linii do produkcji peletów
Source of idea Źródło pomysłu	human factor (the chairman) czynnik ludzki (prezes)	human factor (the board) czynnik ludzki (zarząd)	human factor (owners) czynnik ludzki (właściciele)
Cause Przyczyna	old boilers had to be replaced starych kotłów	emissions and production costs had to be reduced konieczność zmniejszenia emisji, potrzeba obniżenia kosztów produkcji	niche in the market, supply of wood waste nisza w rynku, podaż odpadów drzewnych

Table 1 cont. / Tabela 1 – cd.

1	2	3	4
Source of financing Źródła finansowania	public 95%, company's 5% publiczne 95%, własne 5%	public 70%, company's 30% publiczne 70%, własne 30%	company's 100% własne 100%
Contributing factors Czynniki sprzyjające	financing from public sources, local wood resources finansowanie ze źródeł publicznych, lokalna baza surowcowa	financing from public sources finansowanie ze źródeł publicznych	ecological awareness stimulating the demand, relations in energy prices were good for biomass świadomość ekologiczna stymulująca popyt, korzystne dla biomasy relacje cen na źródła energii
Hindering factors Czynniki utrudniające	difficulties in obtaining public funding for investment trudności w pozyskiwaniu środków finansowych na inwestycje	difficulties in obtaining public funding for investment trudności w pozyskiwaniu środków finansowych na inwestycje	insufficient advertising of renewable energy sources, difficulties in breaking barriers to using biomass as a fuel niewystarczające propagowanie odnawialnych źródeł energii, trudności w przełamaniu niechęci do stosowania biomasy jako paliwa
Direct positive results Korzyści bezpośrednie	the heat installation was modernized; emissions were lowered, local res (biomass) were made use of unowocześnienie instalacji ciepłej, zmniejszenie emisji, wykorzystanie lokalnych odnawialnych źródeł energii	emissions were lowered; market position of the company improved zmniejszenie emisji, poprawa konkurencyjności firmy	company's competitiveness was improved, demand for pellets was met, wood waste was utilized poprawa konkurencyjności firmy, zaspokojenie popytu na pelety, zagospodarowanie odpadów drzewnych

The biggest problem in implementing the innovative solutions was their financing. All the analysed companies applied for public funds, reserved for investments covering, among other things, clean technologies. In the case of the district heating utility plant the new boilers fuelled with biomass would not have been installed at all, had the company failed to get partial financing from the Eco-Fund and the Provincial Fund for Environmental Protection and Water Management. This confirms the great role the centrally or provincially distributed funds can play in promoting innovations, e.g. in renewable energy sources. Innovative activities in the field of RES can be successfully promoted by advertising renewable energy and by creating advantageous financial conditions for financing such new solutions.

CONCLUSIONS

The above presented innovations in the use of biomass for heating purposes allow for more general conclusions concerning motives, mechanisms involved in the innovative undertakings as well as contributing and hindering factors that affect innovative activities in a more intensified use of woody biomass as a source of energy.

1. The direct stimulus to take up innovative activities is quite often a necessity to face new situation like new more stringent standards, breakdowns of older devices or rising prices of fossil fuels.

2. The human factor plays the decisive role in innovative undertakings. The presence of pro-innovative people in the company seeking innovative solutions is the key element providing good chances for a successful implementation of an innovation. Enhanced activity in building contacts with research bodies, consulting firms, local businesses and the like is a great help in the realisation on innovative undertakings.

3. A significant role in implementing innovations in renewable energy sources is played by public funds which allow for partial financing of innovative projects. Other important factors are local biomass resources and the ecological awareness of the community which stimulates the demand for "clean energy".

4. Factors that hinder innovative undertakings in the scope of renewable energy sources are difficulties in obtaining financial means for project realisation and, locally, mental barriers present in local communities that prevent them from using woody fuels as a source of energy.

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Streszczenie. W pracy zanalizowano trzy przypadki zakładów, w których przeprowadzono działania innowacyjne polegające na wykorzystaniu biomasy drzewnej do produkcji energii cieplnej lub paliwa drzewnego (pelety). W dwóch zakładach zostały zainstalowane kotły do spalania biomasy drzewnej, a w trzecim zakładzie zainstalowano linię technologiczną do produkcji peletów. Analiza została wykonana na podstawie informacji uzyskanych podczas wywiadów przeprowadzonych w zakładach. W powodzeniu działań innowacyjnych zasadniczą rolę odegrały osoby o nastawieniu proinnowacyjnym, będące „motorem” innowacji. Najważniejszym problemem w realizacji podejmowanych działań

było finansowanie innowacji. Znaczną rolę w powodzeniu działań innowacyjnych odegrały możliwości wykorzystania środków publicznych do ich finansowania. Zrealizowane działania innowacyjne przyczyniły się do wzrostu konkurencyjności zakładów, wykorzystania lokalnie dostępnych zasobów biomasy drzewnej oraz redukcji emisji zanieczyszczeń i CO₂ do atmosfery.

Słowa kluczowe: innowacje, odnawialne źródła energii, biomasa, pelety

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